DEFINING AND ASSESSING TRANSFORMATIONAL CLIMATE CHANGE ADAPTATION:

A FRAMEWORK FOR APPLICATION TO AGRI-FOOD PROJECTS

Faith knows no bounds®
CRS
CATHOLIC RELIEF SERVICES

OXFAM

The international community is increasingly calling for greater emphasis on transformational adaptation in response to climate change: transformational climate change adaptation (TCCA). This call has been particularly acute in agriculture, food systems, nutrition and agro-ecological systems in low-income countries. There is, however, a lack of clarity, let alone consensus, in the literature and climate change community generally on how to define, operationalize or measure its integration into projects. To address this gap, this paper proposes a framework of four indicators of transformation – the breadth and depth of change, the intention to achieve transformation, scale and sustainability. These four indicators are applied to four types of interventions in agri-food systems: (1) strengthening the public enabling environment, institutions and market systems; (2) Diversification and relocation of production (geographically); (3) New or Improved Agri-Food Technologies, Practices or Systems; and (4) addressing the Root causes of Vulnerability, Marginalization and Power Inequality.

ACKNOWLEDGEMENTS

The report was prepared by Dr. Richard Kohl on behalf of Catholic Relief Services and Oxfam America. The report benefited from comments by Gina Castillo, Larry Cooley, Julia Compton, Eric Munõz, James Morrissey, Simon Winter, Colm Foy, and three anonymous internal and external reviewers. It is based on a review of publicly available USAID documents, peer-reviewed journal articles, and the scientific literature on climate change, as well as information from experts on climate change adaptation and related subjects, whose anonymity is respected and whose generosity with their time is gratefully acknowledged. The opinions expressed are solely those of the author and in no way reflect the views of any of the commentators, reviewers, Catholic Relief Services, Oxfam America or any of their financial supporters.

This paper should be cited as:

Kohl, Richard (2024). *Defining and Assessing Transformational Climate Change Adaptation: A framework for application to agri-food projects*. London, Oxfam.

For more information, or to comment on this paper, email Gina Castillo, gina.castillo@crs.org, Eric Muñoz, eric.munoz@oxfam.org or Richard Kohl at richardkohl@strategyandscale.com.

CONTENTS

ACRONYMS

Abbrev.	Term	Abbrev.	Term
AEZ	agro-ecological zone	IPCC	Intergovernmental Panel on Climate Change
AFS	agri-food systems	IR	intermediate results
BREFS	Bureau of Resilience, Environment and Food Security	MinAg	Ministry of Agriculture
CCA	climate change adaptation	MS	market systems
CCR	climate change resilient (seeds)	Mt	metric tons
CCV	climate change vulnerability	PEE	policy enabling environment
CIF	climate investment funds	PEEMS	public sector enabling environment and market systems
COP	Conference of the Parties	PSI	public sector institutions
CRS	Catholic Relief Services	SA	sustainable agriculture
CSA	climate smart agriculture	SPP	strategies, projects, and programs
CVA	climate vulnerability assessment	TCCA	transformational climate change adaptation
D&R	diversification and relocation	TVBPS	agricultural technologies, varieties, breeds and practices and systems
DTM	drought tolerant maize	UNFCCC	UN Framework Convention on Climate Change
FTF	Feed the Future	UNDP	United Nations Development Programme
GCF	Green Climate Fund	USAID	United States Agency for International Development
GEF	global environmental facility	USG	United States Government
GFSS	global food security strategy	VMPI	vulnerability, marginalization and power inequalities
Ha	hectares	VCs	value chains
IFAD	International Fund for Agricultural Development	WRI	World Resources Institute
ILK	indigenous and local knowledge	WWW	whether, where and when

EXECUTIVE SUMMARY

The impact of climate change on global weather has increased with more record-setting temperatures and more frequent and severe extreme weather events. The impacts on agriculture, agri-food systems and, more generally, food production, security and resilience, are major and growing.

In this view, not enough transformational adaptation is occurring nor are major international development donors funding and implementing transformational adaptation activities. In response, there is a growing demand that adaptation efforts need to be not only expanded, but also to be transformational in nature.

Oxfam America and Catholic Relief Services (CRS) wanted to assess the extent to which transformational climate change adaptation (TCCA) has been integrated into the agri-food work of the work of major donors. However, there is neither a commonly agreed upon definition of TCCA in agri-food systems, nor an analytical framework or a set of indicators that could be used to conduct such an assessment. Hence, this paper seeks to provide such a definition, an analytical framework, and a set of indicators that could be used as an assessment tool.

A review of the literature on TCCA confirms "a lack of common understanding about what transformation entails" and "which real-world examples constitute transformation."[1] Nonetheless, the review identifies ten characteristics of TCCA:

1. intentional
2. systems: locus and scope of change
3. degree of change: depth and breadth
4. limits of change
5. scale or potential for future scale
6. sustainability: financial and institutional
7. root causes of vulnerability and marginalization
8. social norms, beliefs and values
9. good development process
10. time or speed of change.

The paper proposes several criteria to determine which characteristics or measures should be included in a definition and framework to analyse transformational climate change adaptation in agri-food systems. The criteria for selecting characteristics were essential, simple, understandable and applicable.

After review and application of the measures, several of the characteristics were selected to incorporate into an analytic framework. Others that did not were dropped; and a few were found to be types of climate change adaptation rather than characteristics.

Five characteristics that do meet the criteria are: breadth, depth, intention, scale, and sustainability. Based on these findings, and to incorporate both the characteristics and the types of TCCA, the paper recommends a matrix approach, with a matrix for each type of climate change adaptation.

[1] Vermeulen et al. (2018).

This results in four 3 x 4 matrices as below:

Table 1: Type of climate change adaptation (e.g., policy enabling environment, institutions and markets)

	Not Present	Low	Medium	High
Breadth and Depth				
Scale				
Sustainability				

The paper proposes sub criteria useful to assess breadth and depth, scale and sustainability in general (and intention, separately), how that needs to be adapted for each of the four types of climate change adaptation and provides guidance for how to rate each characteristic for each of the four types. In the sample matrices, guidance is illustrated using a hypothetical example.

In applying the matrix approach to any project or sample set of projects, it is necessary to first determine how much TCCA 'should' be integrated into that project as a basis for comparison. In other words, whether and to what extent TCCA should be integrated into a program or project. The literature suggests that currently only a small percentage of climate change impact demands immediate transformational action. However, this varies widely by the crop/product being produced, country and specific agro-ecological zone (AEZs), so context matters. Any future user of this approach—whether an assessor or evaluator—will need to establish a reference point or standard for each project).

The paper concludes that there are sufficient climate vulnerability assessments and other sources that estimate the impact of climate change on agri-food systems to permit an assessor to establish at least a rough benchmark for transformational adaptation for a given project. The availability and quality of CVAs and related relevant information on climate change impact must be a basic criterion for selecting projects for any future assessment.

In order to apply the TCCA framework to a specific portfolio of work supported by a donor, two additional steps to strengthen the guidance offered in this paper for each matrix: (i) convening an expert advisory panel with broad expertise and experience in the intersection of climate and agri-food systems; and (ii) based on the improved criteria developed by the expert panel, an assessor or assessment team will need to apply these criteria to a small sample of projects to refine them. This pilot approach should also be applied to the development of benchmarks.

The disaggregate results of the transformational assessment tool will allow advocates using the results to say where development funders are or are not doing transformational work and specify the types of TCCA.

PURPOSE AND METHODOLOGY

The international community is increasingly calling for greater emphasis on *transformational* adaptation in response to climate change: transformational climate change adaptation (TCCA). The IPCC Technical Summary devotes an entire section to the subject, *Systems Transitions and Transformational Adaptation,* emphasizing its importance in multiple systems, including societal, energy, land, and ocean ecosystems.[2] At each successive UNFCC COP, there is an increasing recognition of the need to accelerate adaptation as climate shocks get locked in.[3]

This call for more TCCA has been particularly acute in agriculture, food systems, nutrition and agro-ecological systems (hereafter all included under agri-food), especially in low-income countries, where billions of people are either food insecure or at risk of food insecurity.[4] Yet observers have noted that the extent to which climate change adaptation (CCA) is occurring in agri-food systems in these settings, and especially transformational change, seems to be incommensurate with either the need or the urgency. [5] A growing number of voices[6] assert that too many development resources continue to be devoted to "business as usual" i.e. incremental improvements in productivity and incomes, or the increasingly frequent and severe cycles of "crisis response, disaster relief, and recovery pathways," rather than transformational adaptation.

Two of the many international NGOs that have a longstanding commitment to supporting and addressing climate change adaptation are Oxfam America (Oxfam) and Catholic Relief Services (CRS). These two organizations sought to commission a study of the extent to which key donors are integrating TCCA into its agri-food strategies, programs and projects (hereafter "projects" as a catchall).

However, Oxfam and CRS recognized that there is a lack of clarity, let alone consensus, in the literature and climate change community generally on how to define or operationalize TCCA, let alone measure its integration into projects. It is also not clear where the boundary between incremental and transformational CCA exists. Not surprisingly, given the unclear status of how to define and measure CCA and determine whether it is incremental versus transformational. As a result, there does not exist an analytic framework, indicators or set of assessment criteria for conducting such an assessment of international agri-food donors and implementers. Without such a framework or indicators, it would be challenging to conduct a rigorous, objective evaluation of development projects that serve as the basis of future analysis and advocacy.

Based on these considerations, Oxfam and CRS determined that it was necessary to do a "pre-study" to address those issues. That is this study, which has three goals:

1. To evaluate common elements of TCCA and articulate a framework that can be applied to agri-food livelihoods and systems, particularly focusing on small-holder farmers;
2. To demonstrate how the framework can be operationalized and applied to donor projects; and

[2] Pörtner *et al.* (2022).

[3] See for example the High-Level Communique: The Adaptation Acceleration Imperative for COP26 organized by the Global Center on Adaptation (GCA) in Rotterdam in September 2021, at the launch of the GCA. Supporters of this call include the UN Secretary General, Managing Director of the IMF, the President of the African Development Bank, the Executive Director of the Green Climate Fund, and the President of the International Fund for Agricultural Development (IFAD).

[4] "According to the 2023 edition of the *State of Food Security and Nutrition in the World* report, between 691 and 783 million people faced hunger in 2022, representing an increase of 122 million people compared to 2019. Apart from hunger, the report also highlights that 2.4 billion people experienced moderate or severe food insecurity and 900 million people faced severe food insecurity." See United Nations. (no date).

[5] Kray *et al.* (2022).

[6] See Kinley (2017), Carter *et al.* (2018), Carter *et al.* (2021), Carter and Ferdinand (2020), Ashley *et al.* (2020) Ajulo *et al.* (2020) and FAO (2022).

3. To identify the elements, conditions or pre-requisites that support scaling of transformational adaptation.

In developing the framework, this study centers the role of gender, gender inequities and inequality in power relations more generally. The rationale for this is two-fold. First, in Sub-Saharan Africa, the majority of women are employed in agriculture and at a rate higher than men. Women's representation is even more prominent in Asia, where 71 percent of women are working in agrifood systems compared to 47 percent of men.[7] Secondly, gender inequities are pervasive in agri-food systems, making women more vulnerable and less able to adapt.[8] These inequities extend to ownership and access to land,[9] access to credit and levels of financial wealth, ownership of machinery and other inputs, as well as informal challenges embedded in social and cultural norms and practices. Adaptation efforts that ignore gender and other power imbalances will likely have limited impact on those who most need support, and indeed risk exacerbating inequality and increasing vulnerability.

AUDIENCE

The research is intended to contribute to the knowledge base of the two commissioning organizations, Oxfam, and CRS. Additional target audiences include donors working on climate change and agri-food systems, development NGOs/development practitioners, climate-focused advocacy organizations, think tanks and academics. For those working on adaptation, better analysis and identification of what types of strategies and interventions constitute transformation can improve program investment.

METHODOLOGY

This study was based on a review of the literature on transformational climate change adaptation combined with a small number of Key Informant Interviews. The literature search was conducted iteratively mostly between September and December 2023 and supplemented with additional, targeted searches in January–February 2024 and June–August 2024 (during the review and editing process). The literature search covered articles published between 2010 and 2023. Research on climate change and adaptation has accelerated and snowballed since the signing of the Paris Climate Accords, so that the knowledge base about the impact of and adaptation to climate change has significantly deepened. Because of this, the research favored articles published after 2018 in general and as recently as possible.

The literature was generated based on key word searches on Google Scholar and Science Direct using various combinations and permutations of the following key words: adaptation, agricultural, agriculture, agri-food, climate change, evaluation, gender, incremental, systems, transformation, and transformational. An iterative, snowball approach was used (i.e., following up on relevant citations from the articles initially identified).

As the Internet search primarily generated articles from peer-reviewed journals, it was supplemented with a search for gray literature. Searches were conducted of major websites of international donors and institutions involved in climate change and/or agri-food systems such as USAID, the Bill and Melinda Gates Foundation, Climate Investment Fund, Green Climate Fund, Global Environment Fund, International Fund for Agricultural Development, UKAID (formerly FCDO) and the World Resources Institute.

[7] FAO (2023).

[8] For a general discussion, see Adeola *et al.* (2024), Awiti (2022), Dibakoane *et al.* (2022), and Mesfin (2022).

[9] See, for example, Meinzen-Dick *et al.* (2019).

ORGANIZATION AND OVERVIEW

The paper is divided into four main sections. Section II reviews definitions and characteristics of CCA from the literature as to what would make it transformational. Starting with ten characteristics widely found in the literature, the paper evaluates them based on whether they seem essential to capture the core of meaning of what is being described in the literature and whether they are simple, easily understandable and feasible enough to collectively operationalize in the context of desk study assessment of TCCA in agri-food projects. The section finds several characteristics that do not meet some or all of those criteria and recommends they be dropped. Others, it found, are not really characteristics but types of CCA.

Based on the findings, the paper recommends a matrix approach, with one matrix for each type of CCA, evaluated based on the three characteristics that emerged from the analysis: **breadth and depth, scale and sustainability**. The recommendation is that each project be assessed based on whether the project overall was intended to affect climate change adaptation, and to be transformational. In turn each characteristic should be assessed by the degree to which it is present: not present, low, medium or high. Thus, each matrix would be a 3 x 4.

Section III looks further at specific examples of changes or interventions that can be seen as TCCA and recommends adding two additional types, and therefore matrices, to those recommended in Section II, bringing the total to four. These are:

1. public sector enabling environment and market systems (PEEMS)
2. diversification and relocation of production;
3. agricultural technologies, varieties, breeds, practices and systems (TVBPS)
4. root causes of vulnerability, marginalization, and power inequalities (VMPI).

Section IV discusses how an evaluator might know whether and to what extent transformational climate change adaptation is needed in a given location given the current and expected impact of climate change on agri-food systems. This requires assessing *climate risk and vulnerability* via Climate Vulnerability Assessments (CVAs). There are enough CVAs or similar assessments available for many countries that are major hosts of agri-food projects, e.g., Sub-Saharan Africa, to judge the extent to which TCCA should have been integrated into them to be used as a benchmark for comparison with what actually happened.

The outlines of a concrete tool —a set of four matrices—which could be used to assess TCCA is presented in Section V. Measurable sub criteria for breadth and depth, scale and sustainability, sample completion of the individual cells, and some guidance to support a potential evaluator in applying the matrices support use of the tool.

The conclusions and recommendations in Section VI suggest that the content of these matrices be first reviewed and revised by a multi-disciplinary team of agri-food experts with relevant expertise, applied to a small sample of agri-food projects, and revised again before a formal study is conducted.

DEFINITIONS OF TRANSFORMATIONAL CLIMATE CHANGE ADAPTATION

The literature on TCCA in general, and in agri-food systems in particular, lacks "a common understanding about what transformation entails" and "real-world examples [of what] constitute[s] transformation."[10] This section looks at definitions of TCCA to distil the essential features of climate change adaptation that qualify as transformational. It then assesses the feasibility of those characteristics identified from the literature. Broadly, any term included should capture the essence of meaning and intent of what characterizes TCCA. If the terms are to be used to conduct an actual assessment, it needs to be sufficiently *simple, understandable and applicable* to an actual assessment. *Simple* means selecting the minimum number of characteristics that can capture most of the content. *Understandable* means a reviewer with the necessary competence would be able to comprehend the criteria sufficiently to be able to apply them to actual projects. *Applicable* means that a potential desk review which largely relies on project mid-term and final evaluations and other project documentation will be able to find sufficient information relevant to those criteria to make assessments about them.

COMMON DEFINITIONS OF TCCA

There is a growing body of work on what constitutes and can be described as "transformational" or "transformative" adaptation (Box 1). Most of those definitions take as their starting point IPCC (2022), which characterizes TCCA as: "changing the fundamental *attributes* of a *system*, including altered goals or *values* and addressing the *root causes of vulnerability*."[11] (Emphasis added) It is important to note that both the IPCC definition and those contained in Box I refer to the changes, themselves, or in some cases the intermediate results, but not to the impact of those changes.

Box 1. Sample Definitions of Transformational Adaptation (all emphasis is added)

- "Transformative adaptation is theorized to occur 'across technological, economic and social' domains, including fundamental shifts in 'paradigms, goals and values.,"[12]
- "[I]ntentional responses to climate impacts that significantly shift the locations of agricultural production systems, introduce substantially new production methods or technologies at scale, or otherwise fundamentally alter key aspects of agricultural systems." [13]
- "When a system is A]bandoned and replaced with something fundamentally different … adaptation that changes the fundamental attributes of a system" [14]
- "[A]daptation involves deep, systemic, and long-term changes in systems and behaviors[15]

[10] Vermeulen *et al.* (2018).

[11] *Ibid*, p. 99.

[12] Dilling *et al.* (2023).

[13] Carter *et al.* (2018).

[14] Brooks (2017).

[15] Adaptation Committee (2022).

- "Change in the fundamental attributes of natural and human systems… adaptation includes system-wide changes, questioning the effectiveness of current systems, social injustices, and power imbalances"[16]
- "[A]ctions aiming at adapting to climate change resulting in **significant** changes in structure or function that go beyond adjusting existing practices… **can be adopted at a large scale**, can lead to new strategies in a region or resource **system**, transform places and potentially **shift locations** …. **deep and long-term** societal changes that influence sustainable development (include **values**, **worldviews**)"[17]
- "[S]hifting agricultural production systems through **significant, widespread** changes to become more resilient to longer-term projected future climate impacts"[18]
- " … a structural change in the institutional, cultural, technological, economic, and ecological dimensions of a **system** to establish new development pathways."[19]
- "Transformative adaptation characteristics: restructuring, **path-shifting**, innovative, multiscale, systemwide, and persistent" …. **fundamental systems' changes that address root causes of vulnerability"** [20]
- "Adaptation interventions can be qualified as transformational when they include 1) **system-wide change** or changes across more than one system, 2) focus on the current and medium (future) change and 3) involve direct questioning of the effectiveness of **existing systems, social injustices, and power imbalances**."[21]
- **"Transformational adaptation** refers to a change in the **fundamental attributes of a socioecological system** in anticipation of climate change and its impacts … Adaptation interventions can be qualified as transformational when they include system-wide change or changes across more than one system, focus on the current and medium (future) change, and involve direct questioning of the effectiveness of **existing systems, social injustices, and power imbalances."**[22]

Deubelli-Hwang and Mechler (2021) recently conducted a bibliometric review of 92 articles on adaptation. They identified eight factors (bold emphasis added):

1. takes place in **systems** of 'any level, from the individual through to the collective, industry or region' … and include governance regimes and power structures, group and network dynamics, ecological, agricultural, economic and social systems, livelihood schemes, … that fundamentally alter the entire **system**, characterized by **system-wide change** or changes across more than one system, takes place at the **system level** as the loci of change
2. changes in **behavior, values, and worldviews** (i.e., social norms)
3. requires change processes **at scale**
4. depends on the **depth of change** (see e.g., Pelling *et al* 2015): profound and deep-rooted;
5. addresses the **underlying, social, cultural, and economic root causes of risk** or the structural, sociopolitical **root drivers of vulnerabilities**, **risks**, and **inequalities**

[16] FAO (2022).

[17] IPCC (2022).

[18] Carter *et al.* (2018).

[19] Haque *et al.* (2023).

[20] Fedele *et al.* (2019).

[21] UNDP (no date).

[22] FAO (2022).

6. involves creating changes in agency and to **power relations**, explicitly challenging authorities and hierarchies to affect a change in governance regimes, institutional arrangements, community dynamics and **power structures**
7. **includes specific participatory processes or approaches to change** (i.e., inclusive, development-centered approaches)
8. is deliberate and actively initiated (i.e., **intended** or **intentional**).
9. They conclude that TCCA: "entails large-scale, profound and deep-rooted changes of the system, challenging its status quo." They also note a clear "operationalization gap' in terms of translating transformational change ambitions into concrete transformative measures that can be directly replicated in practice and a lack of concrete examples of TCCA.

Building from the above list, this paper proposes ten potential characteristics of CCA that could make it transformational:

1. intentional
2. systems: locus and scope of change
3. degree of change: depth and breadth
4. limits of change
5. scale or potential for future scale
6. sustainability: financial and institutional
7. root causes of vulnerability and marginalization
8. social norms, beliefs and values
9. Good development process
10. time or speed of change.

CHARACTERISTICS THAT MAKE ADAPTATION TRANSFORMATIONAL

INTENTIONAL

"Intentional" is a characteristic frequently cited in the literature.[23] However, transformational change can occur even in the absence of explicit intentions. For example, external shocks such as extreme weather events or market disruptions may force communities or individuals to pursue transformative adaptation, albeit neither planned nor intentional.[24] Similarly, donor projects whose goals did not include transformational climate change adaptation might, perhaps unintentionally, successfully promote and affect adaptation.

However, it is important to know whether such impact was intentional because that could impact funding and what elements to include in projects supporting TCCA in the future. An additional argument in favor of

[23] See the quote from Carter *et al.* (2018) in Box 1 and also Colloff *et al.* (2021), who coin and use throughout their paper the term, ITA—intentional transformative adaptation. Deubelli-Hwang and Mechler (2021) also include this as one of the common criteria they find in the literature.

[24] See for example Ensor and Berger (2009) and Leichenko and O'Brien (2008).

including intention is that it will be difficult to measure the impact of a set of changes. Moreover, because the purpose of this framework is to inform future advocacy, even if USAID or other donors are integrating TCCA to some extent, it is important to know whether this was intended and a result of systematic policies and priorities. "Intentional" should, therefore, be included as an indicator in an assessment framework.

SYSTEMS: LOCUS AND SCOPE OF CHANGE

Transformational change involves systemic change as evidenced by its frequent mention in Box 1 above. This is true in general, and particularly in agri-food systems precisely because the objects being changed are the systems themselves. To change systems requires systemic/systems change.[25]

The literature mentions almost every imaginable relevant system: technological, production, economic, social, political, and cultural as well as natural systems.[26] This is apparent from the long quote from Deubelli-Hwang and Mechler (2021) above, and Fedele et al. (2019):

> *Transformative adaptation' therefore refers to these changes that fundamentally* ***alter the entire system's ecological and/or social properties and functions****. It aims to reduce the root causes of vulnerabilities to climate change, such as* ***social, cultural, economic, environmental, and power relations****, by transforming them into more just, sustainable, or resilient states. [Emphasis added]*

The system-level or systemic nature of change is one of the major factors that distinguish transformational from incremental change. Systems are relevant to adaptation in the agri-food sector in at least three areas: (1) agri-food production systems as part of TVBPS;[27] (2) relevant large-scale context; policy enabling environment – policy, legal, regulatory (PEE), public sector institutions, agri-food market systems (MS), and value chains (taken together as PEEMS); and (3) socio-economic and cultural systems that determine access, knowledge, wealth and other assets, (VMPI).

Systems are clearly essential to TCCA, and the concept is simple and easy to understand. However, it seems to make more sense to view these systems, and these three systems in particular, as domains or *types* of transformational adaptation, rather than characteristics of it. An assessment could be conducted to determine the extent to which each type is present in a project, which could then be measured in terms of other characteristics discussed in this section are present.

DEGREE OF CHANGE: DEPTH AND BREADTH

The IPCC matrix in Table 2 below explicitly mentions the depth, speed, and scope of change necessary to qualify as "transformational." *Depth* implies that the change is extensive. Other authors refer to fundamental, significant, profound or a paradigm shift.[28] The *scope* of change relates to how widespread the change is. This could seem to be two different things: one refers to the number of people or places adopting changes, or scale. The other is the breadth of the intervention(s). The paper defines "breadth" as the extent to which the changes being introduced at any given scale involve a little, some or most of a relevant system. In the context of production, breadth might be seen as the extent to which a particular agriculture production system is

[25] See one of the few reviews of actual cases of climate change adaptation, Thornton *et al.* (2018).

[26] See for example Fedele *et al.* (2019), who state that: "Fundamental changes in social-ecological systems that address root causes of vulnerability may be needed."

[27] We define an agri-food production system as "a combination of technologies, equipment and other inputs, methods, and practices used by producers to produce crops or raise livestock to meet their own and population demand for food, fuel and fiber." This draws on Jones *et al.* (2017).

[28] See for example: Hellin *et al.* (2023): "Our argument is that a shift is needed from climate smart to climate-resilient agriculture, in keeping with the assertion that resilience can be transformative ('transformability'). This paradigm shift …"

being affected. Is it just one new variety or breed, a new variety or breed combined with some better agricultural practices? Or is it a whole package of practices and technologies that affect much if not all of the production cycle? Relevant to PEEMS, breadth can be seen as the number and scope of changes to the public sector enabling environment, to strengthening or filling in gaps in public institutions and value chains, etc.

Table 2: IPCC dimensions of transformative adaptation[29]

Dimensions	Transformative potential of adaptation		
	Low	Medium	High
Depth	Adaptations are largely expansions of existing practices, with minimal change un underlying values, assumptions or norms	Adaptations reflect a shift away from existing practices, norms or structures to some extent.	Adaptations reflect entirely new practices involving deep structural reform, e.g. complete change in mindset and changing institutional behavioural norms.
Scope	Adaptations are largely localized and fragmented, with limited evidence of coordination or mainstreaming across sectors, jurisdictions or levels of governance	Adaptation affects wide geographic areas, multiple areas and sectors, or are mainstreamed and coordinated across multiple dimensions.	Adaptations are widespread and substantial, including most possible sectors, levels of governance, and actors.
Speed	Adaptations are implemented slowly	Adaptations are implemented moderately quickly.	Change is considered rapid for a given context.
Limits	Adaptations may approach but not exceed or substantively challenge soft limits	Adaptations may overcome some soft limits but do not challenge or approach hard limits.	Adaptations exceed many soft limits and approach or challenge hard limits.

Operationally, the breadth and depth of change is clearly context specific. The introduction of a particular innovation in one context might be a deep change in one context but would be incremental in another. Introducing drought-tolerant hybrid maize to smallholders who are using traditional low-yielding open-pollinated variety would be a huge change, less so to farmers already using hybrid maize seeds

The concepts of depth and breadth are clearly essential to TCCA, simple and easy to understand conceptually — if complex in reality — and should be measurable. Preferably their **impact** can be assessed when evidence exists, such as informed inference (drawing in existing scientific literature or experience elsewhere); if not, then the extent of change will have to suffice.

LIMITS OF CHANGE

Another aspect of the size of change is exceeding what the IPCC calls the "soft"—potentially feasible but not yet — and "hard" — technologically permanently impossible—limits of change. The IPCC suggests that a change is transformational the closer it gets to hard limits, by "approach[ing] or challeng[ing] hard limits."

[29] IPCC AR6 WG2 Chapter 16, Table 16.1 (2435)

The IPCC distinction between hard and soft limits is conceptually simple but operates at a level of abstraction that makes it hard to understand, let alone apply. Indeed, the concept has been criticized as found "in a largely theoretical set of literature" and intellectually confusing.[30]

It is hard to imagine an evaluator reading the final evaluation of a donor project and trying to assess how close various interventions approach hard limits. This would require them, especially when dealing with a wide range of projects, to have an encyclopedic knowledge of both current and prospective theoretical technology barriers. There appears to be no readily accessible database of such limits.[31] Limits to Change do not belong in a TCCA analytical framework.

SCALE OR POTENTIAL FOR FUTURE SCALE

Closely related to the depth and breadth of change is the "dimension" of scale. This element of TCCA is almost universal in definitions in the literature,[32] and therefore it is clearly essential, although its precise meaning is left unspecified.[33] For change to be transformative, it needs to be some combination of: (1) has already adopted and implemented at some significant scale; (2) meets scalability criteria; (3) has potential for application at much larger scale, however "larger" may be defined; and (4) has made progress in advancing along a scaling pathway, addressing constraints and putting in place the preconditions necessary to scale further.

There are two important issues when it comes to using scale as an indicator of TCCA. The first is how scale should be measured; from the starting point to maximum potential levels of adoption, utilization and impact. Scale needs to be defined in relationship to the size of the problem, rather than in terms of progress from an existing starting point.[34] The second is how future potential or current progress and readiness for scale can and should be measured. The scaling literature argues that progress in scaling is not only the number of people or places that have already adopted or are using the intervention; it also requires that an intervention itself be scalable.[35]

[30] See Thomas *et al.* (2021).

[31] *Ibid,* Further, they found in their review of over 1,600 articles that only a quarter provided detailed information on either hard or soft limits and that the concept suffers from "epistemological ambiguity," i.e., uncertainty or doubt regarding its knowability. "Our systematic review of over 1,600 peer-reviewed articles on implemented adaptation reveals that while constraints to adaptation are widely acknowledged in the literature, slightly less than a quarter of articles link constraints to limits being reached at some point and there is a paucity of studies that provide detailed information on how limits may be experienced and when. We also find that roughly one in four studies discussing limits identify hard limits—where no further adaptation actions would be possible."

[32] See Batra *et al.* (2022), Deubelli-Hwang and Mechler (2021) Fedele *et al.* (2020), and IPCC (2022) among others. Batra, citing the Global Environmental Facility's own definition: "transformational change defined such change as: deep, systemic, and sustainable change with **large-scale** impact." [Emphasis added] Fedele noted that in their review of: "... 80 recent conceptual publications about responses of social, ecological, and social-ecological systems to climate change... suggests that transformative adaptation is characterized as being restructuring, path-shifting, innovative, **multiscale**, systemwide, and persistent." [Emphasis added] All of the WRI working papers we reviewed included "greater scale or magnitude" as part of a definition of transformational adaptation, e.g., Dinshaw (2014), Carter *et al.* (2018), and Ashley *et al.* (2020).

[33] For a good summary of the key principles and lessons, see Kohl and Linn (2021), ExpandNet (2011), and Perlman-Robinson and Winthrop (2016). For literature specific to agri-food systems, see Dror *et al.* (2020), Sartas *et al.* (2020), and Woltering *et al.* (2019).

[34] In addition to scale itself, the scaling literature argues for a much more expansive definition of scaling that recognizes that of necessity scale as a scaling goal necessitates tradeoffs among multiple goals. These include reach or numbers of people or places, impact per capita or community, sustainability, ensuring that it at least does not increase existing gender and other inequities, addresses marginalized populations, and unintended and second order effects. Given that most of these considerations are aspects of our definition of TCCA, we use the term scale as shorthand for only the first dimension, reach or numbers. This is often called Optimal Scale. See McLean and Gargani (2019).

[35] See for example the Scalability Assessment Checklist, first developed in 2006 by Kohl and Cooley (2006). The most recent version is found in Management Systems International (2021). Also see Dror *et al.* (2020), Sartas *et al.* (2020), and Woltering *et al.* (2019).

Progress also includes the extent to which foundational elements that will allow for future scaling have been put in place, which makes relevant the concept of transformative and scaling pathways.[36] Scaling pathways are often defined as a sequence of six phases and activities:[37]

1. basic R&D
2. innovation development
3. testing of an innovation or proof of concept
4. transition to scale (creating a strategy, mobilizing resources and partners for scaling)
5. scaling or going to scale
6. implementation at scale.[38]

Scaling is often an iterative process that, even when it gets to phase (5), often proceeds in steps – such as from 50 villages to two districts to a region to an entire country.

Progress on scaling requires foundational elements to both continue scaling and to ultimately allow for sustainable impact at large scale. The first two elements are ensuring that the necessary implementation capacity ("doers") and funding (payers") are in place; and that doers and payers have the motivation, capability and financial and other resources to play those roles.

The third foundational element addresses constraints and creates preconditions. These could include:

1. generating evidence of proof of impact/concept, costs and other information to assess scalability
2. identifying actors with the resources and implementation capacity, doers and payers, for both scaling and implementation at scale (not necessarily the same actors)
3. getting commitments and ownership from key partners including champions, doers and payers to play those roles, and
4. affecting adequate systems changes to create sufficient "space" for scaling, including ensuring equity and avoiding unintended consequences.[39]

It should be clear that systems and systems change are explicitly contained in scaling. Some systems and systems change will affect the scale or potential scale that can be achieved. Others will affect the sustainability of implementation and impact at that scale. Changes to an intervention or scaling pathway that increase the readiness for scaling or potential scale should be included under scale. Those that affect long-term sustainability should be included under that characteristic, discussed below.

Scale is an essential indicator of TCCA. It is simple and easy to understand conceptually, though measurement of potential scale, scalability and the extent to which there has been progress along a scaling pathway—creating preconditions and addressing constraints—is not so simple. However recent advances in

[36] For a discussion of transformational climate pathways in general, see Mapfumo *et al.*, (2015), Werners *et al.* (2021), Wise *et al.* (2014) and Colloff *et al.* (2021). Coloff looks at four characteristics of pathways: " (1) the differing emphases on drivers of change, and whether these are external (linked to environmental and contextual shifts) or internal (linked to goals, internal dynamics and processes); (2) the steps through which transformational changes unfold (large or small) and whether their patterns are structured/deterministic or if they are highly contingent and flexible;(3)the role of agents and decision-makers in bringing about change and the nature of their relationships; and finally,(4)the sustainability of change and the resources needed to sustain long-term change in the face of obstacles and barriers." Werners *et al.* (2021) note that transformational pathways are those that consider accounting complexity and target long-term change.

[37] See for example Feeny and Linn (2017).

[38] Implementation at scale is usually characterized as "sustainable" implementation. However, as we consider sustainability as a separate topic, in this section we focus only on scale and scaling. More generally, the two topics are distinct. Scale can occur or be reached but not be sustainable. Impact (or in this case TCCA) can occur and be sustainable but at a small scale.

[39] The concepts of spaces and drivers of scaling originates with Hartmann and Linn (2008.

the scaling literature, such as the scalability criteria, should make it feasible to assess and scale be included as a characteristic.[40]

SUSTAINABILITY: FINANCIAL AND INSTITUTIONAL

There is a clear consensus in the literature that for adaptation to be transformative it needs to be lasting or sustainable in at least two senses: enduring and in balance with the planet's ecological natural resources.[41]

Transformational adaptation clearly implies or should imply enduring and environmental sustainability. Sustainability in its environmental and duration definitions is essential to TCCA, and both are relatively simple and understandable. Measuring the two is difficult, especially when the information available has been collected around the end of the project, rather than years afterwards. Other challenges to measuring sustainability include:

1. Stakeholders and technical experts may have divergent opinions about how to define it
2. Qualitative indicators are contextually and culturally dependent
3. It involves untangling complex, interconnected systems, and measuring system-wide changes; and
4. Data availability differs widely, especially in low-resource settings with limited historical time series and granularity of weather, agricultural and other climate-related measures
5. Environmental sustainability may depend on the scale or intensity of adoption.[42, 43]

Accordingly, sustainability should be used as a criterion in the sense of durability, lasting, persistent or enduring effects, but environmental considerations should be limited to extreme cases where interventions are clearly not environmentally sustainable in a given context. In the case of TVBPS, sustainability can be measured in terms of whether necessary institutions, financial and technical partners (doers and payers) and systems, such as value chain and market systems are in place. For VMPI and PEEMS, assessing sustainability requires some assessment of political support, economic constraints and resources, and social and cultural aspects. While sustainability will be challenging to assess, it is essential and should be included.

ROOT CAUSES OF VULNERABILITY AND MARGINALIZATION

In looking at vulnerability and marginalization as a component, characteristic or aspect of TCCA, the literature argues that not only is vulnerability a necessary part of transformational change, but such change should go beyond addressing risk or even vulnerability to address its root causes.[44] The root causes include power relations, gender, income and other inequalities, particularly in ownership of or access to critical assets or "capital," broadly defined, such as: land, machinery and equipment, financial wealth (or credit), knowledge, and social standing. Such inequalities and lack of assets result, for example, in marginalized populations' being often concentrated in places exposed to climate change or working marginally productive land. The importance of power relations and inequalities cannot be overemphasized and is widely discussed in the

[40] It is worth noting that USAID's agri-food bureau, BREFS has been developing and disseminating guidance on scaling in agri-food projects, including holding several training workshops. See Feed the Future (2022).

[41] See, for example, Adger *et al.* (2018a), Adger *et al.* (2018b), Eriksen *et al.* (2011). Ford *et al.* (2015), Leichenko and O'Brien (2008), Pelling (2011), and Shackleton *et al.* (2015), among others.

[42] For example, drilling a given number of wells or boreholes that can be used for irrigation may be durable and environmental. Drilling a much larger number can deplete aquifers and lead to salinization of the water table.

[43] Adopted and modified from Ochandarena (2015).

[44] See for example: "The social injustices and inequalities entrenched in global communities create [sic] marginalization making certain groups more vulnerable to disaster risks than others [29]. Social, political, and economic processes within communities create [sic] marginalization [40]. For transformation to be successful, a well-targeted reduction in marginalization is needed." Ajulo et al. (2020).

literature on transformation. For example, Colloff *et al*. found that what they call Intentional Transformational Adaptation impacts power relations and the societal status quo and is, thus, inherently political. For them: "Power imbalances as determinants of transformation can function as major barriers to successful implementation. … Shifts in power are likely to be an important leverage point or necessary condition for ITA."[45]

Gender is seen as a particularly central dimension of looking at TCCA because it is key determinant of both vulnerability as well as barriers to adaptation. Women farmers' face more structural and societal challenges than men, making them less able or inclined to adopt adaptation strategies.[46]

Not only will neglecting gender in any assessment of TCCA seriously undermine the quality of the analysis, but it can also lead to findings and recommendations that may actually increase vulnerability, marginalization and power inequalities. Agri-food projects in general that do not address both gender inequality and empowerment often focus on improving production and yields of crops (or animal products) that are largely controlled by men, increasing men's power within the household and their control over income and other household economic decisions.[47] As one author has noted: "interventions aimed at producing socially just outcomes that address gender inequalities, but which result in locally unacceptable challenges to men's authority in target households … [can] make the intervention inherently unsustainable in the absence of sustained external engagement."[48]

The literature emphasizes that gender is one of many markers of social differences, or what is often referred to as intersectionality. "In the context of vulnerability to the impacts of climate variability, for example, wealthy women with diverse livelihoods might have more in common with wealthy, similarly employed men than they do with poorer women who are reliant on rain-fed agriculture for their food and income."[49] As such, to address root causes of vulnerability, one needs to look at the multiple forms of discrimination and marginalization that occur.

Addressing the root causes of VMPI is *essential* to any definition or analysis of TCCA and must be included as a dimension of transformational adaptation. However, it is not really a characteristic of TCCA, but a *type* of climate change adaptation. Thus, one of the insights from this paper is that an analytical framework to assess TCCA needs to look at the various types of TCCA, and for each type, progress or the extent of change should be measured and assessed along with the various characteristics of TCCA, such as breadth and depth, scale and sustainability.

Returning to VMPI, at a high level, it is relatively simple and easy to understand that people who lack resources are more vulnerable to climate change and less able to adapt to it. While, because of its multi-dimensional nature, assessing progress on VMPI will be somewhat challenging, thanks to the heavy emphasis on gender, in particular, and marginalization, in general, there should be sufficient data and documentation to assess this as an indicator. Therefore, it should be included.

[45] See also Fedele *et al*. (2019) and Schreuder and Horlings (2022), who note: "Instead of accommodating change, [transformation] contests change by challenging the existing power and governance structures, norms, values and worldviews that may impede change."

[46] For example, "women-headed farming households tend to be more vulnerable to the impacts of climate change, and women in all types of households are relatively more vulnerable as well. Women farmers are less likely to adopt adaptation strategies due to financial and resource limitations and less control over land" from Huyer and Partey (2020).

[47] See for example Ntakyou and Van Den Berg (2022). The author's own experience with a rice improvement project in the Casamance in Senegal showed that when the productivity of rice cultivated in creek bottoms—low productivity land traditionally the preserve of women—was significantly improved, men pushed women out off of that land and into other areas of agriculture production.

[48] Carr and Thompson (2014)

[49] *Ibid*. p. 7

SOCIAL NORMS, BELIEFS AND VALUES

Transformational change is, by definition, disruptive and normally provokes resistance from "vested interests, economic lock-ins, institutional path dependencies and prevalent practices, cultures, norms and belief systems."[50] While in cases where the impact of climate change is already severe and visible, smallholder farmers and others may have already taken the initiative to adapt or be open to it. In cases where national governments, donors and others try to initiate TCCA proactively in anticipation of future impacts, local communities may not see the need and be opposed to such efforts.

Instrumentally, changes in beliefs and attitudes about climate impact and adaptive responses require mobilizing support and motivation from the public and private sector and the population writ large.[51] When populations are convinced about the likelihood of climate change as well as its specific impact and timing, they are more likely to both support systemic-level adaptation as well as undertake adaptation on their own.[52]

Social norms and beliefs should be included in an analytical framework for assessing TCCA. Given their close relationship with VMPI, these should be combined into that matrix or type of transformational change, and not included as a characteristic.

GOOD DEVELOPMENT PROCESS

Much of the literature on TCCA emphasizes the importance of process in TCCA; it should be inclusive, participatory, multi-stakeholder, bottom-up as well as top-down, characterized by continuous learning, innovation, and evolutionary, adaptive, and flexible thinking based on learning from experience.[53] For example, Carter et al. (2021) use the term participatory no less than fifteen times in their seminal paper, such as:

> *Planning for transformative adaptation should center on* ***inclusive, participatory processes*** *that engage a diverse range of stakeholders who may often be marginalized in decision-making, such as women, youth, and Indigenous peoples [and] use* ***inclusive, participatory processes*** *to design transformative pathways.*[54] *[Emphasis added]*

In addition, as part of being inclusive, proponents of good process argue that TCCA efforts should be aligned with national policy and political priorities combining a 'whole-of-government' approach with private sector and community engagement.[55]

In terms of the criteria for inclusion, "good process" seems to be essential in some cases but not others. Good process is simple and easy to understand conceptually and is difficult to assess easily – not easily applicable. All of the aspects mentioned under good process are true for most if not all development efforts and bear no necessary or special relationship to either CCA or its being transformational. It is likely that any CCA effort that includes good process may be more effective and therefore to the extent it is transformational, more transformational, good process does not make it inherently transformational. The

[50] Pörtner *et al.* (2022), p. 84.

[51] See Abass *et al.* (2018). "Although adaptation strategies are generally location specific, the influence/assistance and cooperation of both formal and informal institutions is required for successful implementation of adaptation strategies. … Formal institutions are defined as tangible governance and organizational structures whilst informal institutions are cultural norms and traditions which shape the behavior and nature of human interactions."

[52] *Ibid.* "Decisions people make towards climate change adaptation is based on their perceptions about climate change and its likely impacts."

[53] Dixit and Foti (2013).

[54] Carter *et al.* (2021).

[55] FAO (2022).

exception to this is addressing VMPI; in that case the process of doing so must be inclusive and empowering; there cannot be a separation between process and results or means and ends.

In terms of applicability for an assessor reviewing TCCA projects, evaluations and other documentation may or may not include the types of processes that were followed in a project design and implementation. Even in cases where process is mentioned, it would be difficult to determine whether any consultations, participation or other forms of localization mentioned are simply *pro forma*, check-the-box exercises or genuinely inclusive, participatory, and forms of localization.

On balance, the paper recommends that "good process" be included as an indicator or characteristic of TCCA in the context of assessing VMPI but not included in other types of CCA, such as the introduction of new technologies—agricultural technologies, varieties, breeds and practices and systems; diversification and relocation; or public sector enabling environment and market systems.

TIME OR SPEED OF CHANGE

The duration or speed with which change is affected receives somewhat contradictory treatment in the literature. On the one hand, there is a strong thread that the need to integrate TCCA into agri-food projects is urgent, especially in areas already severely affected by climate change or where such impacts are imminent. On the other hand, the literature repeatedly notes that in many cases incremental changes may suffice in the near term (this is discussed in Section IV) and that, given its transformational nature, of necessity it takes time (though it needs to get going right now). It goes on to caution that while the confidence of climate predictions has continuously improved in the last decade, even at the local level, there is still a great deal of uncertainty remaining and incremental adaptation may be preferred before making the much greater commitment of financial and other resources that transformational change requires. This suggests proceeding with caution, allowing time to adjust and pivot based on experience and as new evidence, or modelling becomes available. Finally, the literature notes that if incremental measures are pursued steadily over time, they could cumulate over time into transformational change.[56]

Most of the literature at least implicitly recognizes, though does not resolve, the tensions between the urgent need for transformation, the reasons to proceed cautiously, and the fact that transformational change takes time. By assessing whether or not, and to what extent, TCCA is integrated into a project means that to some extent speed in the sense of urgency is already being addressed. Whether or not a project is proceeding quickly to actually implement TCCA is difficult to assess; many development projects have incentives for speed in the form of "quick wins" and "low hanging fruit" but this often comes at the cost of sustainability, scale or depth of change. It would be hard for an assessor to determine whether or not a project is implementing TCCA quickly and profoundly or just superficially. Therefore, time or speed is not essential, contradictory (and therefore difficult to understand), and infeasible to assess, and should not be included as an indicator or characteristic of TCCA.

[56] *Ibid.*

Table 3. Review of ten potential characteristics of transformational climate change

Characteristics from the literature	First Cut – Should this be included as an indicator and why	Second Cut – Additional considerations
Intentional *retain*	Clearly simple and understandable. Should be feasible based on project documentation and KIIs. Essential because study will need to look at extent of change from initial conditions, as actual impact is not feasible.	Intentional helps assess whether changes will produce impact on CCA. Should be included for projects OVERALL, not in individual types of CCA.
System: Locus or scope of change *retain but integrate into other characteristics and types*	Yes. Systems and systems change clearly essential, found in almost all of the literature. Easily understandable. However, is contained in other characteristics (e.g., breadth of change, as well as most types of TCCA). Neither simple nor practical as a single indicator.	Integrate into breadth and types of system change, i.e., PEEMS, VMPI, and TVBPS.
Degree of change: Depth & breadth *Retain*	Essential, understandable, simple and relatively feasible. Use as one combined characteristic.	
Limits of change (hard and soft) *Drop*	Meets none of the four criteria, difficult to understand, determine limits, or measure.	
Scale (including potential and readiness for future scale) *Retain*	Essential – scale is a major determinative of transformational. Easily understood, actual scale easy and feasible to measure.	Potential or readiness for scale can rely on extensive existing literature and criteria on that subject.
Sustainability: financial and institutional *Retain*	Essential, easily understandable, and relatively simple. May be challenging to measure.	Focus on whether long-term funding and implementation are in place by project end.
Root causes of vulnerability and marginalization, and power inequalities *retain as a Type of TCCA*	Essential and easily understandable. Not simple or easy to measure, as it is multi-dimensional. Not a characteristic but a type. **Combine with social norms and beliefs.**	Retain as a Type of TCCA.
Social norms, beliefs and values *retain and combine with VMPI*	Essential, easily understandable, simple and easy to measure. Not a characteristic but a type. **Combine with VMPI.**	Retain as a Type of TCCA.
Good development process (e.g., inclusive and participatory) *partially retain*	Simple and understandable, but not essential nor feasible. Some types of TCCA can occur without good practice or process, and the converse. **Include in assessing VMPI but not in other types.**	While not included in a formal framework, should be tracked qualitatively in cases where important.
Time or speed of change *drop*	Not simple, essential or easily understandable. Transformation is considered both urgent and time-consuming. Not clear what that would look like in the context of a 3–5 year project or program.	

DEFINITIONS AND CHARACTERISTICS: CHALLENGES, CONCLUSIONS AND RECOMMENDATIONS

This section identified ten characteristics of TCCA widely found in the literature. The paper evaluated these characteristics based on four criteria: essential, simple, understandable, and feasible to measure or assess in a desk study. Based on these criteria, the paper recommends that "hard or soft limits" and "time" or "speed" not be included, and that be "good process" be included in a limited way. The paper recommended including four characteristics: 1. intentional; 2. depth (or the size/quality of change) and breadth or scope; 3. sustainability (duration); and 4. scale.

Of the three remaining characteristics found in the literature, the paper found that several aspects of TCCA are more appropriately considered types, rather than characteristics, of change. These are root causes of vulnerability, marginalization and power inequality" and "social norms and beliefs." Given that these are closely related and mutually reinforcing, the paper proposes to combine them into one, VMPI. (This section also identified two other types of TCCA—TVBPS and PEEMS—that are described and discussed in more detail in Section III.) The section noted that since all those types of TCCA are forms of systems change (socio-economic systems, governance systems and institutions, and production systems), there is no need to include "systems" as a separate characteristic. (It is also included in breadth).

The distinction between types and characteristics suggested that the appropriate framework for assessing TCCA would be to use a matrix approach; one matrix for each type of adaptation. This leads to the recommendation to use a matrix approach for each type of climate change adaptation assessed on four characteristics—breadth and depth, scale and sustainability—with intention to be assessed for the project as a whole. Each of those characteristics can either be not present at all, or rated as low, medium or high in terms of being transformational in that dimension. Thus, the paper recommends as an analytical framework a 3 x 4 matrix, one for each type of change. A sample of that matrix is presented in Table 3 below.

Table 3. Sample 3 x 4 assessment matrix

	Not Present	Low	Medium	High
Depth and breadth				
Sustainability (duration)				
Scale (or potential for scale)				

SPECIFIC TYPES OF TCCA

In Section II, the paper identified four characteristics that can be used to assess the extent to which donors integrate TCCA into their projects and recommended the use of a matrix approach akin to maturity matrices

that are used in monitoring and evaluation.[57] Finally, the paper recommended that an analytical framework for assessing TCCA should look at different specific types of TCCA. Section II identified and discussed two of those types that strengthen or fill gaps in PEEMS and VMPI. Both PEEMS and VMPI can also be considered broad systems relevant to TCCA.

This section deepens the discussion of PEEMS and to a limited extent VMPI, adding two additional types of change. These are:

- diversification and relocation (D&R), defined as geographical shifts in the location of agricultural production (or migration of people, as opposed to production); and
- new or improved technologies, (crop) varieties, (animal) breeds, (agricultural) practices, and systems (agricultural) (TVBPS).

It is important to note that whether or not any of these types of change are transformational will depend on the extent to which they are broad and deep, at scale, and sustainable. What that looks like in practice is discussed in Section V below.

STRENGTHENING OR FILLING GAPS IN PUBLIC ENABLING ENVIRONMENT, INSTITUTIONS AND MARKET SYSTEMS

Changes in systems or systemic change are core features of TCCA. Systems changes usually occur in two areas: the private sector (market systems and value chains) or the public sector. For the latter, this takes two forms. The first are changes to the public sector enabling environment (PEE) such as changes to policies, laws, and regulations, especially systems affecting usage of land, water, forests, and other natural resources. A number of important examples of this have been reforms to governance and the public policy enabling environment in the processes for certification and registration of new seed varieties or animal breeds. By speeding up the process and making it easier, this contributes to the ability to implement TCCA more rapidly in terms of introducing new varieties and breeds.[58]

The second involves creating, strengthening or capacity building of relevant public sector institutions, which are often included as activities in USAID and other donor agri-food projects.[59] For example, it is common for donors to invest in training Ministry of Agriculture staff or public sector agricultural extension workers to update their agronomic knowledge. Such efforts, to the extent they were related to how to understand and address climate change, would clearly be a form of PEEMS. Donors often work with national and sub-national governments in other areas that could support TCCA, such as establishing or strengthening seed certification systems, providing a reliable supply of foundation or breeder seeds sufficient to meet market demand, or putting in systems to conform to EU and US agricultural export requirements.[60]

[57] Another way to think of this is that these are maturity matrices, which are used to track or evaluate the progress or development of an organization, process or program, such as the sophistication of an organization's management and governance. For an application to the agri-food sector in the context of the circular economy, see Scandurra *et al.* (2023).

[58] "One area where regulatory flexibility has been introduced is in the process for variety registration and release. Seed laws typically have not allowed for the registration, dissemination, and, in particular, commercial sale of farmers' varieties (121). Before a new variety can be released it typically has to meet standards for distinctiveness, uniformity, and stability (DUS test) as well as prove that it has value for cultivation and use (VCU test) in multilocation national performance trials over two to three seasons. In order to speed up the process and allow more flexibility in terms of what types of varieties can be registered, some countries have introduced measures to either relax DUS and VCU testing requirements or adopted alternative seed catalogues for farmers' varieties (e.g., Ethiopia, Benin, India, Nepal, Brazil, Peru)." Westengen *et al.* (2023).

[59] See, for example, the case studies of USAID projects in Bangladesh and Senegal, Kohl (2016a) and (2016b).

[60] Several of these related to seeds were part of the USAID partnership called "Partnerships for Seed Technology Transfer in Africa (PASTTA). See Renou (2023).

In terms of strengthening market systems, when new or improved technologies or practices are introduced, they are often accompanied by work to strengthen upstream and downstream linkages and institutions for that value chain.

Changes in PEEMS have significant potential as a form of TCCA, as they almost always involve changes in systems, and occur at a national, regional or value chain level. They therefore have potential to score highly on scale and breadth. However, how they are assessed will depend on the extent to which such changes are targeting, or at least supportive of, climate change adaptation.

DIVERSIFICATION AND (RE)LOCATION OF PRODUCTION: SHIFTS IN THE GEOGRAPHICAL LOCATIONS OF AGRICULTURAL ACTIVITIES

The second type of TCCA interventions fall under the category of **significant shifts in the geographical locations** of agricultural activities, i.e., where crops and livestock are grown and raised.

In cases where shifts in geographic location lead to the wholesale replacement of one product by another in an existing AEZ, this is highly likely to be transformational. For example, cacao and coffee are sensitive to climate change, especially increased temperatures and reduced net rainfall. Climate change is already making production of both products less viable or even unviable in many traditional production zones.[61] As a result, coffee regions are beginning to replace coffee with other crops like citrus in Central America,[62] where estimates are that "[c]hanging temperature and rainfall could reduce the Central American coffee-growing area between 38 and 89 percent by the year 2050 and raise the minimum altitude for coffee production from approximately 2,000 feet to 3,300 feet above sea level."[63] Other important examples are from animal husbandry. Pastoralists that historically raised cattle in semi-arid and arid areas are shifting to smaller ruminants like sheep or goats,[64] or even camels in arid areas.[65]

Diversification is a form of relocation, and indeed to some extent the breadth and depth of this type of change can be seen as a continuum from modest diversification—adding aquaculture into places that are experiencing greater frequency and levels of flooding—to complete replacement of existing products. Thus, at one end of the continuum, fish or seafood farming may be added to rice cultivation, and at the other end, they could replace rice cultivation entirely. The extent to which diversification is transformational will depend in part on context.

The converse is also a viable form of adaptation, wherein a given crop/breed shifts to a different location, what Sloat *et al.* (2020) call 'climate adaptation by crop migration.[66] For example, there has been speculation that the crops that are currently grown in California's Imperial Valley may have to be grown further north. In the US, farmers in Northern California have begun to plant mangos, avocados, cherimoyas, and tropical palms

[61] Bilen *et al.* (2022). "Large portions of important coffee-producing nations, including Brazil, Vietnam, Honduras, and India, will become unsuitable. The most significant reductions in suitability are expected in Ethiopia, Sudan, and Kenya (up to 90% reduction by 2080 [60]), Puerto Rico (84% by 2070 [51]), Mexico (98% by the 2050 s [61]), and Latin America (88% by 2050 [62])."

[62] Carter and Tye (2018).

[63] Scott (2015).

[64] "With less water and food available, herders are trading in cattle for less needy animals like goats and sheep." In Chavez (2023).

[65] See Wako *et al.* (2017).

[66] Sloat *et al.* (2020).

that were historically not viable in that area, and historically grown in the southern half of the state.[67] This adaptation occurs because production zones in general are expected to shift with global warming towards the poles. It can also occur because of the expansion of specific zones within a given area (e.g., to higher altitudes, as is happening in some locations with coffee).[68]

Relocation is *prima facie* likely to be transformative, assuming it is introduced or happening, at least in part, as a form of CCA. It inherently scores high on both breadth and depth, and to be viable requires investments in market systems (e.g., reliable sources for citrus saplings and infrastructure to store, process and export), that only make sense at sufficient scale to support a viable industry.

NEW OR IMPROVED TECHNOLOGIES, VARIETIES, BREEDS, PRACTICES OR AGRICULTURAL SYSTEMS CHANGES

A third type of TCCA is where technologies and production methods introduced are new to that location or agro-ecological zones and change the way existing agri-food products are produced. As this includes new varieties, breeds, practices and technologies, the potential list is extremely wide ranging. It can include new crop varieties, such as the drought tolerant maize example given above, or conversely, varieties that do better with greater flood conditions.[69]

New technologies can also take the form of new machinery and equipment, such as various combinations of drip irrigation, solar water pumps, and in some cases, new forms of water collection and storage. A good example that can facilitate CCA is precision farming, using GPS, drones, sensors and satellites combined with software and computerized data analysis to guide planting, irrigating, harvesting, and other decisions are being used to economize on water and other resources.[70] However, given its high-tech nature and substantial investment requirements, precision agriculture is likely to only benefit larger, better financed-farmers growing cash crops, and is a good example of why technological adaptation will often need to be combined with addressing vulnerability and marginalization to be transformational.

Changes in agricultural practices can support CCA and can include anything in the entire production cycle. For crops, this can range from changes in soil preparation, such as no-till or other forms of conservation agriculture, to changes in planting, irrigation, weeding, harvesting, and post-harvest storage, to name but a few.

This type of adaptation can produce both incremental and transformative changes at least in terms of breadth and depth, depending on how substantial the changes are, which depends heavily on the existing context. For example, the introduction of irrigation to an area characterized by mostly rainfed agriculture is highly likely to be a substantial or transformative change. It is less clear that replacing diesel or electric irrigation pumps with solar-powered pumps is transformative. However, such a change might be significantly

[67] Bland (2023).

[68] It is important to point out that while there are some regional (multi-country) projects, most donor projects are designed and administered within a single country. Given that constraint, relocation of production to a new, more hospitable AEZ is only feasible in countries that have multiple, diverse zones and where projects encompass that diversity.

[69] One such variety of rice is called Swarna-Sub1 and does better in fields that are submerged for 7–14 days, much longer than is commonly practiced. See Dar *et al.* (2013).

[70] See Kono *et al.* (2024).

cheaper, more efficient, and viable in places where access to electricity does not exist, encouraging irrigation to be more widely used. Therefore, the change could become transformational.

It is important to add to this list the reintroduction or expansion of indigenous crops, crop varieties and animal breeds, and local knowledge (ILK). In many cases, age-old varieties/species have valuable traits that make them more resilient to extreme and variable weather conditions. For example, a recent study of five communities in Kenya found that that the use of ILK "improved crop productivity and ensured food security in the face of climate change."[71]

Another type of agricultural change is the use of nature-based approaches such as agroecology and conservation agriculture and other alternatives to the commonly used package of intensive, high-yielding varieties, inorganic fertilizer, and agrochemicals. There is a growing body of evidence that these practices do support adaptation.[72] In the IPCC AR6 WGII, nature-based adaptation is found to have high confidence and a moderate amount of evidence in supporting achievement of SDG2.[73]

Nature-based approaches tend to be systemic, changing the entire production cycle, and will therefore tend to score highly on breadth and probably depth as well. Once again, it is important to note that this type of change is not likely to be sustainable or easily scalable, let alone transformative unless accompanied by other types of adaptive change, such as to PEEMS and vulnerability. The same section of the IPCC AR6 WGII goes on to say:

> *To address smallholder vulnerability to climate change impacts, however, additional policy support beyond agroecology will be needed that is context specific; for example, addressing farmer capacity, limited political power to access land, water, seeds and other key natural resources, structural gender inequities, policy and market disincentives that support large-scale monocultures.*[74] *[references omitted]*

Moreover, nature-based solutions are often introduced for their mitigation impact such as soil and forest management, which increases greater carbon sequestration.[75] While such interventions can achieve both mitigation and adaptation, any study seeking to assess TCCA will need to distinguish carefully between the two.

The World Resources Institute considers one of three types of transformational change to be when it "fundamentally altering a region's predominant type of agricultural landscape."[76] While this can certainly refer to or include changes in geographical locations or new TVBPS, and indeed there is substantial overlap with both of those categories, it can also include adaptive changes like diversification,[77] intensification or conversion of production or partial shifts into new types of production[78] and livelihoods such as from cropping to aquaculture. Thus, many rice growing areas experiencing increased frequency and levels of

[71] Ndalilo *et al.* (2020).

[72] For agroecology, see for example Dittmer *et al.* (2023). "Overall, our review shows that most climate change adaptation responses to agroecological cases reviewed were positive (n = 158 of 226, 70%) compared to their respective baselines", though they don't say how large this change was.

[73] IPCC (2022), *op cit.* p. 815.

[74] *Ibid*, p. 815.

[75] See for example Miralles-Wilhelm (2023). "To date, the focus of NbS [nature-based solutions] applications in food production has been predominantly for carbon sequestration, water quality, and disaster-risk management objectives .... Evidence and analysis of NbS to meet climate change mitigation targets has surged in recent years driven by global community efforts."

[76] Ashley *et al.* (2020).

[77] See for example Vernooy, R. (2022) and Macqueen (2022), Mulwa and Visser (2020) and Asfaw *et al.* (2018).

[78] At least in principle, this is part of USAID's Food Security strategy as well. In its Global Food Security Strategy, it states: "helping small-scale farmers to diversify production through sustainable agriculture, agroforestry, and vegetable gardens." Feed the Future (2021), *op cit.* p.128.

flooding are (further) diversifying into aquaculture and other water-intensive forms of production.[79] Similarly, many smallholders are diversifying into non-agricultural activities. The paper recommends that these be included in diversification and relocation rather than TVBPS.

In sum, TVBPS represents a clear type of CCA. It is more likely to be transformational when it includes a number of changes, or breadth, which combines new technologies, seeds and breeds with more adaptive practices (i.e., that collectively add up to or actually constitute a change in production systems). Such changes are most likely to be transformational when combined with changes in PEEMS or addressing root causes of vulnerability, and preferably both.

ROOT CAUSES OF VULNERABILITY, MARGINALIZATION AND POWER INEQUALITY

Addressing vulnerability is an important aspect of CCA. Populations are more likely to be affected by climate change if they are more vulnerable to it because they lack the resources and agency to respond to climate change effectively. And because they often are located on marginal or low-quality land, they are at greater risk. Vulnerable populations lack key forms of both tangible and intangible capital or assets to adapt to climate change: land, equipment, wealth, knowledge and education, social networks, and access to information and services (such as extension services) to name but a few. Land tenure issues can be particularly challenging.

This paper recommends an "asset" approach to looking at VMPI. Lack of assets and power has been linked explicitly to high inequality, and in turn to increased poverty, the reduced impact of economic growth on poverty reduction, and lower economic growth.[80] Similar to the now classic capabilities approach introduced by Amartya Sen decades ago,[81] this approach is grounded in the assumption that assets start with income and wealth but go well beyond it to a much broader definition. Paul Siegel, in a 2005 paper,[82] provides a solid definition and examples of assets that are representative of this approach:

> *The asset-based approach focuses attention on the productive, social and locational assets of households, with the understanding that the quantity, quality and productivity of their portfolio of assets determines the potential for long-term growth and poverty reduction. As such, household assets are considered the "drivers" of sustainable growth and poverty reduction.*
>
> *The assets of a household are broadly defined to include the productive, social and locational assets that determine the opportunity set of options for livelihood strategies. These actions, in turn, determine outcomes in terms of household well-being.*
>
> *Household assets include tangible assets such as land and other natural assets, specific agro-ecological conditions, equipment and other physical assets, livestock, housing, financial assets, human capital (education, skills, health and nutritional status) and household composition.*

[79] Existing rice-aquaculture systems can also be modified to be more resilient, such as by adopting more saline-tolerant rice cultivars and flushing salt water, in which case it is a form of TVBPS – different and new techniques and systems. See Kabir *et al.* (2016).

[80] One of the early papers to make the connection between power *et al.* and assets (and to explicitly include access to and quality of services) was De Ferranti *et al.* (2004). "First and foremost, there is a need to reduce inequality to productive assets, [especially education]. Also, important is the achievement of more equal access to land, property rights, and other assets such as infrastructure. Second, there is a need to make market institutions work better for everyone through deeper financial and product markets."

[81] See Sen (1999).

[82] Siegel, Paul. (2005).

Intangible assets are also important, such as social capital and political rights (the degree of inclusion/exclusion), and the capacity and openness of institutions. In addition, community and regional assets such as infrastructure (roads, communication, markets), educational and heath infrastructure, location and access to infrastructure and services affect households' livelihood opportunities and returns on other assets.

Location and access are key assets, not just ownership, while the quality of assets is as important as quantity, especially when it comes to land or services such as transportation, education, and extension services. Intangible assets are equally as important as tangible ones.

Additional and important aspects of VMPI are social norms, values and beliefs. Changing women's roles in food production, for example, needs to be accompanied by changing the norms and beliefs about what those roles should be through education, awareness building, and media, as well as by direct engagement.

While this paper has recommended that "good process" not be included in assessing the extent of TCCA generally and in the other three matrices, it proposes that good process and participation are essential to VMPI and should be included. This is inherent to the title that includes power inequalities. Moreover, in the broad definition of wellbeing, empowerment, voice, agency, and autonomy are equally as important as income, consumption, and food security. Without changing power dynamics to at least some extent, improving ownership and access to relevant assets alone cannot be seen as addressing the root causes of VMPI. This means that participation is not only necessary, but to score medium or high needs to go well beyond consultation to include vulnerable and marginalized populations in conducting assessments, selecting and co-designing solutions, implementation, monitoring and accountability for progress. It should be combined with capacity building to support participation in all of those aspects, and in many cases, this will include building social capital such as community institutions.

The discussion of TVBPS in the previous section repeatedly refers to the need to address vulnerability in combination with new approaches. Otherwise, the scale and sustainability of change is likely to be quite limited in many cases to those farmers and other actors who possess sufficient (multi-dimensional) capital to adopt and utilize new approaches. The same is likely to be true of diversification and relocation. Replacing one agri-food product with another takes resources. Thus, to some degree, as with D&R, addressing vulnerability is inherently transformational as it affects change at the systems level, provides resources and power for marginalized populations to discover and implement their own solutions, and increases the scale and sustainability of new technologies.

OTHER TYPES OF ACTIVITIES

There are other activities that various donors have featured in their funding and projects regarding climate change that might also be included as types of change. The paper briefly reviews these and finds that, except for climate services, they do not serve as examples of transformational adaptation, and therefore should not be included in a prospective assessment framework.

CLIMATE SERVICES

Many studies among donors, academia and research institutions have highlighted the need for climate services and access to improved, quality information to support CCA.[83] "Climate services" refers to better access to information and short- and long-term forecasts about weather and other impacts of climate changes (e.g., changes in sea levels). Donors and others have been making substantial investments in improving data collection in the low-income, climate vulnerable countries where weather stations are often few and far between, and have increased investments in climate modelling and forecasting, and information distribution channels such as text messaging and other virtual services. For example, the Systematic Observations Financing Facility (SOFF), which began operations in July 2022, finances improved collection and sharing of the surface-based weather and climate observations in developing countries.[84]

Carr notes: "[Improved] weather and climate information are not, in and of themselves, tools for transformation."[85] Increased information about future climatic conditions, such as reduced access to surface water, can in fact drive maladaptive outcomes such as competitive drilling by farmers that have depleted aquifers or created issues of increased salinity. However, better information can clearly facilitate or have synergies with other types of CCA. Better weather information can be useful in determining what new technologies are relevant *and* when and how to use them. The paper concurs that climate services are an important component of efforts to *support* climate change adaptation akin to other types of improved information such as seed certification. It recommends that they be included in either PEEMS if they are general, or TVBPS if they are more targeted towards supporting a particular agricultural product or production system.

RESEARCH AND INNOVATION, FINANCING, INSURANCE AND PARTNERSHIPS

For reasons of space, the paper mentions only briefly other donor activities that do not represent transformational adaptation. This does not mean they are not important or worthwhile investments. This includes investment in research and development of new innovations, technologies, and practices, as well as the piloting and testing of new solutions. While such investments are critical to producing future transformational changes, they are not likely to be transformational on their own. Similarly, many donors emphasize their prioritization of public, private and public-private partnerships as well as the mobilization of financial resources from international donors, private investment capital, and domestic sources. While partnerships and finance are critical to facilitate TCCA, they are a means to an end. They do not themselves constitute a form of TCCA. Thus, they should not be included in an analytic framework for assessing the extent to which TCCA has been integrated into agri-food projects.

Finally, there are a variety of investments in "impact mitigation." Many of these are financial instruments to help manage risk associated with climate change, such as weather index or other forms of parametric insurance. The paper does not believe that these are transformational for several reasons, including that they face unresolved challenges on multiple fronts and have yet to demonstrate a sustainable business model for smallholder farmers and therefore prove scalability.[86]

---

[83] See for example, Ashley *et al.* (2020) *op cit.*, Carr (2023) and other articles in the special issue of Sustainability and Climate Services: Critique, Integration, and Reimagination.

[84] See Linn (2023).

[85] Carr (2023) *ibid.* p. 1.

[86] These include the lack of granular quality data, lack of competent and profitable distribution channels, and an inadequate regulatory and policy enabling environment. As a result, "voluntary take-up of index insurance typically remains low, even with subsidized premiums, and scaling up is a challenge." See B. Kramer (2019).

SUMMARY

In this section the paper described four types of climate change adaptation: PEEMS, TVBPS, D&R, and VMPI. All four are forms of systems change. A clear conclusion of this section is that whether they are transformational depends essentially on their breadth and depth, how much of the relevant systems are being changed, and to what extent, in ways that support adaptation. That said, D&R and VMPI are inherently more transformative because they do imply broad systemic change.

There is significant interaction, synergies and multiplier effects between the four types of CCA. The impact of new technologies is likely to be greater when combined with supportive changes to the policy enabling environment, and to achieve greater scale and sustainability if marginalized people and communities have access to them and the assets to take advantage of them. This strongly suggests that for a project to be an example of TCCA, it needs to score well on more than one of these types of CCA, if not all four.

CLIMATE RISK AND VULNERABILITY: DE-TERMINATION A LOCALIZED BASELINE FOR TRANSFORMATIONAL ADAPTION

Section III fleshed out four types of CCA that can be used to determine whether and to what extent agri-food projects are transformational. Before filling out those matrices so that they are usable as an analytical framework, it is important to assess whether and to what extent transformational adaptation is necessary. Applying a TCCA definition and framework to assess a donor project implies a comparison between what transformational adaptation has been integrated into a given project or program and what should have been integrated given actual or forecasted climate impacts.

This section examines that question. It shows that, *ex ante*, one would expect TCCA efforts in 2024 to be a small fraction of total adaptation efforts. However, to determine whether or not, how much, and what types of TCCA are appropriate depends on both how a given agro-ecology is being affected by climate change *and* its adaptive capacity given the socio-economic context.

TRANSFORMATIONAL CHANGE IS NOT THE DEFAULT OPTION

The literature is generally quite clear that transformational adaptation is not the preferred option in most situations. This is because it is presumed to be much more expensive, effort intensive, and, by definition, highly disruptive to existing socio-economic relationships (for better or worse), including extensive changes in social norms, beliefs and attitudes, including about the necessity of transformational adaptation. This means that TCCA can be difficult to initiate in terms of mobilizing and aligning political and community support

from diverse stakeholders, let alone gathering sufficient resources and implementation. Thus, transformational adaptation should be restricted to situations where the present impact is already making existing systems and practices untenable. Carter, Ferdinand, and Chen (2018) agree, noting that:

> *… transformative approaches should be used only* ***when the need for them is clear****, based on analysis of data including climate projections and crop models (while acknowledging that these data sources include some degree of uncertainty), or* ***when present-day impacts are already so great that significant change is warranted****.*[87] *[Emphasis added]*

Similarly, Brooks (2017) writing for the UK aid agency, FCDO, in 2017, noted that areas clearly requiring TCCA are currently a small percentage of Sub-Saharan Africa, though this can be expected to increase significantly between 2030 and 2050.

> ***TCCA will be required by the 2020s or 2030s for a small percentage*** *of current production of banana, cassava, beans, groundnuts, pearl millet, sorghum, and yam. [in Eastern and Southern Africa]. … By 2050 this will rise to 30% for some crops, 60% for others.*[88] *[Emphasis added]*

Rippke et al. (2016) also studied the need for TCCA (though nearly ten years ago) based on warming of less than three (3) degrees centigrade, focusing on two criteria: where staple crops and livestock will need to shift locations or regions or where there will be a need for shift in the nature of the entire farming system. For nine staple crops in Africa, they found:

> *… during the 21st century, …. For most crops, however, transformation is limited to small pockets (<15 % of area), and only for beans, maize and banana is transformation more widespread (~30 % area for maize and banana, 60 % for beans).*
>
> *In general, there was a trend for all crops to undergo transformational change along the Sahel belt before 2050s, with maize being the most affected crop. Similar frontier movements were seen in the southwest (Namibia, Angola) and the southeast (Botswana, Zimbabwe and Mozambique).*

As these three representative quotes indicate, at least at the present moment the need for TCCA in general is likely to be limited. That suggests it needs to be assessed on a case-by-case basis.

DETERMINING WHETHER AND TO WHAT EXTENT TCCA IS NEEDED

Determining whether and to what extent TCCA is needed requires measuring "vulnerability," both the climate risk to which a population or community is exposed and their adaptive capacity. These depend on a number of factors, beginning with the local context, both agro-ecological and the broader socio-economic situation. Climate vulnerability assessments (CVA), in the form of maps, indices, and reports, commonly combine scientific and quantitative forecasts with socio-economic assessments and often qualitative input from local stakeholders, though some rely only a subset of these. CVAs are conducted at the micro or meso-level, as in many cases there can be substantial differences in the risks and vulnerability of a specific location, AEZs and local communities because of microclimates or other factors, such as distance from large bodies of water.

[87] Carter *et al.* (2018).

[88] Brooks (2017)

It is beyond the scope of this paper to undertake a thorough analysis of assessing climate vulnerability. For the purposes of this paper, what is relevant is whether or not there is sufficient information for an assessor of TCCA in projects to first determine whether and to what extent it is needed in a given region or country, i.e. to establish a baseline or benchmark for comparison with what is actually contained in a project.

As the primary purpose of this report is to provide a methodology for assessing donor projects, the question is whether sufficient data exists to make a rough determination as to the need and relevance of transformational change to a specific project area. Fortunately, here donor practice does provide some help. USAID, for example, has amassed a fairly large collection of what it calls Regional and Country Risk Profiles, which include Climate Vulnerability Profiles, Climate Vulnerability Assessments, Climate Information Fact Sheets and Climate Change Adaptation Fact Sheets. There are (as of January 2024) 73 individual country profiles on the website.[89] Though these are usually under six pages and provide only a very high-level overview, they do contain a long list of key references. The World Bank's Climate Knowledge Portal provides additional data and information. Use of these resources in some cases would require setting a threshold if that has not already been done (or noting who has set that threshold and evaluating it) and determining whether incremental change can meet CCA needs in a timely way or whether more transformative approaches are warranted.

An evaluator could review these and other materials with a reasonable investment of time and effort to arrive at some sort of counterfactual. Given that the existence, timeliness, and granularity of CVAs for relevant regions and populations will vary widely, this should be an important criterion for selecting a sample of projects to be assessed. At the same time, it may create a positive bias, as countries, donor country missions and projects that have conducted CVAs are more likely to have also integrated TCCA interventions into their strategies, programs, and projects.

This paper recommends that any assessment of the extent to which TCCA has been integrated into a donor project be compared with whether and to what extent there is a need for TCCA in the given context. Many donors' agri-food programs target smallholder farmers and locations with high levels of multi-dimensional poverty and food security. In such cases it is likely that those communities would be considered vulnerable and marginalized, and therefore have low adaptive capacity. They are also likely to live in more locations which are prone to climate change. Thus, in most cases there is a *prima facie* case that in most cases some TCCA is necessary, especially of the VMPI type. That said, some sort of benchmark or assessment of the extent to which transformational adaptation would have been appropriate should be established. On that basis, the paper recommends that an assessor limit the projects under consideration to locations where CCVs exist, as well as the larger potential scale if scaling has not occurred.

PROPOSED MATRICES WITH CRITERIA

As the review of the various **characteristics** and **types** of TCCA in the proceeding subsections makes clear, TCCA is complex. This presents a challenge in translating it into an operational definition and analytical framework that captures the complexity while also being operational and tractable to apply to a project/program assessment.

[89] USAID (n.d.).

Based on the analysis of Section II, the ten characteristics reviewed can be reduced to three – breadth and depth, sustainability, and scale (or potential for scale), plus, for the entire project, intention. This section also showed that systems and systemic change are fundamental to transformational adaptation, and while included in these three characteristics, it is best understood as a type rather than characteristic of TCCA. In Section III, the paper identified four types of TCCA.

The types and characteristics of adaptation identified in this above together serve as the foundation of an analytical framework to assess TCCA and an assessment tool. The assessment tool proposed would be a four x three x four set of matrices: four types, three characteristics, and four measures of the extent these characteristics are present for that characteristic, plus whether the project overall was intentionally trying to effect CCA.

STRENGTHS AND WEAKNESSES OF THE PROPOSED APPROACH AND TOOL

The proposed approach has both strengths and weaknesses. On the strengths side, it captures the multi-dimensional nature of TCCA found in the literature and presumably in individual projects. This also allows for reporting with some degree of granularity along what dimensions donor projects are or are not including TCCA in their designs and implementation, as well as in the aggregate for those dimensions and overall. While certainly requiring some judgment and discretion, it is reasonably transparent and reproduceable; a reader of an assessment would be able to understand how the findings were generated and be able to reproduce them.

The major weakness of this approach is that it does not propose or offer a clear way to judge or assess whether the activities included are transformational or not. In principle, this could be remedied by a variety of options. One possibility would be to give a numerical score to each cell, adding them across all the types and rows, and then somehow (arbitrarily) create a cut-off point between "incremental" and "transformational," or perhaps three categories: "incremental," "somewhat transformational," and "clearly transformational." A second approach might be that to be clearly transformational, a project would have to score medium or better on all criteria in at least two matrices. To be somewhat transformational, it would have to score medium or better on all criteria in one matrix.

There are multiple problems with these and similar approaches. Perhaps the most important is that it assumes that the relative importance of all the different types and characteristics are equal to each other and equally important in different contexts. Second, this type of scoring, essentially linear and additive, implies that these characteristics can and should be evaluated independently, when in fact there are often important synergies, and interaction effects between them within a matrix and across types of TCCA. For example, sustainability and scaling are both affected by the depth and breadth of supportive and complementary systems change, perhaps implying that instead of additive scoring, there should be some sort of multiplicative or weighted approach. Either adds a level of complexity that implies a loss of simplicity and transparency to a potential audience when trying to explain how a score for a given project was arrived at. Perhaps more importantly, weighting often results in scores and cardinal rankings that do not align with intuitive or qualitative assessments; counterintuitive results undermine the credibility of the whole exercise.

Finally, there are similar problems with a second approach. What, for example, if a project scores four mediums, one high, and one low? Is that not transformational? If a project really was successful in addressing VMPI (all highs) but not well on others, so that marginalized people had ownership, access and agency in terms of multiple assets, wouldn't that be transformational? This quickly devolves into a complex morass of

combinations and permutations of scores of low, medium and high across four types that once again loses simplicity and transparency.

This paper recommends against trying to identify a cutoff point for the line between incremental vs. transformative change. The four-matrix approach is capable of determining **whether or not enough** CCA is being integrated into donor projects, given the impact of climate change, regardless of what adjective comes with that. It has the additional advantage of identifying what types of adaptation are being integrated, to what extent, and what other strengths and weaknesses exist in terms of scale and sustainability. This would allow advocates to use the result to advocate not only for more CCA, but to be specific about what types are needed, and what more needs to be done in terms of scale and sustainability.

It is important to emphasize that the sub criteria and particularly their translation into criteria in each cell should be considered a first cut. They were developed based on the author's twenty plus years of experience working with and evaluating CGIAR, IFAD, USAID, and other donor agri-food programs from a scaling and sustainability perspective. Yet there are so few case studies of what claim to be TCCA are in the literature, and those are largely confined to diversification and relocation or a comprehensive changeover to nature-based approaches. There was no way to validate this tool by comparing its predicted findings to existing studies. The findings should be considered a starting point.

A final general consideration is the possibility of double counting. To a large degree, all four types of TCCA are all forms of systems change, and those systems overlap. Double counting seems potentially particularly problematic in terms of supportive institutional changes, such as accompanying TVBPS or D&R with strengthening market systems and relevant value-chain institutions or changes to the policy enabling environment. Such activities will contribute to both scale and sustainability. Should they be covered under scale or sustainability in those two matrices? Or should they be scored in those matrices or separately under PEEMS as part of that type of systems change?

This paper makes two recommendations in this regard. First, any future assessor should pay close attention to double-counting and state clearly both that they have not scored something in both places and why they have chosen to put it into one place, versus another. Secondly, if such changes are specific to a type of TVBPS or D&R – such as a type of seed - they should be included and assessed under scale and sustainability in that matrix, and not PEEMS. General changes to the policy enabling environment or even market systems (but with implications for CCA), such as improving the ease and efficiency of all seed registration and release, should be included under PEEMS.

PROPOSED CRITERIA FOR EACH TCCA CHARACTERISTIC (LOW, MEDIUM AND HIGH)

BREADTH AND DEPTH

"Breadth" can be measured by the number of interventions and share of the relevant total 'system' being affected or changed, i.e., the extent to which change affects an entire system, as opposed to just one component of that system. In the case of TVBP or D&R, breadth could be a single component or intervention. Introducing an improved seed variety or animal breed might be more resistant to drought, flooding, or extreme weather. It could also include technologies and practices involved in production, such as irrigation, land preparation, treatment of weeds, pests and disease, mechanization, harvesting, and output processing and storage. At the other end (high), achieving breadth might involve introducing an entirely new set of changes

across the production system of production, i.e., a comprehensive package, such as agro-ecological or conservation agriculture approach, including new or pre-existing seeds or breeds (including Indigenous or traditional), practices and production methods. For PEEMS, one could imagine a single change to the seed registration and release system, or an entire reform of the same system. For VMPI, breadth would imply covering more types of assets that are driving vulnerability and marginalization.

"Depth" is defined as the extent to which an intervention represents a change or departure from existing practices, or, if measuring impact is possible, the extent to which it offsets the expected impact of climate change on food production, security and resilience. Depth needs to consider whether that possible impact is direct (seeds that have a greater tolerance for drought or flooding) or indirect (better soil management contributes to resilience).

INTENTION

There are two sub criteria for assessing "intention." First, explicit men`tion in project documentation and evaluations or by key informants, and preferably both. At a minimum, a project or activity within a project is expected to have some sort of positive environmental impact generically, and preferably explicitly targets adaptation. Second, the extent to which CCA, regardless of the language or number of mentions, is integrated into results frameworks such as in explicit intermediate results and multiple activities. Preferably it is included as a development objective with, presumably, multiple intermediate results.

Intention should be assessed at the project level.

SCALE

"Scale" has four sub criteria:

4. Actual: the actual number of people or places that have benefitted from the project or intervention
1. Potential: the number of people and places that could potentially benefit i.e., maximum possible or potential scale
2. Scalable: how the project's interventions scores on internationally recognized scalability criteria (see the discussion in Section II)
3. Preconditions and Constraints: the extent to which the preconditions for additional, future scaling of that project or set of interventions have been put in place and that constraints to achieving potential scale have been addressed.

Of these four, 2, 3 and 4 are the most important. Given the size and duration of most agri-food projects, it seems likely that in most cases the actual scale achieved by project end will be a small percentage of potential scale. What is important is whether scaling is likely to continue, if not accelerate, after project completion. From this perspective, actual scale matters to the extent that a critical mass, tipping point or threshold of adopters has been achieved. It is not the absolute number that is important; reaching hundreds of thousands in countries with hundreds of millions of small farmers like Bangladesh or Indonesia is not likely to be a tipping point, whereas it very much would be in Nepal. Similarly, actual scale which is dispersed around the country, creating demonstration effects and local buy-in is likely to be more important in most cases than a larger number concentrated in one district. Potential scale is self-explanatory, the more potential the better.

Creating the preconditions for future scaling should be a major focus of any assessment. This means seeing whether a project has addressed weaknesses and constraints in relevant public and private systems and ensuring that there are domestic actors with the commitment, motivation, drive, resources, skills and capacity to continue scaling. Clearly this is not merely to be measured in terms of numbers, an assessor will need to address which constraints and preconditions are more important than others.

Scalability is related to future scale; the more scalable, the more likely future scaling is to succeed. Examples of scalability criteria in the case of new TVBPS or D&R would include costs versus benefits for potential adopters, ease of adoption and whether other changes might be required to receive impact, affordability for intended users, ability to try the technology at small scale, etc. Scalability criteria often include assessing whether preconditions are in place, so it is once again important to avoid double-counting.

SUSTAINABILITY

"Sustainability" is defined as the extent to which an intervention and its impact are likely to endure over time. There are five sub-criteria, some of which serve double duty in creating the preconditions for future scaling. These are:

Doer/implementer. There is a doer or implementer in place who will continue to produce and distribute (i.e., provide the intervention at scale, and who could expand if scale increases). If it is in PEEMS, is there a public sector agency that can enforce or implement new laws, policies and regulations? For TVBPS and D&R, this might include upstream producers and distributors of improved seeds, breeds or agricultural machinery and other key inputs. In the case of an intervention related to VMPI, ideally a doer would not be needed if assets and agency are embedded in the community or population (e.g., if landless farmers were to receive land). Otherwise, there needs to be an organization that has the implementation capacity to continue to provide needed products or services, such as financing of seasonal working capital or equipment purchases, or extension support to vulnerable populations, or continue to work in communities on gender inequality on an ongoing basis.

Payer/viable funding model. There is a reliable and viable source of funding, financing, or business model (Payer) for the production or provision of the intervention. If the provision of the product or service is private, there are minimum sufficient levels of demand, all actors in the value chain are profitable at acceptable levels of risk, and the ultimate adopter or payer has the ability and willingness to pay. If public, the aggregate cost (scale multiplied by unit cost) is feasible given fiscal and budgetary constraints. In the case of a program to address VMPI, there is sustainable financing for this whether public or private (consumer/beneficiary pays).

Other complementary institutions. For TVBPS and D&R, in addition to producers and distributors, this might also include the existence of markets, processors and other downstream linkages in place (i.e., there is sufficient demand for ultimate outputs commensurate with current scale and production can meet increased demand as it grows). It might also include access to financing, machinery services, and other complementary inputs. For PEEMS and VMPI, there could easily be other agencies or ministries involved even if they were not the primary Doer or Payer.

Aligned incentives. Political economy interests of relevant stakeholders, producers and adopters/users/beneficiaries need to be aligned with and supportive of ongoing production, provision, adoption and utilization of the intervention, including final demand. Adopters/users/beneficiaries see that continued use is profitable or otherwise beneficial, considering costs and risks. The same is true, at least minimally, for social and cultural norms. For PEEMS, political economy includes political support from government and key stakeholders (i.e., a viable political coalition that is likely to continue over time).

Demand absorption. If the interventions imply new products or increased production of existing products, there needs to be sufficient demand for them at current and future scale without adversely affecting prices and profitability. This is clearly relevant to TVBPS, D&R, and VMPI. For VMPI, if populations that previously did not have access to certain assets now do, it seems likely that they will produce more, possibly a market surplus.

HYPOTHETICAL EXAMPLE

This subsection contains each of the types of TCCA with the cells filled in to provide further definition. For each of the matrices, the paper illustrates the criteria with an example drawn from a hypothetical project that centers around addressing the growing frequency, intensity and duration of droughts in a region where maize is the staple cereal crop and grown by almost all smallholder farmers (as is common in many countries in East and Southern Africa).[90] The principal interventions of that project are introducing two largely new (to that area/population) technologies; (i) improved varieties of climate change-resilient (CCR) seeds (CCRS, such as drought-tolerant maize) and (ii) solar-powered irrigation kits (SIK) and practices including water pumps, rainwater collection and lined storage pits, and drip irrigation. It also supports introducing market gardens for extra income and supporting household nutrition; improved irrigation would support both maize and vegetable production, which are assessed in the TVBPS matrix.

The introduction of a package of CCRS and the SIK is accompanied by policy reforms to the seed registration and release process. These reforms will make it possible in the future to get a continued stream of improved seeds onto the market more rapidly and easily. More transformational policy changes are made in two areas: creating a climate-change resilient (CCR) seed certification process and labelling and national approval and accreditation of solar-powered irrigation kits. The PEEMS matrix assesses these policy reforms and the extent of their implementation.

The diversification and relocation matrix is covered in a separate example and empirical examples. Following the discussion in the text, the example is where a given coastal region is suffering from increased flooding and saltwater intrusion, adversely affecting rice and traditional livestock production.[91] Aquaculture (along with flood-resistant rice varieties) is introduced as an adaptation measure where it previously was minimal or involved largely freshwater fish. New aquaculture focuses on moving to shrimp farming and other species that thrive in brackish or saltwater. Thus, at low levels of breadth and depth, aquaculture is a modest form of diversification and at higher levels becomes relocation.

Examples and illustrations for VMPI are unfortunately not presented, as they are beyond the experience and expertise of the author.

[90] For a recent summary of the expected impact of climate change and drought, and ways to adapt to it in Sub-Saharan Africa, see McMillen *et al.* (2022).

[91] This is actually happening in many coastal areas of South Asia, such as in Bangladesh and Myanmar. See Oo (2022).

MATRIX CONTENTS

PUBLIC SECTOR ENABLING ENVIRONMENT AND MARKET SYSTEMS MATRIX

In the PEEMs matrix, depth and breadth are affected by four factors. The first sub criterion is how far this reform or change has progressed from intention to implementation. For example, assume this is a change in a public sector law, regulation or process, as in the example in the matrix below. An implementation sequence might be as follows: (i) the law, regulation or new procedures have been drafted/designed; (ii) the law, regulation or new procedures have been passed, signed or approved; (iii) the pre-conditions for implementation have been put in place (additional rules or regulations plus operational responsibility and a budget); (iv) actual implementation has begun or well along. This would largely be measured on the dimensions of breadth or depth.

Sustainability for PEEMS is a little different from the sub criteria described in (5) above, which are more relevant to either TVBPS or Diversification and Relocation. First, the extent to which implementing institutions either exist or have capacity and capability to implement at scale, and to accommodate growth as scale increases over time. Second, whether budgets or a viable funding model are in place and for what duration. Third, the extent to which political will, support by key private stakeholders is in place, or whether there exist vested interests who stand to lose and may oppose the reforms and change

Public sector enabling environment and market systems matrix

	Not Present	Low	Medium	High
Breadth & Depth		• At least one change that would directly support CCA, or a few changes that would indirectly support CCA • In aggregate a small, expected change or impact	• Comprehensive changes to PEEMS that would indirectly support or impact CCA, OR multiple changes to PEEMS that would directly support CCA • In aggregate a moderate expected change or impact	• Multiple/comprehensive change to PEEMS that would directly support or impact CCA • Includes measures to support implementation and operationalization • In aggregate a large, expected change or impact
Example		• Legislation passed allowing for criteria, testing and labeling for climate change resilient seeds put in place • Public Accreditation criteria and process for SIKs put in place	• As with Low plus implementing regulations, policies, procedures and operational responsibility, budget and rollout strategy put in place • Creation of national website with accredited SIKs producers, dealers • Training of extension workers in how to promote and support farmers in using SIKs and climate change resilient seeds	• As with medium, combined with rollout of CCR certification processes • Three-year multi-media awareness and advertising campaign for CCR and SIKs through public-private partnership • Extra funding for three-year campaign by extension workers to promote SIKs and CCR seeds
Scale		• Current scale at sub-national level, represents a fraction of potential scale • Potential scale small: relevant to a limited demographic, or number of agri-food products and locations • Few preconditions for future scaling in place or constraints addressed	• Actual changes at national level representing a larger but still small fraction of potential scale • Potential scale moderate: could be extended to multiple demographics, agri-food products and locations • Few preconditions for future scaling in place or constraints addressed	• Actual changes apply already to a significant share of potential scale and of most important agri-food products • Potential scale would affect a majority of agricultural economy • Most necessary preconditions in place and constraints addressed, future continued scaling highly likely

		• Intervention package scores poorly on scalability criteria	• Intervention package scores well on scalability criteria	
Example		• CCR seed criteria et al. will be established for only one crop planted by a minority of farmers and regions	• CCR seed criteria established for multiple crops that approach roughly half of country, esp. primary staple cereals • Half of SIKs on the market have been reviewed and accredited	• CCR seed criteria established for all crops in whole country • All SIKs on the market have been reviewed and accredited
Sustainability		• Institutions either do not exist to implement or lack capacity and capability to implement, complementary institutions lacking • Budgets or funding model lacking or short-term • Political will and support lacking; vested interests may oppose it	• Institutions exist with capacity and capability to implement, but complementary institutions lacking • Budgets or funding model short-term • Political will and support of other stakeholders in place for a few years	• Institutions exist with strong capacity and capability to implement complementary institutions in place • Long-term funding model in place • Political will and support in place for foreseeable future
Example		• Ministry of Agriculture (MinAg) lacks the capacity to implement regulations • No or inadequate funding for implementation • Weak seed certification and inspection • Private seed companies resistant to CCR labelling	• MinAg. has the capacity to draft and implement regulations and policies • Short-term, adequate funding in place • Seed certification, inspection and extension systems exist but with little incentives to add CCR seeds to existing work • Seed sector stakeholders neutral or somewhat supportive	• MinAg creates and staffs' separate division for CCR varieties and adaptation practices, fully staffed • Viable long-term funding in place, via small tax on certification • Strong seed certification inspection and extension capacity and institutional support • Seed sector stakeholders supportive, actively demanding it, co-funding and implementing awareness and advertising campaign

Technology, Varieties, Breeds, Practices and Systems matrix

	Not Present	Low	Medium	High
Breadth & Depth		• A single or a few unconnected interventions or innovations • Aggregate impact of the intervention package (including breadth) will partly offset impact of climate change on production, food security and resilience	• Includes complementary or package of interventions both technical and practices • Affects multiple aspects of production cycle • Aggregate impact of the intervention package will significantly offset impact of climate change on production, food security and resilience	Medium criteria plus • Affects most or entire system of production or beyond, i.e., diversification • Relevant to more than one agri-food product (crop or animal) • Aggregate impact of the intervention package will roughly offset climate change impact
Example		• SIKs are introduced alone • 4–5 varieties of CCR maize introduced	• Package of SIKs (including drip, rainwater collection and storage) • CCR varieties plus conservation agriculture practices, e.g., zero till, intercropping, rotation	• Medium criteria plus better irrigation practices more generally (e.g., moisture meters) • Plus, soil conservation practices affecting land prep, fertilizer, planting, weeding and harvesting
Scale		• Current scale at sub-national level, represents a fraction of potential scale • Potential scale small: relevant to a limited demographic, or number of agri-food products and locations • Few preconditions for future scaling in place or constraints addressed • Intervention package scores poorly on scalability criteria	• Actual changes at national level representing a larger but still small fraction of potential scale • Potential scale moderate: could be extended to multiple demographics, agri-food products and locations • Few preconditions for future scaling in place or constraints addressed • Intervention package scores well on scalability criteria	• Actual changes apply already to a significant share of potential scale and of most important agri-food products • Potential scale would affect a majority of agricultural economy • Most necessary preconditions in place and constraints addressed, future continued scaling highly likely
Example	• Irrigation package demonstrated by 100 lead farmers, adopted by 2000	• SIK package adopted by 10,000 farmers • Potential scale 1 million, 10% of rural population	• SIK package adopted by 100,000 farmers in the target geography, nationally several districts have agreed to introduce it in	• SIK package adopted by 200,000 farmers in the target geography, and lead farmers identified to demonstrate in all other districts

	• Cost is over $500 for the package, not affordable for smallholders • No clear commercial suppliers	• Cost is $250–500 for the package, affordable for some small farmers • Technology is complex to apply, install and master; especially for low literacy farmers • One commercial producer and few distributors	partnership with commercial producer of kits • Potential scale 5 million, 50% of rural population • Cost is under $250 • Multiple commercial SIK producers and large number of distributors	working with support from trained public extension workers • Potential scale as before • Cost is $125-250 as before • Technology is easy to apply, install and master • Sufficient suppliers, installation services, for national coverage • Public-private partnership exists with scaling strategy and joint funding in place
Sustainability	• Doers and payers of intervention produce at limited scale • Profitability and other incentives not clear or not present; had been subsidized or paid by project • Other upstream, downstream, NOT in place • Ability, willingness of adopters/users to pay unclear	• Doers and payers of the intervention are in place and able to meet demands at greater scale and appear to be profitable • Existing adopters have ability to pay (affordable) and willingness to pay • Market demand for new or increased output is unclear, prices likely to drop if it exceeds demand in local village markets	Low criteria plus • Doers, payers, and other actors have necessary implementation capacity, viable business/funding models or profitability to meet potential scale • Some other upstream, downstream, and other actors producing and distributing needed (complementary) products & services are in place • Majority of potential users and adopters are willing and able to pay • Output market is able to absorb some increased production without adverse impact on price, new products at less than potential scale	Medium criteria plus • Most or all other upstream, downstream, and other actors[92] producing and distributing needed (complementary) products & services are in place able to scale • All actors are profitable and have incentives to support products at scale • The package aligns with political, financial, and other constraints and incentives facing end-users/adopters in terms of food security, risk, and profitability • Market for outputs is able to absorb all increased production or new products without adverse impact on price

[92] Upstream actors might include input producers and distributors. Downstream actors principally are output buyers or markets. Complementary actors include services like agricultural extension, financing, and machinery services.

Example	• Entire SIKs are only available at demonstration sites. Only pumps commercially available • Prices high • Demand, willingness to pay uncertain even if available • CCR seeds imported distributed free or well below market prices	• One or more regional suppliers of SIKs and CCR varieties in place, limited production capacity • No installation services or after-market support, spare parts available • Market research limited to limited geographic area shows ½ of small farmers willing and able to pay for SIK kits • Several seed companies have released CCR varieties • No evidence on national demand, willingness to pay for either CCR varieties or SIKs	• One or more national suppliers of SIKs and CCR varieties are in place, able to ramp up production to cover country • Distribution limited but growing • Suppliers have proven profitability with SIKs, see it as growth product • Market research suggests 50% of small farmers nationally interested • Subsidized loans and payments plan available from public-bank partnership; funding only covers 10% of project sales for 3 years • Seed companies see CCRs varieties as highly profitable, expanding production, distribution and promotion • Demand for staple grains (e.g., maize) can absorb increased supply at moderate scale	Medium criteria plus • Installation services, after-market support, spare parts in place and profitable • Subsidized loan program available for 50% of potential SIK and CCR variety demand for 5 years • Linkages created between users and wholesale horticulture buyers, processors and exporters; can absorb increased supply • Cold storage chains being put in place for aggregators to urban markets • Local product quality sorting and standards being put in place • Should be able to absorb all increased production • Consumers have no issues with CCR seed varieties taste, texture, etc. • Maize demand can absorb increased supply at large scale

DIVERSIFICATION AND RELOCATION MATRIX

Example for D&R is the introduction of aquaculture (along with flood-resistant rice varieties) as an adaptation measure where it previously was minimal or involved largely freshwater fish. New aquaculture focuses on moving to shrimp farming and other species that thrive in brackish or saltwater.

D&R is largely similar to TVBPS. In terms of breadth, the key sub criterion is the extent to which the new agri-food product is replacing the old one. At the Low end is simple diversification which may marginally displace or substitute for existing products. At the medium and high end, new products are substantially or completely replacing existing products. As with TVBPS, at the medium and high end the introduction includes a package of complementary interventions and more and more covers the entire production cycle.

Diversification and relocation matrix

	Not Present	Low	Medium	High
Breadth & Depth		• A single new crop, animal or product (e.g., shrimp, citrus, fish) is added to a production system • Largely a form of diversification, replaces a small percentage of total production • Aggregate impact of the intervention package will partly offset impact of climate change on production, food security and resilience	• Significantly replaces production of existing products with new product • Multiple new products • Includes complementary or package of interventions both technical and practices • Aggregate impact of the intervention package will significantly offset impact of climate change	Medium criteria plus • Affects entire system of production • Completely or largely replaces existing products • Aggregate impact of the intervention package will roughly offset impact of climate change
Example		• Shrimp farming that uses brackish or salt water introduced as diversification measure, replacing freshwater aquaculture	• Multiple brackish/saltwater seafood introduced • Displaces traditional freshwater fish farming • Accompanied by innovations and new infrastructure in irrigation	Medium criteria plus • Displaces existing aquaculture and much of rice cultivation • Ban on new drilling of bore holes, regulation of existing bore holes to restore freshwater aquifer
Scale		• Current scale at subnational level, represents a fraction of potential scale • Potential scale small: relevant to a limited demographic, or number of agri-food products and locations • Few preconditions for future scaling in place or constraints addressed • Intervention package scores poorly on scalability criteria	• Actual changes at national level representing a larger but still small fraction of potential scale • Potential scale moderate: could be extended to multiple demographics, agri-food products and locations • Few preconditions for future scaling in place or constraints addressed • Intervention package scores well on scalability criteria	• Actual changes apply already to a significant share of potential scale and of most important agri-food products • Potential scale would affect a majority of agricultural economy • Most necessary preconditions in place and constraints addressed, future continued scaling highly likely

Example		• Affects one-third of farmers in target zone with existing aquaculture. • Potential adoption as diversification in millions, 25% of coastal region • Switching or investing to salt/brackish water products expensive • No major public or private initiatives exist to support further scaling	• Most aquaculture farmers have switched to seafood; some new farmers are adopting aquaculture • Public-private partnership to support conversion in place • Developed freshwater to seafood conversion kits decreasing costs and difficulty	Medium criteria plus • Most farmers in the region now produce saltwater shrimp, many considering multiple products or shifting to seafood as primary product • PPP has large campaign and resources to support scaling; build awareness, provide extension support
Sustainability		• Doers and Payers of the intervention are in place and able to meet demands at greater scale • Existing end-users/adopters have the ability to pay (affordable) and willingness to pay • Market demand for new or increased output is unclear	Low criteria plus • Doers, payers, and other actors do have necessary implementation capacity, viable business/funding models or profitability to scale • Some other upstream, downstream, and other actors producing and distributing needed (complementary) products & services are in place • Most existing and future end users are willing and able to pay • Output market is able to absorb some increased production without adverse impact on price, new products at less than potential scale	Medium criteria plus: • Most or all other upstream, downstream, and other actors producing and distributing needed (complementary) products & services are in place able to scale • All actors are profitable and have incentives to support products at scale • The package aligns with political, financial, and other constraints and incentives facing end-users/adopters in terms of food security, risk, and profitability • Market for outputs is able to absorb increased production or new products without adverse impact on price
Example		• 1–2 hatcheries for shrimp and shrimp feed suppliers in place; long-term profitability iunclear	• Full suite of shrimp/seafood inputs in place (fry, feed, medicines) and profitable	Medium criteria plus • Input and output certification in place, including compliance with export market regulations

		• Downstream limited to own consumption and local markets; producers breaking even or better.	• Input and output certification and grading being developed. • Processing and cold storage chains are being developed. • Some links to urban markets are established. • Most new producers profitable.	• Processing and cold storage chains exist and can manage growing volume. • Urban and export market linkages are large enough to absorb growing production. • Seafood growers' association in place, able to advocate for resources, support

VULNERABILITY, MARGINALIZATION AND POWER INEQUALITIES MATRIX

The VMPI matrix is based on the notion of vulnerability and marginalization as a result of a lack of assets and/or power to access and use them.[93] The asset approach is discussed extensively in Section III, along with including social and cultural norms, values and beliefs. Norms, values and beliefs both reinforce and interact with material and other concerns, and by disempowering certain populations, play an independent role of creating vulnerability and marginalization.

Translating this into the core categories of breadth and depth, breadth can be measured simply in terms of the number of assets and norms being addressed. In other words, if structural poverty (vulnerability and marginalization) can be seen as an interlocking, complex system of lack of assets and capabilities reinforced by social norms and political economy factors, then breadth measures the extent to which, or the share of that system is being addressed. A list of assets, and how they appear at various levels of scale (micro, meso, and macro) is in Annex I.

Depth is more about whether the root causes are being addressed, or not, and to what extent. For example, as of this writing most, if not all, agri-food projects funded by bilateral and multilateral donors are required to have a gender dimension to them, but in many cases that is largely incremental. If new technology is being introduced, then it is common to find that half of the participants in trainings, farmer field schools, field trials, etc., are women (unfortunately, whether they are currently involved in the production of that product, or not). While this may help women farmers improve productivity and arguably improves their knowledge capital or assets, it does not really address root causes like lack of access to (good) land, land tenure and property rights, financing, etc.

In terms of scaling and sustainability, socio-economic interventions that affect underlying power distributions are inherently difficult to scale, as they do imply large changes in structures and behaviors and threaten existing power relationships, provoking opposition.

Unlike the other three matrices, "Good Development Process" is considered. This is measured using the four forms of participation first proposed in the classic work of Sarah White, who distinguishes between nominal, instrumental, representative, and transformative participation and emphasizes: "Sharing through participation does not necessarily mean sharing in power."[94]

Finally, it bears repeating that some changes that affect vulnerability and marginalization could also be assessed in other matrices and raise the question of where to assess them and how to avoid double counting. For example, a low-interest finance program for equipment purchases targeting women farmers could be under TVBPS as creating preconditions for scale. Or under PEEMS, the program could involve changes in national laws, regulations and practices regarding land tenure or who is legally allowed to own land or have their own financial accounts. This paper suggests that the default assumption is that such actions, if they affect assets and access, should be considered under a distinct matrix, under VMPI.

[93] Asset-based approaches entered the development literature around the year 2000 in reaction to the fact that existing development policies failed to address the extreme levels of inequality found in much of Latin America and Caribbean nor produce a permanent exit from poverty. Seminal articles at the time include De Janvry and Sadoulet (2000), De Janvry and Sadoulet (2001), and Siegel and Alwang (1999).

[94] See her article. White (1996).

Vulnerability, marginalization and power inequalities matrix

	Not Present	Low	Medium	High
Breadth & Depth		• Addresses only one or a few assets, most likely to be tangible assets • Minimal attention to root causes such as laws, regulations and institutions • Focus is mostly at the household and community level	• Covers a number of assets that are complementary to other interventions, i.e., new technologies • Includes both tangible and intangible assets • Addresses root causes at the Regional or National level in terms of affecting change in institutions and enabling environments, but progress is preliminary	• Medium criteria plus explicit attention to changing social and cultural norms, values and beliefs • Explicitly addresses power inequalities, at least at the communal level • Medium criteria plus • Significant progress in reforming relevant institutions and the enabling environment
Good Development Process		• Participation is nominal and/or Instrumental in the White framework. • Community is consulted but interests and needs may not be considered. • Communities see participation as a cost of getting project or program benefits.	• Participation is at least representative in the White Framework • Communities have a voice or input in making decisions, and that voice is considered in decision-making • Communities have power to stop or change programs	• Participation is at transformational in the White Framework • Community voice extends to selecting and co-designing interventions, monitoring outcomes and making decisions about strategic changes • Communities are fully empowered, equal partners
Scale		• Current scale at subnational level, represents a fraction of potential scale • Potential scale small: relevant to a limited demographic, or number of agri-food products and locations • Few preconditions for future scaling in place or constraints addressed	• Actual changes at national level representing a larger but still small fraction of potential scale • Potential scale moderate: could be extended to multiple demographics, agri-food products and locations • Few preconditions for future scaling in place or constraints addressed	• Actual changes apply already to a significant share of potential scale and of most important agri-food products • Potential scale would affect a majority of the agricultural economy • Most necessary preconditions in place and constraints addressed,

				future continued scaling highly likely
Sustainability		• Doers and payers have limited interest to support interventions that address issues like gender norms or power relations.	Low criteria plus • Doers, payers, and other actors do have necessary implementation capacity, viable business/funding models or profitability to meet potential scale	Medium criteria plus • Most or all other upstream, downstream, and other actors[95] producing and distributing needed (complementary) products & services are in place able to scale • All actors are profitable and have incentives to support products at scale • The package aligns with political, financial, and other constraints and incentives facing end-users/adopters in terms of food security, risk, and profitability

[95] Upstream actors might include input producers and distributors. Downstream actors principally are output buyers or markets. Complementary actors include services like agricultural extension, financing, and machinery services.

CONCLUSIONS

The purpose of this paper was to provide at least a first attempt at creating a definition, analytical, framework and a set of indicators that could be used to assess the extent to which TCCA has been integrated into donor-funded agri-food projects and programs. Based on a combination of a literature review and KIIs, the paper was able to identify ten adjectives or characteristics of TCCA from the literature. These were then assessed on four criteria: essential, simple, understandable and applicable i.e., able to be used in an actual assessment. This assessment showed that some of the characteristics were in fact types of change, suggesting a matrix approach be used as the assessment tool, with each type of change being evaluated based on characteristics of transformational change.

Separating those out, the paper identified four types of transformational adaptation: 1. policy enabling environment and market systems); 2. agricultural technologies, varieties, breeds, practices and systems; 3. diversification and relocation of production and people; and 4. addressing the root characteristics of vulnerability, marginalization, and power inequalities. For each of these types, the three characteristics (breadth and depth, scale, and sustainability) were identified and could be applied to each type in terms of low, medium and high levels. (VMPI would also include the extent to which good development process was applied.) In addition, the overall project or program should be assessed for whether affecting climate change adaptation was intentional or not. In sum, the proposed assessment tool consists of four 3 x 4 dimensional matrices.

Establishing sub criteria for how to assess those characteristics in each matrix is challenging. The paper offers a first attempt at such sub criteria, drawing on the literature covering scale, sustainability and good process. The paper notes that it is hard to empirically verify the validity of this approach because there are so few case studies of (what authors claim to be) TCCA in the agri-food sector. The few that do exist are almost entirely examples of either diversification and relocation or a comprehensive changeover to nature-based approaches.

Yet the paper contends that large changes in VMPI, PEEMS or even non-nature based TVBPS, can also be considered transformational, and even more so when interventions include multiple types of change, Nonetheless, it recommends that these criteria be reviewed and developed further, ideally by convening an expert advisory panel with broad expertise and experience in the intersection of climate and agri-food systems. At that point, this could be used as an effective tool to evaluate the presence, or absence, of TCCA in agri-food projects. That said, while this tool is a significant contribution to creating an objective standard for such assessments, it is important to keep in mind that it cannot eliminate the need for qualitative judgments by an evaluator or team applying the tool.

Finally, the paper does not recommend an explicit cut-off point to define whether a project is transformational. There is no empirical basis for drawing such a line, especially when twelve scores are involved (four matrices times three characteristics) such that any dividing point would be simply arbitrary. Moreover, given that what is "transformational" is heavily context dependent, a rigid one-sized-fits-all demarcation will result in counterintuitive findings that will be difficult to defend. Conversely, trying to weigh or weight the various types of change or individual dimensions, or identify permutations and combinations of change, is equally problematic as it rapidly becomes complex and loses transparency and simplicity.

The paper concludes that the assessment tool being proposed should be adequate to determine whether a project (or group of projects) is more or less transformational, and in what ways, and that is a better way to frame any assessment. This level of detail is sufficiently granular to identify important trends and patterns that will allow for detailed recommendations to what more is needed and what gaps need to be filled, while remaining tractable. The results will allow for advocates to say specifically where, how and to what extent donors and others are not only integrating TCCA but what types of TCCA. This should provide a strong evidence basis for identifying what more needs to be done and what gaps need to be filled.

ANNEX: TYPES OF ASSETS AND SCALE FOR ASSESSING VMPI

	Micro level	Meso level	Macro level
Asset type	Household (HH) level	Community and local level	Regional, national and international level
Natural	"Private" land, pasture, forests, fisheries, water quality and quantity	"Common" land, pasture, forests, fisheries, water	National and global commons, rivers and watersheds, lakes, seas, oceans, air
Human	HH composition and size Health and nutritional status Education and skills	Labor Pool	Labor Markets
Physical	Productive assets (tools, equipment, work animals) HH assets (e.g. housing, household good and utensils) Stocks (e.g. livestock, food, jewellery)	Productive assets (communal and private) Stocks (e.g. livestock, food)	Productive assets (rental markets) Stocks (e.g. buffer stocks)
Financial	Cash, savings, access to credit and insurance markets	Cash, savings, access to credit and insurance markets	Finance and insurance systems Access to international Finance
Social	HH social ties and networks Intra-household dynamics	Community social ties and networks	Extra-community social ties and networks
Location and infrastructure	Proximity and access to water and sanitation, education and health, marketplace, storage and roads	Water and sanitation in schools, health centers, marketplace, storage facilities, roads Proximity to transport and communication infrastructure	Distance to markets, transportation, communication, information systems, Heath and education infrastructure
Political and institutional	Participation in household decision-making(including power relationships related to gender and age	Participation in community decision-making Governance Security of person and property	Political stability Political participation Effectiveness of collective action Governance Human rights and security of person and property.

BIBLIOGRAPHY

Abass, R., et al. (2018). "The Role of Formal and Informal Institutions in Smallholder Agricultural Adaptation: The case of Lawra and Nandom Districts, Ghana." *West African Journal of Applied Ecology*, 26: 56–72.

Adaptation Committee. (2021). *Approaches to Reviewing the Overall Progress Made in Achieving the Global Goal on Adaptation.* Technical paper. United Nations Framework Convention on Climate Change, The Kyoto Protocol, and the Paris Agreement. Accessed 21 October 2023. /https://unfccc.int/sites/default/files/resource/AC_TP_GlobalGoalOnAdaptation.pdf

Adaptation Committee. (2022). *Synthesis Report for the Technical Assessment Component of the First Global Stocktake*. Framework Convention on Climate Change. 24 March. Accessed 19 October 2023. https://unfccc.int/documents/461356

Adeola, O., et al. (2024). "Explaining Gendered Vulnerability to Climate Change: The Contextual Conditions." In: *Gender Equality, Climate Action, and Technological Innovation for Sustainable Development in Africa.* Sustainable Development Goals Series. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-40124-4_3

Adger, W.N., et al. (2018a). "Advances in Risk Assessment for Climate Change Adaptation Policy." *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 376(2121), 20170300

Adger, W.N., et al. (2018b). "Are There Social Limits to Adaptation to Climate Change?" *Climatic Change*, 93(3–4), 335–54.

Agnolucci, P., et al. (2020). "Impacts of Rising Temperatures and Farm Management Practices on Global Yields of 18 Crops." *Nat Food 1*, 562–571. https://doi.org/10.1038/s43016-020-00148-x

Ahmed, S., and E., Kiester. (2021). "Do Gender Differences Lead to Unequal Access to Climate Adaptation Strategies in an Agrarian Context? Perceptions from Coastal Bangladesh." *Local Environment,* 26(5), 650–65.

Ajulo, O., et al. (2020). "Upending the Status Quo Through Transformative Adaptation: A systematic literature review." *Progress in Disaster Science*, 6(100103), ISSN 2590-0617, https://doi.org/10.1016/j.pdisas.2020.10010

Arbuckle, J.G., et al. (2013). "Climate Change Beliefs, Concerns, and Attitudes toward Adaptation and Mitigation among Farmers in the Midwestern United States." *Clim. Change,* 117(4), 943–50. doi: 10.1007/s10584-013-0707-6.

Ashley, L., et al. (2020). *Applying Climate Services to Transformative Adaptation in Agriculture*. Technical Paper, World Resources Institute. https://files.wri.org/d8/s3fs-public/applying-climate-services-transformative-adaptation-agriculture.pdf. Accessed 15 October 2023.

Asfaw, S., et al. (2018). "Diversification Strategies and Adaptation Deficit: Evidence from Rural Communities in Niger." *World Development*, Vol. 101, 219–34. https://doi.org/10.1016/j.worlddev.2017.09.004.

Awiti, A. (2022). "Climate Change and Gender in Africa: A Review of Impact and Gender-Responsive Solutions." *Front. Clim.*, 4(30 June). https://doi.org/10.3389/fclim.2022.895950

Batra, G., et al. (2022). "Transformational Change for Achieving Scale: Lessons for a Greener Recovery." Pp. 27–38 in Uitto and Batra. Eds. (2022). *Transformational Change for People and The Planet, Evaluating Environment and Development*. Springer Nature, Open Access, https://library.oapen.org/handle/20.500.12657/52824

Baidya, A., and A.K. Saha. (2024). "Exploring the Research Trends in Climate Change and Sustainable Development: A Bibliometric Study." *Cleaner Engineering and Technology,* 18(13):100720. February.

Bezner Kerr, R., et al. (2022). Food, Fibre, and Other Ecosystem Products. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, et al. (eds.)]. Cambridge

University Press, Cambridge, UK and New York, NY, pp. 713–906, doi:10.1017/9781009325844.007.

Bilen, C., et al. (2022). "A Systematic Review on the Impacts of Climate Change on Coffee Agrosystems." *Plants (Basel).* Dec 25;12(1):102. D: 10.3390/plants12010102.

Bland, A. (2023*). Mangoes and Agave in the Central Valley: California farmers try new crops to cope with climate change.* Cal Matters. Accessed 26 October 2024. https://calmatters.org/environment/climate-change/2023/05/california-farmers-climate-change/

Brooks, Nick. 2016. *Transformational Adaptation to Climate Change: Concepts, Examples, and Relevance for Agriculture in Eastern and Southern Africa*. November. Pretoria: Vuna. http://www.vuna-africa.com

Carr, E.R. and Mary C. Thompson (2014) "Gender and Climate Change Adaptation in Agrarian Settings: Current Thinking, New Directions and Research Frontiers." *Geography Compass*. Vol. 8 3:182-197. https://doi.org/10.1111/gec3.12121

Carr, E.R. (2023). "Climate Services and Transformational Adaptation." *Sustainability*, 15(1), 289. https://doi.org/10.3390/su15010289

Carr, E.R., et al. (2023). *Operationalizing USAID's Climate Strategy to Achieve Transformative Adaptation and Mitigation in Agricultural and Food Systems*. Tetra Tech under the USAID BIFAD Support Contract. Prepared for the United States Agency for International Development by the Board for International Food and Agriculture Development (BIFAD) Support Contract, contract number GS00Q14OADU138, Task Order 7200AA21M00003

Carter, R., and S. Tye. (2018). *Thanks to Climate Change, Oranges Are Becoming the New Coffee in Some Parts of Costa Rica.* Insights. World Resources Institute, August 24. https://www.wri.org/insights/thanks-climate-change-oranges-are-becoming-new-coffee-some-parts-costa-rica

Carter, R., and T. Ferdinand. (2020). "This is How Agriculture Can Transform with Climate Adaptation." *Global Center for Adaptation*. https://gca.org/this-is-how-agriculture-can-transform-with-climate-adaptation/. Accessed 21 October 2024.

Carter, R., et al. (2018). "Transforming Agriculture for Climate Resilience: A Framework for Systemic Change." Working Paper. World Resources Institute. https://www.wri.org/research/transforming-agriculture-climate-resilience-framework-systemic-change. Accessed 5 October 2023.

Carter, R., et al. (2021). *Food Systems at Risk. Transformative Adaptation for Long-Term Security*. World Resources Institute. https://www.wri.org/research/food-systems-risk. Accessed 6 October 2023.

Chavez, E. (16 December 2023). "Senegalese Herders Have Raised Livestock for Centuries. Climate change is threatening their future." *Business Insider*. https://www.businessinsider.com/photos-climate-change-senegal-threatens-pastoralists-cattle-herds-2023-12

Cohn, A.S., et al. (2017). "Smallholder Agriculture and Climate Change." *Annual Review of Environment and Resources*. 42: 347–75. https://doi.org/10.1146/annurev-environ102016-060946

Colloff, M.J., et al. (2021). "Adapting Transformation and Transforming Adaptation to Climate Change Using a Pathways Approach." *Environmental Science & Policy*, 124, 163–74, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2021.06.014.

Dar, M., et al. (2013). "Flood-tolerant Rice Reduces Yield Variability and Raises Expected Yield, Differentially Benefitting Socially Disadvantaged Groups." *Scientific Reports* 3(3315). https://doi.org/10.1038/srep03315

De Ferranti, D., et al. (2004). *Inequality in Latin America: Breaking with History?*World Bank Latin American and Caribbean Studies. World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/15009/28989.pdf?sequence=1.

De Janvry, A., and E. Sadoulet. (2000). "Rural Poverty in Latin America: Determinants and Exit Paths." *Food Policy*, 25(4): 389–409.

De Janvry, A., and E. Sadoulet. (2001). "Investing in Rural Development is Good Business," in R. Echeverria, ed. *Development of Rural Economies*. Washington DC: Interamerican Development Bank.

Denton, F., et al. (2014). "Climate-resilient Pathways: Adaptation, Mitigation, and Sustainable Development." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1101–31). Cambridge University Press.

Deubelli-Hwang, T.M., and R. Mechler. (2021). "Perspectives on Transformational Change in Climate Risk Management and Adaptation." *Environ Res Lett,* 16(053002).

Dibakoane S., et al. (2022). "Vulnerability, Impact and Adaptation Strategies of Female Farmers to Climate Variability." JAMBA: *Journal of Disaster Risk Studies*, Sept. 15;14(1):1302. doi: 10.4102/jamba. v14i1.1302. PMID: 36246781; PMCID: PMC9558303.

Dilling, L., et al. (2023) "The Role of Adaptive Capacity in Incremental and Transformative Adaptation in Three Large U.S. Urban Water Systems." *Global Environmental Change*, 79(102649).

Dinshaw, A. (2014). "What Is the Role for Transformation in Adaptation?" Commentary, World Resources Institute, April. https://www.wri.org/insights/what-role-transformation-adaptation

Dittmer, K.M., et al. (2023). "Agroecology Can Promote Climate Change Adaptation Outcomes Without Compromising Yield in Smallholder Systems." *Environmental Management* 72, 333–342. https://doi.org/10.1007/s00267-023-01816-x

Dixit, A., and J. Foti. (2013). *Stakeholder Participation in Climate Change Adaptation Planning*. African and Latin American Resilience to Climate Change (ARCC). Prepared for USAID ARCC by World Resources Institute through a subcontract to Tetra Tech ARD. January. https://pdf.usaid.gov/pdf_docs/PA00JNGZ.pdf

Dror, I., and N. Wu. (2020). "Scaling Better Together: The International Livestock Research Institute's framework for scaling." ILRI. Accessed 25 October 2023. https://www.ilri.org/knowledge/publications/scaling-better-together-international-livestock-research-institutes

Ensor, J. E., and R. Berger. (2009). *Understanding climate change adaptation: Lessons from community-based approaches*. Rugby: Practical Action Publishing.

Eriksen, S., et al. (2011). "When Not Every Response to Climate Change is a Good One: Identifying principles for sustainable adaptation." *Climate and Development*, 3:1, 7–20, DOI: 10.3763/cdev.2010.0060

ExpandNet. (2011). "Beginning with the End in Mind." https://www.who.int/publications/i/item/9789241502320

FAO. (2019) "Transforming Food and Agricultural Systems: A challenge we must face together." https://www.fao.org/newsroom/story/Transforming-food-and-agricultural-systems-a-challenge-we-must-face-together/en

FAO (2022) "Transformative Climate Action", Briefing Note, May. https://www.fao.org/3/cc0180en/cc0180en.pdf

FAO. (2022). *Transformative Climate Change*. Briefing Note. May

FAO. (2023). *The Status of Women in Agrifood Systems*. https://www.fao.org/documents/card/en/c/cc5343en

FAO, IFAD, UNICEF, WFP and WHO. (2021). *The State of Food Security and Nutrition in the World 2021. Transforming food systems for food security, improved nutrition, and affordable healthy diets for all*. Rome, FAO. https://doi.org/10.4060/cb4474en

FAO, IFAD, UNICEF, WFP and WHO. (2023). *The State of Food Security and Nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum*. Rome, FAO. https://doi.org/10.4060/cc3017en

Fedele, G., et al. (2020). "Limited Use of Transformative Adaptation in Response to Social-ecological Shifts Driven by Climate-change." Ecology and Society, 25(1):25.

Fedele, G., et al. (2019). "Transformative Adaptation to Climate Change for Sustainable Social-ecological Systems." *Environmental Science & Policy*, Volume 101, 116–25. https://doi.org/10.1016/j.envsci.2019.07.001.

Feed the Future. (2022). *Scaling for Widespread Adoption of Improved Technologies and Practices. U.S. Government's Global Food Security Strategy Activity Design Guidance.* https://pdf.usaid.gov/pdf_docs/PA00ZW1Q.pdf

Feeny, T., and J. Linn. (2017). *Good Practices Guides for Funders. Scaling Innovation*. IDIA, June. P. 7. https://static1.squarespace.com/static/6295f2360cd56b026c257790/t/62a1d4cea1964a75bd65738e/1654772944165/Scaling%2BInnovation%2BGood%2BPractice%2BGuide.pdf

Feola, G. (2015). "Societal Transformation in Response to Global Environmental Change: A Review of Emerging Concepts." *AMBIO: A Journal of the Human Environment*. https://link.springer.com/article/10.1007/s13280-014-0582-z

Few, R., et al. (2017). "Transformation, adaptation and development: relating concepts to practice." Palgrave Communications 3, 17092 https://doi.org/10.1057/palcomms.2017.92

Ford, J. D., *et al.* (2015). "The Status of Climate Change Adaptation in Africa and Asia." *Regional Environmental Change*, 15(5), 801–14.

Frazier, T., et al. (2022). *Transformational Adaptation to Climate Change in Lower-Income Countries.* Contributing Paper. Global Assessment Report on Disaster Risk Reduction. United Nations Office for Disaster Risk Reduction.

Guntukula, R. (2020). "Assessing the Impact of Climate Change on Indian Agriculture: Evidence from Major Crop Yields." *Journal of Public Affairs,* 20.1(e2040).

Gregorowski, R., and D. Bours. (2022). "Enabling Systems Innovation in Climate Change Adaptation: Exploring the Role of MEL," pp. 159–73 in J. Uitto and G. Batra. Eds. (2022). *Transformational Change for People and The Planet*, Evaluating Environment and Development. Springer Nature, Open Access, Cham. https://library.oapen.org/handle/20.500.12657/52824

Haque, A. T. M. Sanaul, et al. (2023). "Gendered Perceptions of Climate Change and Agricultural Adaptation Practices: A systematic review." *Climate and Development*, 15(10), 885–902, DOI: 10.1080/17565529.2023.2176185

Hartmann, A., and J. Linn. (2008). *Scaling Up: A framework and lessons for development effectiveness from literature and practice*, Working Paper No. 5, Wolfensohn Center for Development at Brookings, The Brookings Institutions. https://www.brookings.edu/wp-content/uploads/2016/06/10_scaling_up_aid_linn.pdf

Hellin, J., *et al.* (2023). "Transformative Adaptation: From climate-smart to climate-resilient agriculture." *CABI Agriculture and Bioscience,* 4(30). https://doi.org/10.1186/s43170-023-00172-4

Huyer, S., and S. Partey. (2020). "Weathering the Storm or Storming the Norms? Moving gender equality forward in climate-resilient agriculture." Climatic Change, 158, 1–12.

IPCC (Intergovernmental Panel on Climate Change). (2018). "Annex I: Glossary." [Matthews, J.B.R. (ed.)]. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* [Masson-Delmotte, V., *et al.* (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, 541–62. https://doi.org/10.1017/9781009157940.008.

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf

Jones, James W. et al. (2017). "Brief History of Agricultural Systems Modeling." *Agricultural Systems*, 155, 240–54. doi: 10.1016/j.agsy.2016.05.014

Jost, C., et al. (2016). "Understanding Gender Dimensions of Agriculture and Climate Change in Smallholder Farming Communities," *Climate and Development*, 8(2), 133–44.

Kabir, M.J., et al. (2016). "Farming Adaptation to Environmental Change in Coastal Bangladesh: Shrimp culture versus crop diversification." *Environ Dev Sustain* 18, 1195–1216.

Kinley, R. (2017). "Climate Change after Paris: From turning point to transformation." *Climate Policy* 17(1), 9–15.

Kohl, R. (2016a). *Scaling Up of Sahel Rice Varieties in Senegal Review of Successful Scaling of Agricultural Technologies*, Produced for by Management Systems International, a Tetra Tech

Company, for the E3 Analytics and Evaluation Project, United States Agency for International Development. November. https://pdf.usaid.gov/pdf_docs/pa00mdrc.pdf

Kohl, R. (2016b). *Scaling Up of Agricultural Machinery. Review Of Successful Scaling of Agricultural Technologies*, Produced for by Management Systems International, a Tetra Tech Company, for the E3 Analytics and Evaluation Project, United States Agency for International Development. October 9. https://pdf.usaid.gov/pdf_docs/pa00mc52.pdf

Kohl, R., and L. Cooley. (2006). *Scaling Up-From Vision to Large-scale Change, A Management Framework for Practitioners*. First Edition. Washington, DC: Management Systems International. https://scalingcommunityofpractice.com/scaling-toolkit-for-practitioners-new-2021-edition-available-now/

Kohl, R., and J. Linn. (2021). *Scaling Principles*. Working Paper, Scaling Community of Practice. https://scalingcommunityofpractice.com/wp-content/uploads/bp-attachments/8991/Scaling-Principles-Paper-final-13-Dec-21.pdf

Konfo, T.R.C., et al. (2024). "Recent climate-smart innovations in agrifood to enhance producer incomes through sustainable solutions." *Journal of Agriculture and Food Research*, 15(100985). https://www.sciencedirect.com/science/article/pii/S266615432400022X)

Kramer, B. (2019). "Can weather index insurance help farmers adapt to climate change?" IFPRI Blog: Issue Post. December 13. https://www.ifpri.org/blog/can-weather-index-insurance-help-farmers-adapt-climate-change

Kray, H.A., et al. (2022). "The urgency and benefits of climate adaptation for Africa's agriculture and food security," Commentary in *Foresight Africa 2022*, Brookings Institution, March 24. https://www.brookings.edu/articles/the-urgency-and-benefits-of-climate-adaptation-for-africas-agriculture-and-food-security/

Kuhl, L., and J. Shinn. (2022). "Transformational Adaptation and Country Ownership: Competing priorities in international adaptation finance." *Climate Policy*, 22(9–10), 1290–1305.

Leichenko, R., and K. O'Brien. (2008). *Environmental Change and Globalization: Double exposures*. Oxford: Oxford University Press.

Linn, J. (2023). *Mainstreaming Scaling: A Case Study of SOFF*. Working Paper. Scaling Community of Practice. December 22. https://scalingcommunityofpractice.com/mainstreaming-scaling-a-case-study-of-soff/

Londsdale, K., et al. (2015). *Transformational Adaptation: What it is, why it matters, and what is needed*. UK Climate Impacts Programme, University of Oxford, Oxford, UK.

MacPherson, R., et al. (2022). "Assessing the Evaluability Interventions of Adaptation-Focused: Lessons from the Adaptation Fund," pp. 173–86 in J. Uitto and G. Batra. Eds. (2022). *Transformational Change for People and The Planet, Evaluating Environment and Development*. Springer Nature, Open Access, Cham. https://library.oapen.org/handle/20.500.12657/52824

Macqueen, D. (2022). *Diversification for Climate Resilience: A global priority.* International Institute for Environment and Development. https://www.iied.org/diversification-for-climate-resilience-global-priority

Maitra, S. et al. (2023). "Cultivating Sustainability: A comprehensive review on intercropping in a changing climate." *Research on Crops*, 24, 702–15.

Management Systems International. (2021). *Scaling Up: From Vision to Large Scale Change. Tools for Practitioners*. Second edition. https://scalingcommunityofpractice.com/scaling-toolkit-for-practitioners-new-2021-edition-available-now/

Mapfumo, P., M. Onyango, S.K. Honkponou, E.H. Elzouri, A. Githeko, L. Rabeharisoa, J. Obando, N. Omolo, A. Majule, F. Denton, J. Ayers, A. Agrawal. (2017). "Pathways to transformational change in the face of climate impacts: an analytical framework," *Climate and Development*, http://dx.doi.org/10.1080/17565529.2015.1040365

McLean, R., and J. Gargani. (2019). *Scaling Impact. Innovation for the Public Good*, Routledge: IDRC. https://idrc-crdi.ca/en/book/scaling-impact-innovation-public-good

McMillen, M.S., et al. (2022). "Improving Drought Tolerance in Maize: Tools and techniques." *Frontier Genetics*, 2022 Oct 28;13(1001001). doi: 10.3389/fgene.2022.1001001.

Meinzen-Dick, R., et al. (2019). "Women's Land Rights as a Pathway to Poverty Reduction: Framework and review of available evidence." *Agricultural Systems*, 172, 72–82.

Mesfin, S. (2022). 5 Reasons Why the Climate Crisis Affects African Women More than African Men. Blog Post, Interaction. https://www.interaction.org/blog/5-reasons-why-the-climate-crisis-affects-african-women-more-than-african-men/#:~:text=Men%20migrate%2C%20but%20women%20stay%20behind%20to%20care%20for%20family&text=The%20U.N.-,estimates%20that%2080%25%20of%20people%20displaced%20by%20the%20climate%20crisis,sexual%20or%20gender%2Dbased%20violence.

Miralles-Wilhelm, F. (2023). "Nature Based Solutions in Agricultural Landscapes for Reducing Tradeoffs between Food Production, Climate Change, and Conservation Objectives." Frontiers in Water: Sec. Water and Climate, 5(18 December). https://doi.org/10.3389/frwa.2023.1247322

Mulwa, C.K. and M. Visser. (2020). "Farm diversification as an adaptation strategy to climatic shocks and implications for food security in northern Namibia." World Development, 129(104906).

Ndalilo, L.A., et al. (2020). "Indigenous and Local Knowledge Practices and Innovations for Enhancing Food Security Under Climate Change," Chapter in *Sustainability Challenges in Sub-Saharan Africa II, Science for Sustainable Societies,* Singapore: Springer Nature.

Nyasimi, M., and S. Huyer. (2017). "Closing the Gender Gap in Agriculture under Climate Change." *Agriculture for Development*, 30, 37–40. https://hdl.handle.net/10568

Ntakyo, P. R., and M. Van Den Berg. (2022). "The Unintended Side-Effects of a Major Development Strategy: Commercialization of Smallholder Production and Women Empowerment in Uganda." *The Journal of Development Studies*, 58(8), 1605–26. https://doi.org/10.1080/00220388.2022.2032671

Ochandarena, P. (2015). *The challenge of measuring climate change adaptation*. Chemonics Blog Post. Accessed 26 October 2024. https://chemonics.com/blog/the-challenge-of-measuring-climate-change-adaptation/

Oo, A.T. (2022). *Adaptation and Resilience Measures to Climate Change: Lessons from Myanmar's rice and fish farmers*. https://iep.berkeley.edu/content/adaptation-and-resilience-measures-climate-change-lessons-myanmar%E2%80%99s-rice-and-fish-farmers

Panda, A. (2018). "Transformational Adaptation of Agricultural Systems to Climate Change." *WIREs Clim Chang*e, 9(4). https://doi.org/10.1002/wcc.520

Pelling, M. (2011). *Adaptation to Climate Change: From resilience to transformation*. New York: Routledge.

Perlman-Robinson, J., and R. Winthrop. (2016). *Millions Learning: Scaling Up Quality Education in Developing Countries*. Brookings Institution. https://www.brookings.edu/articles/millions-learning-scaling-up-quality-education-in-developing-countries/

Pörtner, H. O., et al. (2022). *Technical Summary in Climate Change Adaptation 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In H. O. Pörtner *et al*. (2022) Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY: Cambridge University Press. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

Renou, C. (2023). *Partnerships for Seed Technology Transfer in Africa. Final performance report*. https://pdf.usaid.gov/pdf_docs/PA00ZT5H.pdf

Rezaei, E.E., et al. (2023) "Climate change impacts on crop yields." *Nat Rev Earth Environ* 4, 831–46. https://doi.org/10.1038/s43017-023-00491-0

Rippke, U., et al. (2016). "Timescales of Transformational Climate Change Adaptation in Sub-Saharan African Agriculture. Nature Climate Change, 6 (6). 605–9. ISSN 1758-678X.

Sartas, M., et al. (2020). "Scaling Readiness: Science and practice of an approach to enhance the impact of research for developing countries." *Agricultural. Systems* 183 (102874).

Scandurra, F., et al. (2023). "The Maturity Level of the Agri-food Sector in the Circular Economy Domain: A systematic literature review." *Environmental Impact Assessment Review*, 100(107079). https://doi.org/10.1016/j.eiar.2023.107079.

Schreuder, W., and L.G. Horlings. (2022). "Transforming places together: Transformative community strategies responding to climate change and sustainability challenges." *Climate Action*, 1(24). https://doi.org/10.1007/s44168-022-00024-3

Scolobig, A., et al. (2023). "Transformative Adaptation through Nature-based Solutions: A comparative case study analysis in China, Italy, and Germany." *Regional Environmental Change* 23(69). May.

Scott, M. (2015). "Climate & Coffee." NOAA. https://www.climate.gov/news-features/climate-and/climate-coffee. Accessed 26 October 2024.

Scoones, I., et al. (2020). "Transformations to Sustainability: Combining structural, systemic and enabling approaches." *Current Opinion in Environmental Sustainability*, 42(February), 65–75. https://doi.org/10.1016/j.cosust.2019.12.004. https://www.sciencedirect.com/science/article/abs/pii/S1877343519300909

Sen, A. (1999). *Development as Freedom*. Oxford: Oxford University Press.

Sen, A.K. (2005). "Human Rights and Capabilities." *Journal of Human Development*, 6(2), 151–166.

Shackleton, C., et al. (2015). "Why is Socially-just Climate Change Adaptation in Sub-Saharan Africa So Challenging? A review of barriers identified from empirical cases" *Wiley Interdisciplinary Reviews: Climate Change*, 6(3), 321–44.

Siegel, P.B. (2005). *Using an Asset-Based Approach to Identify Drivers of Sustainable Rural Growth and Poverty Reduction in Central America: A conceptual framework*. World Bank Policy Research Working Paper 3475, January. https://documents1.worldbank.org/curated/en/307691468743185566/pdf/WPS3475.pdf

Siegel, P. B., and J. Alwang. (1999). *An Asset-Based Approach to Social Risk Management: A Concept Approach*. Social Protection Discussion Paper 9926. World Bank, Social Protection Unit, Human Development Network.

Silici, L., et al. (2022). "Evaluating Transformational Adaptation in Smallholder Farming: Insights from an Evidence Review," pp. 159–73 in J. Uitto and G. Batra. Eds. (2022). *Transformational Change for People and The Planet*: *Evaluating Environment and Development.* Springer Nature, Open Access, Cham. https://library.oapen.org/handle/20.500.12657/52824

Singh, C., et al. (2021). "Interrogating 'effectiveness' in climate change adaptation: 11 guiding principles for adaptation research and practice." *Climate and Development*, 14(7):650–64.

Sloat, L.L., et al. (2020). "Climate Adaptation by Crop Migration." *Nature Communications* 11(1243). https://doi.org/10.1038/s41467-020-15076-4. Accessed 26 October 2024.

Stone, J., and Y. Okura. (2021). *Beyond the Buzzword – What does transformation in locally led adaptation really look like?* Global Resilience Partnership, Blog post, July 9. https://www.globalresiliencepartnership.org/beyond-the-buzzword-what-does-transformation-in-locally-led-adaptation-really-look-like/#:~:text=The%20defined%20characteristics%20can%20be,affected%20by%20climate%20change%20impacts.

Tesfaye, K., et al. (2017). "Climate Change Impacts and Potential Benefits of Heat-tolerant Maize in South Asia." *Theoretical and Applied Climatology*. 130, 959–70. 10.1007/s00704-016-1931-6.

Thomas, A., et al. (2021). "Global Evidence of Constraints and Limits to Human Adaptation." *Regional Environmental Change*, 21(85). https://doi.org/10.1007/s10113-021-01808-9

Thornton, P., et al. (2018). "Is Agricultural Adaptation to Global Change in Lower-income Countries on Track to Meet the Future Food Production Challenge?" *Global Environmental Change,* 52, 37–48. https://doi.org/10.1016/j.gloenvcha.2018.06.003.

Tubiello, F. N., et al. (2022). "Pre- and Post-production Processes Increasingly Dominate Greenhouse Gas Emissions from Agri-food Systems." *Earth System Science Data*, 14(4), 1795–1809. https://doi.org/10.5194/essd-14-1795-2022

UNDP (UN Development Programme). (n.d.). "Transformative Systems Change." https://www.adaptation-undp.org/scala-transformative-systems-change. Accessed 26 October 2024.

United Nations. (n.d.). *Food.* Global Issues. https://www.un.org/en/global-issues/food

USAID. (2022a). *Climate Strategy 2020-2030*. April. https://www.usaid.gov/sites/default/files/2022-11/USAID-Climate-Strategy-2022-2030.pdf

USAID. (2022b). *Integrating Local Knowledge in Development Programming*. July. https://usaidlearninglab.org/system/files/2022-10/integrating_local_knowledge_07112022-400pm_1.pdf

USAID. (n.d.). Climate change country profiles. https://www.usaid.gov/climate/country-profiles

USAID Low Emissions Agriculture and Food Systems Advisory Group. (2023). *Technical Note: Low Emissions Agriculture and Food Systems Development Opportunities in Support of Food Security and Climate Action.* https://www.climatelinks.org/sites/default/files/asset/document/2023-08/USAID-LEAFS-Technical-Note-Aug-2023.pdf

Vermeulen, S., et al. (2018). "Transformation in Practice: A review of Empirical Cases of Transformational Adaptation in Agriculture Under Climate Change." *Front. Sustain. Food Syst., Sec. Climate-Smart Food Systems,* 2(10 October). | https://doi.org/10.3389/fsufs.2018.00065

Vernooy, R. (2022). "Does Crop Diversification Lead to Climate-related Resilience? Improving the theory through insights on practice." *Agroecology and Sustainable Food Systems*, 46(6), 877–901. https://doi.org/10.1080/21683565.2022.2076184

Wako, G., et al. (2017). "Camel Management as an Adaptive Strategy to Climate Change by Pastoralists in Southern Ethiopia." *Ecological Process,* 6(26). https://doi.org/10.1186/s13717-017-0093-5. Accessed 26 October 2024.

Werners, S.E., et al. (2021). "Adaptation Pathways: A review of approaches and a learning framework." *Environmental Science & Policy*, 116, 266–75.

Westengen, O.T., et al. (2023). Navigating Toward Resilient and *Inclusive Seed Systems*, Proceedings of the National Academy of Sciences (PNAS), 120 (14) March 27, e2218777120 https://doi.org/10.1073/pnas.2218777120 , https://www.pnas.org/doi/10.1073/pnas.2218777120#sec-5

White, S.C. (1996). "Depoliticising Development: The use and abuses of participation." *Development in Practice*, 6(1):6-15, Feb. DOI:10.1080/0961452961000157564. Accessed 26 October 2024.

Wise, R. M., et al. (2014). "Reconceptualising Adaptation to Climate Change as Part of Pathways of Change and Response." *Global Environmental Change*. doi: 10.1016/j.gloenvcha. 12.002

Woltering, L., et al. (2019). *The Scaling Scan: A practical tool to determine the strengths and weaknesses of your scaling ambition*. PPP Lab Food and Water and CIMMYT, February.

World Resources Institute (WRI). (2021). *Food Systems at Risk: Transformative adaptation for long-term food security*. https://files.wri.org/d8/s3fs-public/2021-06/food-systems-at-risk-transformative-adaptation-for-long-term-food-security.pdf?VersionId=3In9B9i2YJaG3R3OIQLQZBX7zYqENCxq.

Research Discussion Papers

Research Discussion Papers are written to contribute to public debate and to invite feedback on development and humanitarian policy issues. They are 'work in progress' documents, and do not necessarily constitute final publications or reflect the policy positions of Oxfam or Catholic Relief Services. The views and recommendations expressed are those of the author and not necessarily those of either of the organizations that sponsored the research.

For more information, or to comment on this paper, email Gina Castillo, gina.castillo@crs.org, Eric Muñoz, eric.munoz@oxfam.org or Richard Kohl at richardkohl@strategyandscale.com.

This paper should be cited as:

Kohl, Richard (2024). Defining and Assessing Transformational Climate Change Adaptation: A framework for application to agri-food projects. London, Oxfam.

Published by Oxfam America and Catholic Relief Services in December, 2024. DOI: 10.21201/2024.000049

Faith knows no bounds®

CRS CATHOLIC RELIEF SERVICES

OXFAM