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Measuring well-being in agroecological food systems: a multi-scale framework for sustainability indicators

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This article introduces a flexible, multi-scale framework for assessing sustainability in agroecological food systems that explicitly incorporates indicators of biopsychosocial well-being across the levels of individuals, communities and institutions, and economics and ecologies. We seek to operationalize the interactive relationship between biopsychosocial health and sustainability, and argue that well-being constitutes a critical service that underpins the resilience and long-term viability of food systems. Our proposed framework bridges psychological, social, and ecological sciences, leveraging participatory and transdisciplinary methodologies. It integrates two complementary sets of metrics: a primary series of validated and standardized tools designed to quantify the different levels (from individual to ecological) and a second, participatory, community-defined set of indicators we term "vital signs of place". These context-sensitive indicators, developed through collaborative and participatory processes, seek to support epistemic justice by centering diverse ways of knowing and living. To ensure the framework remains actionable and avoids becoming a black box, we emphasize parsimony and practical feasibility in the selection of indicators. A deliberately limited and well-prioritized set of metrics enables meaningful implementation, supports stakeholder engagement, and facilitates interpretation across contexts. The resulting framework balances comparability across regions with adaptability to local priorities and is applicable at multiple scales—from watersheds to regional levels. Central to our approach is the conceptualization of well-being as the dynamic expression of self-directedness, cooperativeness, and self-transcendence both in individuals and communities, following C. Robert Cloninger's biopsychosocial model of personality. This view highlights well-being not merely as a state, but as a developmental process emerging from purposeful agency, social connectedness, and a sense of meaning beyond the self—across individuals, communities, and institutions. We emphasize as well the interactive role of socio-ecological organization in encouraging, or

discouraging, these dimensions of well-being. The different standardized metrics and participatory indicators are looked at from this perspective. By focusing on the lived experiences and biopsychosocial health of rural communities, our approach aims to contribute to long-term sustainability efforts and addresses key challenges related to the Sustainable Developmental Goals. This framework offers tools and actionable guidance for researchers, policymakers, and practitioners seeking to center well-being in the transformation of the socio-ecological organization of food systems.

KEYWORDS

agroecological transitions, biopsychosocial well-being, food systems, participatory research, sustainability indicators

1 Introduction

Measuring sustainability in food systems presents a complex challenge due to the inherently multifaceted nature of these systems. Current metrics often emphasize production efficiency, economic viability, or biophysical outcomes, while overlooking critical social, psychological, and environmental dimensions (Hassan et al., 2025). Nonetheless, food systems are strongly coupled socio-ecological systems, reflecting the nested and mutually reinforcing nature of human and environmental components. Given the essential role of people (producers, retailers, consumers) in food systems, both individual and community well-being are essential considerations for sustainability; well-being influences people's capacity for and engagement in sustainability efforts (Jackson and Holm, 2024). To capture the full spectrum of sustainability, more integrated frameworks are needed, ones that encompass social, economic, and environmental factors (Boylan et al., 2020), while also being grounded in local realities (Hassan et al., 2025).

The need for such integration is uniquely pronounced in agroecological systems[1]. Unlike conventional industrial agriculture—or, for that matter, other industrial systems that treat the human element as a provider of labor—agroecology relies inherently on the ability of people to respond to change and work together. Moreover, it is a knowledge-intensive and relational science, practice and movement that depends fundamentally on the adaptive capacity, agency, and social cohesion of its actors (Wezel et al., 2009, 2020). Agroecological transitions can be understood as dynamic, non-linear processes of socio-ecological reorganization through which farming and food systems are redesigned to align agricultural production with ecological integrity and demands for social justice (McKay et al., 2025). In other words, these transitions are gradual changes in how we farm that push the food system to be less resource intensive and more equitable. Such transitions require farmers to navigate a phenomenological rupture; thus, the success of agroecological systems is inseparable from the biopsychosocial health of the people who manage them. Monitoring dimensions such as purposeful agency and social connectedness is essential and may help prevent technical or ecological innovations from faltering due to unaddressed social or psychological stressors (Barnaud et al., 2008). Box 1 presents the contextual use of our framework, while Box 2 a proposed example of how it could be used in practice.

BOX 1 Comparison in practice: use of the framework.

This framework is designed to enable comparison across agroecological contexts without requiring uniformity in locally defined indicators. Users can achieve comparability via two complementary mechanisms: (1) collecting a shared core set of standardized, validated well-being measures, and (2) the alignment of community-defined indicators within a common set of higher-order well-being domains (e.g., agency, social cohesion, environmental attachment, livelihood security). This structure will allow researchers and policymakers to examine patterns, distributions, and changes in well-being across sites while preserving attention to local knowledge, needs, and priorities.

Importantly, our framework does not rely on the aggregation of all indicators into a single composite score or ranking, which is common in global indices. These indices are valuable for national-level benchmarking, but they tend to obscure biopsychosocial dynamics, and limit interpretability at local scales. In contrast, our framework functions as a comparative *interpretive tool* with standardized indicators useful for cross-site coherence and benchmarking, while the "vital signs of place" offer contextual explanation and a type of diagnosis that gives local insight. Comparison is therefore set at the domain level and in changes observed over time rather than through reductive quantitative summation, which can support learning across sites, adaptive programming, and policy relevance without collapsing diverse lived experiences into a single metric.

Several recent initiatives have endeavored to develop more integrative frameworks to assess food system sustainability, particularly within the field of agroecology (Binder et al., 2010). The FAO's Tool for Agroecology Performance Evaluation (Mottet et al., 2020), for example, and the Agroecology Coalition's Framework (Moeller et al., 2023) represent significant steps toward incorporating multidimensional indicators that address environmental integrity, equity, governance, and productivity. Similarly, the University of Vermont's Farm Resilience Tool (Serrano-Cortés et al., 2023) introduces a participatory approach to generating context-specific assessments of farm resilience by combining literature review with farmer-led validation. These methods seek to empower local communities while

1 We consider agroecology not only as a set of on-farm practices, but as the foundational ecological and social paradigm for the transformation of industrial and delocalized food systems (Deguine et al., 2021; Gliessman, 2016; Hainzelin, 2014). In this view, 'agroecological food systems' are conceptualized as nested, socio-ecological networks where agricultural production is reintegrated with local ecosystems, social justice, and territorial governance.

BOX 2 From framework to practice: a watershed-based example in Wisconsin, USA.

Although the present article is theoretical, the following example demonstrates the practical feasibility of collecting and integrating standardized and participatory well-being indicators.

In Wisconsin (USA), farmer-led watershed groups are good examples of existing, collaborative entities that are well suited to participatory work on well-being in agroecological transitions (cooperatives could serve a similar role in other contexts). Watershed groups are often already motivated to improve water and soil quality within a river basin through peer knowledge sharing, implementation of soil-conserving management practices (e.g., cover cropping, reduced tillage), and participation in stewardship programs supported by public cost-share and technical assistance.

Implementation would begin by defining the scale of assessment (the watershed) and recruiting participants through existing networks. Researchers could convene approximately 40 farmers representing several adjacent watershed groups for a short series of workshops, with intentional recruitment to ensure representation of women farmers, early-career producers, smaller-scale operations, and other groups often underrepresented in conservation and governance processes.

At the first convening, participants would complete a brief baseline survey using the first pillar's core standardized to assess well-being through the lens of self-directedness, cooperativeness, and self-transcendence, alongside a short set of social cohesion questions capturing relational and institutional aspects of community life (e.g., trust, reciprocity, perceived institutional support). These data establish the social and psychological context within which agroecological transitions unfold.

In parallel, two facilitated sessions would support farmers in co-defining a parsimonious set of 6–8 "vital signs of place," tailored to local priorities and drawing on participatory mapping and/or Photovoice exercises. This, to help ensure that the framework captures context-specific indicators of community and ecological health. Mapping activities can use structured prompts to ensure broad participation, while shared meals (when feasible) can further support informal knowledge exchange. Community-defined indicators might include perceived fairness in cost-sharing for conservation practices, confidence that local youth will continue farming, levels of food and financial security, drinking water safety, air quality near farms, and the strength of mutual-aid networks during weather or market disruptions. Photovoice prompts could invite participants to contribute 2–3 images with short captions explaining their relevance to well-being and stewardship.

Survey results and community-defined vital signs of place would then be integrated using a mixed-methods approach aligning quantitative scores with qualitative themes. This joint interpretation (across the nested levels of individual, community, and ecology) allows stakeholders to identify synergies, tensions, and early warning signals—for example, improvements in soil health occurring alongside elevated stress or declining perceptions of fairness—and to adjust the pace or sequencing of practice adoption or expand institutional support services as needed. Within this framework, intervention does not precede measurement but emerges iteratively from it.

Follow-up data collection (e.g., at 12 months) would repeat the core standardized measures and revisit locally defined indicators to assess whether well-being improves alongside agroecological change and whether further adaptation is warranted. This iterative cycle of measurement, interpretation, intervention, and reassessment operationalizes the framework as a learning-oriented and adaptive approach to agroecological sustainability.

In practice, these activities could be embedded within existing watershed group structures—such as annual planning meetings, conservation field days, or steering committee sessions—rather than requiring a parallel process. Standardized surveys could be administered alongside routine evaluation activities, while participatory workshops could be integrated into meetings where watershed priorities, grant applications, or cost-share allocations are already discussed, ensuring that well-being indicators inform ongoing decision-making, governance, and stewardship.

retaining global relevance through modular adaptability (Estrin et al., 2021). In Latin America, the landscape of sustainability evaluation has been significantly shaped by the MESMIS framework (*Marco para la Evaluación de Sistemas de Manejo de Recursos Naturales incorporando Indicadores de Sustentabilidad*). This pioneering model operationalizes the combination of community-defined critical points while allowing for the inclusion of standardized systemic attributes (Astier et al., 2008; Speelman et al., 2007). Such initiatives are promising because they represent a departure from reductionist metrics, attempting to capture the multidimensionality of food systems by integrating environmental integrity with social and governance indicators.

Despite these developments, the fields of sustainability and well-being have remained largely siloed, particularly in western academic discourse. Sustainability science has historically focused on ecological and economic models (Bennett et al., 2015; Leach et al., 2010), neglecting the broader concept of well-being (Barrett et al., 2020; Béné et al., 2019; Friedrichsen et al., 2025), and well-being research has struggled to incorporate environmental and social dimensions (Atkinson, 2021; Betley et al., 2024; Blackburn et al., 2025; Isham et al., 2023; Masterson et al., 2019; Ronen and Kerret, 2020). This is largely due to a prevailing individualistic focus in mainstream positive psychology that neglects wider systemic influences (Gaffaney and Donaldson, 2025), imposes Western values as universal, and overlooks the crucial role of culture and ecological context (Coulombe et al., 2020; Kjell, 2011; Van Zyl et al., 2024).

Sustainability assessment approaches have tended to use either top-down metrics or bottom-up indicators, but not both in a truly integrated fashion (Bell and Morse, 2012; Béné et al., 2024; Méndez et al., 2013). This fragmentation remains a persistent challenge; major research programs aimed at linking biodiversity, ecosystem services, and human well-being note that existing knowledge is often fragmented across disciplines—particularly natural sciences and economics—making it difficult to assess how ecological management improves human well-being (Bennett et al., 2015). In his conceptual review, O'Mahony (2022) calls for a more integrated perspective, one in which sustainability efforts robustly embed well-being, while well-being research must expand to address environmental and planetary health alongside individual flourishing and community solidarity (see also Kjell, 2011). This disconnection is especially evident within food system assessments, where well-being is typically treated in narrow terms such as nutrition and human health, economic accessibility, and social equity (Chaudhari et al., 2021; Verfuerth et al., 2023; Elgendy et al., 2024), rarely incorporating deeper biopsychosocial dimensions such as purposeful agency, social connectedness, a sense of unity and meaning beyond the self, or emergent psychological challenges like climate anxiety and environmental distress. Nevertheless, recent genomic and neuroscience research suggests that the human outlook on life, as measured by personality, orchestrates all the complex adaptive systems that regulate sustainable well-being at all scales from individuals to communities to nature and the world as a whole (Del Val et al., 2024).

There has been limited academic effort to explicitly link sustainability in agroecological food systems with biopsychosocial well-being[2]. Echoing Rogers et al. (2012), we argue that sustainability "must be defined to include meeting human physical, emotional and social needs", while respecting planetary and ecosystem boundaries. Although some studies have explored specific types of relationships, such as the link between mental health and food security (Onyeaka et al., 2024), there remains a lack of an overarching framework that situates well-being at the heart of agroecological sustainability[3].

In this paper, we seek to bridge that gap by proposing a sustainability assessment framework for agroecological food systems that explicitly incorporates well-being, using both standardized multicriteria indicators and adaptable, context-specific measures developed through participatory processes. Drawing on multiple knowledge domains, we anchor our understanding of well-being in Cloninger's biopsychosocial model of personality (Cloninger et al., 1993; Cloninger, 1994, 2013). This model conceptualizes well-being as a developmental process emerging from the cultivation of three core character traits, self-directedness, cooperativeness, and transcendence, respectively reflecting purposeful agency, social connectedness, and a sense of unity and meaning with something beyond the self. We build on this model by emphasizing the role of varying forms of socio-ecological organization in encouraging, or discouraging, the flourishing of these traits of well-being in food systems.

Our overarching aim is to introduce a multi-scale, transdisciplinary framework for assessing well-being in agroecological systems and to explore its implications for both local transitions and the realization of sustainable food futures (Duncan et al., 2017). This approach is designed to balance comparability and standardization with community relevance and adaptability. It evolves iteratively through stakeholder engagement. Our proposal is a theoretical one: we acknowledge that no empirical results or field data are presented at this time. The framework and linkages discussed herein are presented as theoretical contributions and future potentials, rather than demonstrated effects.

In the sections that follow, we outline the conceptual foundations for centering the traits of well-being in the socio-ecological organization of agroecology, describe the metrics and methodology, and present the structure of the multi-scale indicator framework, before linking our findings to the UN Sustainable Development Goals (SDGs) and discussing implications for policy and governance.

2 Conceptual foundations

2.1 Centering well-being in rural agroecological transitions

The methodological challenge of evaluating agroecological transitions stems from their inherently multidimensional and multiscale nature. A comprehensive review by Darmaun et al. (2023) evaluated 14 existing multiscale assessment methods (with academic publications in French and English) against five key requirements: local adaptability, social interaction analysis, conceptual clarity, temporal dynamics, and bottom-up participation. Analyses revealed that no single existing method currently covers all five criteria, often forcing a trade-off between standardizing for benchmarking and adapting for local settings. This underscores the need for novel interdisciplinary frameworks that can create bridges between different dimensions of sustainability. Moreover, agroecological transitions hold significant promise for sustainability gains, but when implemented without attention to social context and the human condition, they risk reproducing the mistakes of past industrial agricultural transformations (HLPE, 2019).

One strategy for bridging dimensions and avoiding past mistakes is to embed well-being indicators, both scientifically validated and community-defined, into agroecological innovation from the onset (Gratton et al., 2024). Monitoring well-being alongside agronomic outcomes could allow practitioners to detect social or psychological stressors early and adjust interventions accordingly, while also permitting the incorporation of variable definitions of well-being set by the communities themselves. Moreover, attention to well-being can help agroecological initiatives establish a clear and integrative understanding of what success means, providing actionable indicators to guide socio-ecological reorganization through resource allocation and investment in the specific social and ecological components that brought about the said success.

Agroecological transitions are not only technical or ecological processes; they are profoundly social and psychological. While agroecology emphasizes sustainability, resilience, and justice in food systems, its success ultimately depends on the capacity and willingness of individuals and communities to enact and sustain new practices (Marchand et al., 2014; Sanchez-Mata et al., 2026). In this context, well-being is not a secondary outcome but a central goal and a primary driver of agroecological transformation (Matson et al., 2016). Individual well-being and self-awareness, community well-being and other-centeredness, as well as the agroecological well-being of nature as a whole are all strongly interdependent (Bezner Kerr et al., 2023; Buckton

2 We acknowledge that the perceived novelty of linking well-being and sustainability primarily reflects a Western/Eurocentric academic outlook. In the Global South, these connections may be better-established through paradigms such as Latin America's *Buen Vivir*. *Buen Vivir* is not conceptualized as individual welfare, but as a holistic, culturally appropriated vision of collective well-being anchored in social justice, quality of life, and ecological balance. Similarly, in indigenous cosmovisions, nature is viewed as a sacred primary source of life that nourishes and supports rather than as a mere economic resource. Under these indigenous worldviews, nature management is guided by a reciprocity principle where the natural and social worlds are intrinsically linked. Consequently, the well-being of humans depends on following rules of interaction with all things that exist. For further exploration of these epistemologies, see Escobar (2016), Sabourin et al. (2025), Toledo (2000).

3 The observation that a broader conception of outcomes gives meaning and value to those engaged in agroecology underscores the framework's necessity. As we will discuss, a broader conception of agroecological outcomes (beyond, environmental and economic) is what gives meaning and value to people engaged in agroecologically-based production systems. Not being able to incorporate these dimensions relegates essential dimensions of well-being to secondary considerations and narrows the value of agroecology.

et al., 2023), which suggests that they must be jointly cultivated to be sustainable.

This dynamic is critical. Well-being acts as a driver for systemic change by enabling crucial social processes. Place-making research, for example, suggests that transitions happen through social processes, as they involve the construction of institutions that foster self-governance and social cohesion necessary for overall systems' change. The active and deliberate building of transformative capacities (collective capacity-building, self-efficacy, self-directedness, and new narratives) in specific places is essential to transforming socio-ecological systems (Horlings et al., 2020). Transitions toward sustainable food systems have been shown to be more effective and enduring when grounded in improvements to biopsychosocial health, social cohesion, and a shared sense of meaning and agency (Méndez et al., 2013; Gliessman, 2016), often realized through local processes that assert a multi-dimensional view of good farming and empower collective agency (Darnhofer et al., 2016; Strauser et al., 2022; Strauser and Stewart, 2024).

Progress toward greater well-being enhances the adaptive capacity of farmers and rural communities and is linked to essential biopsychosocial resources, such as efficacy, resilience, and motivation, that are needed to navigate the uncertainties and trade-offs inherent to systemic change (Keshavarz and Masoomi, 2026). Cloninger's biopsychosocial personality model supports the cultivation of such resources. By highlighting three character traits—self-directedness, cooperativeness, and self-transcendence—this framework clarifies which psychological capacities are most crucial for adaptive change and collective action during the challenges of the 21st century (Cloninger, 2013). For instance, self-directed individuals are more likely to initiate and persist in pro-environmental practices, exercising agency in the face of challenges. Cooperativeness fosters collaboration and trust within farming communities, enabling people to work together toward common sustainability goals. Self-transcendence contributes to a sense of connectedness to nature and future generations (Cloninger, 2013), values that together underpin the long-term orientation of agroecology and the canonical definition of sustainability (Brundtland, 1987). In other words, individuals who have higher scores in these character traits, as measured by the Temperament and Character Inventory (TCI), are better equipped to embrace agroecological practices that require personal change, collective action, and a forward-looking mindset.

However, as studies in epigenetics show, there is no gene, or set of genes, that unequivocally trigger such traits of well-being (Kandler and Instinske, 2025; Zwir et al., 2021). Such capacities are potentials for all. But they are encouraged, or discouraged, by differing forms of lifestyle and socio-ecological organization. For example, a context of economic and ecological insecurity with little community and governmental support for those harmed will likely encourage just the opposite of these traits: hopelessness and despair, rather than self-directedness; conflict and competitiveness, rather than cooperativeness; individualism and self-centeredness, rather than self-transcendence. Recognizing the role of the context alerts us to the scope of policies and forms of agroecological governance that might shift personalities in more helpful directions.

At the meso level, community well-being, other-centeredness, and cohesion are equally critical. Agroecological practices often depend on cooperation, shared resources, and social learning, which are only possible in communities that are both socially integrated and psychologically supported. Strong community ties facilitate the co-creation and dissemination of knowledge while providing emotional and material support to mitigate the risks of changing environments. An example of this is community-based watershed management, where high social cohesion and trust (i.e., social capital) are essential for motivating farmers to collectively implement soil and water conservation practices—such as soil bunds and vegetative barriers—to reduce erosion and water contamination, an effort that would fail if undertaken by individuals acting alone (Pretty and Ward, 2001; Hailu et al., 2021). When individuals feel embedded in supportive, meaningful social structures, they are more likely to engage in long-term, collective sustainability efforts and embrace transitions that may initially be costly or uncertain. This underscores a central premise of our sustainability framework: technical innovation will falter without being *people-centered*, that is if we ignore the human dimensions of systemic agroecological transformation (Gliessman, 2016).

Centering well-being in agroecological transitions is thus both a practical necessity and an ethical imperative (Bezner Kerr et al., 2022). Moreover, debates over regenerative agriculture (which shares ecological goals with agroecology but often lacks its socio-political emphasis) suggest that regenerating relationships is part of the equation, reflecting the importance of the relational dimension of social well-being (Bell et al., 2024). Gosnell (2022) reframes sustainability not merely as an environmental or economic goal, but as a deeply rooted dimension of the human condition. She further highlights that the realization of ecological health requires integrating the inner transformation that fosters farmers' feelings of kinship with nature, arguing that regenerating soil goes hand in hand with the regeneration of farmers' dignity, sense of purpose, and connection to land and community. Our framework responds to this need by integrating well-being as a core dimension of sustainability, operationalized through both standardized and participatory indicators. In doing so, we aim to provide a tool that respects local knowledge, enhances agency, and fosters long-term engagement in agroecological change.

2.2 Cloninger's biopsychosocial model of well-being

To conceptually anchor our framework, we draw on Cloninger's biopsychosocial model of personality and his research on well-being. As stated earlier, well-being emerges from the development of three interrelated character dimensions: self-directedness, the capacity for autonomous purpose and responsibility; cooperativeness, the capacity for empathy, social tolerance, and community integration; and self-transcendence, the ability to see oneself as an integral part of a larger whole, fostering spirituality, meaning, and connection beyond the self (i.e., nature,

God or the universe)[4]. Cloninger's theory, grounded in decades of empirical research (e.g., neurological, large population studies, interventions, psychometrics, etc.), consistently links these traits to improved mental health, resilience, and prosocial behavior (Cloninger et al., 1993; Cloninger, 1994, 2013; Zwir et al., 2021). By viewing well-being as a character developmental process, rather than a static or subjective condition, it becomes possible to align personal growth with sustainability transitions and goals. In the context of agroecology, Cloninger's model provides a conceptual bridge between individual biopsychosocial development and collective ecological outcomes. Self-directedness supports agency, persistence, and responsibility in adopting new practices; cooperativeness fosters trust, collaboration, and collective learning within farming communities; and self-transcendence encourages long-term, intergenerational concern for land, nature, and future generations. These traits are not fixed dispositions but developmental potentials that are encouraged or discouraged by socio-ecological organization. Contexts characterized by insecurity, isolation, or lack of institutional support may suppress these capacities, whereas supportive, participatory, and relational environments can foster them—highlighting the importance of governance and social conditions in shaping well-being during agroecological transitions.

That inner transformation does not take place *ex nihilo*, however. It develops in response to the conditions of one's context, including social structures, cultural influences, community ties, and ecological conditions a person experiences. Consider that no inner transformation is likely in circumstances that might require a person to radically change their social relations of identity—what Bell et al. (2024) calls a *phenomenological rupture*—without the opportunity to embrace a different network of identities. For example, for a conventional farmer to switch to organic farming typically requires more than implementing the legally approved standards in their area. For the transformation to organic to be lasting, it also entails thinking about one's identity differently, and finding networks of social support and friendship with a considerably different group of people.

A crucial part of that new identity is whether it enhances self-directedness, strengthening a farmer's sense of agency, self-efficacy, and autonomy in adopting sustainable practices, rather than a more passive embrace of dominant agricultural narratives. Fostering cooperativeness can increase community solidarity, and facilitate collective learning and joint experimentation, which are critical for strengthening social networks and enabling self-governance institutions necessary for overall systems change (Kernecker et al., 2021; Magliocca et al., 2025). Nurturing self-transcendence can deepen environmental stewardship and foster a long-term, intergenerational perspective, consistent with the outward-looking orientation implied by self-transcendence. Consistent with this orientation, research on self-transcendence values (i.e., biospheric values and, to a lesser extent, altruistic values) shows that these values are among the strongest and most consistent predictors of pro-environmental concern and behavior (De Groot and Steg, 2008, 2009, 2010; Steg, 2016; Steg et al., 2014). Indeed, Cloninger argues that an "outlook of unity" enables functioning "with plasticity and virtue," thereby supporting sustainable harmony with nature and other people (Cloninger, 2004, 2013; Zwir et al., 2022). Importantly, evidence from personality research using the TCI indicates that physical, mental, and social well-being depend strongly on profiles of self-directedness, cooperativeness, and self-transcendence (Cloninger, 2004, 2013; Cloninger et al., 2010; Cloninger and Zohar, 2011; Josefsson et al., 2011). Beyond the TCI literature, cooperative and prosocial orientations are also associated with higher well-being across cultures (Aknin et al., 2013). In line with this broader evidence base, higher self-directedness is associated with greater perseverance and resilience under stress (Vosloo and Van Staden, 2024), and higher cooperativeness correlates with more adaptive emotion-regulation strategies when coping with challenges (Chae et al., 2019).

The causality of these associations is two-way, as is typical in social life. The nurturing of self-directedness, cooperativeness, and self-transcendence encourages the socio-ecological relations that in turn encourage these traits of well-being—and vice versa. Recognizing how causes affect effects that in turn cause causes, in a never-ending interplay, provides a wider range of options for stimulating agroecological transformations, as we will come to later.

Although these traits and their socio-ecological contexts have not been widely studied in farming populations, their known relationships with healthy and prosocial behaviors suggest they would influence which farmers would engage most effectively in sustainability transitions. By explicitly incorporating self-directedness, cooperativeness, and self-transcendence into our proposed indicators (for instance, through the TCI), we ensure the framework captures these key biopsychosocial drivers of sustainable behavior. Cloninger's model thus provides a unifying backbone for interpreting both individual and community well-being metrics. Each indicator can be viewed through the lens of purposeful agency, social connectedness, and a sense of greater meaning, within the context of conditions that encourage or discourage them.

In line with Cloninger's theory, no single character trait alone defines well-being. Rather, well-being emerges from the integrated development of personality and its expression in multiple domains of context. In this paper, we refer to well-being as feeling good (i.e., happiness), doing good (i.e., mature and actively virtuous living), physical health (i.e., vigor, vitality, absence of disease or infirmity), and prosperity (i.e., success, good fortune, and flourishing) (Cloninger, 2004). This theory-informed, integrative perspective on well-being represents a novel contribution to agroecological assessment, grounding the individual and social dimensions of sustainability in a rigorous model of human personality development and its contextual inducements. It places biopsychosocial development in the context of agroecological vitality as an essential aspect of what gives life meaning and value. Each metric in the assessment not only measures a relevant outcome, but also reflects an underlying facet of the human condition, factors essential for fostering lasting well-being and driving sustainable transitions.

4 Cloninger's model finds parallels in the Global South paradigms previously mentioned: cooperativeness aligns with the collective agency and social justice of *Buen Vivir*, while self-transcendence reflects the indigenous cosmovision, whereby the individual identifies as a constituent part of a sacred, living whole rather than an isolated actor.

2.3 Developing a framework that includes well-being metrics

We propose a two-pronged framework for evaluating well-being in agroecological transitions, combining standardized, theory-informed indicators with participatory, context-specific metrics. This approach balances comparability across sites (and countries) with responsiveness to local contexts, cultures, and values, offering a robust model for multi-scalar, integrative assessment.

Pillar 1: The first pillar of the framework consists of one standardized survey instrument designed to evaluate the state of and changes in individual and community well-being over time. To ensure the applicability across diverse agroecological settings, this pillar will involve a core suite of validated, cross-culturally relevant tools that collectively capture well-being, psychological stress, and character development. The pool of validated instruments that can be drawn from is shown in Table 1.

Together, this suite of validated instruments offers a multidimensional, theory-informed profile of well-being. While some tools may appear overlapping, each has been selected to reflect distinct facets of our working definition of well-being—feeling good, doing good, physical health, and prosperity—and to enable flexibility across different research and community contexts. The final goal of the evaluation framework is to determine the best-suited indicators to keep across contexts.

For example, the Satisfaction with Life Scale (SWLS) offers a concise global measure of life satisfaction, valuable for capturing cognitive evaluations of well-being. In contrast, the WHO-5 Well-Being Index focuses on recent emotional states, allowing for short-term tracking of mood and affect. These tools together help differentiate between stable life judgments and transient emotional states—both important for understanding how agroecological transitions are experienced over time.

The Harvard Flourishing Index spans broader domains such as health, character, purpose, and financial stability. It offers a valuable composite measure aligned with our "doing good" and "prosperity" dimensions, but its breadth may obscure specific changes in stress or psychological functioning. To complement this, we include the Perceived Stress Scale (PSS), which captures environmental and psychological pressure—key for identifying vulnerabilities or trade-offs during periods of systemic change.

Finally, the TCI uniquely operationalizes Cloninger's model, directly measuring self-directedness, cooperativeness, and self-transcendence—the core psychological capacities that support sustainable behavior. While these traits may overlap with elements of flourishing or resilience, they serve a distinct purpose in our framework: linking personal character development to agroecological context.

In short, the selected tools are not redundant but complementary, each illuminating different temporal, emotional, or psychological aspects of well-being. Together, they allow for both breadth and depth in assessment, aligning with our commitment to a nuanced, pluralistic understanding of well-being that can be adapted to site-specific goals and constraints.

Pillar 2: The second pillar of the framework is a participatory "vital signs of place" toolkit that supports communities in co-defining what well-being means in their contexts. More specifically, "vital signs of place" are a small set of locally meaningful indicators co-defined by communities through participatory processes. They complement standardized well-being measures by identifying place-specific priorities and stressors that serve as decision-support signals for adaptive agroecological governance. Analogous to clinical vital signs (e.g., blood pressure), which flag the need for attention without prescribing treatment, "vital signs of place" indicate when social or ecological conditions in a specific context warrant adaptive response. Their number is intentionally limited (typically 6–8) to maintain parsimony and feasibility. While likely qualitative or ordinal, these "vital signs of place" metrics can be documented with clear definitions and can be tracked over time.

Note that this second pillar builds on the first, by allowing communities to clarify what is most important to them in terms of the community-level indicators of well-being and sustainability. Using participatory processes, researchers will be able to help generate metrics that center local values, lived experience, and situated knowledge in agroecological transitions and food system sustainability projects. As in medicine, these vital signs inherently provide critical information about the overall state of a community. Is a community thriving? Is the current state of the community durable long term? How does community well-being depend on

TABLE 1 Comparative overview of validated well-being instruments.

Instrument	Focus and dimensions	Key features and applications	Supporting reference
SWLS (Satisfaction with Life Scale)	Cognitive-judgmental life satisfaction.	Brief (5 items); good for global cross-cultural benchmarking.	Diener et al., 1985
WHO-5 (Well-Being Index)	Subjective psychological well-being and positive affect.	High sensitivity; captures vitality and interest in daily activities.	Topp et al., 2015
TCI (Temperament and Character Inventory)	Psychobiological personality structure and long-term resilience.	Links individual agency to cooperation and self-transcendence.	Cloninger, 1994
Harvard Flourishing Index	Holistic flourishing (health, purpose, character, social).	Comprehensive; captures social and environmental domains alongside mental health.	VanderWeele et al., 2019
PSS (Perceived Stress Scale)	Perception of stress and uncontrollability.	Critical for assessing farmer vulnerability to ecological or economic shocks.	Cohen et al., 1983

and shape the local agroecosystem or environment? Perhaps one community sees collective action and a voice or role in local environmental policy as key components of both well-being and environmental sustainability. Agroecological transitions will not be sustainable in this context without ensuring farming communities have autonomy and agency in decision-making.

Community-led advisory boards or similar local groups can guide the identification and co-development of these community-level well-being indicators through methods such as storytelling circles, *Photovoice* projects, and participatory mapping exercises (Newman et al., 2011; Sachet et al., 2021). In this way, community members identify what well-being *means to them* in the context of their agroecosystem. For instance, photovoice invites participants to document their experiences through photography and discuss them, which has been shown to elevate surfacing values such as mutual aid, food fairness, and connection to land (Huber et al., 2023). Likewise, community mapping and group discussion activities can help identify shared priorities, stressors, or markers of local flourishing (Berg, 2022).

Outputs from this process might include indicators like "sense of belonging in the farming community" (rated by residents), "presence of mutual aid networks", "perceived fairness in local food distribution", or "spiritual connection to the land". These "vital signs of place" indicators are collaboratively defined and refined through iterative feedback, then documented with clear definitions and, where possible, locally appropriate methods for tracking change over time or differences from one setting to another (e.g., community surveys or focus group ratings)[5]. The result is a flexible but rigorous tool for surfacing and measuring community-centered dimensions of well-being that standardized metrics alone may miss. Community-driven development of these measures also serves to promote community engagement and mutual service to one another.

Importantly, community-defined "vital signs of place" are intentionally designed to reflect locally meaningful dimensions of both well-being and sustainability; therefore, they are not expected to be identical across sites. Rather than aggregating these indicators directly, our framework supports combining them, when useful, according to how they align under larger well-being categories. For example, locally defined indicators can first be mapped onto a shared set of higher-order well-being categories (e.g., agency, social cohesion, environmental attachment, livelihood security) that are consistent across sites and aligned with standardized indicators and relevant SDG categories. This allows distinct local indicators (such as youth engagement in farming, mutual aid networks, or perceived fairness) to be interpreted within a common analytical structure without erasing contextual specificity.

Aggregation should then occur within these categories, using appropriate ordinal or normalized scoring approaches (e.g., Likert-scale means), depending on data type and feasibility. Cross-site comparisons can therefore be conducted across categories and trajectories of change over time, rather than through direct comparison of individual community indicators or the creation of opaque composite indices. This approach preserves the multidimensional character of well-being, supports interpretability, and enables learning across contexts while ensuring local relevance.

These outputs can be combined in modular fashion to align with context-specific needs and constraints. Together, they provide a multidimensional and theory-grounded profile of well-being, suitable for tracking the effects of agroecological transitions over time. This pillar also addresses emerging biopsychosocial challenges in farming communities—such as climate-related emotional stress. To assess phenomena like eco-anxiety, climate anxiety, or *solastalgia* (distress caused by environmental change, Galway et al., 2019), the proposed framework incorporates elements from emerging tools such as the Climate Change Anxiety Scale (Clayton and Karazsia, 2020), the Eco-Anxiety Questionnaire (Hogg et al., 2021), and the Environmental Distress Scale (Higginbotham et al., 2006). While still under development in some settings, these tools allow researchers and communities to capture how ecological disruption impacts mental health and adaptive capacity.

2.3.1 Combining pillars

By combining both pillars, our framework is designed so that well-being is assessed as both a scientifically measurable construct and a culturally meaningful, evolving experience. The participatory process, in particular, captures intangible and context-dependent dimensions of well-being that standardized tools alone may overlook. It also promotes epistemic justice by valuing local knowledge systems alongside scientifically validated measures. Involving community members in defining metrics fosters greater relevance and ownership of the assessment process, and may allow them to interpret findings in light of their own priorities and apply them in decision-making (cf. Caprara et al., 2015; Haldane et al., 2019; Davis and Ramírez-Andreotta, 2021; Mooney et al., 2023).

We contend that the first, standardized, pillar of our proposed multi-scale well-being framework is better suited than macro-level statistical reports, such as the UN Human Development Index (HDI) or the OECD's *Well-being Framework* (OECD, 2024), because it is specifically designed to assess systemic transformation and localized human dimensions in agroecological food systems. While the aforementioned reports function primarily as statistical reports for governments, documenting a range of well-being outcomes across countries, the agroecological framework operates at the individual, community, and ecological levels. This localized approach provides theoretical depth by explicitly anchoring the assessment in a robust model of personality, which conceptualizes well-being not merely as a state but as a developmental process in response to context. Moreover, the

5 The operationalization of these qualitative indicators can be augmented by analyzing the collected narratives and stories (e.g., from storytelling circles or Photovoice discussions) using Artificial Intelligence (AI) and computational linguistics or Natural Language Processing (NLP). NLP approaches are applied in conservation social science to accelerate evidence synthesis by processing large, unstructured bodies of textual evidence, such as social and other media, to examine public views of biodiversity or assess polarization in climate change discourse. This capacity for automation is critical for handling large volumes of complex data that would otherwise be infeasible to process manually (Chang et al., 2025). See Garcia and Sikström (2013), Garcia et al. (2015), and Garcia et al. (2020).

framework employs a two-pronged approach that balances cross-case comparability with local relevance and epistemic justice by integrating a second pillar of participatory, community-defined metrics, ensuring that contextual nuances and lived experiences are captured alongside scientific indicators. This allows the approach to treat biopsychosocial health as a cornerstone of long-term viability and resilience within the food system itself.

3 A multi-scale framework for well-being indicators

A multi-scale approach is essential for integrating well-being into agroecological sustainability assessments. Our proposed framework spans three interconnected levels of sustainable resilience: individuals, communities, and ecologies, reflecting the nested and mutually reinforcing nature of human and environmental systems. Anchored in Cloninger's model of personality development, it links personal flourishing to collective solidarity and ecological responsibility. In adapting principles of multi-scale sustainability assessments, we emphasize the inclusion of biopsychosocial and community health dimensions, which are often overlooked in environmental indicator systems. Indicators are organized as follows:

- **Individuals level (linked to self-directedness):** psychological, physical, and affective well-being of individuals involved in food systems (e.g., farmers, family members), shaped by socio-ecological context.
- **Community/Institutional level (linked to cooperativeness):** social cohesion, trust, shared agency, institutional support, and local governance qualities, shaped by socio-ecological context.
- **Economic/Ecological level (linked to self-transcendence):** livelihood security, environmental health, intergenerational responsibility toward land and nature, shaped by socio-ecological context.

A schematic representation (Figure 1) illustrates the nested relationship between these levels, showing, for example, how enhanced individual well-being and agency can strengthen community engagement and capacity, which in turn supports ecological stewardship reinforcing well-being at all levels[6]. We also emphasize, with the two-headed arrows, the bi-directionality of causality, showing the effects of contextuality and the contextuality of effects. By structuring both pillars of our framework across these levels, we aim to make explicit the cross-level interdependencies that are often studied in isolation.

6 The last level opens to transcendental notions of nature, something that can go beyond what is perceptible through the physical senses. The implication of this is that, ultimately, no enclosing circle exists at this level, in line with Empedocles's and later Augustin's visions of a boundless circle of reality whose center is everywhere, present in all levels of existence.

3.1 Examples of indicators

To operationalize the framework, Table 2 below presents illustrative indicators at each level, individual, community, and ecological, organized by source: standardized tools and community-defined metrics. The standardized set includes validated instruments discussed earlier (e.g., WHO-5, Harvard Flourishing Index), while the participatory set reflects context-specific insights drawn from *Photovoice*, mapping, and community dialogues.

Although many community-defined indicators are unique to their local setting, they often align with the framework's well-being categories such as social connectedness, environmental attachment, or collective agency. By organizing both indicator types side by side, Table 2 clarifies how cross-site comparability and contextual relevance can be jointly supported within a multi-scale assessment.

This table is not exhaustive, but illustrates the *dual logic* of the framework. For each scale, standardized indicators provide top-down consistency and scientific validity, while community-defined indicators provide bottom-up relevance and meaning. For instance, at the individuals level, a standardized survey might show an improvement in average life satisfaction scores, while participatory Photovoice might reveal *why*—perhaps farmers feel less isolated due to new peer networks. At the community level, a formal social cohesion index might be complemented by local narratives about how a new farmers' cooperativeness increased trust and mutual aid. At the ecological level, scientific measures of soil health could be paired with farmers' own observations of wildlife returning to their fields, which they interpret as a positive sign. In practice, the standardized and participatory measures inform each other, creating a richer picture of well-being outcomes than either alone.

3.2 Methodology for operationalization

Prior to rolling out the framework, standardized (core) metrics will be determined by a research team via preliminary research and development (e.g., literature review of relevant metrics, expert consultation, and identification of survey items). The framework is then built on this pre-defined set of broad well-being domains that align with key sustainability goals and the SDGs. These core domains (such as physical health, mental health, social connectivity, economic security, and ecosystem vitality) are applied consistently across all projects to provide a common foundation for assessment.

Implementing the framework involves a structured yet flexible process that balances scientific rigor with local relevance. The approach combines standardized monitoring with community-based insight generation, guided by a *decision-tree* logic that supports iterative refinement. The process unfolds by the following key steps:

1. **Deploy the core standardized measures**—For each core domain, the framework includes a fixed set of validated, cross-culturally relevant indicators. This core battery of instruments is administered to ensure direct comparability. The selection

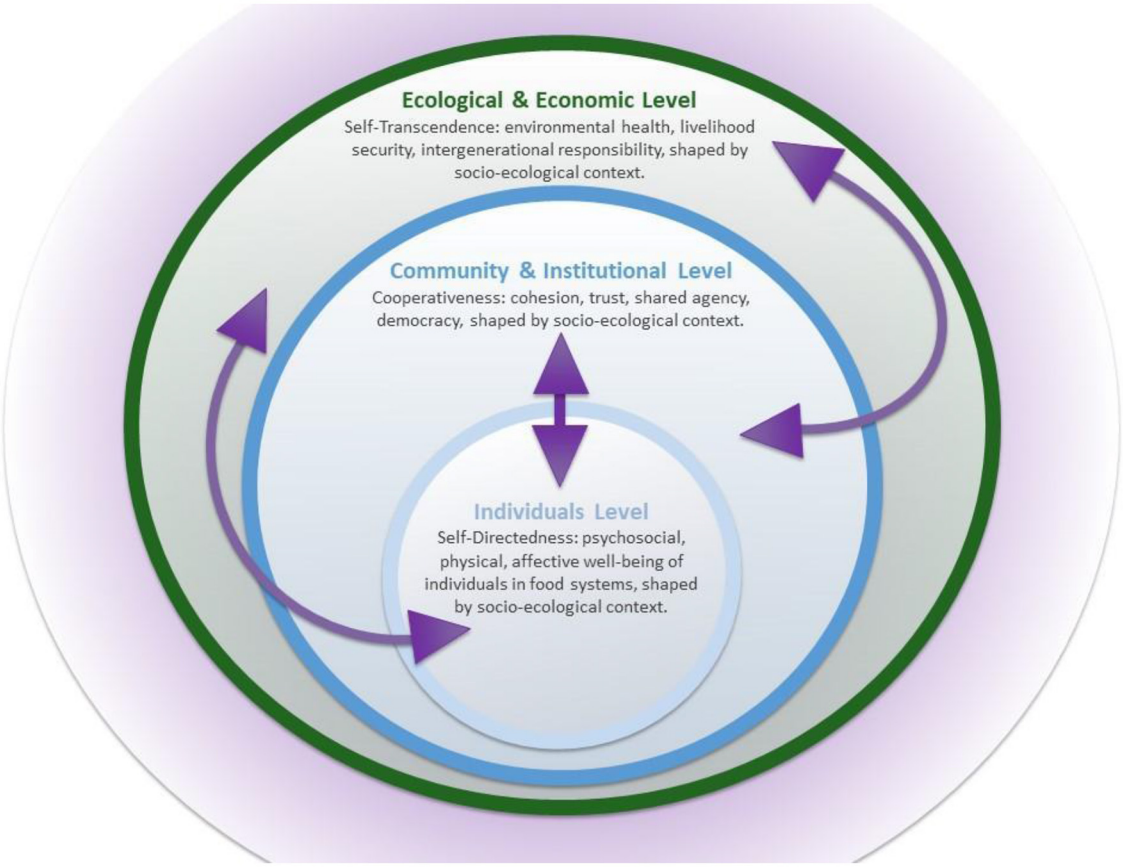

FIGURE 1
Multi-scale framework for assessing well-being in agroecological food systems. This diagram illustrates the integrated biopsychosocial approach across three scales: individuals, community/institutional, and ecological/economic. The outer purple boundary represents the overarching socio-ecological context—including global climate patterns, international policies, and cultural cosmovisions—that shapes and constrains all internal processes. Recursive feedback loops (indicated by arrows) show the dynamic relationship between scales; for instance, individual agency informs community cooperation, which in turn drives ecological stewardship.

TABLE 2 Examples of standardized (core) vs. community-defined (participatory) well-being indicators across different scales in an agroecological food system framework.

Scale	Standardized indicators (examples)	Community-defined indicators (examples)
Individuals (personal biopsychosocial well-being)	*WHO-5 Well-Being Index* (mental well-being); *Satisfaction With Life Scale* (life satisfaction); *Perceived Stress Scale* (stress level); *Temperament and Character Inventory*.	Personal narratives of change (e.g., farmers' stories of improved quality of life); Photovoice images and captions illustrating individual challenges or achievements in the farming transition.
Community/institutional (social cohesion, governance, cultural well-being)	Community cohesion or trust surveys (e.g., social capital index, trust in local institutions); indicators of collective action (number of cooperative groups, participation rates in communal activities); local governance metrics (inclusive decision-making processes, presence of supportive policies).	Community mapping of local "assets and stressors" (e.g., identifying gathering places, mutual aid networks, conflict hotspots); Storytelling circle outputs defining community values or concerns (e.g., "sense of belonging," "youth engagement" in agriculture as vital signs of place); Co-developed indicators via advisory board (e.g., perceived fairness in food distribution, cultural heritage preservation in farming).
Ecological/economic (human-environment and livelihood interface)	Environmental quality and security perceptions (survey of perceived soil health, water quality, biodiversity on farm); objective sustainability metrics linked to well-being (e.g., crop diversity index, soil organic matter as proxy for long-term security); economic stability indicators (farm income variability, generational farm succession rates as a sign of intergenerational well-being).	Locally identified ecological indicators (farmers' traditional signs of a healthy landscape, such as presence of certain wildlife or flowering times); Participatory monitoring logs (community rain and drought observations linked to anxiety levels); qualitative indicators like "hope for next generation" captured in focus groups (e.g., willingness of youth to stay in farming).

criteria (validity, reliability, feasibility, etc.) were used to establish this core set.

2. **Engage the community to co-define additional indicators**—Using the participatory toolkit, facilitate community workshops or meetings to discuss the standardized domains and identify any additional locally valued aspects of well-being not covered by those metrics. Encourage participants to suggest indicators or signals of change that matter to them. For example, community members might highlight "youth involvement in farming" or "trust in traditional knowledge" as key factors for their well-being. These become candidate **vital signs of place** to include.

3. **Integrate and prioritize indicators, emphasizing parsimony**—Combine the standardized and community-defined indicators into one framework. This involves mapping community indicators onto the higher-order categories and SDGs to see overlaps or unique areas. If the combined list is too lengthy or complex, collaboratively prioritize a limited set that is most meaningful and feasible to track. The goal is to avoid overburdening the assessment with too many indicators ("less is more" principle). We ensure that at least some indicators at each scale (individual, community, ecological) are retained, to keep the multi-scale integrity.

4. **Validate and refine through iterative feedback**—Pilot the chosen indicators with a small group or for a short period and gather feedback. Are the survey questions understood consistently? Do community members feel the participatory indicators truly reflect their well-being? Use this feedback to refine wording, add or drop indicators, and adjust methods. This step may repeat multiple times (hence the iterative nature of the framework development). Only once indicators are validated locally and produce reliable information do we finalize the framework for full implementation.

By following this process, the framework systematically integrates standardized and participatory methods—an approach that remains rare (Béné et al., 2024). Each step ensures that both scientific rigor and community voice are maintained. The emphasis on parsimony at Step 4 is critical: many sustainability assessments fail because they attempt to track too many indicators, leading to data fatigue and confusion. By carefully selecting a minimal essential set of metrics, we make the framework practical for real-world use while still comprehensive in covering key well-being dimensions. To provide a clear visual roadmap of this implementation strategy, Figure 2 summarizes the operational workflow. The diagram illustrates how the parallel streams of standardized (Step 1) and community-defined (Step 2) data converge into a single integration phase (Step 3). It depicts the iterative feedback loop inherent to Step 4.

4 Discussion

A core premise of our work is that well-being and sustainability must be pursued together to effectively advance the UN Sustainable Development Goals. Thus, our framework addresses the interconnectedness of well-being and sustainability, a contextual vision of agroecology (Bell, 2018) that directly bridges UN Sustainable Development Goals (SDGs). We therefore aim to fill a critical gap by providing an integrated system for measuring well-being within food systems, connecting local outcomes to global targets. This alignment seeks to provide evidence on how individual biopsychosocial health and community-defined 'vital signs' can be operationalized within international reporting frameworks and agreements. By bridging the gap between 'local voices' and global policy objectives, the framework ensures that the human dimensions of sustainability are captured in progress toward the 2030 Agenda. Table 3 below provides examples of how we see the mapping of some of our proposed indicators with SDG targets.

4.1 Strengths and innovation

This study puts forth a framework that systematically links well-being with agroecological sustainability at multiple scales. A key strength is its theoretical integration of a psychobiological model (Cloninger's dimensions) with agroecological context. Although recent agroecology and food-system sustainability assessments typically include multi-dimensional human and social well-being indicators, our overarching framework that draws on personality-based well-being typologies is novel (see Bezner Kerr et al., 2022; Friedrichsen et al., 2025; Janker and Mann, 2020; Orou Sannou et al., 2023). By doing this, we seek to address a critical gap: the lack of understanding of how individual biopsychosocial factors contribute to sustainable behavior and outcomes in farming communities—and vice versa. Our framework also pioneers a means to combine standardized psychometric measures with participatory, community-defined indicators in one assessment system. Even the unique community-defined "vital signs of place" can be used to compare well-being across locales, given that indicators can be aggregated under broader well-being categories. For example, defined metrics might use different language or outcomes, but all be related to agency. By assessing directional changes in agency across several vital signs, the impacts of agricultural transition on well-being can be compared and understood even more deeply.

Previous approaches have tended to use either standardized metrics and instruments in a top-down, prescriptive manner or bottom-up procedures tailored from the beginning by local communities[7]. We offer a practical way to integrate

7 Established models like the IDEA method employ a standardized system of indicators to generate a score that provides high comparability for funding and policy evaluation. Although effective for benchmarking, its reliance on translating diverse data into 'elementary units of sustainability' can sometimes overlook the nuanced, qualitative complexities of a specific local context (Briquel et al., 2001). In contrast, the participatory logic of our "Pillar Two" is aligns with the frameworks such as the aforementioned MESMIS, that has demonstrated significant success in using bottom-up indicators across 28 Latin American case studies (Speelman et al., 2007). In this, our framework seeks to unify the two traditions (standardized and participatory), to prioritize the identification of local factors that weaken or strengthen a system rather than, attempting also to ensure a higher epistemic justice and capture the multi-functional goals of peasant food systems. Beyond this, our framework advances this by explicitly embedding Cloninger's biopsychosocial model of personality as a unifying backbone, a theoretical integration that has been absent in predecessors.

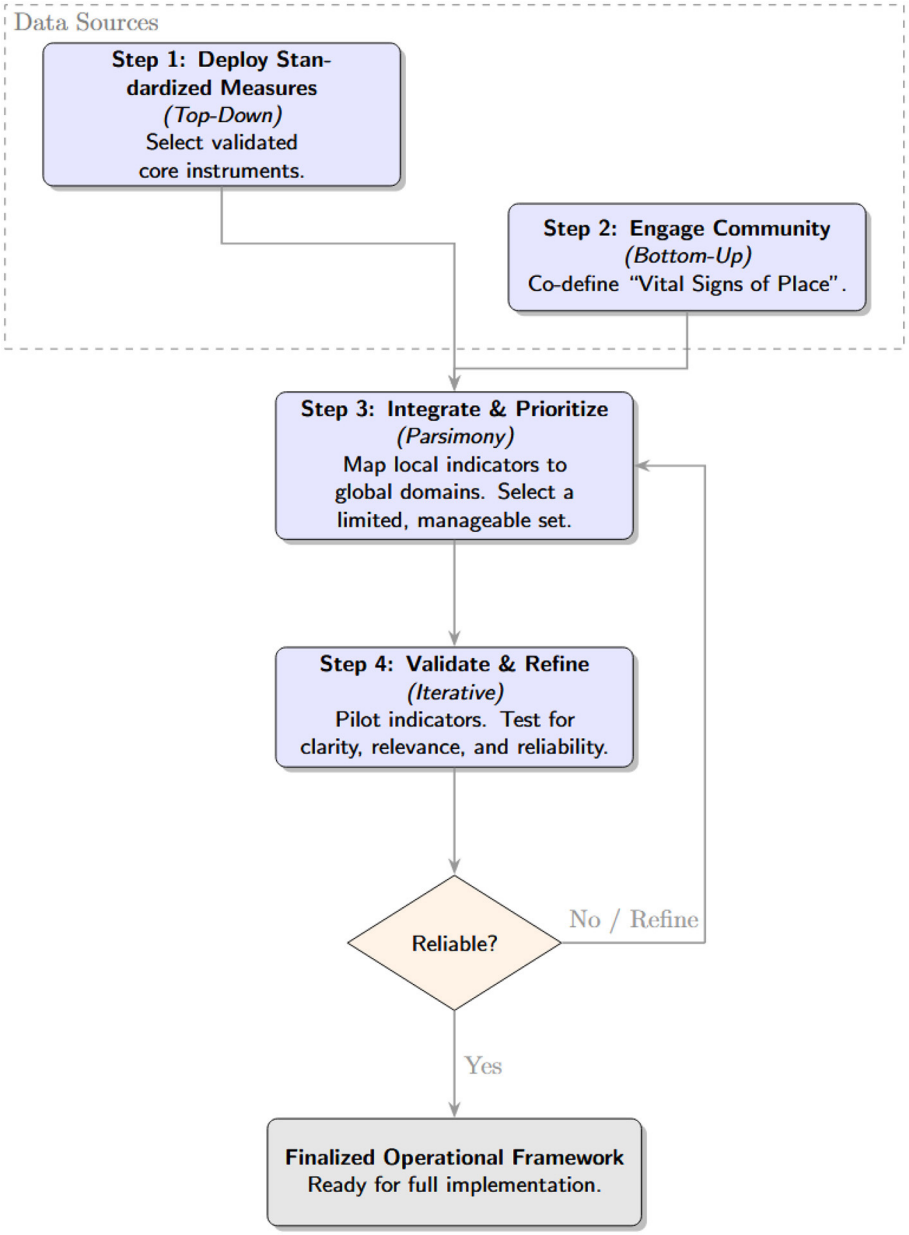

FIGURE 2
Methodology workflow for operationalizing well-being indicators.

approaches, complete with a decision procedure for indicator selection and emphasis on parsimony to keep it manageable.

Moreover, the framework explicitly bridges scales—connecting individual-level outcomes (e.g., personal well-being) to the context of community-level processes and ecological conditions. This multi-scale coherence is rarely seen in sustainability metrics, yet it is crucial for capturing the full picture of agroecological transitions. By capturing feedback loops (how improved well-being can spur better environmental stewardship and vice versa), we hypothesize the framework could yield insights into leverage points for accelerating sustainability transitions.

Although this goes beyond the scope of our presentation, our framework's design can also facilitate longitudinal tracking of change. By incorporating baseline, midline, and endline assessments (and potentially follow-ups), it could enable the study of trajectories in well-being and sustainability. This would be particularly important for establishing causal relationships and learning over time. For example, we can observe whether improvements in well-being precede improvements in ecological practices (or vice versa), shedding light on the directionality of the sustainability-well-being nexus. Few agroecology studies have this temporal component, as many are cross-sectional. Implementing our framework in pilot projects over time could generate valuable longitudinal case studies.

TABLE 3 Mapping of framework's indicators to SDG targets.

Framework level	Representative indicators	Primary SDG alignment	Examples of SDG target(s)
Individuals	WHO-5 Index; Satisfaction with Life Scale; Perceived Stress Scale (PSS); Climate Anxiety Scale	SDG 3: good health and well-being	Target 3.4: promote mental health and well-being. Target 3.d: strengthen capacity for early warning and risk management of health risks.
Individuals	Sustainable farming narratives	SDG 12: responsible consumption and production	Target 12.8: ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.
Community/institutional	Social capital index; participation rates in cooperatives	SDG 16: peace, justice, and strong institutions	Target 16.7: ensure responsive, inclusive, participatory and representative decision-making.
Community/institutional	Perceived fairness in food distribution	SDG 2: zero hunger	Target 2.1: ensure access by all people to safe, nutritious and sufficient food.
Economic/ecological	Farmers' traditional signs of healthy landscape; soil organic matter	SDG 15: life on land	Target 15.1: conserve and restore terrestrial and freshwater ecosystems.
Economic/ecological	Hope for next generation; youth engagement in farming	SDG 8: decent work and economic growth	Target 8.6: substantially reduce the proportion of youth not in employment, education or training.

Based on examples provided in Section 3.1.

4.2 Challenges and limitations

Notwithstanding its strengths, the framework faces several challenges. One major challenge is measurement diversity vs. standardization. While the inclusion of community-specific indicators is a strength, it complicates comparability. Different communities may choose indicators that are not directly comparable or quantifiable. We mitigate this by also collecting a core set of standardized data, but integrating the two data types for analysis requires careful methodological work[8]. As mentioned earlier, developing protocols to translate qualitative outputs into quantitative insights is an open area for innovation. We have suggested grouping local indicators under common well-being domains (health, agency, environment, etc.) to allow some higher-level comparison, but this remains a delicate process subject to interpretation.

The strategic selection of indicators must be tailored to the specific goals of the assessment. Good indicators must exhibit validity, objectivity, consistency, and sensitivity to change, while remaining accessible and representative of the community. For community-led systematization (where the objective is to analyze lessons learned and plan local agroecological transitions) the framework should prioritize indicators with high sensitivity and ease of determination. Participatory 'vital signs of place' fit this need, as they allow communities to capture qualitative shifts that standardized metrics might miss. These indicators are therefore particularly valuable for bottom-up planning, as they are defined by the actors themselves, ensuring high representativeness and local relevance. Conversely, for evaluating public policies or conducting cross-regional comparisons, the standardized part will better ensure objectivity and consistency. Instruments from our first pillar provide more rigorous, comparable, data necessary for national monitoring and reporting, all while being informed by the instruments from the second pillar. Similarly, indicators related to standardized economic and ecological proxies allow policymakers to benchmark progress across diverse contexts, while the participatory ones can indicate the potential for policy acceptance and uptake. By distinguishing between these application scales, we contend that the toolkit remains both scientifically robust and practically useful for a wide range of uses.

Another challenge is ensuring cultural validity and sensitivity of standardized instruments. Scales like SWLS or WHO-5 have been used globally, but their interpretation can vary by culture. Responses may be influenced by cultural norms about expressing satisfaction or mental health. Additionally, in many languages the exact phrasing of well-being concepts can change meaning. We must invest effort into translating and validating these instruments in each local context (perhaps conducting cognitive interviews or pilot testing in the community to ensure questions make sense). This challenge is well noted in healthcare science—measurement invariance is not always achieved across different populations (Cruchinho et al., 2024). Our approach to address this includes involving local partners in questionnaire design and potentially adjusting standardized tools (while maintaining as much consistency as possible). Certain standardized metrics might have to be dropped or replaced in a given context if they prove inapt, which could affect cross-site comparability. Thus, there is a tension between global standardization and local adaptation that will need to be continuously navigated, including the recognition of different paradigms, epistemologies and cosmovisions when implemented in Global South and non-Western contexts.

We also acknowledge challenges in data collection and resource requirements. Our approach means more extensive data gathering—surveys, interviews, group workshops, etc. This demands time, funding, and expertise (e.g., facilitators for participatory sessions, psychologists for survey analysis). In a world

8 The present article does not delve into methodological propositions for integration. Examples of this can be using mixed methods analysis, qualitative coding of narratives, or creating composite scores for participatory indicators, and need to be the focus of the empirical implementation of the framework.

of resource and time-limited projects, there might be pressure to simplify. We argue that the added value of understanding the place-based definition of well-being justifies the effort, but future users of the framework will need adequate capacity. Training community members as co-researchers (e.g., to conduct surveys or facilitate discussions) could help, reframing data collection as a participatory process that could support local empowerment. Still, ensuring quality and consistency of data from participatory methods is not straightforward, and we must be vigilant about documentation and researcher biases.

A further challenge lies in interdisciplinary and transdisciplinary collaboration. By its nature, our framework operates at the intersection of social sciences, health sciences and agroecology. Successful implementation requires collaboration between agronomists, ecologists, psychologists, sociologists, and the community. Such collaborations can be hindered by differences in terminology, methods, and even values (Anderson and McLachlan, 2016; Lopez-Merino and Lamine, 2024). We have to create a common language (e.g., what "well-being" entails) and mutual respect among team members. On the upside, this challenge is also an opportunity: transdisciplinary teamwork can foster creative solutions and methodological advances. For instance, combining remote sensing for land health with community well-being mapping could produce new integrated indicators. We see our framework as a living project that will evolve through these collaborations, potentially yielding methodological innovations in mixed-methods integration and participatory science.

Despite these challenges, we maintain that centering well-being is essential. The potential risks of not doing so are evident: agroecological projects might fail if farmers are too stressed, alienated, or unsupported to implement changes. By contrast, addressing well-being can create a positive feedback loop—happier, healthier communities are more resilient and innovative, which enhances sustainability, which in turn further improves well-being. Our framework is an attempt to measure and ultimately leverage that positive feedback.

4.3 Implications for policy and governance

Embedding well-being into agroecological indicators has significant implications for policy and governance at multiple levels. First, it broadens the objectives of agricultural and rural development policy: success is not only higher yields or improved soil metrics, but also healthier, more resilient communities. Policymakers may need to redefine targets and KPIs (key performance indicators) for agroecology initiatives to include well-being outcomes (e.g., farmer retention rates, mental health improvements, community empowerment indices). This shift could catalyze more holistic programs that combine agronomic support with health and social services. For instance, an agroecology extension program might partner with rural health agencies to simultaneously address sustainable farming techniques and farmer stress management—a cross-sectoral approach we would support.

Our framework also emphasizes participation and local knowledge, implying changes in governance structures. Governments and development agencies would benefit from creating formal channels for community input when designing sustainability metrics and interventions. This aligns with the growing trend of co-production of knowledge in policy; indeed, a study in Australia (Zyngier et al., 2024) showed that convening diverse stakeholders to identify indicators and solutions led to a rich matrix of options and revealed areas of consensus and conflict, improving policy relevance. Similarly, by involving Community Advisory Boards in defining "vital signs," local governance capacity is strengthened. Communities essentially become partners in monitoring and evaluation, not just subjects of it. This can increase trust in government programs and ensure interventions are culturally appropriate. It also helps decentralize sustainability governance, empowering local entities (cooperatives, municipalities, farmer unions) to take ownership of well-being goals that feed into national targets.

Multi-level governance is also crucial. The two-way, interactive causality of our framework invites coordination between national/international bodies (which set standardized metrics and SDG commitments) and local actors (who innovate and contextualize metrics). Policymakers might establish frameworks where a core set of well-being indicators is mandated for all agroecology projects (for comparability), while also mandating a participatory indicator-development process for each project to capture local priorities. Resources and guidelines would need to be provided for these participatory processes, e.g., ministries of agriculture could issue toolkits (like our "vital signs" guide) and fund training for facilitators. Over time, as data is collected, there could be feedback loops: local innovations in indicators that prove useful could be scaled up or inform the evolution of national indicators, just as appropriate national level interventions may encourage local innovations. In this way, governance becomes more adaptive and iterative (Folke et al., 2005), reflecting field realities.

There are also implications for funding and program evaluation. Donors and agencies often require measurable outcomes; by providing well-being metrics, we give them additional criteria to evaluate success. This could unlock funding for integrated programs (for example, rural development grants might start to require a well-being assessment component). Moreover, policy frameworks like the EU's Common Agricultural Policy or national agricultural strategies might incorporate farmer well-being explicitly as a goal, once tools to measure it are available. It is conceivable that in the future, something like a "Well-being Impact Assessment" could be conducted alongside environmental impact assessments for agricultural projects, to evaluate potential social effects on communities before implementation.

From a governance perspective, one challenge will be to ensure equity and representation in the participatory aspects. It is important that the voices of marginalized groups (e.g., smallholders, women, indigenous communities, farm and food workers, youth, LGBTQ+) are included when defining well-being indicators. Policy can mandate inclusive approaches—for instance, requiring that participatory sessions include a certain percentage of women farmers or youth. This ensures the resulting metrics and

subsequent decisions do not inadvertently reflect only the most powerful stakeholders' views. Such inclusive processes contribute to social justice, echoing the emphasis on epistemic or cognitive justice in our framework (Fricker, 2007; Anderson and McLachlan, 2016).

Finally, the integration of well-being calls on intersectoral governance. Agricultural authorities must collaborate with public health, education, and environment sectors. For example, improving farmer mental health might involve rural healthcare provision (telemedicine, counseling services), which is outside the typical remit of agriculture departments but essential for sustainable farming communities. Our framework's data can be a catalyst for these conversations, eventually providing evidence that interventions in one domain (like mental health services) have payoffs in another (like use of conservation practices). It encourages breaking down silos in governance, fostering a more coordinated approach to rural well-being and sustainability. In summary, using this framework could lead to more human-centered agricultural policies, participatory governance models that empower communities, and cross-sector collaborations that together create a more enabling environment for agroecological transitions.

4.4 Future prospects

This article is an effort by an interdisciplinary collective of scholars to bring together disparate elements that collectively can advance the inclusion of well-being in the analysis of (agroecological) transitions. At the time of writing, a number of research projects are taking shape that will allow our team to start testing and implementing the framework in different settings. If validated through pilot applications, the framework could inform future agroecological transition efforts. The production of an open-access "well-being in agroecology" toolkit is an important expected outcome of this work, to provide standardized surveys, workshop guides, and analysis templates that any project can adapt and adopt. Such a toolkit would help mainstream the inclusion of well-being in sustainability assessments. Over time, accumulating data from different contexts could allow for meta-analyses: e.g., to test whether certain well-being factors (like community cooperativeness) consistently predict agroecological success, or to compare well-being outcomes of different types of interventions (e.g., organic farming vs. food sovereignty initiatives). Furthermore, the framework enables "before-and-after" assessments of specific interventions, allowing researchers to compare the efficacy of different approaches—such as organic certification vs. food sovereignty movements—in diverse agricultural contexts.

Through iterative refinement, our objective is to address the challenges outlined: fine-tuning indicator sets, improving protocols for data integration, and ensuring the process is scalable. We will also explore the use of decision-support tools to visualize results for stakeholders (e.g., dashboards that show changes in well-being alongside ecological metrics). By doing so, we aim to make the data actionable. For example, local cooperatives could use the results to lobby for policy support, or a project team might shift strategy upon seeing a certain well-being metric decline.

Ultimately, this discussion highlights that while embedding well-being in agroecology assessments is complex, doing so offers a transformative lens. Well-being's inclusion prompts all involved to consider farmers and communities not just as beneficiaries of sustainability, but as co-creators and central actors whose quality of life is inseparable from the health of the land.

5 Conclusion

This article has argued for and outlined a new approach to measuring sustainability in food systems—one that explicitly embeds human well-being into agroecological metrics. By doing so, we provide both a conceptual innovation and a practical tool for guiding agroecological transitions. Conceptually, we break from the tradition of treating sustainability as mainly an environmental or economic issue, instead framing it as a biopsychosocial-ecological endeavor. We anchored this perspective in Cloninger's psychobiosocial model of personality, linking the inner development of individuals (in self-directedness, cooperativeness, transcendence) interactively with the outer development of sustainable practices and resilient communities. This anchoring is novel in sustainability science, offering a theory-driven way to understand why some communities thrive in transition while others struggle. Practically, we propose a multi-scale framework with a dual logic: it combines standardized, comparable indicators with participatory, context-specific "vital signs of place," enabling assessments to be both globally coherent and locally meaningful. The emphasis on parsimony and iterative co-design ensures the framework is implementable.

By centering well-being in sustainability metrics, we unlock new insights and intervention pathways for agroecological transitions. We contend that sustainability both depends on and nourishes well-being: farmers who embody well-being are better stewards of the land, and healthier agroecosystems create conditions for individuals and communities to flourish. This virtuous cycle needs to be intentionally cultivated and monitored. The framework presented here offers a way to do that, and once implemented seeks to produce actionable information for practitioners and policymakers. As agroecology gains prominence worldwide as a pathway to achieve the SDGs, incorporating well-being will ensure that its transitions are not only ecologically sound and economically viable, but also humanly and socially enriching. In the long run, a food system transformation that measures what matters to people is more likely to sustain the collective commitment needed to overcome the systemic challenges of socio-ecological reorganization that lay ahead. Embedding well-being is therefore a pragmatic step—a conceptual innovation that becomes a practical necessity for truly sustainable food futures.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

PL-M: Validation, Conceptualization, Writing – original draft, Writing – review & editing. VS: Writing – review & editing, Visualization, Writing – original draft, Validation, Conceptualization. MB: Visualization, Conceptualization, Validation, Writing – review & editing. KC: Validation, Conceptualization, Writing – review & editing. CC: Writing – review & editing, Validation, Conceptualization. DG: Conceptualization, Writing – review & editing, Validation. CG: Conceptualization, Writing – review & editing, Validation.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors KC, MB, CC and DG declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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