# TRANSDISCIPLINARY RESEARCH APPROACHES FOR CROP SCIENCE RESEARCH: THEORY, PRACTICE, AND IMPLICATIONS FOR RESEARCH DESIGN

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## Introduction

Current challenges in agri-food systems, such as climate change, population growth, ecosystem degradation, and increasing demand for healthy and diverse diets, cut across geographical, cultural, and disciplinary boundaries. Successfully meeting these challenges will require research approaches that draw on a broad base of scientific and practical knowledge and expertise to develop and implement innovations in crop varieties, agronomy, markets and policies. Success needs to be measured in gains from multiple traits, including climate resilience (drought or heat tolerance), nutritional value, value to women farmers or the marginalized, and market traits valued by a range of consumers, as well as the necessary attention to productivity and income-generation (De Grandis & Efstathiou, 2016; FAO, 2023). The systematic exclusion of women and other minority voices may be partly explained by their limited representation in agri-food systems governance (Amoak et al., 2022), as well as programs bereft of research designs that embrace a plurality of views. This field has also been criticized for the lack of coherence when it comes to defining problems due to differing perspectives from stakeholders which undermines projected gains of breed programs (Brandt et al., 2013). In the last decade, advancements within the CGIAR and beyond, including tools and frameworks from the Excellence in Breeding (EiB) Platform and the Gender and Breeding Initiative (GBI), have worked to improve market intelligence, breeding programs, seed systems, and the safeguarding of genetic resources. However, there is still scope for further innovation in research processes in terms of how breeding objectives are decided, how stakeholders' perspectives are incorporated, how teams are organized and function, how knowledge gets translated into action, and how success is defined and measured.

## Methods and Research Question

We attempt to understand the potential of TDR in transforming crop science to becoming more responsive to the broader needs and preferences. The premise is that by understanding and applying TDR principles, crop science and research can move towards more innovative, inclusive, and sustainable solutions, addressing the pressing challenges or present and future agricultural needs. We address the questions of how can crop science:

- Effectively deploy the principles of transdisciplinary research (TDR)?
- Leverage TDR to meet breeding targets more strategically, efficiently, and impactfully?

**To do so, we** Combine theoretical knowledge of TDR with practical insights **to examine oppportunities and contraints that TDR promises.**

For methods, we conducted a **literature review** and a **survey** involving:

- **28 breeders** (5 women, 23 men)
- **19 crop leads** (8 women, 11 men)
- Planned surveys with **social scientists**.

This survey explored the information breeding teams use, where they obtain it, how they prioritize traits based on diverse user needs, and how their performance is evaluated. It also evaluates their consideration of end-user preferences and how multiple traits are assessed with these users in mind. This provides an understanding of the breeding program's operations and the considerations breeders take into account when making decisions as well as the incentives for doing so.

### Summary of the Literature Review on Transdisciplinary Research

- Transdisciplinary research (TDR) is a **solution-oriented approach** that crosses disciplinary boundaries and **involves non-academic stakeholders** in the knowledge creation process. It integrates academic, practical, and Indigenous knowledge, allowing flexibility in methods. This approach is particularly useful for addressing **complex societal issues**, known as "wicked problems."
- **Key principles** of TDR include **inclusiveness**, **interdisciplinary collaboration, systems thinking, and participatory methods**. These principles ensure that research is both scientifically rigorous and socially relevant, facilitating solutions that drive social change. Collaboration among diverse stakeholders, such as scientists, policymakers, and practitioners, fosters mutual learning and robust interventions.
- TDR offers several **advantages**, such as data-driven approaches and better outcomes from public-private partnerships. In crop breeding, this collaborative model accelerates the adoption of new crop varieties and technologies that meet diverse needs. However, TDR faces **challenges**, including **institutional barriers**, **difficulty in reaching consensus**, and the **complexity of merging diverse disciplinary methods**. Effective TDR requires strong coordination, clear communication, and conflict resolution strategies.
- Despite its potential, TDR is resource-intensive and can be hindered by time constraints and **difficulty in measuring success beyond traditional academic metrics.** Transdisciplinary impact assessments, which consider social, economic, and environmental factors, have been introduced to address these challenges. TDR holds significant promise for crop breeding research, though its application in this field is still emerging, requiring collaboration between researchers and practitioners to meet breeding targets and foster real-world impact.

## Data Results and Findings

**Information Sources for Breeding**:

- Breeding teams rely on various sources such as **field data**, **farmer feedback**, **market analysis**, and **scientific reports** to inform their decisions.
  - However, the use of farmer feedback data and market analysis appears to be inconsistent and lacks rigor.
  - In some cases, farmer feedback is collected through a top-down approach, where breeders preselect traits and ask farmers to rank them, rather than allowing farmers to identify the traits they prefer based on factors such as gender, age, or land size.
  - While some breeding programs actively seek input from women farmers and marginalized groups, challenges remain in integrating these perspectives.
- **Local environmental data** (e.g., drought or heat) plays a crucial role in trait prioritization.

## Data Results and Findings

**Trait Prioritization**:

- Breeders prioritize traits like climate resilience, nutritional value, and market appeal, but the emphasis tends to lean heavily towards climate and environmental factors, particularly when they were asked to prioritize a single most important breeding segment.

**Gender Inclusion:**

- Although the participation of women in breeding decision-making is increasing, and a gender-awareness process is taking hold, women and marginalized groups' involvement in trait prioritization remains underrepresented.

- **Measuring Success**:
- Success in transdisciplinary work is notably underrepresented, as most breeding teams lack integration with other disciplines.
- Typically, success is measured by the number of varieties released, with breeders often equating their achievements to the number of farmers adopting these varieties.
- Rarely do they mention the impact of these varieties on the five key impact areas or the involvement of other disciplines and farmer-first focus.

## TDR Constraints and Future Research

**Biggest TDR Constraints:**

1. **Institutional Barriers**:
   1. Traditional research structures often lack the flexibility to incorporate **cross-disciplinary collaboration**, limiting the effectiveness of TDR.
   2. **Hierarchical decision-making** in breeding programs can reduce the participation of non-academic stakeholders, such as farmers and traders with a one off and non-binding multistakeholder meetings.
2. **Limited Stakeholder Engagement**:
   1. Engaging a broad range of stakeholders (farmers, policymakers, market actors) throughout the research process is challenging due to **resource constraints** and differing priorities.
   2. **Power imbalances** and the **systematic exclusion of marginalized voices**, particularly women and minority farmers, hinder diverse participation.
3. **Coordination and Communication Challenges**:
   1. Successful TDR requires **continuous coordination** between multiple disciplines, which is often impeded by **siloed working practices** and **different terminologies** used across sectors.
   2. **Knowledge-sharing platforms** and mechanisms for collaboration between scientists, practitioners, and local communities are often underdeveloped.

Addressing these constraints in important as breeding programs that include diverse stakeholder input—from farmers to traders—are better able to address multifaceted trait requirements. Programs that engage end-users directly in the breeding process tend to develop traits that are more aligned with local agricultural practices and market demands. As such, future research needs to attend to the question of how can breeding programs effectively engage diverse stakeholders, including farmers and traders, to develop traits that are better aligned with local agricultural practices and market demands?

## References


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CGIAR INITIATIVE ON Market Intelligence

CGIAR INITIATIVE ON Accelerated Breeding