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Resilience Monetization and Credits Initiative

A Background Paper

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James E. Rogers Energy Access Project at Duke

Established in 2017, the James E. Rogers Energy Access Project at Duke (EAP) works with policy makers, entrepreneurs, scholars, and other stakeholders to support evidence-based decision-making to alleviate energy poverty. EAP prepares tomorrow's leaders, locally and globally, while supporting the development of new, disruptive tools and models that break down barriers to improved energy access. Building on Duke's excellence as a premier interdisciplinary research university and hub of international collaboration, EAP brings world-class researchers to bear on the highest priority questions of the day to drive energy system development and low-carbon transformation. EAP is a collaboration among Duke University's Nicholas Institute for Energy, Environment & Sustainability, Nicholas School of the Environment, Sanford School of Public Policy, and Bass Connections.

International Fund for Agricultural Development

International Fund for Agricultural Development (IFAD) is an international financial institution and a United Nations–specialized agency. Based in Rome, IFAD invests in rural people, empowering them to reduce poverty, increase food security, improve nutrition, and strengthen resilience. Since 1978, we have provided more than US$24 billion in grants and low-interest loans to fund projects in developing countries.

Ministry of International Cooperation

The Egyptian Ministry of International Cooperation is the national designated entity responsible for developing and strengthening economic cooperation with multilateral and bilateral development partners, including United Nations specialized agencies and international and regional organizations.

It is responsible for proposing the criteria for obtaining external financing; managing, monitoring, and evaluating the disbursement of concessional finance to ensure the optimal utilization of resources; advancing the country's development agenda; and achieving sustainable economic growth. Aligned with this mission, the Ministry is dedicated to fostering strong partnerships through a country-led, multi-stakeholder engagement framework for international cooperation and development financing with development partners, the private sector, and civil society to support the national development agenda, in line with the principles of effective development cooperation. These partnerships are guided by overarching cooperation strategies that are often informed by insights drawn from various evaluations. They aim to maximize socioeconomic returns from official development assistance, ensure alignment of development interventions with national objectives as well as sustainable development goals, and enhance overall management of development cooperation for effective implementation of development projects in Egypt. Moving beyond conventional partnerships, the Ministry of International Cooperation also aims to advance South-South and Triangular Economic Cooperation to promote sustainable development and climate action through strengthening peer-to-peer learning and knowledge-sharing and capitalizing on successful practices in sustainable development and climate action to upscale and replicate in other countries

NDC Partnership

The NDC Partnership is a global coalition of countries and institutions collaborating to drive transformational climate action while enhancing sustainable development. The NDC Partnership brings together more than 200 members, including more than 120 countries, developed and developing, and more than 80 institutions to create and deliver on ambitious climate action that help achieve the Paris Agreement and the Sustainable Development Goals.

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Introduction—Why Another Paper on Climate Finance and Resilience?

Addressing climate change requires urgent and innovative action aimed at both mitigating its effects and addressing its most severe impacts. However, current investment levels are insufficient to match the escalating climate risks and damages. Despite the annual target of $100 billion established at the 2009 United Nations Climate Change Conference/Conference of Parties (COP15), climate finance directed to low- and middle-income countries (LMICs) continues to lag behind stated goals. Adaptation efforts are especially underfunded, with investment falling short by a significant margin, estimated at 5 to 10 times the actual need. COP28, held in 2023, highlighted the injustice of climate change and the threat it represents to decades of development efforts, as LMICs sought, and began to receive commitments for, an additional $100 billion from advanced economies to remedy and prevent climate change–related damages .

Several existing financing means aim to spur investment in adaptation at the household and community level. Contract farming mechanisms, for example, aim to reduce uncertainty regarding agricultural output and its value in volatile markets. Other initiatives such as blue carbon credits and other mitigation credits in the voluntary carbon market aim to move beyond reduced carbon emissions. They focus on investing in projects that offer a range of development and resilience benefits, such as coastal ecosystem reforestation, which not only helps in carbon sequestration but also enhances protection against storm damages.

Unfortunately, these mechanisms are collectively falling short of reaching many highly vulnerable and climate-exposed stakeholders in low-income settings. Consequently, while these stakeholders contribute in significant ways to adaptation, they often either receive minimal benefits or none at all from global climate adaptation finance.

This document has been developed as part of an endeavor to propose an innovative solution—the Resilience Monetization and Credit Initiative (RMCI)—aimed at bridging the gap in resources made available to those most urgently in need of climate adaptation finance. Under this initiative, *resilience credits* are introduced as a novel asset class designed to align public and private capital to deliver improved resilience to the communities most vulnerable to climate impacts, while also ensuring equitable benefit sharing.

However, mobilizing climate finance for adaptation and resilience through such a credit presents several challenges. One core difficulty is in agreeing upon how to measure and incentivize enhanced climate resilience and recovery from climate shocks. Unlike the tracking of climate change mitigation efforts, which can be measured in standardized units such as tons of carbon dioxide equivalents that are then valued according to the social cost of carbon, there lacks a consensus methodology for quantifying climate resilience across various sectors, regions, and scales, let alone monetizing it.

A variety of measurement tools and frameworks that focus on different sectors and stakeholders are currently being developed or are already in use. **This document aims to explore several key proposals that have gained traction, analyze their relative pros and cons, and provide an initial recommendation for quantifying resilience (Section 1).**

We employ the agricultural sector as an illustrative example because of its climate vulnerability and significant societal impact; however, the initiative's overarching goal is to ensure scalability and applicability across diverse sectors.

In addition to quantifying resilience, the RMCI will attempt to address the valuation (or monetization) of resilience benefits (Section 2). This area presents an opportunity to develop innovative valuation methodologies that accurately capture the multifaceted benefits of resilience investments, thereby enhancing their attractiveness to the private sector. Another area of focus is the design of a resilience credit market structure (Section 3). While complex, this task offers the chance to create a robust and inclusive market that incentivizes and rewards resilience-building efforts across various stakeholders.

In addressing these aspects, it is important to account for the substantial variation in value added by resilience investments across space, time, and sectors, as well as the diverse array of potential market participants, their interests, and roles. Each actor's perceived value proposition in the credit market must be carefully considered.

This paper is intended to be a living document. Sections 2 and 3 will be further developed as the RMCI progresses, guided by the principles of inclusivity, innovation, and collaboration.

SECTION 1: THE CHALLENGE OF MEASURING RESILIENCE

Resilience can be interpreted in various ways, reflecting the multifaceted nature of the concept.

The Intergovernmental Panel on Climate Change (IPCC) defines resilience as:

> *"The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization and the capacity to adapt to stress and change"* (IPCC 2007).

Similarly, the United Nations defines resilience as:

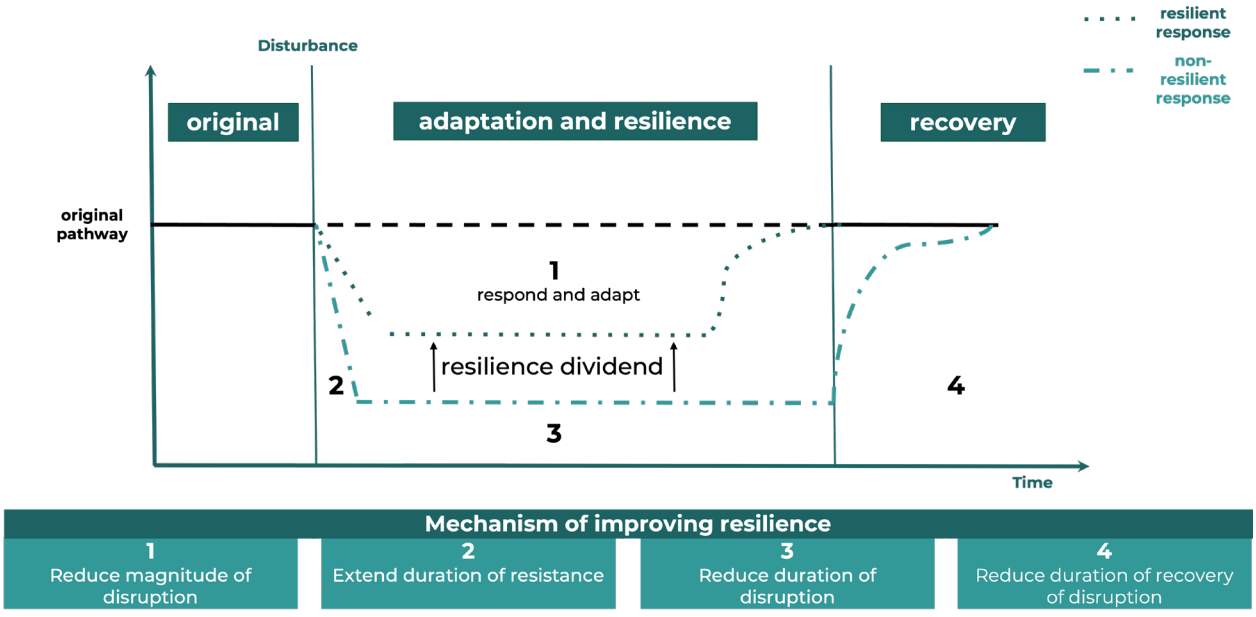
> *"The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management"* (UNISDR 2012).

It is important to note that various institutions may offer distinct definitions of resilience, each reflecting their own unique perspectives. Moreover, resilience is an individual, household, or community attribute that can only be observed after a shock has been realized, by examining the nature and dynamics of the recovery from that shock (Figure 1). In particular, one must be able to answer the following questions to characterize resilience:

- What was the state of well-being of the affected population *before* the shock?
- How *severely* did the shock affect the affected population, or *how great* was the damage?
- Did the population *partially* or *fully* recover from the shock, and eventually return to a similar or even higher state of well-being than the state it was in before the event?
- What was the *length* (or *duration*) of the shock, and what was the rate and duration of recovery from it?

While resilience at the individual and household level is arguably a private benefit that agents (individuals and households) do and should invest in, several problems can lead to suboptimal private investments at this scale. First, many aspects of resilience manifest at the system level, where individual actions may not align with the broader resilience needs of the system. For example, focusing solely on planting high-value crops might increase income for individual farmers, but it can also heighten vulnerability within the agricultural system, especially when the wider impacts (unaccounted-for spillover effects) of such choices are not considered.

Figure 1. Illustrating the resilience dividend



Adapted from International Fund for Agriculture Development [IFAD]

Second, many vulnerable individuals and households, despite facing significant risks, are highly liquidity constrained and lack the financial resources to invest in long-term, often capital-intensive, solutions to enhance resilience. Moreover, cultural norms within households sometimes lead to unequal power dynamics, restricting certain members from making decisions about resilience investments. Third, inadequate information about risks and the effectiveness of different resilience strategies and available solutions complicates investment choices. Lastly, cognitive biases, such as high discount rates or aversion to loss and ambiguity, can impede the adoption of long-term resilience-building measures. These biases may deter individuals from investing in technologies or strategies with uncertain but potentially positive outcomes.

This raises a critical question: how can we mobilize external sources of finance to incentivize investments that are not currently being made and thereby deliver enhanced resilience before additional shocks occur? Addressing this requires a forward-looking investment strategy that identifies who possesses resilience, recognizes the characteristics that contribute to resilience, and demonstrates how these traits can be strengthened through targeted interventions to mitigate the impact of future shocks.

To date, there has been little convergence on a single indicator or measure that adequately captures resilience. Rather, resilience has traditionally been measured by examining various factors and welfare outcomes such as education levels, income, asset ownership, food security, access to early warning systems, availability of climate-smart infrastructure, and access to credit, among others. Resilience measurement tools are also typically designed for specific contexts, such as examining household-level resilience to droughts in agriculture-based communities or studying what constitutes resilience for coastal populations facing risks from sea level rise and storm surge. This localized and sector-specific focus complicates attempts to standardize resilience. Many resilience scholars are, in fact, opposed to even trying to develop generalized measures (Bahadur and Pichon 2017; Jones 2019).

In this section, we provide a brief overview of some existing frameworks for characterizing and measuring resilience, focusing on those most commonly used in empirical studies to offer practical insights. We approach our analysis of these methodologies by assessing whether they satisfy a set of criteria defined through our internal deliberations: simplicity, adaptability, scalability, and parsimony,[1] among others. This overview excludes a large set of theoretical definitions, frameworks, and constructs that appear in this vast area of the literature. We delve into how these different measures have been constructed, highlighting their strengths and limitations. Key aspects covered include the definition of resilience indicators, the unit of observation and analysis, the necessary data collection methods, and, where applicable, the primary data aggregation techniques. We also examine the practical application of these various tools. **This review of resilience frameworks and definitions reveals that a multitude of ideas and metrics have been developed that are divergent in both conceptual and operational dimensions.**

[1] *Parsimony*, in the context of modeling or explanation, entails selecting the simplest model or explanation that adequately explains the data, avoiding unnecessary complexity or additional assumptions.

We structure our discussion as follows. We first examine tools developed by international institutions, such as the International Fund for Agriculture Development (IFAD), United Nations Development Programme (UNDP), Oxfam, and the African Development Bank (AfDB), aimed at facilitating effective resilience-enhancing investments. Notably, this list includes the ability to recover (ATR) indicator, developed by IFAD, which has a number of appealing properties that make it a promising candidate for a standardized resilience metric. This metric stands out for its intuitive nature, simplicity, cost-effectiveness, and demonstrated applicability across various intervention types and contexts.

We then consider a set of tools originating from the work of academic researchers, who tend to prioritize a rigorous and comprehensive evaluation of resilience. Their efforts emphasize the multidimensional and highly contextual nature of resilience, often resulting in the construction of complex indices. While perhaps providing richer explanations of resilience, they can be challenging to operationalize and generalize.

Finally, we discuss a tool developed by the private sector, designed to be simple (composed of a limited set of variables) and cost-effective to measure. However, because of its proprietary nature, the underlying construction and rationale is somewhat opaque. Table 1 provides an overview of the reviewed frameworks and tools.

Measures Developed by International Institutions

Resilience Design and Monitoring Tool (IFAD)

IFAD's Resilience Design and Monitoring Tool (RDMT) is primarily designed to monitor how projects affect beneficiary-level resilience, using survey data collected at the household level (IFAD 2022). This involves collecting data from both targeted individuals (the treatment group) and those not targeted (a comparison or control group), before and during project implementation. The theory of change that informs the construction of the RDMT uses a matrix that categorizes shocks and stressors into four categories:

1. Climate disruptions or shocks and degraded ecosystems
2. Governance and limited resources: lack of governance and insecure access and tenure to land and other natural resources
3. Market instability: insecure access to markets, market fluctuations, and other economic shocks
4. Social and cultural exclusion drivers

Through a methodical, seven-step analysis of vulnerabilities, specific risks, interventions, and expected results, the RDMT produces two case-specific measures that include subjective and objective indicators: an adoption index (AI) and a resilience index (RI).

The AI gauges the level of adoption or results achieved on a scale from 0 to 2,[2] while the RI is based on averaging of responses to the different stressor dimensions. RDMT is then used to evaluate the extent to which project interventions are (1) adopted by the target population and (2) deliver measurable improvements in resilience, given existing vulnerabilities or experiences with the various shocks and stressors.

[2] The AI scale is defined as: 0—no adoption/results, 1—partial adoption/results, 2—full adoption/results.

Table 1. Resilience methodologies and applications

Method and/or Creator	Aggregation Method[a]	Data Source(s)	Where Applied
Resilience Design and Monitoring Tool (RDMT) (IFAD 2022)	Adoption and resilience indices (arithmetic)	Quantitative surveys w/relevant target populations[c]	Kenya
ATR index (Garbero 2016)	Mean value of subjective recovery across shocks (arithmetic)	Surveys with relevant target populations[c]	At least 20 countries
Community Based Resilience Analysis (CoBRA) (UNDP 2013)	Uniform weighting of survey scores (arithmetic)	Mixed-methods focus groups and key informant interviews	Uganda and Kenya
Resilience Index Measurement and Analysis II (RIMA-II) (FAO 2016)	Factor analysis and structural equation modeling (statistical)	Quantitative surveys with relevant target populations[c]	Uganda
Oxfam Base Resilience Index (Hughes and Bushell 2013)	Alkire-Foster method (arithmetic)[b]	Quantitative surveys with relevant target populations[c]	Ethiopia
AfDB Resilience Capacity Index (RCI) (Boka 2017)	Principal component analysis weighting (statistical)	Quantitative surveys with relevant target populations[c]	Ethiopia
Conditional Moments Method (Cissé and Barrett 2018)	Foster-Greer-Thorbecke method (statistical)	Quantitative surveys with relevant target populations[c]	Kenya
Schneider et al. (2023)	Unweighted distance from global mean (arithmetic)	Secondary sources	70 countries
Béné et al. (2022)	Uniform weighting of indicators (arithmetic)	Secondary sources	94 countries
60 Decibels (2023)	Proprietary; not explained (unknown)	Quantitative surveys with investment beneficiaries	India and Kenya

[a] Additional details can be found in the references to each approach. *Arithmetic aggregation* is based on simple averaging, summation, or application of some other prespecified formula. *Statistical aggregation* refers to use of statistical models that develop indices based on correlational patterns in a specific data set rather than reliance on a prespecified formula.
[b] The Alkire-Foster method is not purely based on a prespecified formula, as the definition of binary cutoffs can be adjusted based on the dataset, and there appears to be no clear consensus on the approach to defining them (see more complete description of the method below).
[c] This includes both treated (investment recipients) and control (nonrecipient) groups.

Among other applications, RDMT is currently being used to design and monitor the Kenya Cereal Enhancement Programme-Climate Resilient Agricultural Livelihoods Window. This project has two broad objectives: (1) graduating smallholder farmers to commercially oriented, climate-resilient agricultural practices and (2) empowering local governments and communities to sustainably manage their natural resources while building resilience to climate change.

Ability to Recover (IFAD)

IFAD's ATR index, similarly, aims to measure resilience at the household level in response to various shock events, comparing program recipients' perceived recovery to that of nonrecipients. The ATR index is estimated using mean values obtained from surveys that capture both exposure to and severity of shocks from climate and nonclimate events. It then determines resilience through respondents' subjective perceptions of their well-being (worse off, equally well off, or better off) compared to preshock conditions.

The impact of an investment on resilience is determined by comparing the average resilience of individuals or households who were exposed to the investment (the treatment group) with those who were not exposed (the comparison group).

Unlike the RDMT, the ATR does not explicitly consider adoption of an intervention, but rather relies solely on respondents' subjective perceptions of resilience. However, it can be paired with detailed program evaluation data to analyze the mechanisms delivering changes in resilience. Given these characteristics, ATR can be applied across a wide range of sectors and interventions.

In 2019–2021, IFAD collected data pertaining to this measure for three different investments representative of its overall portfolio at the time, spanning more than 20 LMICs and demonstrating its wide applicability and versatility. Moreover, while the relevant impact evaluations were conducted at each site, IFAD has produced a portfolio-level impact measure using meta-analytic techniques, which showed a 14% overall improvement in ATR relative to a no-intervention counterfactual.[3]

Community Based Resilience Analysis (UNDP)

The UNDP's Community Based Resilience Analysis (CoBRA) addresses community-level resilience based on a household economy approach that measures resilience as a function of income, well-being, and food security following natural disasters (UNDP 2013). CoBRA adopts the sustainable livelihoods framework, which classifies resilience indicators in five categories:

1. Physical capital
2. Human capital
3. Financial capital
4. Natural capital
5. Social capital

Data collection is facilitated through focus groups, which help identify resilient households, followed by key informant interviews with these households. During multiple data collection rounds, scores ranging from 0 to 10 are assigned to resilience characteristics identified as most important by informants. These scores are then uniformly weighted and aggregated to generate a resilience index. It includes a mixture of objective (e.g., levels of education in the

[3] A *counterfactual* is a statement or scenario that describes what would have happened if the intervention had not occurred.

community, measures of infrastructure availability such as roads and markets) and subjective (e.g., perceptions of well-being and security) indicators.

In 2013, CoBRA was employed to assess resilience in rural communities across three counties in Kenya (Marsabit, Turkana, and Kajiado) and one county in Uganda (Karamoja). Focus groups and key informant interviews were conducted over a period of three months, revealing the top three contributing factors to individual and community resilience; the two most important tended to be education and water supply for domestic use.

Resilience Index Measurement and Analysis II (Food and Agriculture Organization of the United Nations)

The Resilience Index Measurement and Analysis II (RIMA-II) is a resilience measure used by the Food and Agriculture Organization of the United Nations (FAO), updated from the original RIMA measure based on learning from the first phase of FAO's work on resilience (FAO 2016). RIMA-II is defined at the household level and is structured around five main pillars:

1. Access to basic services
2. Assets
3. Social safety nets
4. Sensitivity
5. Adaptability

Climate change and institutional environment can be, but are not always, included as additional pillars.

The methodology adopts a food security perspective to build a resilience index using data collected via beneficiary surveys. RIMA-II uses statistical models to uncover hidden connections between different concepts and the five pillars by assuming that what we see (observed variables) is influenced by things we cannot directly measure (latent variables). For estimation of the latent concepts, RIMA-II uses a multiple-indicators, multiple-causes approach based on structural equation models. The idea behind this approach is to explain the statistical correlation between the latent unobserved concepts and observed variables.

RIMA-II was applied in Uganda in 2015 to assess the effects of the two most common shocks experienced by communities there: animal loss and climatic variations. Researchers noted a decline in resilience capacity from 2010 to 2011, followed by a partial recovery in 2012. They further analyzed the determinants of resilience and coping responses within affected populations. Findings revealed that less-resilient populations were female-headed households in rural areas and the most prevalent coping strategies were reliance on savings, support from friends and family, and adjusting dietary patterns to reduce expenditures or compensate for lower agricultural production.

Oxfam Base Resilience Index (Oxfam GB)

The Oxfam Base Resilience Index (BRI) is another multidimensional, household-level resilience measure based on five areas (Hughes and Bushell 2013):

1. Livelihood viability
2. Innovation potential
3. Contingency resources and support access
4. Integrity of natural and built environment
5. Social and institutional capability.

It applies the Alkire-Foster method, a tool originally designed for multidimensional poverty evaluation. This method broadly consists of a researcher defining binary cutoffs for each characteristic and aggregating them into an index. Data collection of 37 resilience characteristics occurs through beneficiary surveys, with each dimension equally weighted to create a base resilience index (BRI). The index includes a mixture of objective (infrastructure, socioeconomic) and subjective (perceptions of well-being) indicators.

In 2012, in an ex post impact evaluation of drought risks in Ethiopia's Somali Region, Oxfam found that households scored positively on 41% of the weighted indicators on average (Hughes and Bushell 2013). Additionally, Oxfam's 2018 report on an intervention aimed to build resilience in northern Kenya presents a BRI difference of 6 percentage points between treatment (44%) and control groups (38%). Furthermore, results indicate that overall, resilience indices were higher for the treatment group across capacities (absorptive, adaptive, and transformative) (Lain and Bishop 2018).

African Development Bank Multidimensional Resilience Capacity Index

AfDB's Resilience Capacity Index (RCI) is constructed using data from beneficiary surveys and is primarily focused on agricultural aspects and land ownership (Boka 2017). This data is analyzed using ordinary least squares and censored regressions to identify determinants of resilience. Then, principal components analysis is used to aggregate selected variables into a multidimensional index while reducing the number of dimensions and identifying major resilience components.

The RCI was utilized to analyze resilience among rural populations in Ethiopia prior to the 2015 El Niño phenomenon. Some sites were revisited in 2016. The analysis revealed resilience to be influenced by environmental constraints, with natural and physical factors such as farm plot location, cultivated land, and oxen ownership identified as primary determinants of resilience.

Measures Developed by Academic Researchers

Conditional Moments Method

The Conditional Moments Method (Cissé and Barrett 2018) was designed to evaluate resilience at the individual level; however, its only documented application has been at the household level. It defines resilience as the capacity to avoid poverty in the face of various stressors and shocks, with an emphasis on maintaining this capacity over time, which is necessary to define a unit as resilient. Data is collected using surveys administered to recipients of

resilience interventions, as well as households not receiving them. Methods from the empirical risk literature are then used to create conditional moment functions that estimate the probability of a household reaching a minimum standard of well-being. Finally, the authors employ the Foster-Greer-Thorbecke aggregation method (originally developed for poverty measurement) to turn the individual estimates into aggregate measures.

Using longitudinal survey data from 2009 to 2013, Cissé and Barrett (2018) evaluated the impact of the insurance program led by the International Livestock Research Institute in pastoral settings in Northern Kenya. They found that younger and female-led households tend to have lower livestock holdings on average, which hinders their capacity to anticipate and avoid the impacts of shocks, since livestock often represents a stock of wealth that can function as insurance—with purchases in good times and sales in bad times.

Schneider et al. (2023)

Schneider and colleagues' recently developed approach is one of two methods that aim to evaluate country-level resilience of food systems, drawing on secondary data from sources like the World Bank and UNICEF (Schneider et al. 2023). Interviews with experts are conducted to define the main resilience indicators to be assessed, and these indicators are then grouped into five categories:

1. Exposure to shocks
2. Resilience capacities
3. Agro- and food diversity
4. Resilience responses/strategies
5. Long-term outcomes

Data—weighted means (by population, gross domestic product [GDP], land area, etc.) of the core secondary indicators—are then retrieved from various secondary sources to build the index and then a normalized country-specific distance from the global mean is calculated.

The approach is described in a working paper that involved the effort of more than 50 researchers from several countries and includes data for nine different already-developed food resilience metrics (as well as contextual variables such as GDP, population, etc.), covering 70 countries from the years 2000 to 2021. Findings suggest improvements in some aspects of food systems across regions since 2000, but no region has shown improvements across all dimensions.

Béné et al (2022)

Béné et al. (2022) offer a second country-level measure for food systems, which again relies on secondary data sources. It develops the Global Food System Sustainability Index (GFSSI), aggregating 29 indicators across four dimensions:

1. Environment (six indicators)
2. Economic (seven indicators)
3. Social and Policy (four indicators)
4. Food and Nutrition (12 indicators)

After standardizing indicators to a [0,1] scale and applying uniform weighting, the GFSSI is created. The authors then attempt to forecast how food system sustainability will evolve as countries develop, under the "middle of the road" scenario (SSP2) within the IPCC's Shared Socioeconomic Pathways framework.[4]

Specifically, using a generalized additive model, the authors assess the effects of changes in GDP on each dimension of the GFSSI index, followed by estimating the effects of changes in each dimension on the aggregated GFSSI based on individual conditional expectations.

The paper describing the approach uses data from 94 countries covering the period 2000 to 2021. In their analysis, the authors found that there was a strong correlation between food security systems and GDP per capita, suggesting that investments in the social dimension, food security, and nutrition are critical drivers for improving food system sustainability.

Measures Developed by the Private Sector

60 Decibels

60 Decibels, a private company focused on measuring social impact in several categories such as agriculture, financial inclusion, and health and disability, has recently introduced a household-level resilience measurement tool comprising three dimensions:

1. Perceived resilience
2. Realized resilience
3. Resources and enablers

While the weighting of these three dimensions to build the index is not disclosed for proprietary reasons, the perceived resilience dimension is grounded in academic research on that concept (Jones and Tanner 2017). Information on the other two dimensions is not publicly documented.

During the COVID-19 pandemic, 60 Decibels conducted resilience evaluations in agricultural communities in India and Kenya. Their modules have gained traction among investors and funders seeking to assess impacts at low cost. One significant shortcoming of the approach, however, is the lack of data collection from a comparison or control group, which leaves the impact assessments susceptible to confounding factors stemming from natural dynamics and random events unrelated to an intervention occurring over time.

Discussion: Comparative Perspective on Existing Resilience Measures

As shown by the given examples, the methodologies for measuring resilience are numerous and diverse. Each has its own advantages and limitations. It is crucial to acknowledge these nuances when comparing them. For example, methods that rely on existing

[4] The IPCC Shared Socioeconomic Pathways (SSPs) are a set of scenarios that describe alternative future trajectories of socioeconomic development and their associated greenhouse gas emissions, serving as a basis for climate change research and policy planning. The "middle of the road" scenario (SSP2) represents a moderate and balanced trajectory of social, economic, and environmental development, neither overly optimistic nor pessimistic, within the SSP framework.

secondary data often provide aggregate-level analysis, limiting insights into interventions that could be most valuable for further investment. On the other hand, methods that allow assessment of resilience at the community, household, or individual levels typically require data collection through household or individual surveys within the targeted population. Constructing a credit for resilience investment therefore requires careful consideration of these key aspects, acknowledging the complexities and trade-offs involved. Table 2 serves as a guide for evaluating methodologies and designing effective resilience strategies. Note that the order in which these aspects are presented does not constitute a hierarchy; the full set must be considered at the same time, and there are often trade-offs across objectives.

Granularity of Analysis

Granularity of analysis is the level at which resilience is assessed, whether on the aggregate, community, household, or individual level.

Eight of the 10 methodologies discussed adopt a micro-level unit of observation and measurement. Accordingly, the microindicators satisfy the essential requirement of taking an approach that is focused on the actual populations whose resilience is being supported by interventions or investments, rather than relying on aggregate or country-level measures**.** This facilitates an investigation of the individual characteristics that enhance or deter resilience. In contrast, Schneider et al. (2023) and Béné et al. (2022) conduct an analysis at a country level that is highly aggregated, and therefore not well-suited to assessment of case-specific circumstances or subnational investments. In other words, these approaches fall short in providing insights on who is resilient and why, within a given context.

Subjective Versus Objective Measures

A second important dimension is whether a resilience methodology relies on purely subjective assessments or is supported or somehow validated with objective measures.

Consider the ATR and CoBRA methodologies. While both examine program participants' perceptions of previous shocks, ATR's simplicity means that it can only be assessed against objective outcomes insofar as additional program data are collected to validate perceptions. On their own, subjective reports of recovery from shocks that are disconnected from program-specific contexts will also fail to shed light on the mechanisms that lead to enhanced or weakened resilience. CoBRA similarly requires the conduct of suitable parallel discussions where targeted participants can reflect on how they perceive their situation relative to their peers, and on which characteristics they identify as differentiators for these self-perceptions. These measures, though valuable, are unlikely to be deemed sufficient on their own to support investment. However, supporting work for verifying the value proposition behind them could address this deficiency.

Counterfactual Approximation

A third crucial consideration is whether a methodology employs a counterfactual approximation to address hypothetical scenarios regarding resilience in the absence of shocks or interventions.

It is impossible to observe the exact same individual under two mutually exclusive scenarios. For example, if a drought impacts a farm in the summer of 2023, it is impossible to see what the farm's crop yields would have been if the drought had not happened. A common practice

Table 2. Overview of alternative resilience measures

	Resilience Management Tool (Organization)	Unit of Analysis	Beneficiary-Focused	Cross-Validation with Objective Measures	Use of Counterfactual	Requires Prior Shocks	Captures Adoption	Intuitive	Parsimonious	Customizable
International Organizations	RDMT (IFAD 2022)	Household	✓	✓	✓	✓	✓			
	ATR index (Garbero 2016)	Household	✓	✓	✓	✓	—			
	CoBRA (UNDP 2013)	Community	✓	—	—	✓	—			
	RIMA-II (FAO 2016)	Household	✓	✓	✓	✓	—			
	Oxfam BRI (Hughes and Bushell 2013)	Household	✓	✓	✓	✓	—			
	AfDB RCI (Boka 2017)	Household	✓	✓	—	✓	—			
Academia	Conditional Moments Method (Cissé and Barrett 2018)	Individual/ Household	✓	✓	✓	—	—			
	Schneider et al. (2023)	Country	—	✓	—	—	—			
	Béné et al. (2022)	Country	—	✓	—	—	—			
Private Sector	60 Decibels (2023)	Household	✓	Unclear	Unclear	Unclear	✓			

Note: The colors in the final three columns depict how well each methodology complies with each criterion. Darker shades signify greater compliance.

to address this limitation consists of defining a suitable approximation for the unobserved, or counterfactual state (in this example, the lack of a drought event).

This counterfactual approximation involves selecting another household/farm/individual with characteristics closely resembling those of the targeted group. To be fully valid, the exposure to the event or intervention would have had to be exogenously determined, meaning it was unrelated to any other differences between the treated and comparison observations. In the drought example, while counterfactuals look to provide a reference concerning how individuals' lives would have evolved in a timeline without a shock, a second possible reference to assess an individual's resilience can be the individual themself at two different moments: before and after a shock. However, this method is not perfect because other factors could also influence the outcome. Valid counterfactual estimation, while costly and technically challenging, is essential to demonstrating impact. This cost and difficulty can be managed, however, by requiring counterfactual evaluation over a sample of observations affected by a resilience portfolio.[5]

Shock Occurrence(s)

A fourth aspect is that most methodologies that attempt to fully capture resilience, especially at the beneficiary level, require some shocks to occur and affect the population of concern.

Through observing shock events in conjunction with resilience-building activities, insights can be drawn into how individuals' resilience has evolved in tandem. For instance, methodologies such as RDMT, ATR, and 60 Decibels typically carry out surveys at various intervals to capture these dynamics.

Notably, only RDMT and 60 Decibels clearly and explicitly track adoption of interventions. **Crucially, it is not necessary for all members of the population to be affected by a shock for resilience benefits to manifest.** Shocks are *probabilistic* and *stochastic* (they do not usually affect everyone), and so resilience benefits can be observed in a subset of observations that are tracked within a broader portfolio. Considering that resilience credits would ultimately need to be verified, a well-designed verification procedure must account for the incidence of shock events in the targeted population when determining the sample size required for that verification. Specifically, if shocks are uncommon, larger sample sizes across more diverse geographies or monitored over longer periods of time would be necessary.

Scalability

The final group of characteristics shown in the final three columns of Table 2 relate to the scalability of each approach. Here, colored circles indicate the extent to which methodology complies with three criteria, with darker shades denoting higher compliance. First, we discuss the intuitiveness of a model relative to the conventional understanding of resilience. An *intuitive* measure aligns well with established definitions of resilience, capturing the ability to absorb disturbances while retaining structure, self-organization, and adaptability to stress and change. Relatedly, the measure should be relatively simple to construct, ensuring that assumptions and techniques are transparent and replicable.

[5] To highlight the importance of counterfactual measurement, it is useful to point to experiences and controversies that have arisen with other similar financial instruments, namely for mitigation (carbon credit) benefits. The debate over additionality is what additional mitigation and investment has achieved in practice, relative to the noninvestment counterfactual. The experience with reduced emissions from deforestation and forest degradation demonstrates the risks of ignoring appropriate counterfactuals (West et al. 2020).

The second characteristic in this rubric refers to *parsimony* or *conciseness*, which emphasizes the importance of cost-effective resilience measurement. A parsimonious measure achieves maximal explanatory power with minimal variables, while including all relevant key variables. It is important to highlight that parsimony involves a trade-off between using fewer inputs (which makes implementation easier) and achieving greater explanatory power (which usually requires more information). In this analysis, we are allowing for the assumption that the various models presented can explain resilience similarly, but we highlight in darker shades those that do it with fewer inputs.

The final, third characteristic relevant for implementation is the generalizability of methodologies across different contexts and domains, as well as interventions. This aspect is relevant because an attractive resilience credit must be applicable to more than just the agricultural sector to generate momentum and support for such investments.

With respect to these criteria, the ATR measure stands out for its simplicity, intuitiveness, generalizability, and applicability across many contexts and sectors precisely because it is not focused on specific mechanisms or interventions. However, the list of specific stressors or shocks that should be considered in a resilience credit based on the ATR remains unstandardized. Also importantly, measurement of ATR rests on a valid impact evaluation approach that estimates impact relative to a counterfactual: before and after intervention. Its main weakness, is then that it is fully based on subjective perceptions and does not capture detailed information on why resilience may have improved, since it does not directly capture adoption or many other types of indicators that the more complicated index measures contain. **These shortcomings must be addressed by the monetization methodology for ATR to determine what improvements in ATR are actually worth to different parties.**

To summarize and conclude, all of the previously mentioned methodologies define and operationalize resilience somewhat differently. Achieving convergence on a single practical definition that is good enough and balances the various considerations discussed prior is one of the most important challenges to developing a resilience credit. Indeed, the lack of a standard measure that can be compared across projects or interventions, sectors, and populations, while still offering context-specific insight on what works to build resilience, and under what conditions, is a major hurdle to overcome.

At the same time, momentum for resilience measurement and benefits could be necessary to drive innovation in resilience valuation, which is essential to spread and scale an effective model. Existing data and future tests of resilience credits based on ATR,in the context of several different illustrative investments will be required to provide evidence on that measure's ability to accurately and generally capture attributable changes in household and community resilience. This piloting must be supported by comprehensive evaluation data that sheds light on the ATR's advantages, shortcomings, and particularly on the monetization of the measure. It is expected that this would, in turn, lead to refinement and greater clarity on how to verify that resilience credits are delivering on their promises.

SECTION 2: THE CHALLENGE OF VALUING RESILIENCE

In addition to measuring resilience in a standard way, a critical challenge is determining the actual value of any enhancements in resilience. To work as a viable investment opportunity, resilience credits will have to be based on both the standardized comparable measure, as discussed in Section 1, and factor in the valuation of changes in that measure, which we now consider. Again, the focus of this discussion is not limited to a single sector, although we sometimes use agriculture as an illustrative example and plan to conduct validation and replication activities that leverage that sector.

There are several critical challenges to monetizing resilience. First, it requires the pricing of a future dividend based on empirical probabilities of future shocks and resulting damages, both of which are uncertain. While the likelihood of such shocks occurring will always remain indefinite, risk can be reduced by building a track record of interventions that work, adopting better and more precise measurements of how and for whom resilience will be delivered, and improving climate predictions.

Second, resilience is not a commodity that is currently traded in markets, making it difficult to establish its initial price base. The goal of the resilience credit initiative is to help establish such a market, but determining a primary price base is challenging in any nascent market. Moreover, resilience will have different values to different players. These include resilience credit users, investors seeking financial and social returns, local financial institutions, local governments, and development partners aiming to mitigate risks and alleviate poverty. A monetization methodology must try to capture these various perspectives and create a market test of the approach, connecting willingness to invest with benefits experienced on the ground. Thirdly, although nonmarket valuation methods are available that allow inclusion of the value of positive spillovers or unpriced benefits from resilience, the derived values vary greatly depending on factors such as regional differences, demographics, types of interventions, and various other variables, including constraints on the ATR. Therefore, it will typically be infeasible to carry out detailed social cost-benefit analyses for all investments, or to commission detailed studies of the full set of changes in welfare, which would be the most theoretically appropriate ways to assess their overall value to society. A more pragmatic approach could be to support a validation and replication agenda that takes a systematic meta-analytic approach to understanding the factors influencing the value of resilience interventions. Such an approach would be used to understand what specific investments in particular settings are likely to be worth and to understand what the variance of the outcomes distribution is likely to look like (which gives a sense of investment upsides and downsides).

We start our analysis here, by describing the stakeholders involved in more detail and outlining the main factors that likely drive their valuations of resilience investments, thereby influencing potential adoption of resilience-aimed projects. Broadly speaking, we can identify the following four especially critical groups of stakeholders:

1. **Users of resilience credits.** These are the primary beneficiaries of resilience investments, such as the producers who cultivate crops, rear livestock, or process agricultural commodities, especially in areas threatened by climate change. For the purposes of illustration, we focus especially on single smallholder farming households (SHFs) (though larger operations could also be considered, as well as agents operating in other, non-farm sectors). These farmers are highly vulnerable to both natural

(droughts, plagues, etc.) and other types of economic (price spikes or collapses) shocks. Although such farmers might be willing to invest in resilience in the hope of reducing their own vulnerabilities and protecting their livelihoods, they are often constrained by limited resources and competing needs. They struggle to access loans from banks because of perceived high risks, and they may not know what kind of investments would be most effective. This lack of information, along with financial constraints, limits their ability to invest in resilience. These challenges are further exacerbated as a result of changing climate patterns. In summary, all these factors—information and credit constraints, and perceptions of risk of adopting new solutions—make it difficult to understand SHFs' true resilience valuations.

2. **Local financial institutions.** The second stakeholder group comprises local financial institutions, mainly local banks. These banks face a major challenge in not being able to issue loans to many potential borrowers because of perceived high default risks associated with their vulnerabilities. To encourage lending, these institutions require mechanisms to mitigate risks. Their valuation of resilience can be measured through the potential profits from interests on future loans facilitated by investments in resilience. Meanwhile, if farmers are able to invest in successful resilience-building, their risk of default should decline over time, enabling banks to issue new loans in the future.

3. **Investors and development partners.** The third major stakeholder group is the investors, private entities, and development partners who have an interest in enhancing resilience, either for advancing their own self-interest (e.g., securing supply chains and profits), or for satisfying their social responsibility or development objectives. In February 2021, Bloomberg estimated that by 2025, environmental, social, and governance (ESG) assets will exceed $53 trillion, while the total assets under management are projected to be $140.5 trillion (Diab and Martin Adams 2021). Demand for ESG-related projects is expected to further increase in the coming years, and resilience could be an attractive investment for many investors, were it available. Thus, resilience credit investors represent the demand for a product in resilience investment that has yet to meet adequate supply. These investors could include businesses up and down the value chain who rely on the production yield and reliability of SHFs. The increased reliability of these farmers provides financial incentives for value chain businesses to support SHFs and their resilience investments.

   Additionally, development partners (e.g., bilateral or multilateral development agencies, including organizations like IFAD) can ignite that supply by creating the conditions needed to establish a resilience credit marketplace. As farmers invest in resilience and its measurable impact grows, the idea of resilience credits issuance will become feasible. This would allow farmers to tap new resources to invest in resilience and issue more credits in the future. It is important to note that the price of the resilience credits in this new market will not depend on initial development partner investments, but on the market forces of demand and supply that drive it.

4. **Local governments**. No stakeholders are more motivated than local governments. They seek to ensure the economic resilience and social fabric of their communities. With increased exposure to climate risks, local governments are obligated to find systemic and sustainable solutions.

Valuation Approaches

Within this stakeholder ecosystem, there are several potential approaches to valuation. One of the most appealing for scalability is to observe a market price for resilience credits, determined by investor demand and opportunities provided by resilience suppliers (i.e., the credit users and development organizations supporting them). However, the experience with carbon and other similar types of markets suggests that leaving these prices to the market alone may be insufficient because of information gaps, risks, and unpriced externalities or spillovers. To that end, valuation of outcomes from resilience investments will be useful to help development partners and international development organizations provide additional incentives to the marketplace. Financial benefits that accrue to specific stakeholders, especially increased net income or profits, are likely to be especially powerful changes to spotlight, but nonfinancial social returns should not be ignored. These nonmonetary benefits may include benefits in the form of improved health and human capital and externality benefits to others living in more resilient communities, among others.

In piloting the monetization of ATR benefits, we propose implementing a policy-oriented validation methodology that focuses on these three main stakeholder perspectives. To capture investor willingness to pay for resilience benefits, the work would attempt to solicit interest in supporting various hypothetical initiatives using a sort of gaming approach, that would vary risk levels and payoffs—both financial and nonfinancial—among a group of interested investors. On the beneficiary side, Duke's research team could work with IFAD's datasets to validate ATR benefits, demonstrating concrete advantages to SHFs. This involves studying how various financial and nonfinancial outcomes (higher income, reduced expenditure, better health, etc.) are related to higher ATR. The latter approach should also be extended to replication evaluations of new pilot resilience investments that are based on the resilience credit idea, where the evaluation designs could be tailored specifically to the needs of the resilience credit and monetization initiative. The aim is to establish alignment between ATR and other resilience indicators and estimate the value of both financial and nonfinancial resilience benefits. Finally, these pilot studies could also engage the lenders and banks (intermediaries) who are needed to make a financial apparatus work at the local level, examining the value proposition for them in detail.

Including all of these perspectives together will require some resources for primary data collection and secondary data analysis. The payoff is that the effort will form the basis for social cost-benefit analysis, which could be carried out around a specific portfolio, as proposed here. This systematic evaluation of resilience interventions helps benchmark investments and can be replicated across different sectors and populations exposed to climate risks.

SECTION 3: RESILIENCE CREDITS—A NEW ASSET CLASS

Building upon the discussions regarding monetization in Section 2, the next questions arise: what market-based instruments or approaches could drive capital into resilience investments? What financial structures could help address the lack of motivation among stakeholders to align around the capital needs of farming communities and others that require upfront funding?

A potential pathway is a *resilience credit*. A resilience credit establishes a mechanism to translate the value of resilience investments into a market-based financial instrument. These resilience gains may stem from one or more projects or investments (including portfolios of projects/investments) that improve social capital, market connectivity, and other goals, and include both direct impacts and spillovers that improve resilience to climate risks. The underlying premise is that a resilience credit would facilitate the flow of capital, allowing farmers access to the requisite funding to make the upfront investment. In return, investors can leverage this credit to capture the value generated by resilience initiatives and recoup their investment at a later date.

This idea for a resilience credit builds upon the concept and learnings related to other financial incentive-based approaches, particularly carbon credits. A key differentiating factor is the focus on an instrument that attributes value to climate resilience investments, rather than solely carbon mitigation as is the case with carbon credits. As a basis for developing such an instrument, this initial concept is designed for smallholder farmers and rural agriculture communities. As it is developed and further refined, however, it is intended to have applicability across the full range of climate resilience investments. Common features of resilience credits may include those shown in Table 3.

It is anticipated that the resilience credit will be a key component in financing programs for target beneficiaries. An illustrative financing mechanism facility that incorporates resilience credits would have three key aspects (Figure 2):

1. **Funding basic farming activities and resilience investment**. Local lenders provide SHF financing to cover the costs of annual/seasonal farming inputs such as seed, equipment, soil preparation, and others.
    a. These inputs would include investments into climate resilience, such as an improved irrigation system.
    b. The lending facility would most likely be designed as a blended capital facility to better absorb the potential risk associated with SHFs.

Table 3. Features of a resilience credit

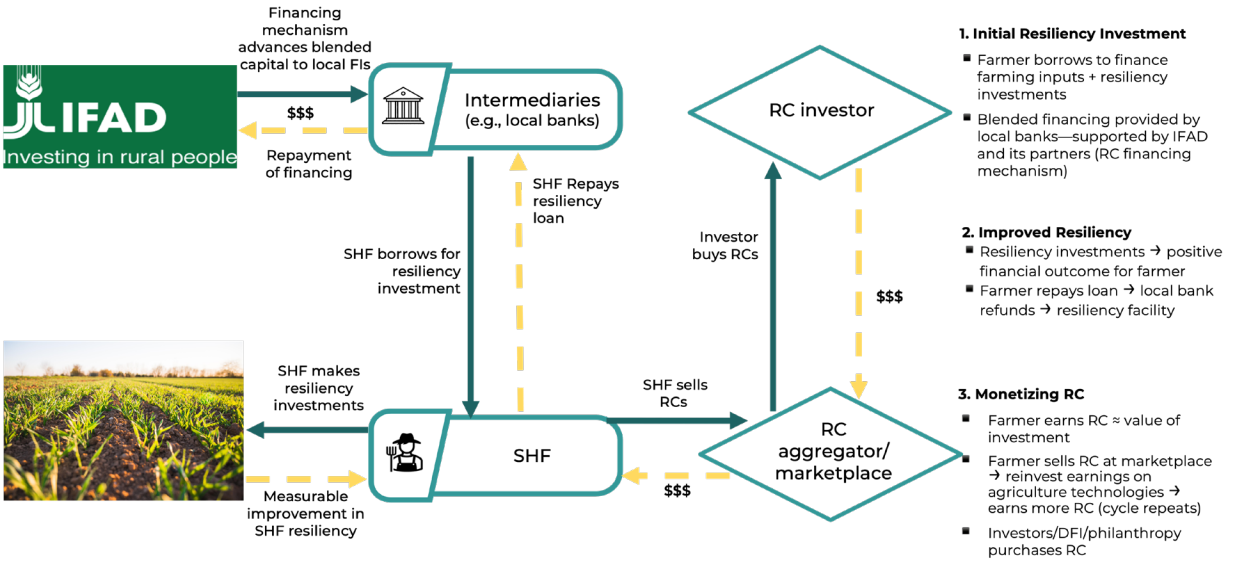
Feature	Description
Purpose	Create value to stimulate investment that mitigate the adverse impact of climate on the general well-being and income generating capabilities of SHFs.
Resilience credit value	Value based on resilience investment benefits to adapt and manage potential climate risks.
Valuation mechanism	To be based on accepted methodologies regarding the increased capacity for a beneficiary to be resilient regarding the adverse impact of climate events (see Section 2).
Certification and verification	Third-party, independent review and verification regarding the investment.
Transferability	Credit designed to be bought and sold on either private sale or market-platform basis.

2. **Improved resilience.** These upfront climate mitigation investments would drive improved yield and production outcomes, increasing the resilience of SHFs.
    a. Farmer has an improved capacity to repay.
    b. With the verified investment into resilience, the farmer is able to generate resilience credit.
3. **Monetizing the resilience credit.** Proceeds from the sale of resilience credits will allow farmers to realize the value of their resilience investments and reinvest in additional projects.
    a. Farmer receives the resilience credit.
    b. Farmer is able to sell the resilience credit into the marketplace. Proceeds allow the SHF to reinvest earnings into improved agriculture capabilities/technologies, and/or increased savings.
    c. Investors purchase the resilience credits, which can be traded on a platform/exchange or privately.

The interactions between the stakeholders, as envisioned, would happen in two steps: firstly as indicated by the arrows in green and secondly, the ones in yellow (Figure 2). Consider the relation between the local financial institutions and the SHFs. As previously discussed, the local banks find that extending credit to potential beneficiary farmers is very risky because of their vulnerability to unexpected shocks. The intervention of the financial mechanism would address this concern by absorbing a significant portion of the resilience investment risks, allowing the bank to consider SHFs worthwhile borrowers.

Once SHFs are able to borrow from local financial intermediaries (e.g., regulated banks, microfinance institutions and nonbank financial intermediaries), they will be able to invest in

Figure 2. Resilience credit financial instrument



resilience-oriented activities or assets (enhanced seeds or fertilizers, water pumps, etc.) that reduce their vulnerability to shocks and result in measurable improvements in livelihood returns over time. As the farmers become more resilient, they will be able to pay off their loans, replenishing the banks' capital resources. In addition to collecting interest on their loans, local financial intermediaries will also have gained knowledge about the creditworthiness of SHFs, and how that creditworthiness is enhanced by resilience. This will contribute to a lower risk of default from future similar subsidized and unsubsidized loans.

With minimal financial resources, farmers lack both the means and incentive to make the upfront investment in techniques that can improve their resilience. Further, the benefits of such investments may only accumulate over time, leaving the farmer in a negative cash position in relation to the investment cost until the farmer is able to recoup improved yields and outcomes. The resilience credit mechanism looks to alleviate these constraints. With the resilience credit, farmers will benefit from their ability to extract the value of their resilience investments.

The resilience credit drives several benefits, which underpin the motivation for the key stakeholders identified in Section 2 of this paper.

- **Local financial institutions.** To date, the perceived risk associated with SHFs (and other similar small and vulnerable producers in low-income contexts) has severely limited local banks' willingness to extend credit to these parties. The measurable benefit regarding improved production outcomes and higher net income makes these clients more reliable counterparties for the lenders, thereby reducing the perceived risk. This includes the clients' increased ability to be depositors—with their savings—to the local financial institutions, a key area of focus and point of entry for lenders in rural emerging market settings.
- **Development partners**. Increasingly, international stakeholders recognize the role that climate events play in driving migration. Resilience investments' ability to maintain economic opportunities through the retention of local jobs is likely to only gain increasing attention from the international community in the coming years.

As more investors participate in the market and provide capital for resilience investments, farmers will be able to invest in more projects, thereby increasing overall resilience. It is important to note, as discussed previously, that resilience credits represent a new market. Therefore, the price of the resilience credits will not depend on the initial bank loan amounts, but more on the market valuations produced by this supply-demand interaction.

This financial mechanism facility concept is designed to address the needs of all the involved stakeholders. Its main strength lies in the transparency provided by the ability to measure resilience, thereby informing participants of the benefits gained, and how they influence their own benefits and future decisions, including monetization strategies. While the biggest challenge previously impeding resilience loans has been the high risk of such investments, this mechanism begins to address it through more standardized measures and valuations of resilience that allow risk-sharing. The hope is that this will in turn initiate a chain reaction that will eventually allow for the resilience credit market to be independent and successful.

As further work is done in developing the resilience credit mechanism and the related financing constructs, several key issues will need to be considered.

- **Building upon carbon credits**. Substantial work has been undertaken over the past years related to carbon credits. Drawing on insights and lessons from this established framework, the development of resilience credits stands to benefit significantly. This synergy enables a more rapid progression in adapting to climate challenges.
- **Merging mitigation and resilience benefits**. Many investments will have both carbon mitigation as well as resilience improvements. The opportunity to merge the benefits will not only increase the value for SHFs but, as noted prior, will allow the resilience credit to leverage the more established carbon credit mechanisms.
- **Enabling local regulatory environments**. Local governments can play key roles in setting incentives for valuing resilience credits and driving financing by local capital players.
- **Geography/microclimates**. Local factors will be paramount with regard to the selection of appropriate resilience investments. There is a need to better identify climate vulnerability in potential target communities.
- **Application beyond the agriculture sector**. Numerous communities and livelihoods are exposed to climate impact; hence, resilience credits are potentially applicable to a broad range of sectors and communities.

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