An overview and analysis of global climate-related interventions in the coffee sector

By Janina Grabs[1], with research support from Annkathrin Mathe[2] and Sophie Lambert[3]

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[1]Escuela Superior de Administración y Dirección de Empresas (ESADE), [2,3]Copenhagen Business School (CBS)

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Project context

The PACSMAC project is a 5-year collaboration between Copenhagen Business School, the University of Dar es Salaam, Jimma University, Lafayette College, and ESADE Business School. The project aims to investigate how climate change – and the ways actors across the value chain are trying to adapt to or mitigate it – affect coffee farmers' livelihoods and land-use decisions. Work package 1 is dedicated to understanding: 1) How might climate change itself, alongside the mitigation and adaptation efforts intended to address it, affect the governance of coffee value chains originating in Ethiopia and Tanzania? And 2) How do these changes affect the distribution of value along the chain, upgrading opportunities and farmer livelihoods?

In order to answer these questions, we start with a holistic mapping and assessment of mitigation and adaptation interventions – that is, projects initiated by global or local actors that aim to support coffee farmers and have an explicit climate component – to understand the scope of efforts currently underway.

Introduction

Climate change threatens the viability of coffee production in a multitude of ways. Not only are Arabica coffee plants highly sensitive to temperature changes, coffee-growing regions are also likely to experience weather extremes such as droughts, floods, storms, and irregular rainfall patterns to a much greater extent than previously. Growing regions may shift, while pests and diseases may appear in new regions that are unprepared for them. Given that millions of smallholder farmers rely on coffee production for their livelihood, it is imperative to aid them to either adapt to such novel and changing growing conditions or to switch from coffee production to more suitable crops and other livelihood options. This working paper inquires to what extent such support, in the form of climate-related projects or interventions, exists in the field and provides an overview and analysis of the actors, locations, and activities that are currently being implemented. In total, we identify and analyze 160 interventions that have been or are currently running in 35 countries. In covering the entirety of related information available online in English, Spanish, and German, it serves as a survey of the reality of climate change-related activities. In the next step, this reality will be further assessed – in particular, with a focus on how it can serve to improve farmers' livelihoods – and linked to case studies of Tanzania and Ethiopia, two important coffee-growing countries with a range of climate change-related challenges. This working paper will first provide an overview of the methods we used to collect and analyze the data, and then present the results of the analysis. The aim is for this working paper to serve as the starting point for a first, collaborative research article.

Methods

Our goal in this paper was to generate a database of farmer-focused projects or interventions that had at their goal climate change mitigation, adaptation, or resilience, as defined by the interventions themselves. To arrive at the greatest coverage of relevant results, we combined a structured website search with a keyword search on Google that will be described in more detail below.

Inclusion and exclusion criteria

We only listed and analyzed projects or interventions that fulfilled two inclusion criteria:

First, in their description/aims the projects needed to mention explicitly one of three sets of terms: climate (change, adaptation, mitigation, resilience); farm/farmer resilience; or carbon (cycle, sequestration, credits). This inclusion criteria was set to differentiate projects that self-identify as having a climate change focus from other types of interventions that might be pursuing activities tangential to climate adaptation and resilience, but which do not themselves frame it as climate-related. One part of our analysis provides an inductively coded overview of all activities that projects pursue in order to construct a bottom-up overview of what is currently seen as appropriate or desirable climate mitigation, adaptation, or resilience action. Had we not focused on self-identification, but included projects on the basis of their activities, we would have had to a priori decide what we consider climate-related activities, which would have biased that later overview. However, this inclusion criteria means that our database may not capture select projects that pursued climate-related activities if the project descriptions never mentioned climate or any of the other keywords above.

Second, to be included the initiative had to be focused on coffee farmers or at the very least the upstream supply chain (including, for example, efforts aimed at mills). This meant, for instance, that interventions that solely focused on long-term sectoral policy planning, without any pilot projects or farmer outreach, were not included in the analysis.

In contrast, we did not exclude interventions on the basis of the year they were executed, the country where they were implemented, or the actors that planned, implemented, or financed a project, and thus provide a comprehensive overview of climate mitigation and adaptation actions across time, space, and actor fields.

In addition to specific projects, we also reviewed one of the most common forms of farmer support – certification and verification schemes – for their climate-related content. To a certain extent, this step makes up for the drawback of our inclusion criteria for the interventions mentioned above as it enables us to assess to what extent non-climate programming might still include climate modules. We will assess the certification in a separate step, rather than mixing them in as part of the interventions.

Search protocol

We took a two-pronged strategy in our search for interventions, in which we first conducted a directed website search of specific organizations, and then moved to a structured keyword search to fill in the gaps left by our directed website search.

For the directed website search, we focused on organizations in three institutional arenas related to the topic at hand: Organizations in the coffee space (including private firms as well as non-governmental organizations (NGOs) focused on coffee sector sustainability and development); organizations in the climate change realm (mainly focusing on international organizations, NGOs, and business coalitions focusing on climate change-related action); and organizations focusing on (sustainable) development, particularly in coffee-producing countries. We constructed a list of organizations for each institutional arena based on secondary literature (Grabs, 2017; Grabs & Carodenuto, 2021; Grabs & Ponte, 2019) combined with the expertise of the team members (reproduced in Appendix 1) and reviewed each organization's website in order to find interventions that fall within the inclusion criteria, which were subsequently included in our database and coded. This search strategy yielded 84 interventions that were included in our database.

In a second step, we conducted a structured keyword search on Google in English, German, and Spanish to supplement our directed website search, in which we used the keyword combinations listed in Appendix 2. We screened the first 10 pages of search results for relevant projects we did not yet include in our database. This yielded an additional 55 results in English, 7 results in German, and 14 results in Spanish, for a total of 160 interventions.

Finally, we reviewed a comprehensive list of third-party certification programs as well as own-company programs in the coffee sector for their climate-related content. The reviewed certification programs were selected on the basis of their recognition in the literature and practice, for instance via the GCP equivalence mechanism. In total, we reviewed 17 programs; Appendix 3 shows a list of surveyed programs.

Coding protocol

We first coded interventions by their key characteristics such as the year they started and ended, the key organizations involved in implementing and financing them, their geographical target (at a national and, if specified, subnational level), the numbers of farmers targeted, and the total and per-farmer budget spent. We furthermore summarized information about the description of the intervention, its target outcomes, and theories of change, as well as (where available) the first evidence of outcomes.

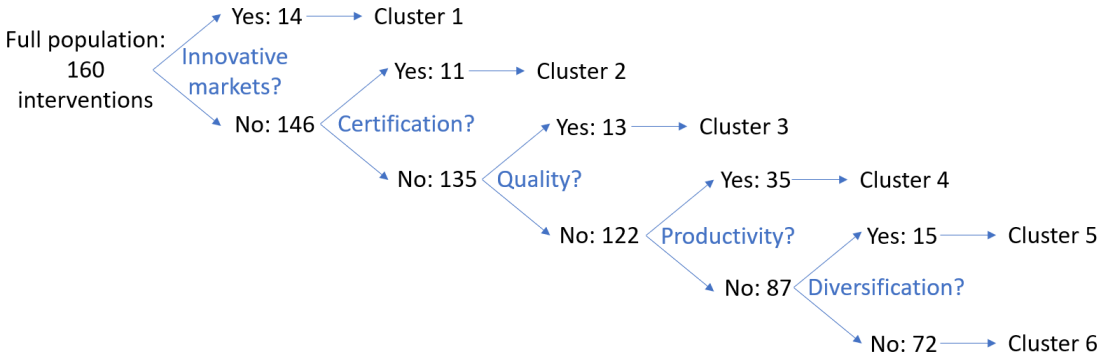
Once all this information was assembled, we engaged in a bottom-up coding exercise to identify and structure the activities pursued by climate-related interventions in the coffee sector as follows. We created four categories of

activities – 'Climate change mitigation activities', 'climate change adaptation activities', 'Value chain/upgrading activities', and 'Other activities' that may be part of the projects – and generated a first range of activity subcategories within each category on the basis of a first scan of all interventions. Thereafter, we reviewed each project description, theory of change, and evidence of outcome and coded the types of activities that were present in each intervention by adding detailed information in the relevant subcategory field. If an activity was not yet represented among the subcategories, we added a new subcategory and filled in the relevant information. Once we had coded all activities and reached exhaustiveness in terms of subcategories, we first compared and merged some subcategories, adjusting their name to reflect a similar level of aggregation of activities. We then reviewed all interventions again and complemented the coding to ensure that all final subcategories were accounted for.

Analysis

In addition to calculating summary statistics of the data in question, we also pursued a *clustering analysis* to better understand the mix of activities pursued in each intervention and to identify emerging patterns; as well as a *network analysis* to assess the central and peripheral actors that are involved in providing the interventions.

For the *clustering analysis*, we transformed all the coded activities into subcategory dummies (1 meaning the activity was pursued in some capacity; 0 meaning there was no such evidence) and categorized interventions on the basis of their assumed theory of change/livelihood upgrading pathway by drawing on the coded value chain/upgrading and other activities, as follows: Interventions were categorized as "Cluster 1: Access to innovative climate-related markets pathway" if the dummies for the activity "low carbon coffee" or "carbon credits" was equal to 1; they were categorized as "Cluster 2: Certification pathway" if the dummy for "certification" was equal to 1; they were categorized as "Cluster 3: Quality-linked pathway" if the dummies for "quality premiums" or "quality improvement" were equal to 1; they were categorized as "Cluster 4: Resilient productivity pathway" if the dummies for "climate insurance", "resistant varietals", "productivity improvement" or "financial literacy" were equal to 1; they were categorized as "Cluster 5: Alternative livelihood pathway" if the dummies for "diversification" or "alternative crops" were equal to 1; and fell into the "Cluster 6: Status quo maintenance" if none of the previous conditions applied. In creating these clusters, we followed this exact order, moving from most specific to least specific and only assigning categories to not yet categorized interventions, such that an activity that pursued *both* certification and quality improvement, for instance, would be categorized as "Cluster 2: Certification pathway". This approach is visualized in the figure below.



For the *network analysis*, we extracted the 270 organizations that were listed as project partners from each of the interventions and first constructed an individual-by-group matrix showing which organization was part of which project. We then transformed this into an adjacency matrix that reflected organizational linkages (via projects) to

understand which organizations are the best-connected and most-linked with one another and take on a central position in the global network of climate change mitigation and adaptation action in the coffee sector. We furthermore calculated three metrics that illustrate the place of an organization in the resulting network: its degree centrality (the number of unique connections to other organizations); its weighted degree centrality (which also takes into account the number of projects that connect two organizations and sums all such connections); and its betweenness centrality (which represents the extent to which an organization is situated on the shortest path between two other organizations and therefore reflects the extent to which it sits 'in the middle' of a given network.

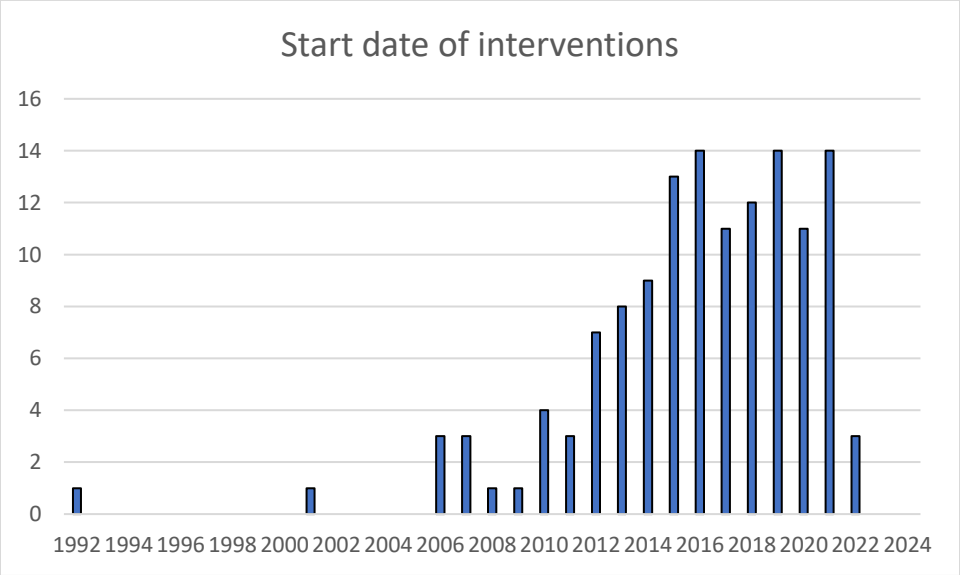
We visualized the resulting network, highlighting important nodes in two ways: the size of the node and the existence and size of the descriptive label. The size of node and descriptive label reflects its weighted degree centrality (WDC) (adjusted for visualization purposes as $\sqrt[1.75]{\frac{WDC}{2}}$ in order to increase the size of the smallest and decrease the size of the largest nodes); while we only highlight organizational labels that either have very high WDC (>16) or a combination of high betweenness (>1000) and weighted degree centrality (>12). The thickness of the connectors (or edges) further represents the number of projects that two organizations were jointly members of. These choices were made to provide the largest amount of information contained within the network while still ensuring that the network remains readable.

Results

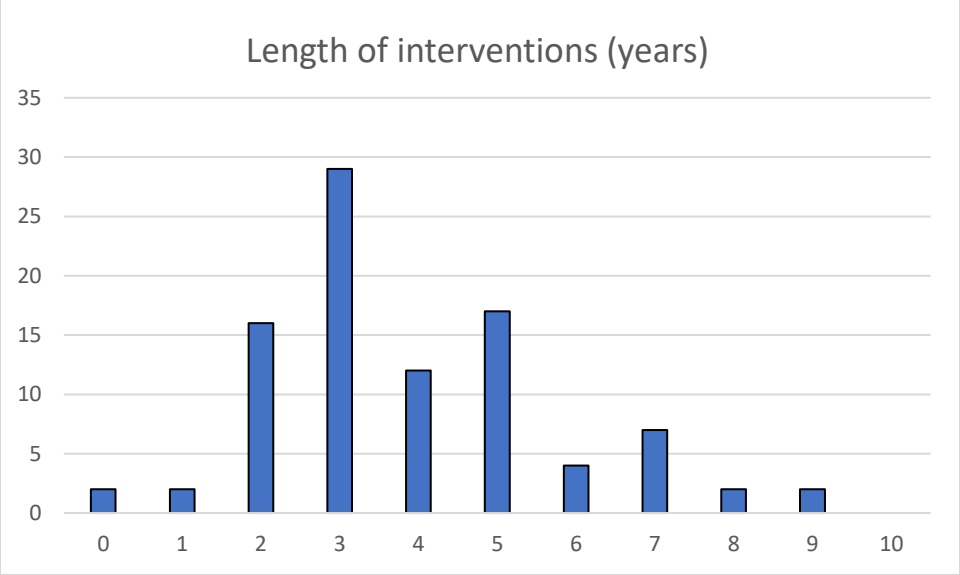
Descriptive statistics – intervention timing, geographical distribution, sizes, and funding

Start date and length of interventions

An overview of the starting years of the 160 interventions in our database clearly shows that a focus on climate change (mitigation and adaptation) has been a growing trend since the early 2000s. While we find select projects that started previous to the year 2000, the majority of projects started between 2015 and 2021, with a steady increase in the prior years.

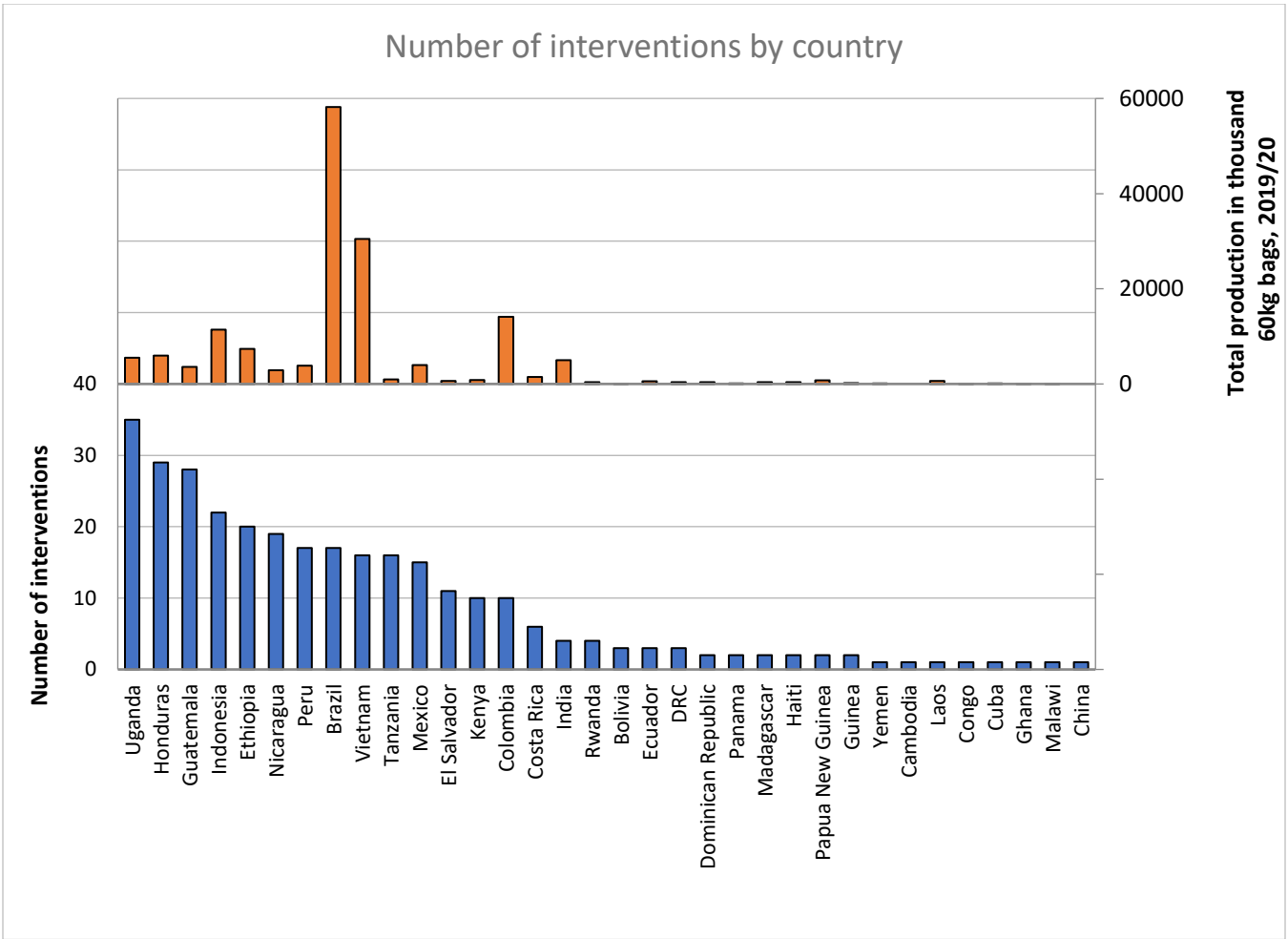


Of the 160 interventions on which we have information, 119 have since concluded; 14 are currently ongoing; and 27 did not specify an end date, such that they could still be ongoing right now. This reflects the fact that there is a strong trend to relatively short-term projects between 2 and 4 years of length, with the majority of projects taking 3 years, and the longest one taking 9 years.

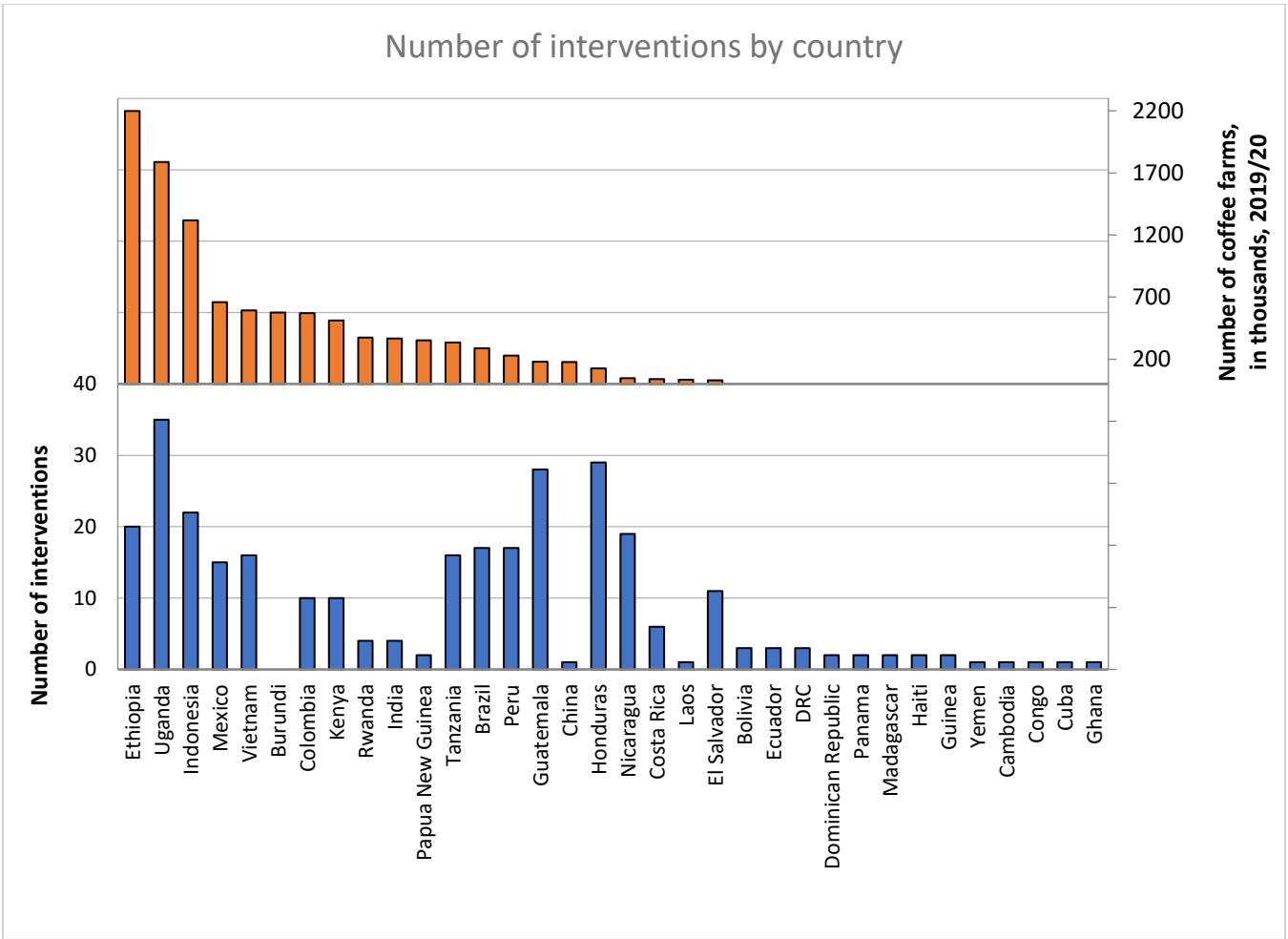


Geographical distribution

The projects have a broad geographical spread, though a few countries stand out: Uganda, Honduras, Guatemala, Indonesia, and Ethiopia each have over 20 interventions. It is notable that, when comparing the total coffee production of each country, the countries with the most interventions tend to be the ones in the low-medium production category, producing between 2% and 6% of total world output. This is in line with the goal of preserving coffee origin diversity in the global market, though it may underemphasize coffee origins with large amounts of production that may face climate risks such as Brazil, Colombia, and Vietnam.



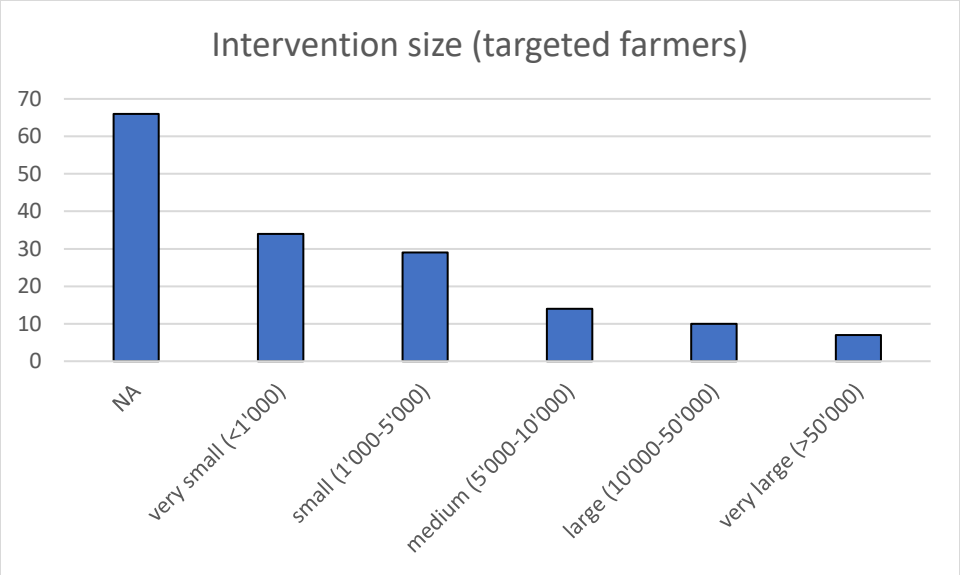
When comparing the number of interventions with the estimated number of coffee farms in each origin country (taken from Browning, 2019; Café de México, 2022), we see that some countries with the largest number of projects – such as Ethiopia, Uganda, and Indonesia – hold some of the largest numbers of farms in the world. However, we also see a high intensity of project coverage in countries with comparatively low estimated numbers of farms, such as Guatemala, Honduras, Nicaragua, and El Salvador. These Central American origins however have been identified as some of the global priority regions for climate change adaptation funding due to the way human and natural adaptation needs related to maintaining agricultural productivity and ecosystem integrity intersect (Hannah et al., 2013), and show high smallholder vulnerability to climate change (Donatti et al., 2019), which may explain this focus.



Intervention size and number of benefitted farmers

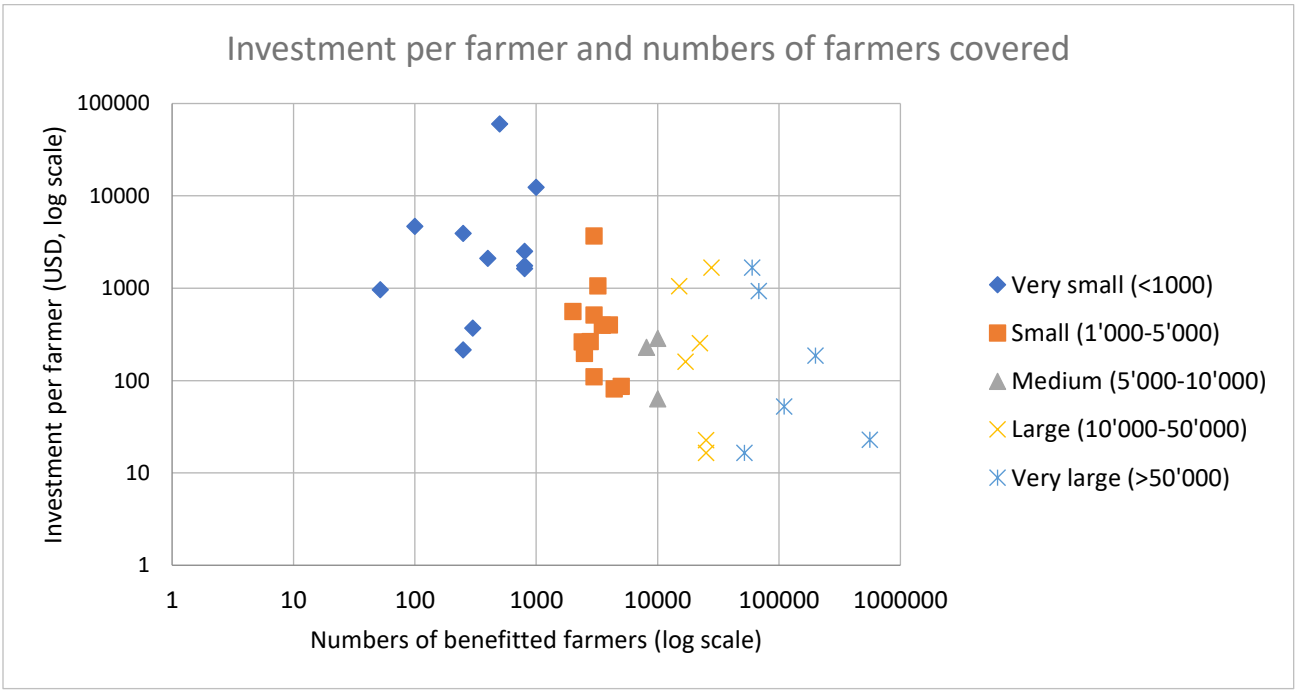
We also aimed to estimate the number of benefitted farmers and compare them to the smallholder farmer population of each origin. Unfortunately, only 58% of the interventions reported the number of benefitted farmers, while 66 interventions did not provide any such information, which did not allow us to aggregate this number on a country-wide level. However, we can compare the projects that did provide information on intervention size, which show a large spread in intervention size.

The median targeted number of farmers (or farmer households) is around 2600. We found 34 very small interventions that targeted fewer than 1000 farmers, 29 that targeted between 1'000 and 5'000 farmers, 14 that targeted between 5'000 and 10'000 farmers, and 10 that aimed at between 10'000 and 50'000 farmers. 7 reported that they targeted over 50'000 farmers, though in these cases it is questionable to what extent farmer-level outreach activities were conducted in an intensive way. In total, around 1.8 million coffee farmers or farming households have been targeted as beneficiaries of the identified climate-related interventions between 1992 and 2022. This constitutes around 14% of the estimated 12.5 million coffee farms/farming households worldwide that may have been reached by an intervention. Excluding the largest 7 interventions (due to the questionable quality of outreach), however, this number only reaches 443'000 farmers or 3.5% of global farming households.



Funding

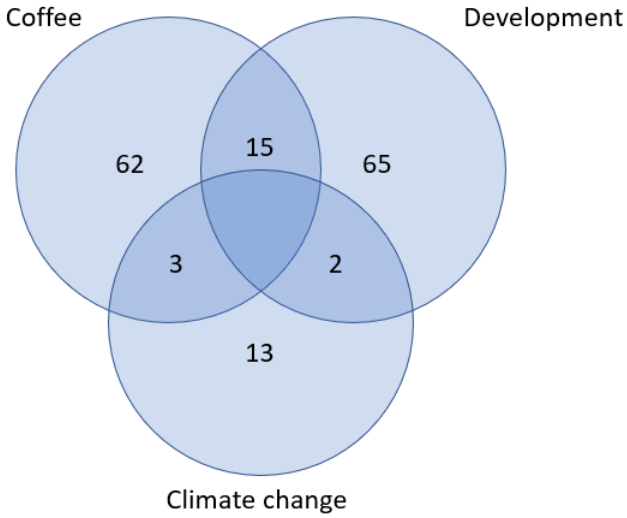
Although we did not find budgetary information for the majority (97) of interventions, the 63 interventions that did report financial information showed us that over the period studied, a minimum of $666 million have been invested into projects aiming at climate change mitigation or adaptation in the coffee sector. The budgets reported ranged from $50'000 to $345 million. For the 38 interventions that report both budgets and the number of targeted farmers, we find that the investment per farmer ranges from 16 USD to 12'000 USD (median of 398 USD, mean of 1195 USD). We plotted the investments per farmer against the number of benefitted farmers, which shows us that broadly, as one might expect, the smaller projects spend more money per farmer than the larger projects; however, we also find considerable variation between the diverse projects.



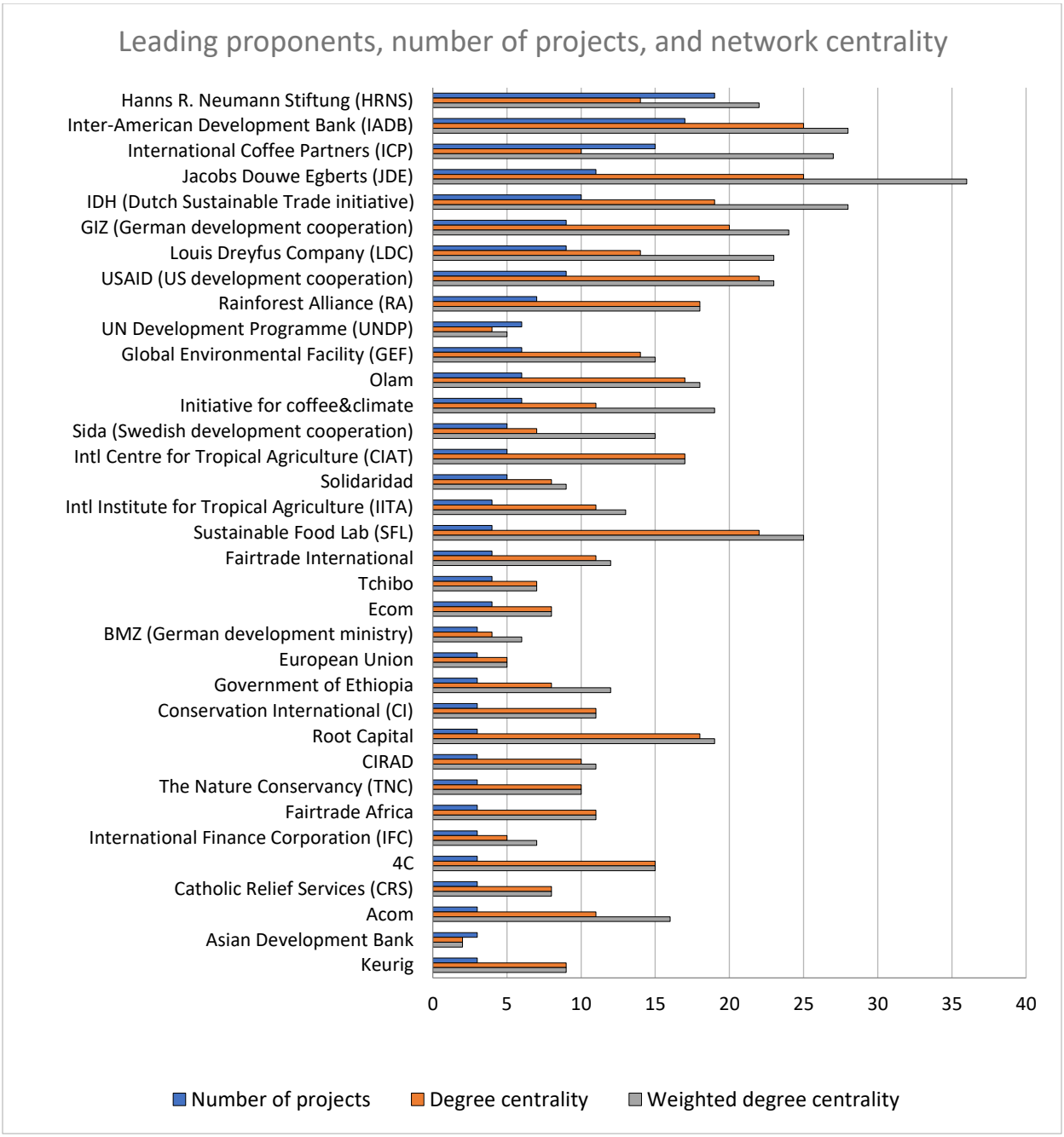
Key organizations and networks

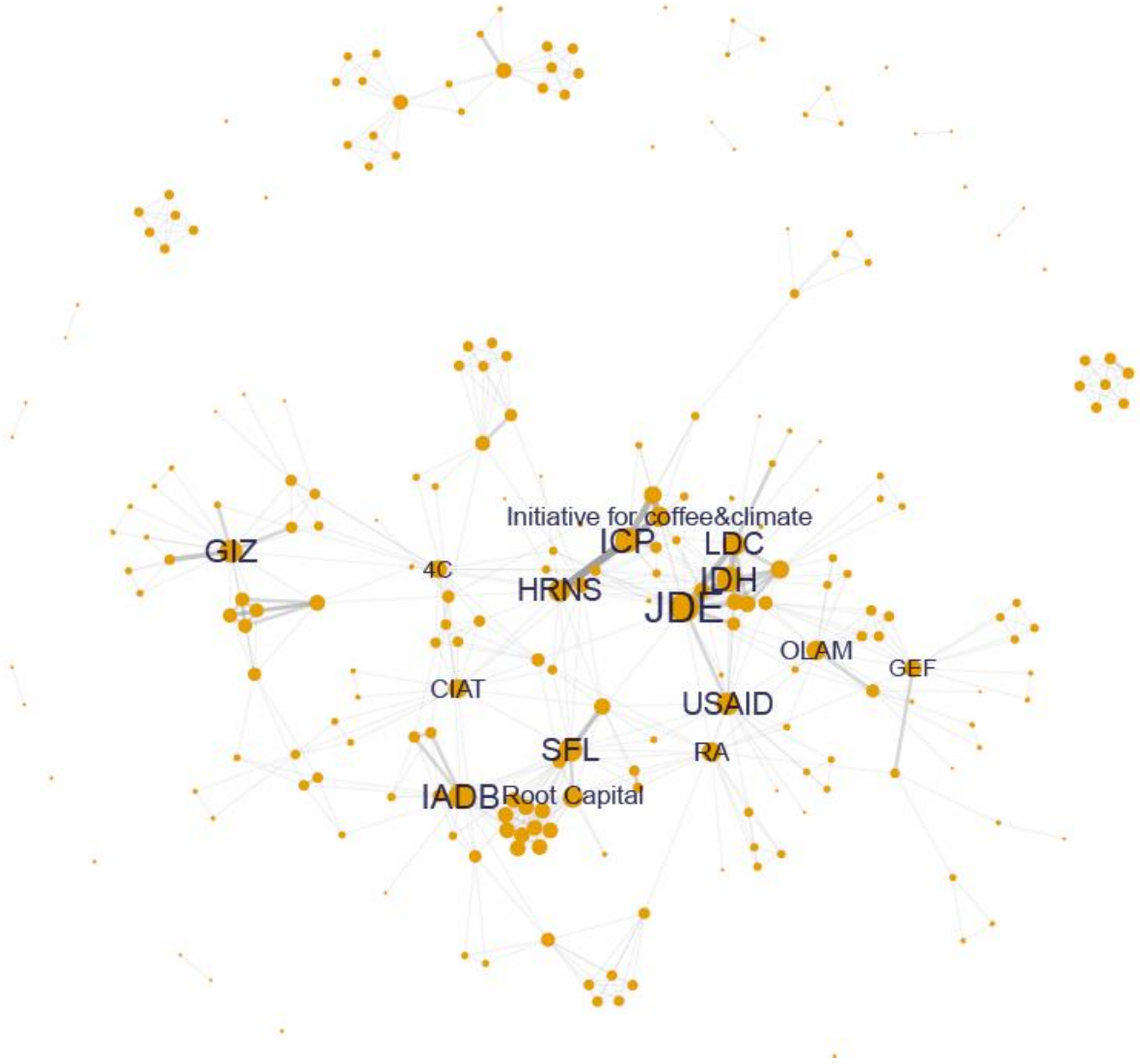
Key organizations involved in climate-related activities

On the basis of the main project proponents or implementers, we grouped interventions into three main institutional governance arenas they originated in: Coffee, development, and climate change. Interventions originated mainly in the coffee and development arenas, with climate change-related institutional actors and funders not yet stepping up to focus on coffee production as a focal area.

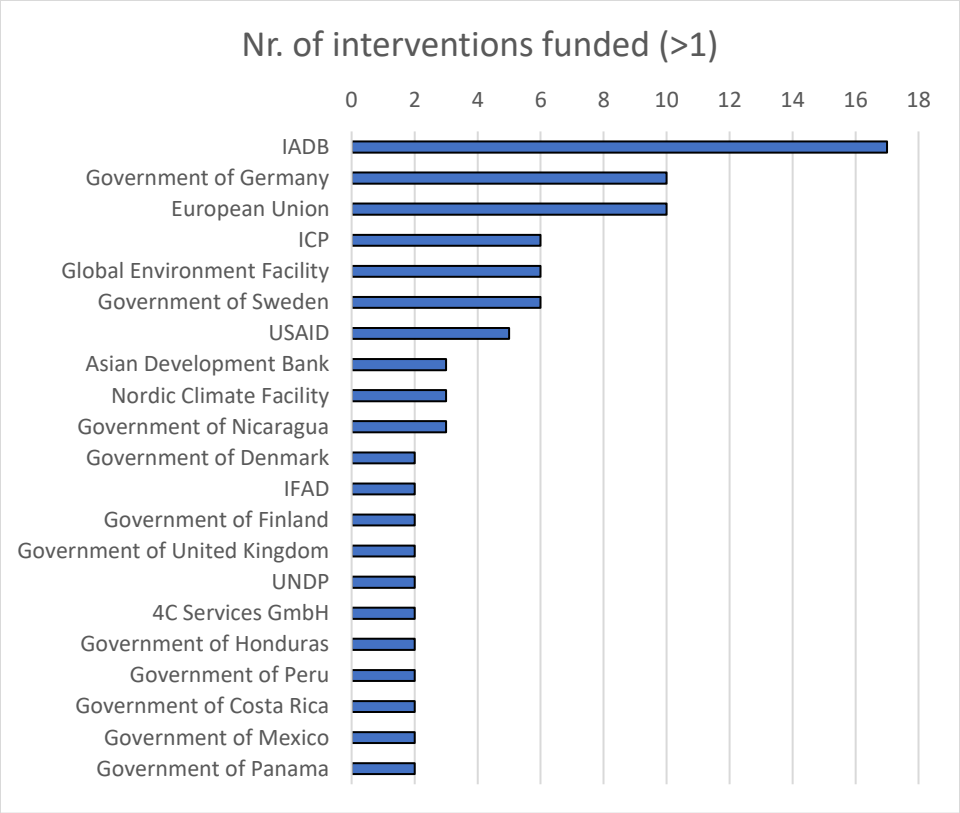


We find that the space is very clearly dominated by a few organizations. Leading in the field is the Hanns R. Neumann Stiftung (HRNS), the foundation of the coffee trader Neumann Kaffee Gruppe, which co-created the coffee&climate initiative together with the International Coffee Partners (a small group of mainly German coffee roasters) in the early 2000s. We can further identify the Inter-American Development Bank, the GIZ, and USAID as major funders and/or implementers of climate-focused interventions in the coffee space. Jacobs Douwe Egberts (JDE), the second-largest roaster after Nestlé, is also involved in a large number of projects that are climate-oriented. IDH, Rainforest Alliance, and Fairtrade International are dominant civil society organizations. We also note a number of other traders involved in this space, such as Louis Dreyfus, Ecom, and Olam. While the network centrality of many organizations is in line with the number of projects they are involved with, we also can find that several organizations 'punch above their weight' when it comes to being well-networked in terms of links to other organizations – this is especially the case for JDE, the Sustainable Food Lab, and Root Capital. These stand-outs can also be seen in the network graph on the following page.


Leading proponents, number of projects, and network centrality
Hanns R. Neumann Stiftung (HRNS)
Inter-American Development Bank (IADB)
International Coffee Partners (ICP)
Jacobs Douwe Egberts (JDE)
IDH (Dutch Sustainable Trade initiative)
GIZ (German development cooperation)
Louis Dreyfus Company (LDC)
USAID (US development cooperation)
Rainforest Alliance (RA)
UN Development Programme (UNDP)
Global Environmental Facility (GEF)
Olam
Initiative for coffee&climate
Sida (Swedish development cooperation)
Intl Centre for Tropical Agriculture (CIAT)
Solidaridad
Intl Institute for Tropical Agriculture (IITA)
Sustainable Food Lab (SFL)
Fairtrade International
Tchibo
Ecom
BMZ (German development ministry)
European Union
Government of Ethiopia
Conservation International (CI)
Root Capital
CIRAD
The Nature Conservancy (TNC)
Fairtrade Africa
International Finance Corporation (IFC)
4C
Catholic Relief Services (CRS)
Acom
Asian Development Bank
Keurig
0
5
10
15
20
25
30
35
40
Number of projects
Degree centrality
Weighted degree centrality



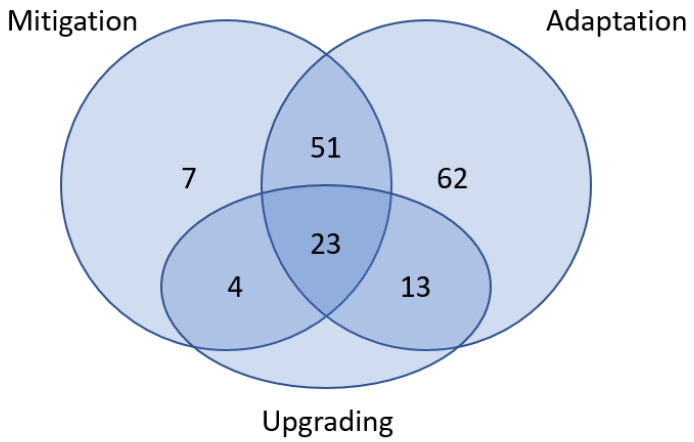
The main funders of the interventions with financial/funding information are the Inter-American Development Bank, the Government of Germany, and the European Union, followed by the International Coffee Partners, the Global Environment Facility, and the Government of Sweden.


Nr. of interventions funded (>1)
0
2
4
6
8
10
12
14
16
18
IADB
Government of Germany
European Union
ICP
Global Environment Facility
Government of Sweden
USAID
Asian Development Bank
Nordic Climate Facility
Government of Nicaragua
Government of Denmark
IFAD
Government of Finland
Government of United Kingdom
UNDP
4C Services GmbH
Government of Honduras
Government of Peru
Government of Costa Rica
Government of Mexico
Government of Panama

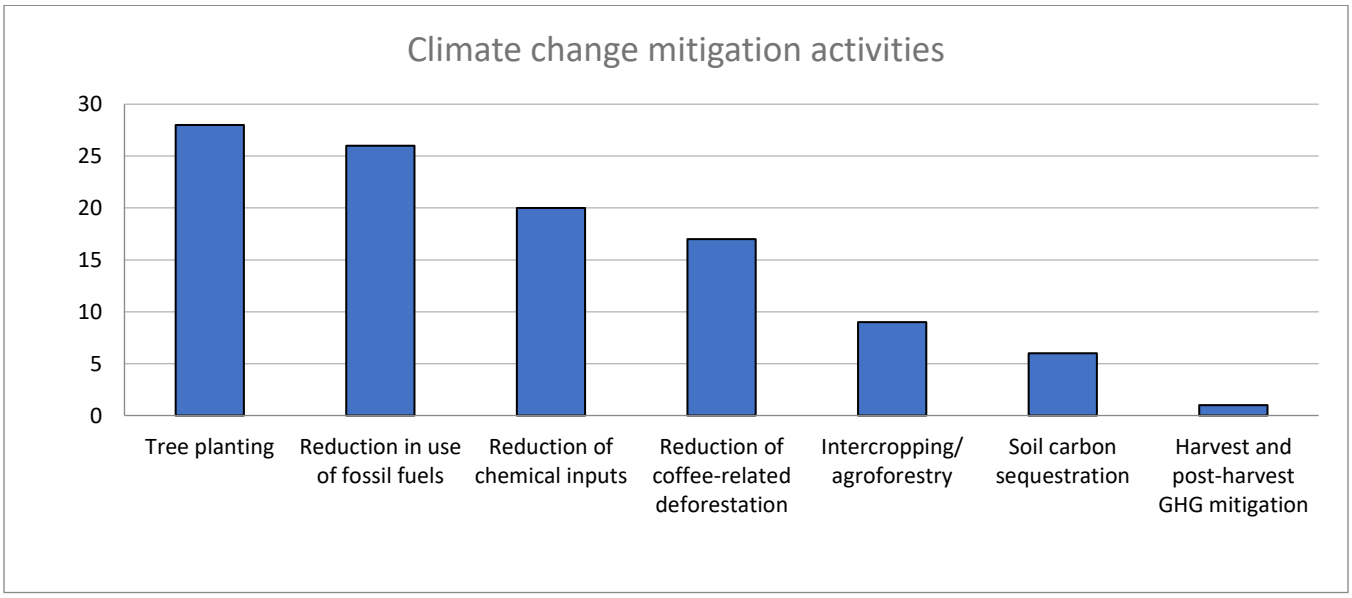
Key climate-related activities and combinations/clusters of activities

Types of climate-related actions/measures

We find that while most (149/160) interventions focus on climate change adaptation, many also integrate mitigation measures. 40 interventions (one-quarter of the total) also have clear value-adding or upgrading activities as part of the intervention. Merely mitigation-focused interventions are comparatively rare.

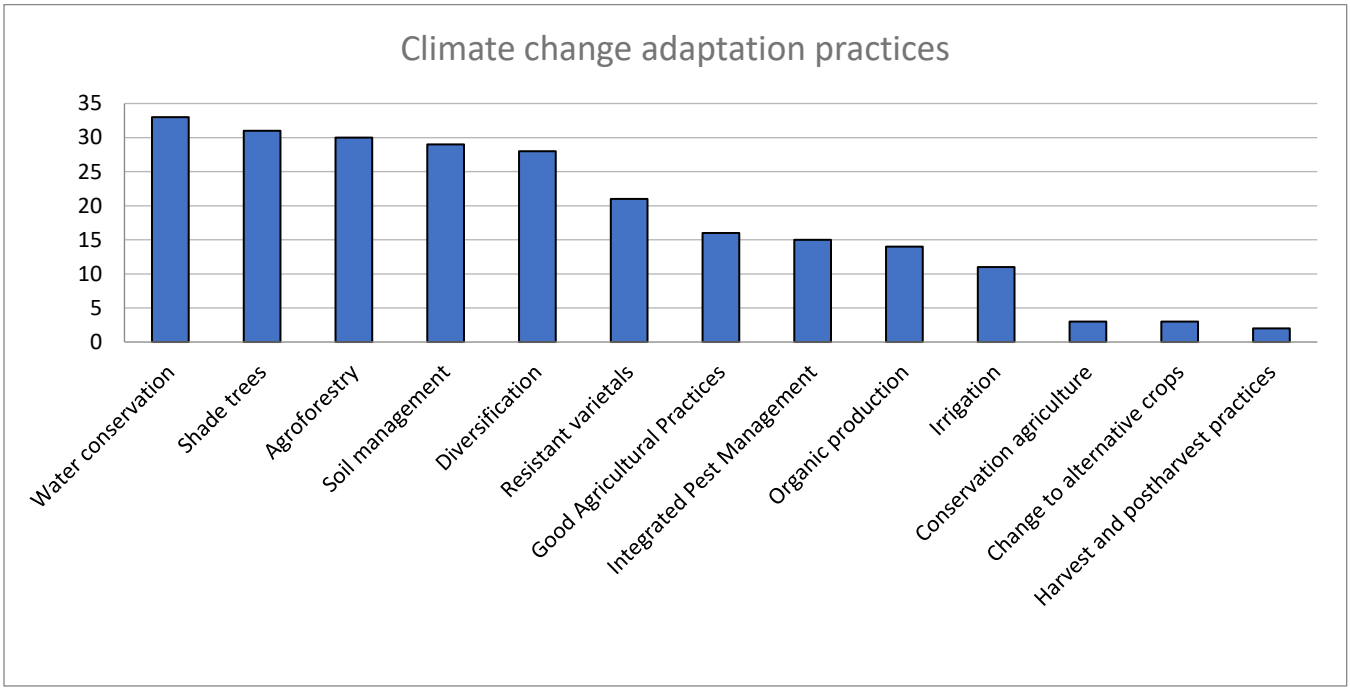


Slightly over half of the identified interventions (85/160) include climate mitigation measures. The following graph shows the most common mitigation measures:



When turning to adaptation measures, we find a broad range of measures. Most prominent is the planting of shade trees and/or support of agroforestry, but also water conservation, income diversification, soil management and the introduction of resistant varietals are commonly supported adaptation measures. While crop diversification or intercropping is relatively common, only a few interventions also look into supporting farmers

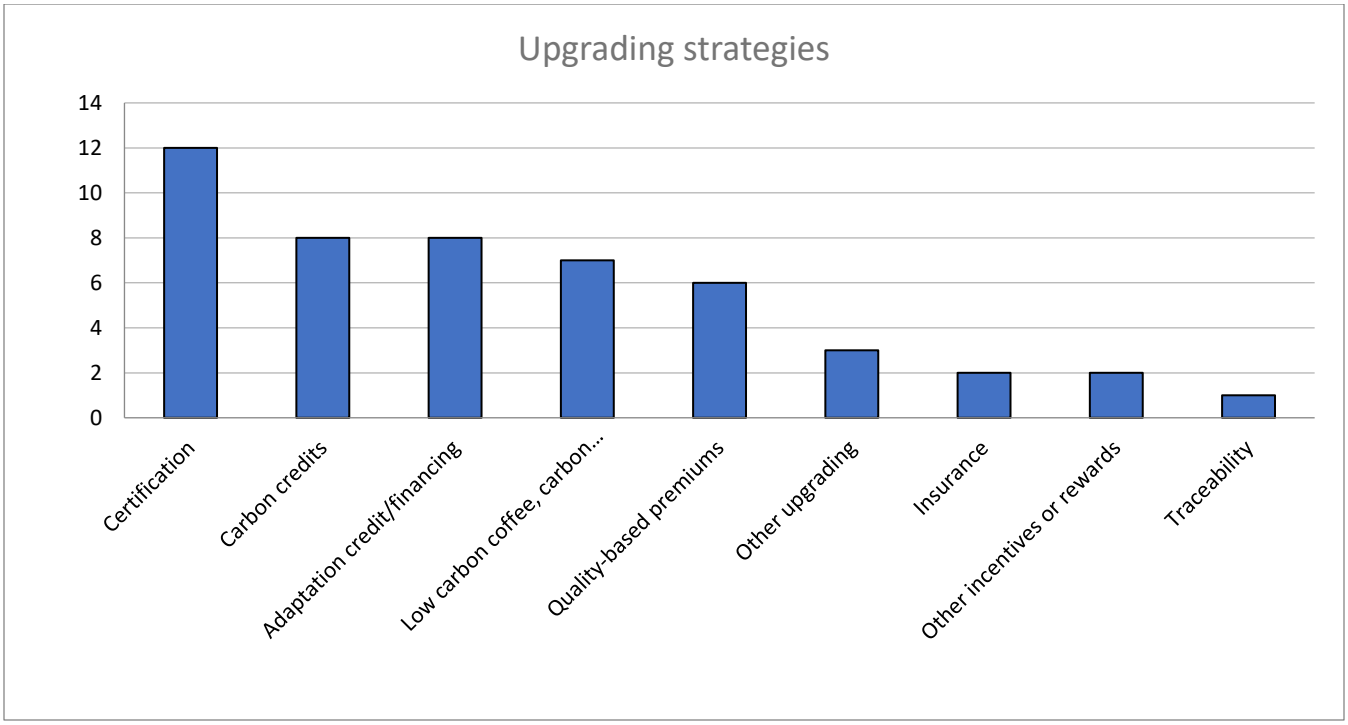
to switch toward alternative or more suitable crops entirely. This may in part be due to the dominance of coffee sector-related actors (see governance arena overview).



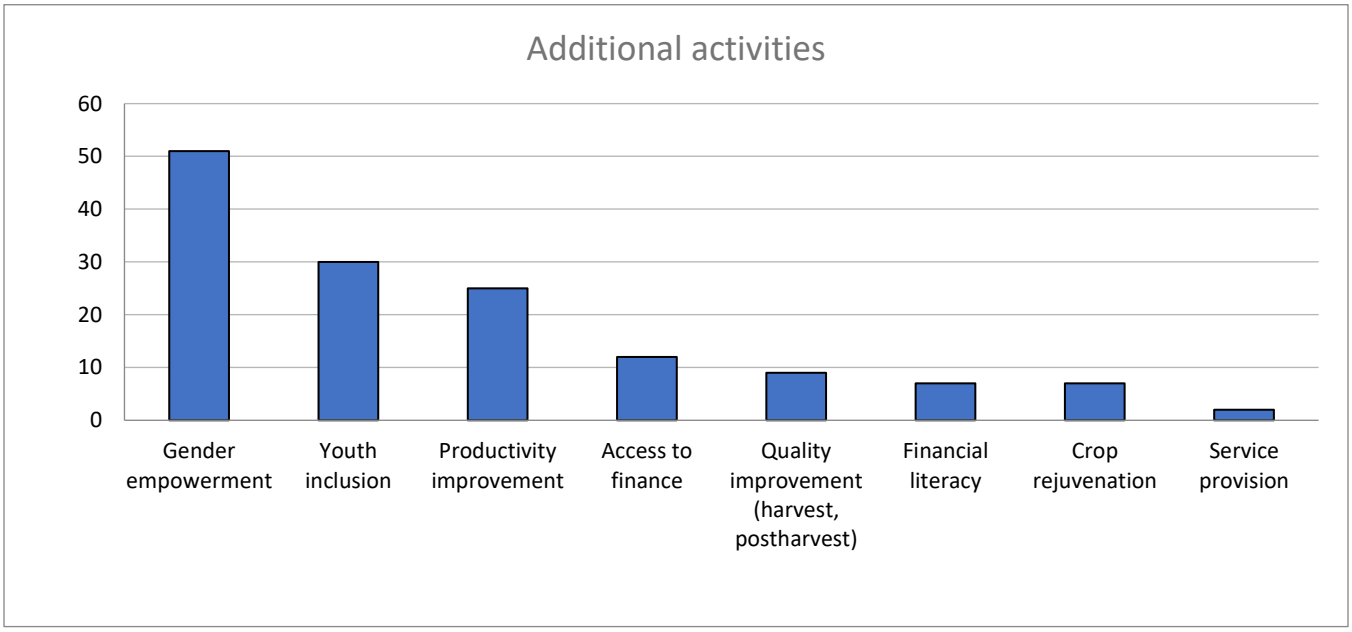
We further find that a number of practices are framed by actors as falling into both the mitigation and adaptation category – for instance, planting shade trees or pursuing agroforestry practices is framed as both contributing to increased greenhouse gas absorption on the farm as well as making farms more resilient against climate change-related extreme weather events. Soil management, too, is seen as having both the potential to sequester greater amounts of carbon as well as increasing resilience against erosion and water scarcity induced by climate change. The reduction of chemical inputs and/or increased reliance on organic production methods, too, can be seen as both reducing the emission of greenhouse gases (especially those embodied in the production of energy-intensive pesticides or fertilizers) as well as increasing the health of the soil and ecosystem surrounding it which may be important for climate resilience. In this way, climate-related practices are seen to have important co-benefits for both mitigation and adaptation – but to what extent these practices are harnessed for producers' livelihood improvement differs strongly between interventions.

Upgrading and additional activities

While many interventions aim at farmer capacity building on the above practices via training, comparatively few simultaneously aim at improving farmers' position in the value chain, for instance by marketing low-carbon or carbon-neutral coffee. Of those that do, most support farmers' certification (despite the fact that certification schemes do not always lead to farm-gate price benefits). Occasionally, projects introduce financing mechanisms or access to credit specifically for adaptation measures or aim to introduce climate-risk insurance.

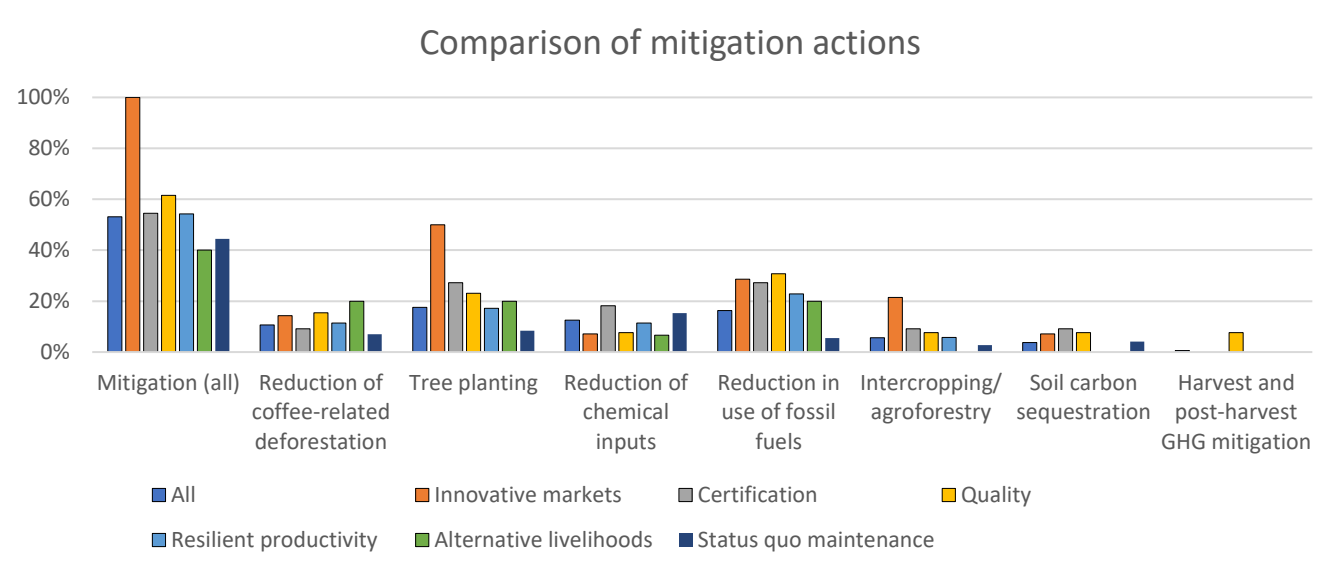


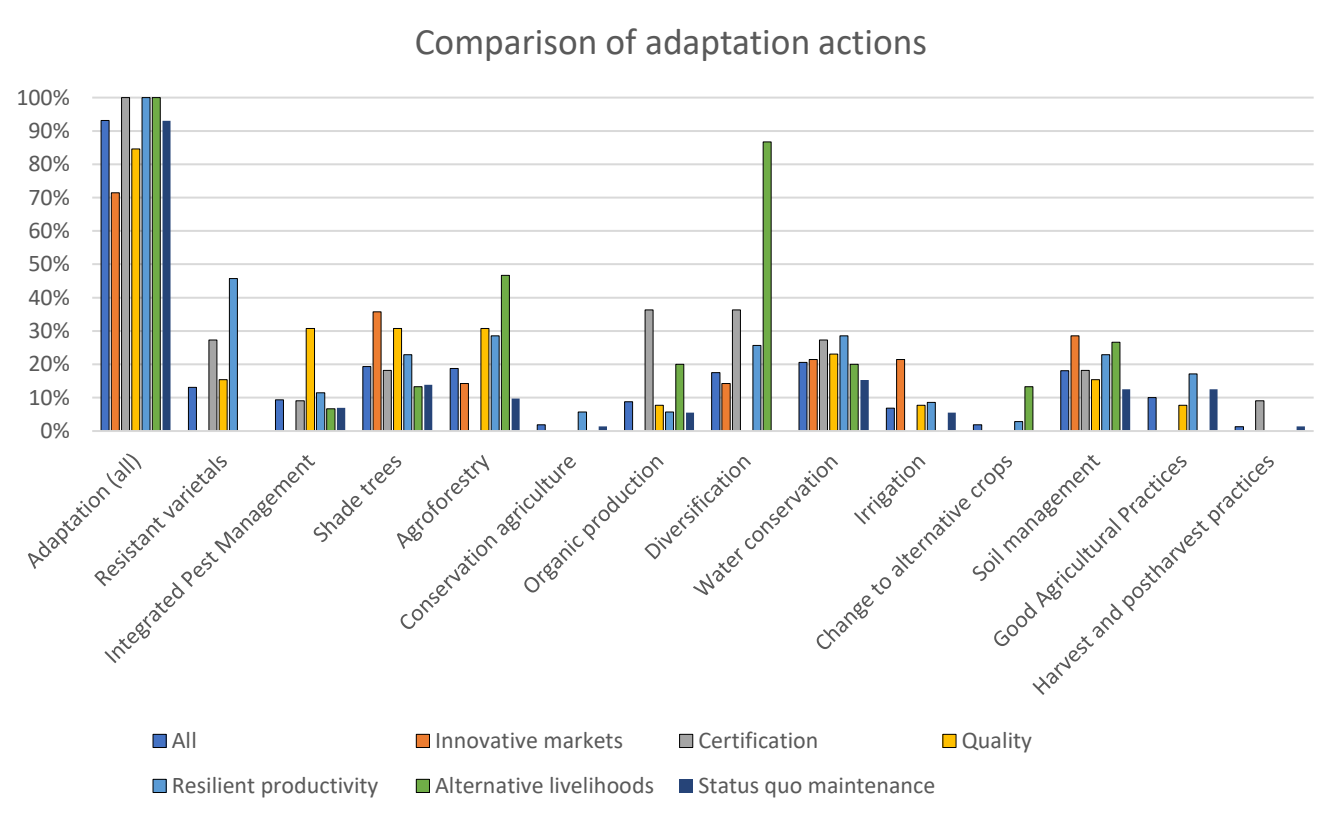
Most interventions also had secondary or parallel goals and activities. Most common in this domain was the empowerment of women and youth as well as improving the productivity of farmers as a way to boost incomes. Some interventions also focused on improving quality, sometimes with the explicit goal to access specialty markets as an upgrading pathway (see above).

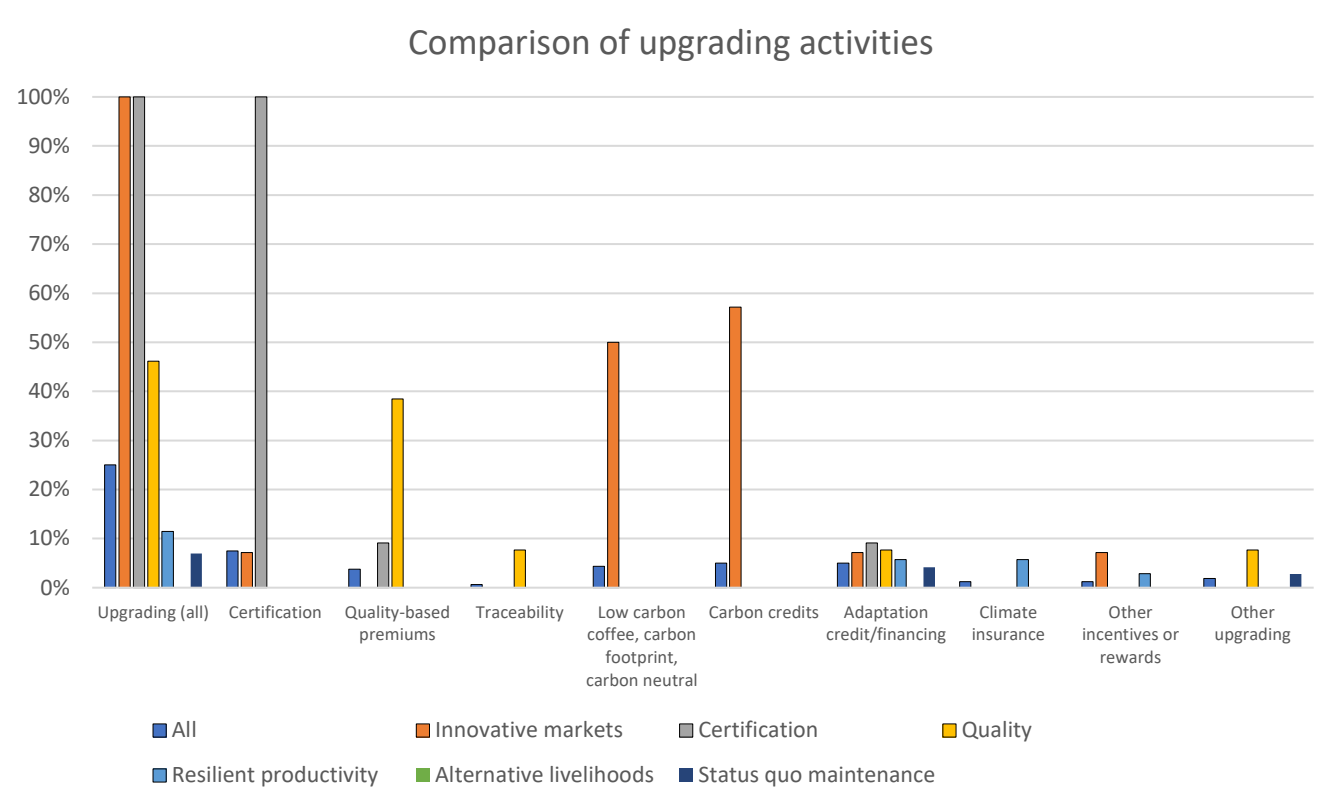


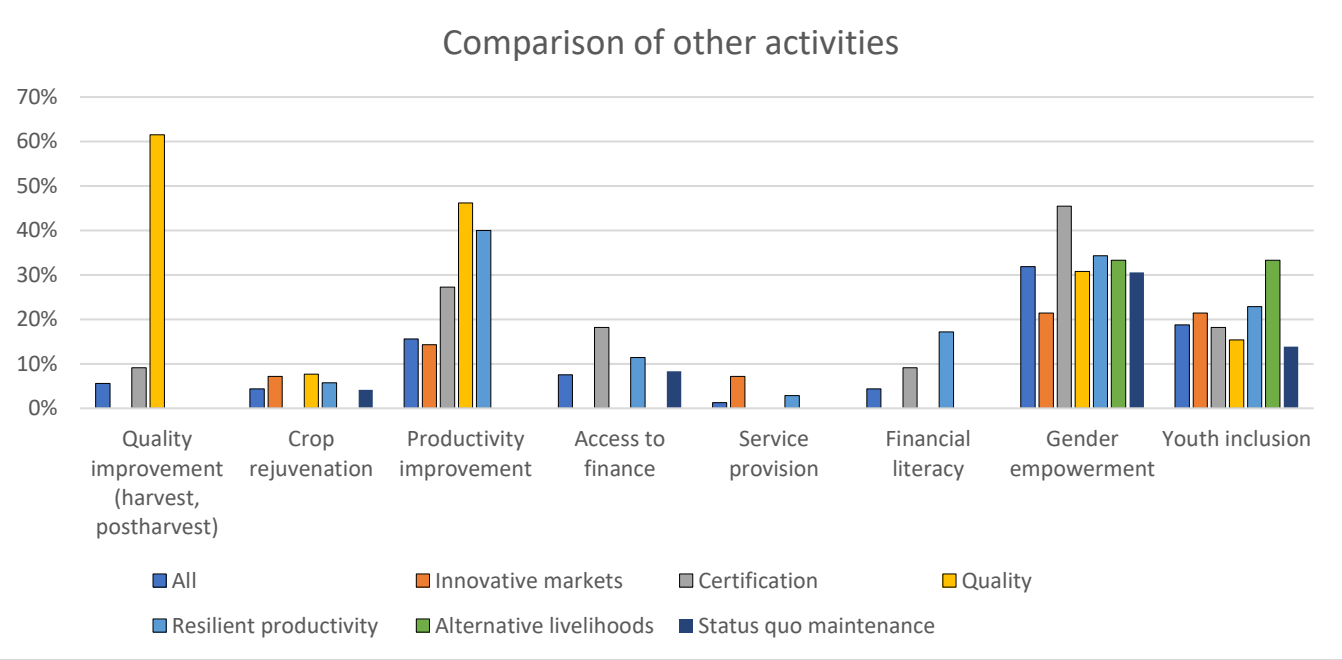
Pathways to livelihood upgrading

Based on the presented information above, we can identify six different theories of change or hypothesized pathways leading to livelihood upgrading in the context of climate-related interventions. We present these six pathways below, which result from the purposive clustering described in the methods section. The following two charts show the comparative frequency of specific mitigation and adaptation actions in each of the clusters, which will be described in the text below.









Pathway 1: Access to innovative climate-related markets (14 projects)

A small number of projects aim to help coffee farmers gain access to innovative climate-related markets such as the carbon credit or offsetting market, or aim to access novel climate-sensitive consumer markets by marketing low-carbon or carbon-neutral coffee. Given the nature of such markets, all such projects have a focus on climate

change *mitigation*, although, in 70% of cases, they also include climate adaptation practices. Comparatively, projects using this pathway place greater emphasis on tree planting off-farm as well as on-farm (via agroforestry or intercropping). This may be because this tends to be the easiest way for farmers to prove mitigation additionality, a sine qua non for being included in carbon offsetting programs.

Pathway 2: Certification (11 projects)

11 projects in the dataset draw on third-party certification as a way to combine better farm practices with livelihood upgrading, and therefore assist farmers in getting certified in addition to providing support for climate adaptation actions. Occasionally, such adaptation actions are also required by certification standards. Possibly due to a focus on certification compliance, projects in this category frequently mention the reduction of on-farm chemicals and organic production as climate change mitigation and adaptation practices. They also often have a focus on diversification as well as on the distribution of resistant varietals, and this category has the highest share of projects that also conduct gender inclusion activities and offers access to finance (climate- and non-climate related).

Pathway 3: Quality improvement (13 projects)

A third cluster can be identified that focuses on coffee quality improvement as a pathway for farmers to get higher incomes while also making their farms more resilient to climate change. Such projects typically focus strongly on Integrated Pest Management, the planting of shade trees, and water conservation. They also lead the way in the share of projects that focus on fossil fuel reduction practices. By definition, they very frequently train farmers in harvest and post-harvest practices that are correlated with better quality, but also frequently mention productivity-enhancing practices as well as traceability improvements. This may be because a high share of these projects (8/13) are led by actors from the coffee realm which are interested in larger volumes of high-quality coffee, while traceability is often a precondition for participation in high-quality, premium markets.

Pathway 4: Resilient productivity (35 projects)

A fourth pathway eschews a focus on product upgrading per se, but rather focuses on process upgrading by making farms more productive, efficient and 'business-like' while aiming to ensure farms' resilience against adverse weather events such that they can continuously produce large quantities of coffee. This is accomplished most frequently through a focus on productivity training, but we also categorize projects that focus on introducing resilient varieties, teaching financial literacy, or offer climate insurance to farmers into this category, as it fits the same mindset of creating resilient small businesses without necessarily aiming to enter into premium spaces. Projects in this category stand out by focusing on adaptation practices rather than mitigation; within these, we can identify a comparative focus on 'Good Agricultural Practices', water conservation, and soil management. Interestingly, almost one third of projects in this cluster do also advocate for agroforestry, showcasing a potential rethinking in the importance of agroforestry practices after several decades of intentional decreases in shade coffee production (Jha et al., 2014).

Pathway 5: Alternative livelihoods (15 projects)

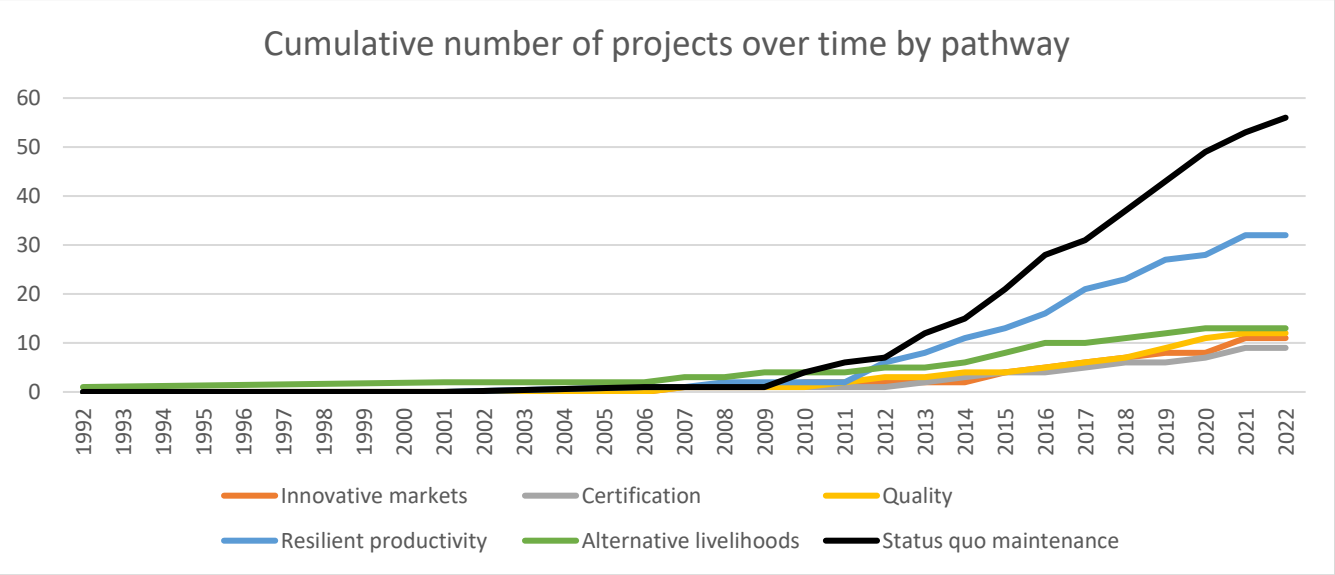
A fifth pathway that we can identify focuses to a greater extent than the others on the diversification of income sources and crops rather than doubling down on coffee. While, as noted, only few projects help farmers move away from coffee entirely, diversification is a prominent climate adaptation strategy – we can see that also projects that were categorized in clusters 1-4 occasionally mention diversification (most notably those that support certification). Here, we focus on those projects that do not also advocate for another product upgrading

channel and also do not advocate for productivity enhancements. We see that categorizing them this way allows us to highlight a strong focus on agroforestry (mentioned in almost half of the projects in this category) as well as a focus on organic production practices only rivaled by the certification pathway. Soil management is also highly important, and this pathway stands out by strong focus on youth inclusion; perhaps due to its focus on both on-farm and off-farm alternative activities that might be more attractive to younger generations.

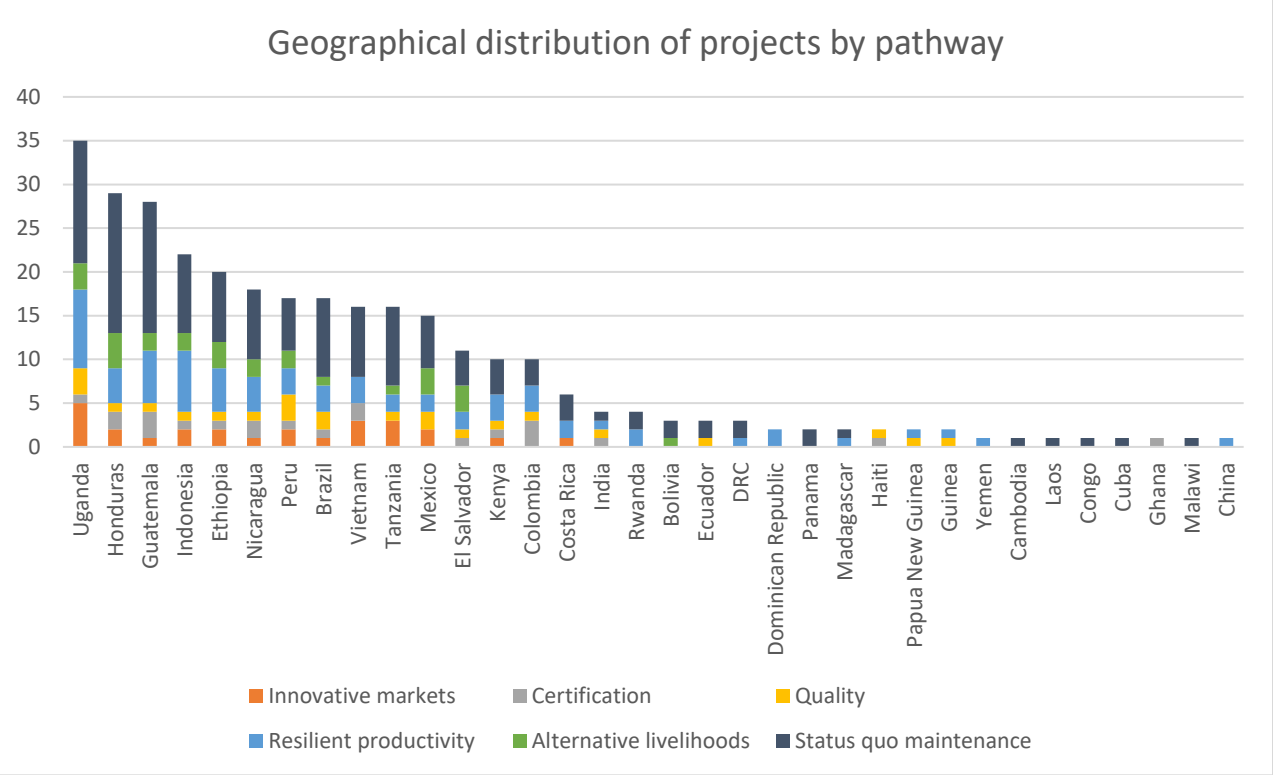
Pathway 6: Status-quo maintenance (72 projects)

Finally, and surprisingly, after coding for all the previous five pathways we are still left with almost half of the projects that have no identifiable theory of change for farmer livelihood upgrading. This may partially be due to a lack of reported information in available materials, but potentially also due to a narrow focus on building select adaptation skills without considering the larger picture of farmer livelihood improvement. We call this pathway 'status-quo maintenance' as it appears to be mainly focused on helping farmer to maintain their current situation and avoid the worst climate-related impacts without considering whether the current situation is beneficial or satisfying for growers. We find a wide range of practices in this pathway with few that are dominant or indicative of this group of projects; perhaps, this is unsurprising as it is a 'hold-all' category. Yet, the take-away – and this is very similar to the conclusion of an alternative, automated hierarchical clustering exercise described in Appendix 4 – is that almost half of the climate-related projects or interventions we found related to the coffee sector do not show a clear pathway to improving farmers' livelihoods and may only make marginal contributions to avoiding farmers' backsliding due to climate-related risks. While a full assessment of the likely impacts of these projects goes beyond the remits of this paper, this is a concerning finding that requires greater scientific attention.

Temporal and geographical distribution of the six pathways



We can see that while some of the earliest projects were focused on diversification and alternative livelihoods, the dominance of projects in the 'resilient productivity' as well as 'status quo maintenance' pathways started with the increasing popularity of climate-focused projects as of 2010. It is notable that quality-focused projects also start to proliferate by 2012, while projects focused on innovative markets tend to have a later start, from 2015 onward. As some of the projects in our database did not provide start dates, please note that the number of projects represented in the chart does not sum to the full 160.



Finally, we provide an overview of the geographical distribution of projects. Please note that as some projects operate in more than 1 country, the sum of the columns in the above chart will be greater than the 160 projects in our dataset.

We find that in most countries there is a relatively proportional distribution of the project types or pathways, though there are some trends. In the largest producers – Brazil, Vietnam, and Colombia – alternative livelihood projects are relatively rare or absent. It is also notable that three of the 11 certification-pathway projects are located in Colombia, a country with great institutional support and an amenable cooperative structure for certification (Grabs, 2021). Alternative livelihood-focused projects are proportionally more common in Honduras, Mexico, and El Salvador. Vietnam also does not have quality-focused projects, maybe due to the fact that it grows exclusively Robusta beans. The two countries of consideration in our empirical work, Ethiopia and Tanzania, show a mix of projects, though it is notable that there is only 1 quality-focused project in Ethiopia despite its recognition as the birthplace of Arabica coffee.

Conclusion

We created a comprehensive dataset of 160 climate-related interventions in the coffee sector targeting coffee farmers through directed and keyword searches, drawing on information available online in English, Spanish, and German. We find that such interventions proliferated since 2015 and have been conducted in 34 countries, with a clustering in countries with largest numbers of smallholder farms such as Uganda, Indonesia and Ethiopia, though other origins such as Honduras and Guatemala are comparatively overrepresented. A social network analysis further highlighted key actors in the climate change and coffee space that include Hanns R. Neumann Stiftung (HRNS), the Inter-American Development Bank, the GIZ, USAID, and Jacobs Douwe Egberts (JDE).

We further identify six pathways that the identified interventions use for the purposes of livelihood improvements, and showed that climate-related practices supported in the projects differ based on the pathway chosen. Nevertheless, one major finding is that almost half of the interventions did not have a clear theory of change that linked climate change mitigation or adaptation actions to product, process or livelihood upgrading, such that these actions threaten to occur in a vacuum that does not account for the increasingly difficulty of making a sustainable living from coffee growing. Future research is required to assess in practice what impacts various programs have on the livelihoods of coffee growers and to what extent climate-related interventions are helping farmers to future-proof their farms and economic portfolios.

Next steps

Planned next steps in this line of work for the PACSMAC team members include: 1) connecting this overview to previous literature on climate change adaptation, environmental, social and livelihood upgrading; 2) creating country-level case studies on the basis of preliminary fieldwork to illustrate country-level challenges and first impressions of intervention potential; and 3) integrating these elements into one cohesive manuscript. We also plan to draw on the presented database to identify organizations and projects to study empirically.

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Appendix 1: List of organizations reviewed for directed website search

Coffee arena: COFCO Agri, ECOM, ED&F Man (Volcafe), LDC, Mercon Coffee Group, Neumann Kaffee Gruppe, OLAM, Sucafina, Sucden, Touton, JDE, Starbucks, Nestle, Keurig Green Mountain, Strauss, J. M. Smucker's Co., Tchibo, Lavazza, Massimo Zanetti, International Coffee Organization, Sustainable Coffee Challenge, Global Coffee Platform, Specialty Coffee Association, Promecafe, IACO (Inter-African Coffee Association), ASEAN Coffee Federation, European Coffee Federation, Coalition for Coffee Communities, Sustainable Agriculture, Food and Environment (SAFE) Platform, Sustainable Agriculture Initiative Platform, COOP Norandino, Honducafe, PERHUSA, Federación Nacional de Cafeteros de Colombia (FNC), Cafe de Colombia, Ecotierra, , Promecafe

Climate change arena: UNFCCC, Nationally Determined Contributions (NDCs), Nationally Appropriate Mitigation Actions (NAMAs), Lima-Paris Action Agenda, Marrakech Partnership for Global Climate Action, Global Climate Action Portal (GCAP, also known as NAZCA portal), Climate Action Methodologies, Data and Analysis (CAMDA), Momentum for Change initiative, Action for Climate Empowerment, Race to Zero campaign, Race to Resilience, Global Climate Action Summit 2018, One Planet Summit 2017, 2018, 2019, Global Environment Facility, LandScale (Rainforest Alliance), SourceUp (IDH), CDP, We Mean Business Coalition, Natural Climate Solutions Alliance, Nature4Climate, Tropical Forest Alliance, Business for Nature, OP2B (One Planet Business for Biodiversity),World Business Council for Sustainable Development, America is all in/We Are Still In, Business Declares

Development arena: UNDP, World Bank, Inter-American Development Bank, UK DFID, UK FCDO (Foreign, Commonwealth & Development Office), UK - Department for Business, Energy and Industrial Strategy / UK Research and Innovation, UK Research and Innovation / University of Oxford, Japanese development agency, Japanese International Cooperation Agency, IDH (sustainable trade initiative), USAID, GIZ, FarmAfrica, Coalition Sustainable Livelihoods (Conservation International + IDH), Solidaridad Network, German Investment and Development Company (DEG), OeEB Austria, BIO Belgium, BMI-SBI Belgium, FinDev Canada, IFU Denmark, Finnfund Finland, AFD/Proparco Finland, DCP/SIMEST Italy, FMO Netherlands, Norfund Norway, SOFID Portugal, COFIDES Spain, Swedfund Sweden, SIFEM Switzerland, DCDC Group UK, U.S. International Development Finance Corporation (DFC), AFDB, ADB, EBRD, EIB, IFC, ISDB, EFDI, International Center for Tropical Agriculture (CIAT), COFIDES, CABEI/BCIE, The Latin American and Caribbean Network of Fair Trade Small Producers and Workers (CLAC)

Appendix 2: Keywords used in keyword search

English

- "Climate change mitigation" AND "coffee" AND ("project" OR "intervention" OR "action" OR "plan" OR "workshop" OR "funding")
- "Climate change adaptation" AND "coffee" AND ("project" OR "intervention" OR "action" OR "plan" OR "workshop" OR "funding")
- "Climate change resilience" AND "coffee" AND ("project" OR "intervention" OR "action" OR "plan" OR "workshop" OR "funding")
- "Climate change" AND "coffee" AND ("project" OR "intervention" OR "action" OR "plan" OR "workshop" OR "funding")

German

- “Klima Mitigation” OR “Klimaschutz”) AND "Kaffee" AND ("Projekt" OR "Intervention" OR "Aktion" OR "Plan" OR "Workshop" OR "Finanzierung" OR "Initiative" OR "Hilfe" OR "Maßnahme"
- “Klimaanpassung” AND "Kaffee" AND ("Projekt" OR "Intervention" OR "Aktion" OR "Plan" OR "Workshop" OR "Finanzierung" OR "Initiative" OR "Hilfe" OR "Maßnahme"
- Klimaresilienz” AND "Kaffee" AND ("Projekt" OR "Intervention" OR "Aktion" OR "Plan" OR "Workshop" OR "Finanzierung" OR "Initiative" OR "Hilfe" OR "Maßnahme")
- “Klimawandel” AND "Kaffee" AND ("Projekt" OR "Intervention" OR "Aktion" OR "Plan" OR "Workshop" OR "Finanzierung" OR "Initiative" OR "Hilfe" OR "Maßnahme"

Spanish

pequeño agricultor/minifundista, cambio climático, adaptación, resiliencia, café, caficultor, cafetero

Appendix 3

3rd party certification: Fairtrade, Organic (EU or USDA), Rainforest Alliance, 4C, Smithsonian Bird-Friendly Coffee

Company-own programs: GCP Baseline Coffee Code, Nespresso AAA, Nescafe Plan “Coffee by Women”, Starbucks C.A.F.E. Practices, NKG Bloom, Olam AtSource, Olam Livelihood Charter, Certifica Minas, ECOM SMS (Sustainability Management Services) Verified, Enveritas Enveritas Gold, Volcafe Way, Mercon LIFT

Appendix 4

In addition to the manual clustering analysis, we also pursued hierarchical clustering on categorical variables in R. In doing so, we first constructed the dissimilarity matrix of activities by calculating the Gower distance between them. We then used this dissimilarity matrix as an input to perform hierarchical, agglomerative clustering. We started by constructing visual dendograms that used various clustering algorithms and visually compared them to determine the method that produced the most balanced set of clusters, which turned out to be the Ward clustering method. We confirmed the superiority of the Ward method by calculating and comparing the size of clusters that resulted by pursuing each method, alongside the closeness of observations in each cluster (calculated by the within sum of squares). As there was no notable break in the number of clusters beyond which the within sum of squares did not improve anymore, we decided to limit the number of clusters to 5, as this allowed for a sufficiently granular analysis of different combinations of characteristics. We then assigned each intervention its respective cluster number to analyze them in even greater detail. Figure X shows the resulting patterns. After consideration of the results, we found that this automated clustering did not allow us to make targeted enough inferences about the types of programs in question and decided to turn to more directed clustering focused on various types of upgrading pathways as described in the main text.


Distribution of characteristics across clusters
youth
gender
financial_literacy
service_provision
finance
productivity
crop_rejuvenation
quality_improvement
upgrading_other
incentives_other
climate_insurance
adaptation_finance
carbon_credits
low_carbon_coffee
traceability
quality_prems
certification
harvest_post-harvest_adapt
gap
soil_management
alt_crops
irrigation
water_conservation
diversification
org_prod
conservation_ag
agroforestry
shade_trees
ipm
resistant_vars
harvest_post-harvest_mitig
soil_carbon
agroforestry_intercropping
fossil_fuel_red
chemical_red
tree_planting
deforestation_red
Activities
1
2
3
4
5
Cluster number
perc
1.00
0.75
0.50
0.25
0.00