Full Title: What works in agrarian adaptation: a systematic assessment of CGIAR climate research evidence

Short title: What works in agrarian adaptation

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Abstract:

Effective climate adaptation in agrarian settings is critical for the billions of people whose livelihoods depend on agriculture, yet evidence on what adaptation actions actually reduce climate risk remains fragmented and difficult to generalize. In this study we assess the effectiveness of agrarian adaptation using 403 empirical case studies published by CGIAR scientists and partners in peer-reviewed journals between 2012 and 2023. We constructed adaptation rationales connecting climate stressors to adaptation actions and resulting benefits, classifying benefits as reductions in exposure, reductions in sensitivity, or increases in adaptive capacity, consistent with the IPCC framework for climate risk reduction. We further distinguished between indigenous and local agrarian adaptation (ILAA) and planned adaptation, depending on who initiates and designs the action. Both categories addressed drought, flooding, and extreme weather as primary stressors. ILAA actions centered on crop selection, farming techniques, and land and water management, delivering roughly equal sensitivity and adaptive capacity benefits, with livelihood diversification producing the highest benefits per action despite being relatively infrequently implemented. Planned adaptation was dominated by climate-smart agriculture, land and water management, and education and behavioral change, and generated substantially more adaptive capacity benefits than sensitivity benefits. Neither adaptation type delivered meaningful exposure benefits. These patterns reflect a fundamental divergence in adaptation rationales: ILAA prioritizes near-term reduction of sensitivity within existing livelihoods structures, while planned adaptation emphasizes

longer-term capacity building. This divergence carries practical risks, as planned interventions focused on adaptive capacity may undermine the short-term sensitivity benefits communities depend on and face limited uptake when they challenge existing social arrangements. Bridging these divergent rationales by aligning planned adaptation with local livelihoods goals before pursuing transformative change offers a pathway toward more effective, locally led, and co-produced agrarian adaptation.

What Works in Agrarian Adaptation: A Systematic Assessment of CGIAR Climate Research Evidence

1. Introduction

Since the Paris Agreement, which included a commitment of the parties to track progress on adaptation to climate change, tracking and assessing the impact and outcomes of adaptation policy and action have received increasing attention [1–6]. However, different perspectives on what aspect of adaptation should be measured and often incommensurable measurement approaches have limited assessments of adaptation's effectiveness in reducing climate risk and vulnerability. The IPCC's Sixth Assessment Report [7] included language reflecting the unclear and disjointed character of work on adaptation effectiveness, flagging it as a knowledge gap and area for further research. This issue is particularly pressing in agrarian settings, where the primary production focus of livelihoods renders people and assets particularly vulnerable to the impacts of climate change [8].

In this paper, we argue that a great deal of evidence regarding effectiveness exists in the literature on agrarian adaptation, particularly in the Global South [9–11]. For example, a rich body of agrarian adaptation literature identifies adaptation outcomes, but not in ways that that identify and evaluate the logics of adaptation action that connect climate stresses to the actions taken to address those stresses and the benefits those actions deliver [12]. By articulating the pathways by which adaptation actions reduce climate risk and particularly vulnerability, we can rigorously capture lessons about what actions deliver

benefits in the context of different climate stressors, what kinds of benefits are delivered when specific actions are taken to address different stressors, and therefore what actions deliver the greatest return on the limited resources available.

This preliminary effort to map agrarian adaptation effectiveness draws on a database of 403 empirical studies of adaptation actions and their outcomes published by CGIAR scientists and partners in refereed journals between 2012 and 2023 [13]. Our analysis addresses a range of questions relevant to understanding agrarian adaptation and its effectiveness: what stressors are being addressed, what actions are being taken to address those stressors and what benefits have been delivered by those actions. Further, it identifies both differences and similarities in the stresses, actions, and benefits prioritized by formal adaptation planning (sometimes called planned adaptation) and indigenous and local agrarian adaptation (ILAA), also called autonomous adaptation. There are substantial similarities in the climate stressors emphasized by both planned adaptation and ILAA. However, the actions taken to address those stressors, and the number and types of adaptation benefits delivered by these actions, suggest these two adaptation arenas are characterized by divergent adaptation rationales. Clearly articulating this disconnect can support efforts to bridge these arenas and support effective locally led adaptation, the co-production of adaptation solutions, and steps toward transformative adaptation.

1.1. Agrarian Adaptation

Agrarian systems have long been a focus of adaptation research and practice, with the cascading and compounding impacts of climate change on agriculture giving them

heightened attention [14]. A vast literature considers the likely impacts of climate change on agricultural production and producers [8,15–19], efforts of agrarian populations to adapt to climate variability and change [20–32], and formal programs and projects aimed at promoting agrarian adaptation [9,33]. Further, the challenges faced by people and production in such systems are a core part of global climate assessments such as the Intergovernmental Panel on Climate Change (IPCC) [8,15,34,35]. Adaptation is not the sole solution for agrarian challenges brought on by climate change. The existence of both soft limits (where options might exist but require substantial social, economic, or political transformation) and hard limits (where adaptation options lose their effectiveness at higher levels of warming or no actions can avoid impacts on human well-being) to adaptation means we cannot adapt endlessly [36–40].

However, the continuing growth of the literature reflects the fact that effective adaptation is and will be critical if we are to address the consequences of a regime where the reduction of greenhouse gas emissions (i.e. mitigation) is happening far too slowly to avoid substantial impacts on agrarian populations and their well-being. For example, the IPCC's Sixth Assessment Report concluded that crop yields, and fisheries and agriculture more broadly, were experiencing the highest risks of any sector from observed climate impacts [15,41]. This report also noted that in the Global South, the region of the world with the highest vulnerability to climate impacts, the impacts of climate change on crop production for nearly all crops are negative [8].

At the same time, there is little general discussion about what we know about adaptation effectiveness in agrarian contexts. The water chapter of the IPCC's Working Group II report analyzed the effectiveness of adaptation to water related hazards and stressors, concluding that while there are several benefits of adaptation, its role in reducing climate and related risks is not well documented [34]. In the same report, the chapters on both poverty, livelihoods, and sustainable development [15] and food, fiber and other ecosystem products [8] do not offer clear assessments of what actions have been taken with regard to adaptation for these issues, or the extent to which adaptation actions are meeting needs.

In this paper, we offer a preliminary assessment of agrarian adaptation effectiveness, demonstrating that it is possible to organize disparate cases into a coherent analysis illustrating broad lessons. This assessment draws on 11 years (2012 to 2023) of refereed, English-language journal articles on climate change adaptation published by CGIAR authors and their partners and retrieved from eight CGIAR repositories. The methods used for article retrieval is explained in Carr and Mukherji [13] and the full database of all CGIAR climate change related journal articles is available online [42].

The CGIAR, the world's largest publicly funded research and innovation organization, works on all aspects of the agri-food system from pre-production to markets and consumers, but with a greater focus on the production phase of the food systems. It has 14 research centers that covers research on crops, livestock, fisheries, forests/agroforestry, water, biodiversity and food-policy related issues in the Global South. The climate portfolio of the

CGIAR spans five major sub-topics, namely, impacts of climate change on agri-food systems and resulting adaptation interventions; impacts of agri-food systems on climate change and resulting mitigation interventions and methods and metrics for measuring impacts and effectiveness of both adaptation and mitigation. CGIAR scientists and partners have conducted extensive research into adaptation in the agrifood sector, including undertaking vulnerability analyses [43–45], developing tools to assist in planning for future climate conditions [46–48], policy analyses [49,50], and empirically analyzing the outcomes of adaptation actions. This last category of research presents an opportunity to learn what works in agrarian adaptation from CGIAR experience. While this is not a comprehensive sample of the agrarian adaptation literature, the climate shocks/stressors/impacts addressed and the actions emphasized to address those issues align with the emphases captured in the IPCC's Sixth Assessment Report. This suggests that the patterns emerging from the analysis of this subset of the literature are likely to reflect patters in the wider agrarian adaptation literature.

1.2. Adaptation Rationales and Benefits: A Foundation for Assessing Adaptation Effectiveness

Deriving broad lessons about what works in agrarian adaptation, and adaptation action more broadly, is a persistent challenge within the adaptation community of practice. Carr and Nalau [12] argue that the root of this challenge lies in a community of practice-level focus on the specific adaptation challenges and needs of different socio-ecological contexts. This focus on specificity, while warranted at the project level, obscures larger

lessons from experience, such as which actions, under what conditions, are most effective for addressing a specific stressor.

To learn from the experience of adaptation implementation requires organizing the information about adaptation actions in a manner that logically connects the problem (one or more climate stressors or risks), the actions taken to address those problems, and the outcomes of those actions – what Carr and Nalau [12] call adaptation rationales. They suggest such rationales require the measurement of outcomes against goals that apply beyond a project's specific context but are anchored in concrete risks/stressors, actions, and benefits. Carr and Nalau developed such goals by defining adaptation as an effort to reduce the vulnerability of people and places to the impacts of climate change while increasing people's ability to take advantage of emerging opportunities. Following this definition, adaptation actions should deliver benefits that address one or more components of climate risk (lowering exposure) and vulnerability (reducing sensitivity and/or increasing adaptive capacity). Carr and Nalau [12] classify adaptation benefits into categories reflecting these broad adaptation goals:

1) Exposure Benefits: An intervention, policy, or action provides an exposure benefit if it lowers the frequency and/or magnitude of impacts on a person, population, or system targeted by the project.
2) Sensitivity Benefits: An intervention, policy, or action provides a sensitivity benefit if it reduces the consequences of a climate-related event on a person, population, or system. The event may still occur with the same/greater frequency and magnitude,

but the person, population, or system will not be as affected by the event as before the intervention.

3) Adaptive Capacity Benefits: An intervention, policy, or action provides an adaptive capacity benefit if it increases the ability of a person, population, or system to manage climate impacts or realize an opportunity emerging from climate change, including by transforming how and where they live. This can happen even if that population, person, or resource remains exposed to and very sensitive to a climate impact, though typically increasing adaptive capacity facilitates productive efforts to lower exposure and sensitivity.

Defining the goal of adaptation as the delivery of one or more of these adaptation benefits fills the gap in adaptation rationales that has obstructed the development of general lessons about adaptation effectiveness. For example, measuring the number and kind of adaptation benefits delivered by different actions allows us to assess which actions are most effective at delivering specific benefits under different conditions. Even this simple measurement of adaptation, focused on the presence or absence of a benefit without evaluating its magnitude or impact, enables a comparative exploration of the outcomes of efforts to address different climate stressors at different scales. This first step allows us to assess opportunities for meaningful generalization in adaptation action and effectiveness, supporting the development of evidence-based good practices.

This effort also allows us to elaborate the adaptation rationales behind specific actions or sets of actions. Comparing the adaptation rationales associated with formally planned and

funded adaptation actions with those undertaken by Indigenous or local agrarian actors allows us to compare a) the climate stressors prioritized, b) the adaptation actions prioritized, and c) the types and number of benefits delivered by these actions across these two arenas of adaptation action. This comparison highlights gaps between the adaptation rationales that inform action in planned versus Indigenous and local adaptation, such as differing goals across different adaptation actors and varying perceptions of what actions are most effective for addressing specific climate impacts or stresses. As we discuss below, such differences are manifestations of different understandings of what it means to effectively address a climate stress or impact. This divergence, if unacknowledged and unaddressed, creates risks for project design and intervention uptake. Identifying such gaps can facilitate conversations that bridge gaps between ILAA and planned adaptation rationales, furthering efforts to promote locally-led adaptation [51–53] and the co-production of adaptation actions [54–56].

2. Methods

This review draws from a database of 2,652 articles on the topic of climate change published by CGIAR researchers between January 2012 to December 2023. This database was created through a bibliographic search of the CGSpace repository of published and peer reviewed journal articles with DOI, using “climate change” as the key word. Any article that mentioned the words “climate change” in its title, abstract or key words was included in the repository.

Once the database was compiled, we employed a four-step process using a large language model (LLM), OpenAI 4o. At each step, prompts were developed through an iterative process of drafting, testing, assessing outcomes by reviewing a random sample of article analyses in the outputs, revising the prompts, and rerunning the analysis until error rates in a sample of the outputs dropped below 1%. In the end, the use of the LLM accelerated the assessment process but did not remove the need for careful expert cleaning and analysis. The final analysis in this paper relied heavily on expert cleaning of the data by the authors to ensure accuracy and quality. Our experience aligns with that of Buck, et al [57] in their study of the use of artificial intelligence to facilitate a scientific assessment in that the use of AI tools required many revision cycles at each step of the analysis described below (see Annex 1 for a list of prompts).

In the first step, prompts were developed around inclusion/exclusion criteria that defined whether articles were about climate change adaptation or not. This step identified 981 articles as relevant to climate change adaptation. In the second step, prompts were developed to identify the broad categories of adaptation research represented in these articles: empirical studies of adaptation, conceptual work on adaptation, studies of species (plant or animal) adaptation, studies of ecosystem adaptation, modeling and planning studies with implications for adaptation, vulnerability studies or analyses, or adaptation policy analysis. The most common were empirical studies of adaptation actions. There were also a substantial number of studies that reflected modeling or planning efforts whose results might inform future adaptation decision-making, but which

were not themselves studies of adaptation actions. The remaining categories of research were much smaller parts of the database.

In the third step, prompts were used to separate the articles classified as empirical studies of adaptation into either formally planned adaptation actions (i.e. government, donor, or other formal actor-funded and designed) or Indigenous and/or local agrarian adaptation (ILAA) actions. A final set of prompts described the adaptation actions defined in each article, categorized each action into one of 15 categories, identified the adaptation benefits intended by that action, and assessed whether the action delivered those benefits.

Before final analysis, the outputs of the tool were manually reviewed and cleaned for accuracy. In that process, we used expert judgement to consolidate the 15 categories of action initially developed by the AI into eight categories of ILAA action and nine categories of planned adaptation action (Table 1). This consolidation addressed ambiguous cases where distinctions between categories did not reflect meaningful differences in intent, action, or outcome.

ILAA Category	Examples illustrating the category	Planned Adaptation Category	Examples illustrating the category
Crop selection and farming techniques	Shifts in existing seed varieties [58–60]	Climate-smart agriculture	Introduction of no tillage techniques and crop residue retention [61–63]
	Changes in crops planted or animals raised [64,65]		Introduction of small-scale irrigation [66–68]
	Changes in planting times and crop calendars [69–71]		Introduction of new hybrid seeds [72–74]
Community-based adaptation	Establishment of or use of village/community institutions to coordinate adaptation efforts [75–77]	Community-based adaptation	Establishment of community seed systems and banks [75–77]
	Community-level seed or farm product sharing and storage [78–80]		Formalization of traditional ecological knowledge [67,81,82]
Disaster risk reduction	Formation of local committees to facilitate disaster risk reduction [83,84]		Development of participatory approaches to facilitate the co-development of adaptation responses with communities [85–87]
	Changes in home and infrastructure construction to manage flooding [83,88]	Disaster risk reduction	Establishment of formal programs to mitigate floods and other hazards [89–91]
Land, water, and resource management	Tree planting and other indigenous agroforestry efforts [70,92,93]		Development of/improving access to early warning systems [94–96]
	Shifts to land management strategies that promote ecosystem restoration [97,98]	Land, water, and resource management	Formal promotion of agroforestry to address soil and other issues [86,99,100]
	Developing local institutions for water management [101,102]		Formal planning of rainwater harvesting [85,95,103]
	Implementation of water conservation measures. [104–106]		Evaluation of soil quality under different management scenarios to identify best practices [61,107,108]
Education and behavioral change	Mobilizing indigenous knowledge of biotic and abiotic indicators to predict rainfall patterns [109–111]	Education and behavioral change	Training programs to enhance farmers' understanding of technology adoption [112–114]
	Use of local ecological indicators to inform seasonal agricultural calendars [71,109]		Training met service staff, middlemen, and farmers on the use of weather and climate data [115–117]
	Shifting perceptions of a changing climate and how to manage it [69,118,119]		Field demonstrations of crops and practices [120–122]
Livelihoods and income diversification	Uptake of farming by pastoral groups [123,124]	Gender and social inclusion	Training women to improve their access to markets, seed, and other assets [125–127]
	Inclusion of nonfarm activities by farming households [124,128,129]		Implementing gender-sensitive adaptation interventions [130,131]
	Utilization of forest products to diversify farming livelihoods [132–134]		Encouragement of off-farm income activities to support investment in needed farm equipment [135–137]

Technology and innovation	Local introduction of improved crop varieties to address stresses on production [128,138,139]		Livelihoods and income diversification	Increasing access to credit [83,140]
	Local adoption of technologies like forecasts, mechanization, fertilizers, and pesticides [85,97,141]		Technology and innovation	Developing and testing seeds and animal breeds with the goal of fostering producer resilience. [87,142,143]
Livestock adaptation	Shifting herd composition to more drought-tolerant animals [64,144]			Use of mobile devices and digital technologies to transmit information and inform farmer decision-making. [145–147]
	Adjustments to feed production and selection [148–150]		Livestock adaptation	Adoption of grazing management and zero-grazing practices to manage reduced pasture and water availability during dry seasons [151–153]
	Promotion of livestock migration as an adaptation strategy [109,154,155]			Training programs to improve animal management practices. [156,157]

Table 1: Eight categories of ILAA action and nine categories of planned adaptation action

The set of empirical studies of adaptation that resulted from this process contained 403 papers. Of these, 153 reported on ILAA and 302 reported on planned adaptation efforts (52 articles appear in both the ILAA and planned adaptation sets, as they reported on both). The cases were heavily focused in sub-Saharan Africa and Asia (Table 2). Specifically, the dataset reflects high levels of coverage throughout most parts of sub-Saharan Africa (though not Central Africa), along with South Asia, East Asia, and Southeast Asia. All other regions are lightly represented in the dataset.

Region	Planned	ILAA
Sub-Saharan Africa	197	100
Asia	131	59
South America	10	6
Global	6	2
Middle East and North Africa	7	1

Table 2: Regional distribution of empirical adaptation cases in the CGSpace dataset.

For both ILAA and Planned adaptation, the cases in the dataset focused on drought, flooding, and extreme weather, with general climate variability also a focus. Within planned adaptation, the largest sets of actions in the dataset were climate-smart agriculture, education and behavioral change, and land, water and resource management. For ILAA, the largest sets of actions were crop selection and farming techniques, land, water and resource management, and livelihood diversification (Figure 1). This dataset broadly aligns with the IPCC AR6 [158] assessment that “Droughts, pluvial, fluvial and coastal flooding are the most common hazards for which adaptation is being implemented.” Figure 1 also suggests that the CGIAR database is representative of broader understandings of agrarian adaptation captured by AR6 [158]:

Current adaptation in natural and managed ecosystems includes earlier planting and changes in crop varieties, soil improvement and water management for livestock and crops, aquaculture, restoration of coastal and hydrological processes, introduction of heat- and drought-adapted genotypes into high risk populations, increasing the size and connectivity of habitat patches, agroecological farming, agroforestry and managed relocations of high-risk species.

More specifically, the stressors and responses represented in this database, when considering its geographic focus, strongly aligns with the IPCC assessment of adaptation focus [159] in these regions on drought, flood, variability, and extremes.

Planned Adaptation

	Climate-Smart Agriculture	Community-Based Adaptation	Disaster Risk Reduction	Education & Behavioral Change	Gender and Social Inclusion	Land, Water, and Resource Management	Livelihood Diversification	Livestock Adaptation	Technology & Innovation
pests and diseases	8	5	0	6	2	6	0	0	3
drought	144	53	20	100	14	145	47	14	51
flood	73	27	13	51	6	74	28	5	21
extreme weather	90	26	16	60	7	71	27	7	27
water scarcity	14	3	2	6	1	26	4	2	4
climate variability	39	12	5	26	3	40	8	2	13
sea level rise	11	4	3	8	0	10	4	0	3

Indigenous and Local Agrarian Adaptation

	Community-Based Adaptation	Crop Selection and Farming Techniques	Disaster Risk Reduction	Education & Behavioral Change	Land, Water, and Resource Management	Livelihood Diversification	Livestock Adaptation	Technology & Innovation
drought	50	103	7	30	102	56	19	29
flood	28	64	7	19	63	41	8	16
pests and diseases	4	6	0	2	5	5	0	1
climate variability	9	31	0	12	27	18	8	11
extreme weather	23	67	5	18	61	34	8	12
sea level rise	3	6	3	2	8	6	0	0
water scarcity	4	4	1	2	9	3	3	1

Figure 1: The climate stress/adaptation action combinations most reported in the CGIAR adaptation dataset. Each cell represents the number of cases where a specific action (across the top of each grid) was used to address a specific climate stressor (the vertical axis of each grid).

3. Results

3.1. Indigenous and local agrarian adaptation actions

The 152 papers addressing ILAA reported 358 climate stressors. The most addressed stressor was drought (38.3%), followed by flood (22.6%), and various forms of extreme weather (20.7%). Climate variability made up 10.6% of all climate stressors addressed in the dataset, and all other stressors were less than 5% of those reported.

These stressors were addressed by 497 adaptation actions. Globally, the most common ILAA actions were those related to crop selection and farming techniques (26.4% of all actions in the dataset), land, water, and resource management (25.8%), livelihoods diversification (15.3%), and community-based adaptation (11.4%)) (Figure 3).

Of the 497 actions reported in the papers, 460 actions delivered 1856 adaptation benefits (Figure 3). The most common benefit delivered was a sensitivity benefit (48.9% of all benefits delivered), followed by an adaptive capacity benefit (48.7%). Very few actions delivered an exposure benefit (2.4%), reflecting the limited number of options available for indigenous and local actors to avoid exposure to a climate impact.

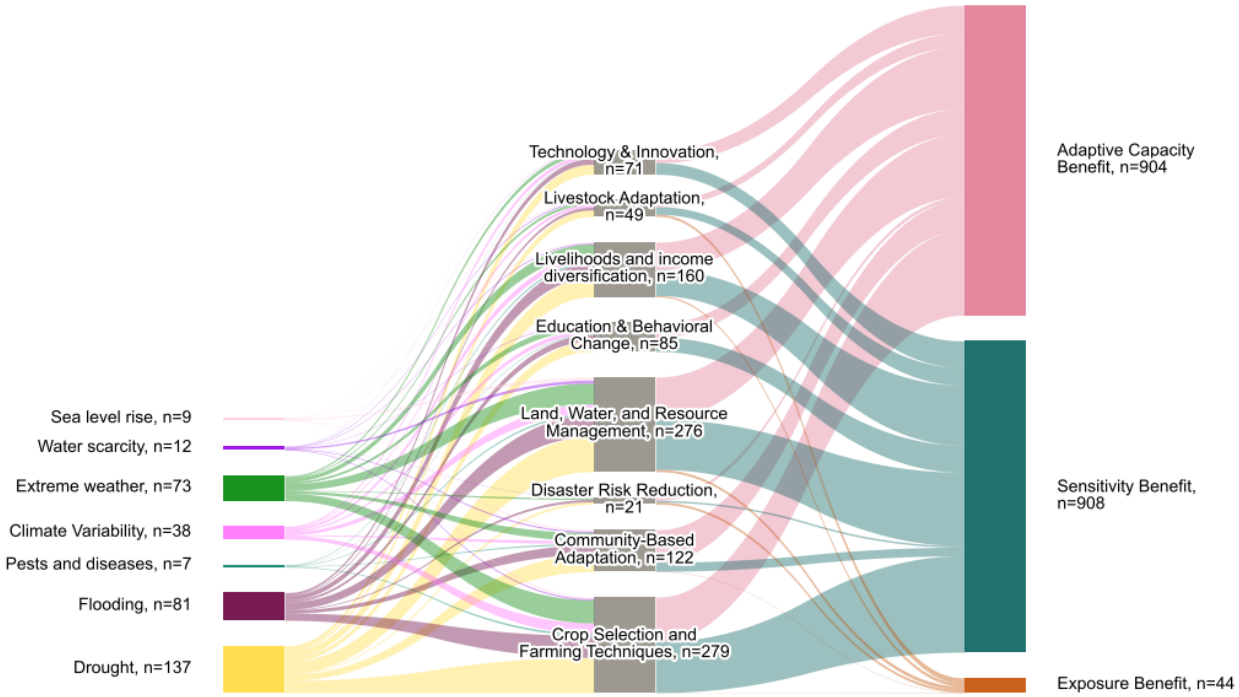

Figure 3: A flow diagram of the overall ILAA adaptation rationales, connecting climate stressors on the left to climate actions (center) and the broad types of adaptation benefit that resulted from these actions.

Disaggregating ILAA actions by the climate stress or risk they were meant to address highlights broad similarity in terms of the distribution of actions taken to address different stressors and the ratio of benefit types delivered by those actions (Figure 4).

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ILAA

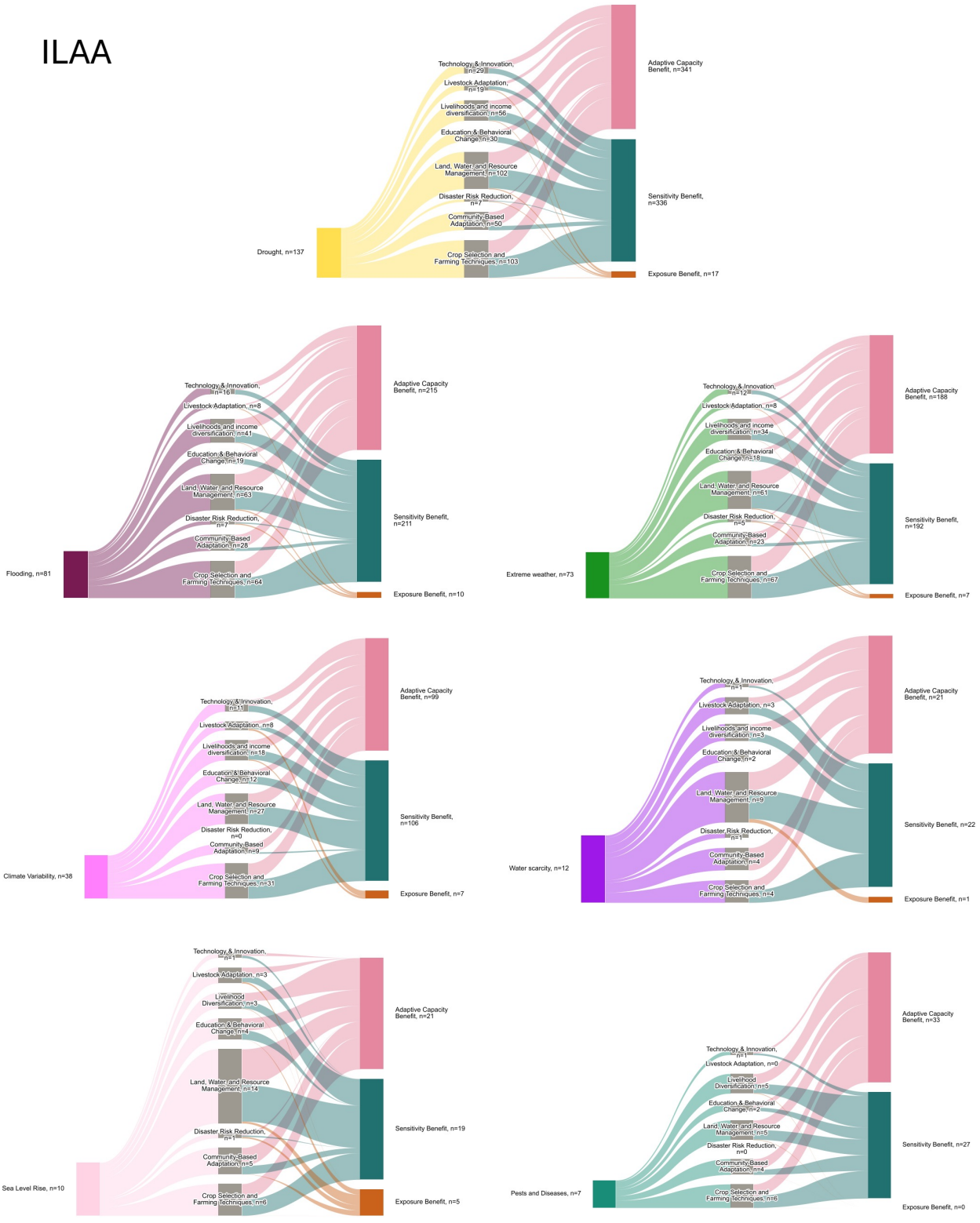

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Figure 4: A visualization of the ILAA rationales associated with each climate stressor in the database.

However, ILAA actions have different levels of efficacy as measured by the number and type of benefits they produce across stressor-specific adaptation rationales (Figure 5).

3.1.1. ILAA and Exposure Benefits

ILAA actions are not delivering many exposure benefits. The most benefits occur in the context of livestock adaptation actions taken to address climate variability. For example, Turner, et al [155], in a study of 32 villages across Niger and Mali, found that residents of these villages relied on extra-village mobility of livestock to manage an increasingly variable climate. However, they also noted a seasonality to the exposure benefits provided by this action, where residents counted more advantages than costs during the rainy season (in part because the movement of livestock reduced the risk of crop damage), and more evenly balanced benefits and costs during the dry season. Even in this specific stressor/action combination, only half of these actions return an exposure benefit. Between one quarter and one third of livestock adaptation actions taken to address flooding and drought yielded exposure benefits. Disaster risk reduction actions aimed at addressing drought, flooding, and extreme weather also return an exposure benefit between ¼ and 1/3 of the time. All other ILAA adaptation actions deliver few, if any, exposure benefits.

3.1.2. ILAA and Sensitivity Benefits

ILAA actions produce many sensitivity benefits across actions and stressors. Actions focused on crop selection and farming techniques produce one or more sensitivity benefits per action regardless of the climate stressor they are intended to address. Livelihoods diversification also produces one or more sensitivity benefits per action (there were too few cases of livelihoods diversification applied to water scarcity to assess if sensitivity benefits were produced). Land, water, and resource management actions resulted in fewer sensitivity benefits per action than crop selection and farming techniques, but the difference in benefits delivered between these two sets of action is small and may not be meaningful. Livestock adaptation actions and education and behavioral change actions generate significant sensitivity benefits when addressing drought, flooding, extreme weather, and climate variability. There were too few cases of application of these actions to the other stressors to determine if they were delivering many sensitivity benefits. Disaster risk reduction, community-based adaptation, and technology and innovation actions delivered far fewer sensitivity benefits across the range of climate stressors considered.

ILAA Benefit Delivery

Exposure

	Community-Based Adaptation	Crop Selection and Farming Techniques	Disaster Risk Reduction	Education & Behavioral Change	Land, Water, and Resource Management	Livelihood Diversification	Livestock Adaptation	Technology & Innovation
pests and diseases	*	0.00	*	*	0.00	0.00	*	*
drought	0.00	0.01	0.29	0.00	0.04	0.07	0.32	0.00
flood	0.00	0.00	0.29	0.00	0.05	0.05	0.38	0.00
extreme weather	0.00	0.00	0.40	0.00	0.03	0.03	0.25	0.00
water scarcity	0.00	0.00	*	*	0.11	*	*	*
climate variability	0.00	0.00	*	0.00	0.00	0.11	0.63	0.00
sea level rise	*	0.00	*	*	0.00	0.00	*	*

Sensitivity

	Community-Based Adaptation	Crop Selection and Farming Techniques	Disaster Risk Reduction	Education & Behavioral Change	Land, Water, and Resource Management	Livelihood Diversification	Livestock Adaptation	Technology & Innovation
pests and diseases	*	1.33	*	*	0.60	1.60	*	*
drought	0.22	0.97	0.29	1.03	0.79	1.05	1.11	1.07
flood	0.21	1.05	0.29	0.68	0.76	1.17	1.00	1.19
extreme weather	0.17	1.01	0.20	1.17	0.69	1.03	0.88	1.17
water scarcity	0.00	1.50	*	*	0.89	*	*	*
climate variability	0.11	0.87	*	1.00	0.93	0.94	1.38	1.18
sea level rise	*	0.83	*	*	0.88	0.83	*	*

Adaptive Capacity

	Community-Based Adaptation	Crop Selection and Farming Techniques	Disaster Risk Reduction	Education & Behavioral Change	Land, Water, and Resource Management	Livelihood Diversification	Livestock Adaptation	Technology & Innovation
pests and diseases	*	1.50	*	*	1.00	1.40	*	*
drought	0.72	0.84	0.57	0.97	0.71	1.13	0.89	0.00
flood	0.93	0.92	0.43	0.68	0.67	1.17	0.63	1.19
extreme weather	0.61	0.87	0.60	1.11	0.62	1.09	0.63	1.08
water scarcity	0.50	1.25	*	*	0.56	*	*	*
climate variability	0.67	0.77	*	0.83	0.67	1.00	1.13	1.27
sea level rise	*	0.83	*	*	0.25	0.83	*	*

Total

	Community-Based Adaptation	Crop Selection and Farming Techniques	Disaster Risk Reduction	Education & Behavioral Change	Land, Water, and Resource Management	Livelihood Diversification	Livestock Adaptation	Technology & Innovation
pests and diseases	*	2.83	*	*	1.60	3.00	*	*
drought	0.94	1.83	1.14	2.00	1.54	2.25	2.32	1.07
flood	1.14	1.97	1.00	1.37	1.48	2.39	2.00	2.38
extreme weather	0.78	1.88	1.20	2.28	1.34	2.15	1.75	2.25
water scarcity	0.50	2.75	*	*	1.56	*	*	*
climate variability	0.78	1.65	*	1.83	1.59	2.06	3.13	2.45
sea level rise	*	1.67	*	*	1.13	1.67	*	*

Figure 5: ILAA effectiveness, as measured by the number and type of adaptation benefits delivered per adaptation action taken. Each cell represents the number of benefits

delivered by a specific action (across the top of each grid) for a specific climate stressor (the vertical axis of each grid). Combinations for which there are fewer than five cases, marked by an asterisk in the cell, were excluded.

3.1.3. ILAA and Adaptive Capacity Benefits

ILAA actions focused on livelihoods diversification, crop selection and farming techniques, land, water, and resource management, and community-based adaptation produce adaptive capacity benefits across all or nearly all climate stressors (crop selection and farming techniques, when applied to water scarcity, is an exception). Education and behavioral change actions deliver the largest number of adaptive capacity benefits per action, but there are too few cases to assess the production of benefits when addressing pests and diseases, water scarcity, and sea level rise. Livestock adaptation actions delivered adaptive capacity benefits for drought, extreme weather, and climate variability but few benefits in the context of flooding. Technology and innovation, along with disaster risk reduction actions, delivered the lowest number of adaptive capacity benefits per action.

3.1.4. ILAA and Adaptation Benefits Overall

Overall, the ILAA actions that delivered the greatest number of adaptation benefits were livelihoods diversification, crop selection and farming techniques, land, water, and resource management, and livestock adaptation. Education and behavioral change actions also delivered significant benefits per adaptation action, but there are relatively few cases of these actions documented in the CGIAR database. Community-based adaptation is

marked by a large divergence between the sensitivity benefits delivered (low) and the adaptive capacity benefits delivered (on par with other effective categories of action, such as crop selection and farming techniques). Disaster risk reduction and technology and innovation delivered the least adaptation benefits across nearly all climate stressors.

3.2. Planned agrarian adaptation actions

The 302 papers addressing planned adaptation reported 650 climate stressors. The most addressed stressor was drought (40.5%), followed by extreme weather (21.2%), and floods (20.6%). All other stressors were less than 10% of those reported. These stressors were addressed by 1118 total adaptation actions.

Globally, the most common planned adaptation actions were climate-smart agriculture (25.3% of all actions in the dataset), ecosystem-based adaptation (25.2%), and education and behavioral change (13.5%), with all other actions each making up 10% or less of the total. Most of these actions were not designed with or by those they were intended to benefit. Instead, they were often introduced and incentivized as responses to challenges identified by actors outside the communities in which they were implemented.

Of all planned adaptation actions captured in the dataset, 1043 (93.3%) delivered a total of 2576 adaptation benefits (Figure 6). Adaptive capacity benefits were the most delivered (59.1%). Sensitivity benefits (39.9% of all benefits) were also delivered in significant numbers. Only 1% of all benefits derived from planned adaptation actions were exposure benefits.

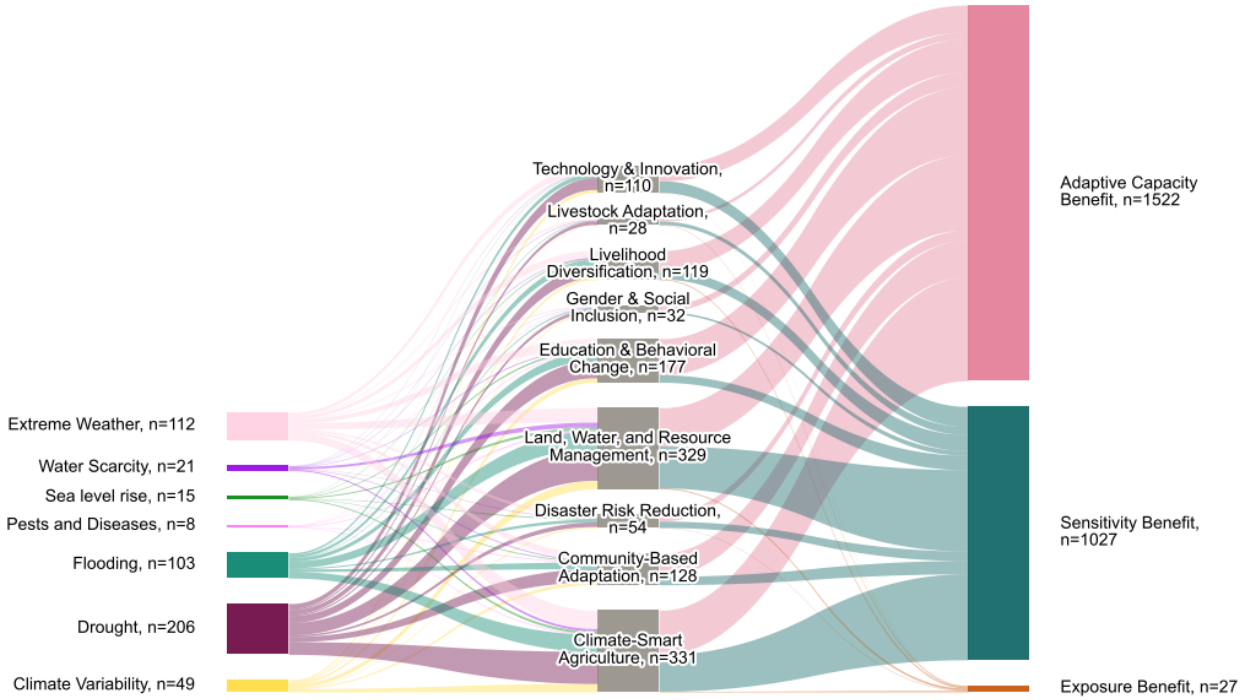

Figure 6: A flow diagram of the overall planned adaptation rationales, connecting climate stressors on the left to climate actions (center) and the broad types of adaptation benefit that resulted from these actions.

The planned adaptation rationales associated with the seven climate stressors show greater variability in the selection of actions taken to address different stressors than seen in ILAA adaptation rationales. These different portfolios of action, however, produced remarkably consistent ratios of adaptation benefits (Figure 7).

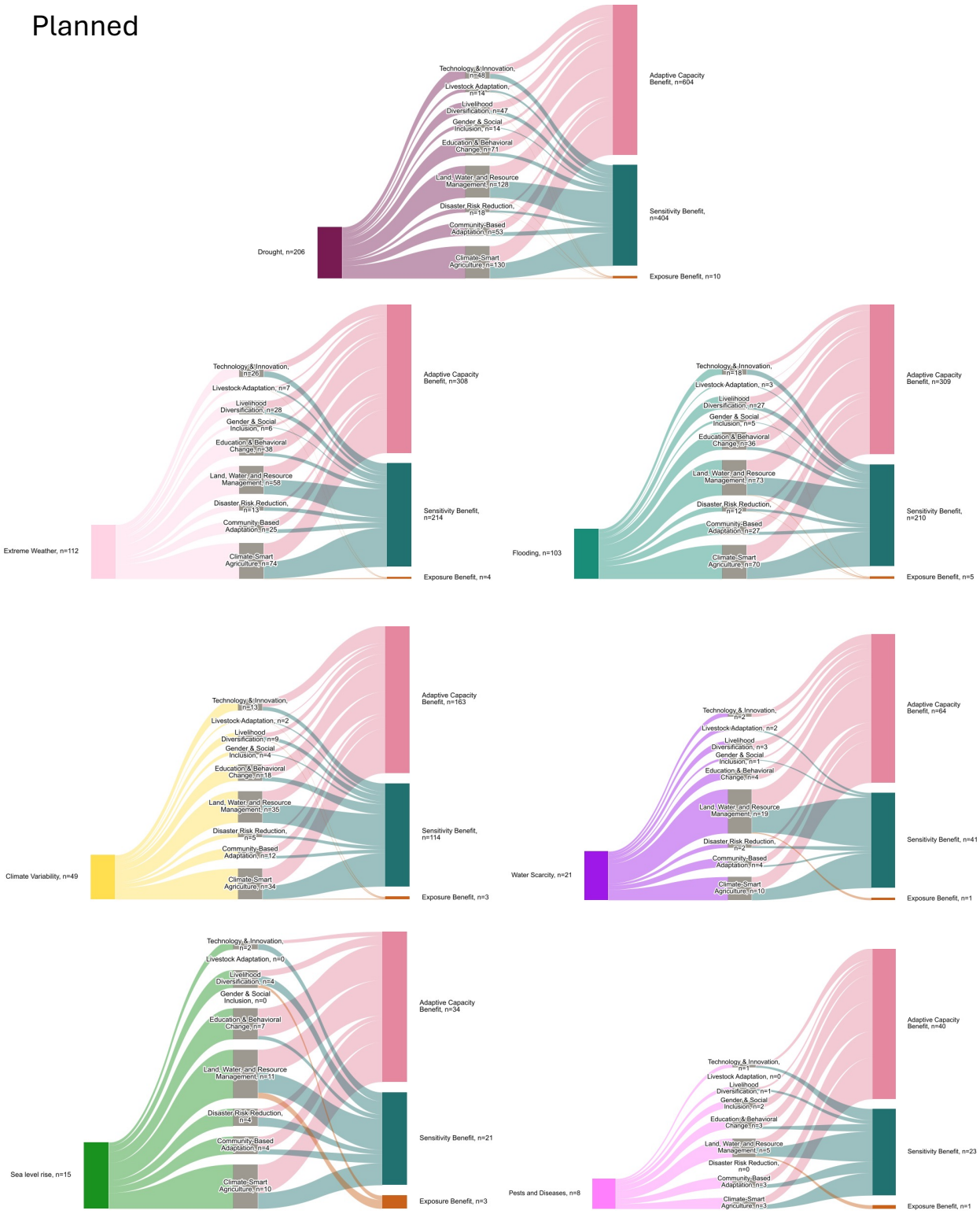

Figure 7: A visualization of the planned adaptation rationales associated with each climate

stressor in the database.

As with ILAA actions, planned adaptation actions have different levels of efficacy as measured by the number and type of benefits they produce across stressor-specific adaptation rationales (Figure 8).

Planned Adaptation Benefit Delivery

Exposure

	Climate-Smart Agriculture	Community-Based Adaptation	Disaster Risk Reduction	Education & Behavioral Change	Gender and Social Inclusion	Land, Water, and Resource Management	Livelihood Diversificatio n	Livestock Adaptation	Technology & Innovation
pests and diseases	0.00	0.00	*	0.00	*	0.20	*	*	*
drought	0.02	0.00	0.06	0.00	0.00	0.02	0.04	0.14	0.02
flood	0.01	0.00	0.08	0.00	0.00	0.03	0.04	0.00	0.00
extreme weather	0.03	0.00	0.00	0.00	0.00	0.00	0.04	0.14	0.00
water scarcity	0.00	*	*	0.00	*	0.05	*	*	*
climate variability	0.03	0.00	0.00	0.00	*	0.00	0.11	*	0.00
sea level rise	0.00	*	*	0.00	*	0.18	*	*	*

Sensitivity

	Climate-Smart Agriculture	Community-Based Adaptation	Disaster Risk Reduction	Education & Behavioral Change	Gender and Social Inclusion	Land, Water, and Resource Management	Livelihood Diversificatio n	Livestock Adaptation	Technology & Innovation
pests and diseases	2.00	1.00	*	0.67	*	1.60	*	*	*
drought	1.02	0.45	0.78	0.32	0.57	0.98	0.51	1.29	0.71
flood	1.01	0.33	0.67	0.31	0.80	1.00	0.59	0.67	0.89
extreme weather	1.09	0.44	0.77	0.29	0.50	1.02	0.50	1.00	0.69
water scarcity	1.50	*	*	0.00	*	1.11	*	*	*
climate variability	1.09	0.33	0.80	0.61	*	1.00	0.78	*	0.69
sea level rise	0.50	*	*	0.14	*	0.64	*	*	*

Adaptive Capacity

	Climate-Smart Agriculture	Community-Based Adaptation	Disaster Risk Reduction	Education & Behavioral Change	Gender and Social Inclusion	Land, Water, and Resource Management	Livelihood Diversificatio n	Livestock Adaptation	Technology & Innovation
pests and diseases	3.67	2.33	*	2.33	*	1.60	*	*	*
drought	1.20	1.17	0.89	1.54	1.79	0.91	1.15	1.07	1.04
flood	1.23	1.15	0.92	1.50	2.20	0.97	1.19	0.33	0.67
extreme weather	1.22	1.04	0.62	1.61	1.67	0.95	1.11	0.86	0.81
water scarcity	1.80	*	*	1.25	*	1.05	*	*	*
climate variability	1.44	1.08	0.80	1.78	*	0.69	1.00	*	1.46
sea level rise	0.90	*	*	1.14	*	0.73	*	*	*

Total

	Climate-Smart Agriculture	Community-Based Adaptation	Disaster Risk Reduction	Education & Behavioral Change	Gender and Social Inclusion	Land, Water, and Resource Management	Livelihood Diversificatio n	Livestock Adaptation	Technology & Innovation
pests and diseases	5.67	3.33	*	3.00	*	3.40	*	*	*
drought	2.24	1.62	1.72	1.86	2.36	1.91	1.70	2.50	1.77
flood	2.26	1.48	1.67	1.81	3.00	2.00	1.81	1.00	1.56
extreme weather	2.34	1.48	1.38	1.89	2.17	1.97	1.64	2.00	1.50
water scarcity	3.30	*	*	1.25	*	2.21	*	*	*
climate variability	2.56	1.42	1.60	2.39	*	1.69	1.89	*	2.15
sea level rise	1.40	*	*	1.29	*	1.55	*	*	*

Figure 8: Planned adaptation effectiveness, as measured by the number and type of adaptation benefits delivered per adaptation action taken. Each cell represents the number of benefits delivered by a specific action (across the top of each grid) for a specific

climate stressor (the vertical axis of each grid). Combinations for which there are fewer than five cases, marked by an asterisk in the cell, were excluded.

3.2.1. Planned Adaptation and Exposure Benefits

Almost no planned adaptation actions captured in the CGIAR database delivered meaningful exposure benefits.

3.2.2. Planned Adaptation and Sensitivity Benefits

Overall, planned adaptation actions delivered a lower return of sensitivity benefits per action than seen in ILAA. Areas of strength for planned adaptation actions include land, water, and resource management actions and climate-smart agriculture actions, particularly in the context of flooding, extreme weather, water scarcity, and climate variability. Livestock adaptation delivered one or more sensitivity benefits when addressing drought and extreme weather. It delivered fewer benefits in the context of other stressors.

All other actions delivered less than one adaptation benefit per action across all stressors. Education and behavioral change actions and community-based adaptation delivered less than one half of an adaptation benefit per action across all stressors. Livelihoods diversification, disaster risk reduction, and gender and social inclusion actions delivered slightly more benefits per action, but still well under one benefit per action across all stressors.

3.2.3. Planned Adaptation and Adaptive Capacity Benefits

Relative to other types of adaptation benefits, planned adaptation actions overall delivered much higher numbers of adaptive capacity benefits. The most effective, in terms of benefits per action, were gender and social inclusion actions. However, there were only enough cases of these actions to enable evaluation for drought, flooding, and extreme weather. Climate smart agriculture actions, community-based adaptation actions, education and behavioral change actions, and livestock adaptation actions all delivered more than one adaptation benefit per action across all climate stressors for which there were more than five cases. The one exception was education and behavioral change efforts applied to water scarcity, which delivered fewer than one benefit per action. Land, water, and resource management actions delivered close to one benefit per action across nearly all climate stressors, with the lone exception being climate variability. Technology and innovation delivered nearly 1.5 adaptive capacity benefits per action for water scarcity and climate vulnerability, and greater than one benefit per action for drought. Only disaster risk reduction actions delivered less than one benefit per action across stressors

3.2.4. Planned Adaptation and Adaptation Benefits Overall

Most planned adaptation actions, regardless of category or climate stressor, produced at least one adaptation benefit per action taken. As a portfolio, planned adaptation actions emphasized the delivery of adaptive capacity benefits over exposure and sensitivity benefits. The one category of action that is an exception is land, water and resource management actions, which deliver slightly more sensitivity benefits than adaptive capacity benefits across nearly all climate stressors. This suggests that planned agrarian adaptation, while responsive to the immediate needs of small producers under climate

change (and thus the delivery of sensitivity benefits), has a core focus on delivering adaptive capacity benefits that are most effective at addressing longer-term trends and concerns associated with each stressor.

4. Discussion

Assessments of climate impacts on agrarian systems and populations demonstrate the pressing need for effective agrarian adaptation, while the exposure of agrarian populations and livelihoods to further changes in precipitation and temperature promise to make this need an ongoing challenge. The assessment of agrarian adaptation effectiveness presented in this article demonstrates that studies of implemented adaptation contain lessons about what works when addressing different climate stressors if, within each case, we can build meaningful adaptation rationales connection climate shocks/stressors/impacts, the actions taken to address them, and the adaptation benefits (if any) associated with those actions.

Our assessment of the CGIAR database suggests that the IPCC's assessment that "Most observed adaptation is fragmented, small in scale, incremental, sector-specific, designed to respond to current impacts or near-term risks, and focused more on planning rather than implementation" [7] is not fully accurate for agrarian adaptation. First, this assessment captures over 400 cases of implemented adaptation, and at least in the CGIAR database, the attention to implemented adaptation is greater than the attention to planning for adaptation (though planning is clearly a point of significant focus in the dataset). This may

be explained by the nature of CGIAR's mission, which is to provide research and innovation support for implementation of agricultural development initiatives by national governments, donors or NGOs, and increasingly, those relate to climate change related adaptation. Second, while a great deal of ILAA is small-scale and incremental, aimed at addressing near-term sensitivity to climate stressors, planned adaptation's focus on adaptive capacity suggests a focus on longer-term stresses and outcomes. Our assessment supports the argument that most observed adaptation is incremental, but we explain below why this is the case in agrarian settings.

Our assessment highlights critical divergences between ILAA and planned adaptation rationales that could stand in the way of the design and implementation of impactful adaptation actions. However, this assessment also suggests opportunities for research and practice that can increase the effectiveness and impact of adaptation action.

4.1. Explaining Patterns of ILAA Benefits

The form of these rationales and their outcomes reflect a broader logic of agrarian and small-producer livelihoods broadly characterized as a subsistence ethic [160–163], where that ethic informs a broader logic of livelihoods as a means of not only meeting material needs, but defining and reinforcing individual, household, and community structures of authority and power [164–166]. Therefore, we expect decision-makers, who are often heads of households, extended family production units, or communities, to prioritize actions that align with and reinforce existing roles and responsibilities. This expectation is borne out in the data.

In the case of most stressors, more than half of all ILAA actions are focused on agricultural adaptations and ecosystem-based adaptations. This reflects a convergence of factors. First, these actions represent things that small producers can control through their own decision-making and often through the mobilization of existing or accessible assets. Second, these tend to be incremental adaptations that operate within existing livelihoods structures without disrupting the social order and its relations of authority and power.

This logic explains the contrast between the most adopted ILAA actions across climate stressors and the actions that delivered the greatest number of adaptation benefits per action. In this dataset, crop selection and farming techniques, and land, water, and resource management, are the two most commonly implemented categories of action. However, they are not the categories of action that yield the greatest number of benefits per action. They deliver 80% of the benefits per action associated with more effective activities such as livestock adaptation, livelihoods diversification, and education and behavioral change. Those more effective activities make up only 4%, 15%, and 9% of all actions taken, respectively. This contrast reflects the fact that some of the actions delivering the greatest number of benefits are those that might also result in challenges to or transformations of the social order. Livelihoods diversification and education and behavioral change are two categories of activity likely to open opportunities for new roles and responsibilities within society and change the status-quo.

The logic of agrarian livelihoods decision-making also explains the very close ratio of sensitivity benefits to adaptive capacity benefits seen in ILAA actions. The two dominant categories of ILAA action, crop selection and farming techniques and land, water, and

resource management, deliver slightly more sensitivity benefits than adaptive capacity benefits. These benefits are important for addressing the immediate, pressing needs of agrarian producers. While adaptive capacity benefits producers as well, those actions which generated a larger number of adaptive capacity benefits than sensitivity benefits, such as community-based adaptation actions (12% of the total), education and behavioral change actions (9% of the total), technology and innovation (6% of the total), and disaster risk reduction actions (2% of the total), were implemented less frequently than those providing a greater number of sensitivity benefits. This may be a product of resource constraints, as the resources needed for building adaptive capacities are likely to be higher than those needed for providing sensitivity benefits. However, this pattern may also reflect the fact that increased adaptive capacity is not necessarily a desirable outcome for ILAA decision-makers. First, building adaptive capacity often has fewer immediate benefits than decreasing sensitivity and exposure. Second, reluctance to invest in adaptive capacity in ILAA may also result from local leaders who perceive it as a threat to their existing privileges [165].

4.2. Explaining Patterns of Planned Adaptation Benefits

Planned adaptation actions show efficacy in delivering adaptation benefits across all domains, but most of these benefits accrue to adaptive capacity. Adaptive capacity, while important for addressing immediate challenges linked to climate change such as climate variability, also has potential to catalyze transformative change in agrarian systems experiencing climate stresses. Despite this potential, planned adaptation work focuses on

incremental changes in small producer systems. For example, there are few actions aimed at livelihoods diversification or gender and social inclusion in the planned adaptation dataset.

While it is difficult to know the exact reasons why planned adaptation results in a portfolio of relatively incremental actions without detailed, case-level evidence, there is strong circumstantial evidence to support the argument that this pattern of benefits emerges from the interplay of planned adaptation actions and the decision-making of individuals and communities who interact with and shape the uptake and impact of these actions. Specifically, as noted in the discussion of ILAA above, agrarian decision-makers lack incentives to adopt transformative actions. While this explains why ILAA actions tend to be incremental, planned adaptation actions are developed in formal contexts, often at some distance from the communities and individuals they are supposed to benefit. Therefore, we should expect that planned adaptation actions might have a greater emphasis on potentially transformative actions, if only because their designers operate without the disincentives that mark ILAA decision-making. Further, some of the actions that most effectively deliver adaptive capacity are those which have substantial potential for catalyzing and supporting transformative change. However, these are not the actions emphasized by planned adaptation. Instead, the focus of increasing adaptive capacity is on improving existing livelihoods decisions through the provision of information and training and improving the outcomes of agricultural livelihoods through the introduction of new technologies and farming techniques. Further, when potentially transformative planned adaptation actions are implemented, they tend to deliver few adaptation benefits.

For example, education and behavioral change actions, while the third most-implemented category of actions in planned adaptation efforts, delivered relatively few adaptation benefits compared to climate smart agriculture and ecosystem-based adaptation.

There may be several reasons for lack of adaptation actions of a more transformative nature. First, in low-income agrarian contexts, transformation often involves diversification of livelihoods away from agriculture. CGIAR's focus is on agriculture, and its researchers are less likely to focus on non-agriculture-based livelihoods diversification, which may have more possibilities of transformation than agricultural investments alone. Second, transformative change within agricultural sector (e.g. entirely new crops, value chains, new markets) may require larger investments than many existing projects can make. The lack of transformative initiatives may reflect a lack of resources invested in this sector. Third, households and communities have actors who are invested in the status quo and therefore may have little interest in transformative actions that put their status and privileges at risk.

4.3. What Works in Agrarian Adaptation: A Preliminary Assessment

Broadly speaking, this assessment suggests the following preliminary lessons about agrarian adaptation effectiveness.

1. There is little evidence that either planned or ILAA actions effectively deliver exposure benefits. Exposure is extremely challenging to address in agrarian contexts: farmers cannot simply move themselves and their farms to new locations. This is why the greatest benefits emerge in the context of livestock adaptation, which includes pastoral

groups and others that can move animals to new locations where the climate stress is not present or is reduced.

2. Both ILAA and planned agrarian adaptation are heavily focused on drought, flooding, and extreme weather. Less attention has been paid to climate variability. In the context of ILAA, this reporting may reflect limited evidence that farmers living with climate variability consider this part of their baseline situation to be addressed through everyday livelihoods decisions, rather than a challenge requiring specific adaptation actions [167–169]. Other stressors have very limited cases. We expect that this will change in the future, as extreme heat and heat stress are increasingly affecting agricultural production in many parts of the Global South.
    a. ILAA adaptation has historically been effective for delivering adaptation benefits in the context of drought, flooding, climate variability, changes in pests and diseases, and climate extremes through on-farm actions, changes in land, water, and resource management, and livelihoods diversification. ILAA livestock adaptation actions have also been quite effective in delivering adaptation benefits in the context of flooding, drought, extreme weather, and climate variability. ILAA actions tend to deliver a balanced mix of sensitivity and adaptive capacity benefits.
    b. Planned agrarian adaptation is broadly effective at delivering adaptation benefits across all stressors considered in this assessment. Planned land, water, and resource management actions, along with actions aimed at gender and social inclusion, are the most effective at delivering adaptation benefits. These actions

tend to deliver greater levels of adaptive capacity benefits than sensitivity benefits, though planned land, water, and resource management actions deliver slightly greater numbers of sensitivity benefits than adaptive capacity benefits.

3. On-farm adaptation actions, whether indigenous and local decisions about variety selection or planned adaptation efforts to introduce new seeds and farming techniques, deliver adaptation benefits. However, planned adaptation actions are most effective at delivering adaptive capacity benefits, while ILAA actions deliver a balance of sensitivity and adaptive capacity benefits.
4. Community-based adaptation activities and education and behavioral change activities, whether from ILAA or planned adaptation sources, are more effective at delivering adaptive capacity benefits than sensitivity benefits.
5. The choice of adaptation action is not entirely linked to efficacy, at least as measured by the delivery of adaptation benefits. For example, for both ILAA and planned agrarian adaptation, livelihoods diversification is as effective or more effective at delivering sensitivity and adaptive capacity benefits than many on-farm or resource management actions. However, ILAA livelihoods diversification actions are implemented at only 60% of the rate of ILAA on-farm and resource management actions. Planned livelihoods diversification actions are implemented at only 30% of the rate of planned on-farm and resource management actions. This reflects the fact that the process of adaptation decision-making is not only about selecting actions that deliver the greatest number of benefits, but also selecting actions that effectively balance the need for adaptation benefits with decision-makers' priorities (e.g. CGIAR projects focus on agricultural

livelihoods and not necessarily on off-farm diversification), resource availability (transformative change may need resources which are not readily available with communities or implementors) and the desire to maintain the existing social order on the part of powerful actors at the community and household levels.

4.4. Diverging Agrarian Adaptation Rationales

ILAA actions and planned adaptation actions address similar stressors at similar rates (Figures 4 and 7). In this dataset, both principally addressed drought, with flooding and extreme weather secondary concerns. This suggests a high level of alignment between ILAA needs and those identified by planned adaptation. Superficially, it also appears that ILAA and planned agrarian adaptation select similar actions to address these stressors and do so at similar rates with a few exceptions. For example, planned adaptation emphasizes education and behavioral change to a much greater extent than ILAA, while ILAA engages with livelihoods diversification much more often than planned adaptation. Planned adaptation focused more on formal agricultural interventions in the form of climate-smart agriculture and technology and innovation, while ILAA rests more heavily on local on-farm knowledge and practice.

This superficial similarity is belied by the divergence in the adaptation benefits these two broad adaptation rationales deliver. As a global portfolio, ILAA actions deliver similar amounts of sensitivity and adaptive capacity benefits, while planned adaptation actions deliver more adaptive capacity benefits than sensitivity benefits. However, this difference in outcome is larger than a simple comparison of percentages of benefit might suggest.

Planned adaptation activities tend to focus more *directly* on adaptive capacity benefits, such as by delivering trainings or enhanced capabilities via agricultural extension. On the other hand, many adaptive capacity benefits associated with ILAA actions are *incidental* to realizing other benefits. For example, the reduction of the sensitivity of agricultural production to decreasing rainfall might involve adopting new land management techniques to maximize soil moisture. While these techniques directly reduce the sensitivity of agricultural production to this climate stressor, understanding why such interventions work creates adaptive capacity by introducing farmers to a broader logic of soil management that might be applied to other stressors in the future. Therefore, the number of adaptive capacity benefits generated by ILAA actions likely overstates the importance of adaptive capacity benefits in the adaptation rationales behind these actions.

This divergence in outcomes reflects a fundamental divergence in the adaptation rationales that inform ILAA and planned agrarian adaptation. Where planned adaptation focuses on longer-term challenges and needs, ILAA emphasizes addressing current challenges. This means that while these two broad adaptation arenas are aligned in many ways, such as in their focus on implementing on-farm actions and resource management actions, these activities are means to different ends. We cannot assume that climate-smart agricultural interventions are necessarily complementary to ILAA shifts in crop selection and farming techniques. Instead, there is a risk that the long-term focus of many climate-smart agricultural interventions will negatively impact the short-term sensitivity benefits realized through ILAA actions. Understanding the different adaptation rationales that inform the actions selected to address a given stressor, and the benefits derived from

that action, is critical to aligning planned and ILAA adaptation to avoid maladaptive outcomes.

4.5. Opportunities for Convergence to Improve Agrarian Adaptation Effectiveness

The divergent adaptation rationales that inform ILAA and planned agrarian adaptation produce similar incremental outcomes because most planned adaptation does not consider the logics of the agrarian livelihoods that shape the outcomes of their efforts. This demonstrates a lesson that is well-understood in both the development studies and development community of practice: designing and implementing interventions that impose actions, technologies, and goals on individuals and communities tends to result in low rates of adoption and even perverse outcomes. However, the assessment of agrarian adaptation effectiveness in this article highlights points of contact between ILAA and planned adaptation that can be mobilized to improve adaptation effectiveness and impact, while enabling the development of transformative pathways toward a more just and sustainable future.

The characterization of ILAA that emerges from this assessment aligns closely with research on agrarian livelihoods which suggests that these livelihoods balance the need for material security with broader social goals [170–172], particularly the desire of decision-makers to retain their privileged positions in households and communities [164]. This suggests that an uncritical approach to the valorization of locally led adaptation is unlikely to result in effective adaptation. Instead, adaptation actions developed by communities

that yield the largest number of sensitivity benefits, if not all adaptation benefits, are likely to be those whose greatest strength lies in one or two characteristics: their ability to reinforce existing social orders, rather than their ability to address the widest set of needs in the community, or their ability to be implemented with minimal resources.

This assessment suggests that the key goal of ILAA rationales is to reduce the sensitivity of existing activities (and their attendant social orders) to climate stressors. This is an inherently incremental approach to adaptation ill-suited to contexts of rapid change in climate variability or other conditions or where conditions are departing the historical biophysical basis of production. Such systems will require transformation to ensure the viability of both people and production in the future. Imposing transformative change on these systems is unlikely to generate lasting change, as agrarian livelihoods are very resilient to externally imposed change [166]. However, by aligning planned adaptation actions with a longer-term transformative goal with the goals of agrarian livelihoods through an initial emphasis on sensitivity benefits is likely to generate the levels of material and social security that allow for the emergence of pathways marked by the uptake of new practices, activities, and eventually roles and social structures. All contexts are marked by innovators who understand how to introduce new practices or activities in a manner acceptable to the households and communities in which they live [166]. Identifying and learning from these innovators to better understand what sorts of sensitivity-focused interventions might address key vulnerabilities such that increasing adaptive capacity and changing social structures are no longer threats to be managed, but opportunities to be realized, appears to be a key component of effective co-production.

At the same time, the dataset assessed in this article suggests that there are individuals in indigenous and local contexts who can implement activities, such as those associated with education and behavioral change, in a manner that is socially acceptable and which delivers adaptation benefits. The often-limited number of these actions relative to others which deliver fewer adaptation benefits per adaptation action, and which are likely to result in incremental changes that support the perpetuation of existing social structures, offers an opportunity for mutual benefit. Planned adaptation practitioners can learn how to design and present effective but potentially threatening adaptation actions to decision-makers in a manner that renders these actions acceptable. Local actors might benefit from leveraging the greater resources and networks of planned adaptation practitioners to implement and scale up their chosen actions. For example, while there are relatively few ILAA behavioral change and education efforts, those that exist tend to deliver many benefits. Farmers and others who develop such initiatives within agrarian communities and households do so with an understanding of what efforts can generate value without creating concerns among decision-makers that limit uptake. This suggests that the co-production of planned adaptation actions aimed at behavioral change and education with communities is likely to inform project and activity design in a manner that increases uptake and delivers greater benefits. Similarly, planned adaptation efforts aimed at livelihoods diversification risk low uptake if they overtly threaten changes to the existing social order. However, the presence of livelihoods diversification efforts in ILAA suggests it is possible to present such actions in a way that does not threaten decision-makers such that uptake is limited.

5. Future Directions

If agrarian adaptation is to meet the needs of those living in and dependent upon agrarian systems – and much of the world's population is either directly or indirectly dependent on these systems – it must not only understand what actions appear to reduce exposure, lower sensitivity, or increase adaptive capacity, but also why particular actions do or do not produce these results. This initial assessment of agrarian adaptation effectiveness, by suggesting preliminary adaptation rationales for ILAA and planned agrarian adaptation takes a substantial step in this direction. In so doing, it opens a number of questions for future research that will further our understanding of what works in agrarian adaptation.

First, the strong convergence of ILAA and planned adaptation around on-farm actions and resource management presents opportunities for detailed case studies where existing ILAA actions overlap with implemented planned agrarian adaptation actions. Such cases can evaluate the extent to which the ILAA and planned actions complement or compromise one another and why. While the longer-term focus of planned adaptation might present challenges to shorter-term ILAA goals, it is also possible that these two arenas of adaptation action and their goals might be aligned to meet both short- and longer-term needs where they are implemented.

Second, this assessment rests on a simple presence/absence measure of adaptation benefits resulting from adaptation actions. However, such measures might misinform policy if, for example, those which deliver the greatest number of benefits per action do so to very small numbers of people. Developing meaningful measures of the value of

adaptation benefits, whether that be in economic terms, in terms of the number of people benefiting, or some other metric, is critical for deepening our understanding of adaptation effectiveness. Future research will provide substantial nuance for the broad, coarse picture of effectiveness presented in this assessment, and may change some ideas about what works in agrarian adaptation.

Third, where adaptation benefits are delivered, who receives these benefits? The distribution of benefits is as important as their presence or absence when evaluating their impact and effectiveness. For example, if education and behavioral change actions produce many benefits, but those are only realized by existing decision-makers and authority figures, the impact of these actions might be limited. Further, understanding the distributional aspects of adaptation benefits will deepen our understanding of how the logics of agrarian livelihoods inform adaptation action. While the evidence in this assessment strongly suggests that ILAA actions reflect these logics, greater nuance in terms of who benefits from different adaptation actions will either confirm or challenge this initial explanation for the patterns of adaptation effectiveness described in this article.

Finally, as this assessment has demonstrated, there are many combinations of adaptation action and climate stressor – in both ILAA and planned agrarian adaptation – for which we our dataset had either no cases, or too few cases to make reliable claims about effectiveness. In particular, we have little evidence for what works to address pests and diseases, water scarcity, and sea level rise. Whether such cases exist and simply need to be documented in the literature, or if case study research is needed, filling these gaps will help deepen our understanding of agrarian adaptation effectiveness.

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