Inclusive sustainable landscape management in West and Central Africa: Enabling co-designing contexts for systemic sensibility

Nafiisa Sobratee-Fajurally[1] and Tafadzwanashe Mabhaudhi[2]

[1]University of KwaZulu-Natal, Durban, South Africa.

[2]International Water Management Institute, South Africa

Abstract

The report creates contexts for a systemic understanding of the CGIAR Transforming agric-food system (TAFS-WCA) initiative starting with work package (WP) 3 and expanding the causality effects across the other WPs of the Initiative. The main focus of WP3 is inclusive landscape management, whereby access to and proper use of land and water resources is a prerequisite to building a healthy, productive environment for resilient agri-food systems and livelihoods. Mapping synergies with other Work Packages ensure that respective contributions are integrated and impactful. The process intends to provide policymakers, researchers, and practitioners with a strategic framework to activate solutions temporarily with a stakeholder-defined suite of scenarios.

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[1] Corresponding Author: Email: sobrateenafiisa@gmail.com

CONTENTS

List of Acronyms

AWM	Agricultural Water Management
BSF	Black Soldier Fly
IA	Impact Assessment
IWMI	International Water Management Institute
M&E	Monitoring & Evaluation
MELIA	Monitoring, Evaluation, Learning and Impact Assessment
OP	Output
PPP	Public Private Partnership
RII	Regional Integrated Initiative
SDG	Sustainable Development Goals
SR	Scaling Readiness
ToC	Theory of Change
WCA	West and Central Africa
WP	Work Package
WRDSS	Water and Land Resources Decision Support System

BACKGROUND

The aim of this report is to create contexts for “systemic sensibility” to flourish, starting with the components of the CGIAR Transforming agric-food system (TAFS-WCA) initiative Work Package (WP) 3, and expanding the causality effects across the other WPs of the same initiative. The main aim is based on the premise of inclusive landscape management whereby equal access to, and proper use of land and water resources is a prerequisite to building a healthy, productive and One-Health sensitive environment for resilient agri-food systems and livelihoods. WP3 will therefore combine participatory tools and citizen science to co-develop, and implement inclusive landscapes, owned by the communities, that enable sustainable scaling of bundled land, water, aquaculture, and climate-smart agronomic and digital innovations. The activities are being implemented in six countries: Ghana, Cote D'Ivoire, Nigeria, Rwanda, Burundi and Democratic Republic of Congo.

WP3 proposes to (i) co-establish the status and progress of landscape management for sustainable intensification; (ii) design adaptive socio-ecological landscape management plans that are One Health sensitive and embedded in local and national governance systems; (iii) develop a near real-time water resources decision support system (WRDSS) to strengthen landscape resilience planning and investment; (iv) deploy context-specific integrated land, water, fish, crop and agronomic innovations at scale and (v) deploy market-driven circular bio-economy innovations to reduce pressure on water and land resources while mainstreaming One-Health approaches in planned innovations. Bringing these objectives to fruition requires dynamic evaluative criteria that consider the impact of each of the main WP component under consideration and its relationships with its relevant adjacent action situations (AAS). In this report, we essentially seek to understand systemic interactions with repest to WP3 and, to a lesser level the nature of the interactions across the different WPs and their AAS. AAS under the present context could refer to other WPs components or learning and outcomes of previous Impact Assessment (IA) works carried out by the Initiative's partners. Additionally, the Regional Integrated Initiative (RII) bears a crucial element in the form of evaluative criteria for scaling readiness. The present work occurs at the co-design phase of the research-driven TD transformative initiative and examine at a three-fold level: (i) the linkages among project objectives, expected outcomes, Theory of Change statements as outlined in the full proposal document (ii) review scholarly work to characterise elements to be considered when considering a Water-Energy-Food-Ecosystems nexus framing for WP3 (iii) the type of system archetype that would best describe the co-design process achieved.

The main output is to build a system understanding of the Initiative, particularly in developing a systems approach to the implementation of Work Package 3, for which IWMI is leading. Mapping synergies with other Work Packages to ensure that IWMI's contribution is integrated and impactful. To this end, research is problematized within interdisciplinary and transdisciplinary frameworks whereby the overarching aim is to create a desirable impact on society and nature.

1.0 INTRODUCTION

Nutritious, climate-adapted and market-driven food systems implies that small-holder agro-ecosystem is a representation of agriculture in its entirety. It encompasses the ecological perspective, including the governance and provision of ecosystem services (ES) [1–3]. Such an approach requires the integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic, and social. It is transdisciplinary in that it values all forms of knowledge and experience in food system change. It is participatory in that it requires the involvement of all stakeholders from the farm to the food plate and everyone in between. And it is action-oriented because the food system encounter and undergo sociotechnical and socio-ecological transitions with alternative socio-economic, institutional structures, governance and policy actions. The approach is grounded in ecological thinking where a holistic, systems-level understanding of food system sustainability is required[4].

The complexity of food systems gives rise to interdependencies (such as feedback loops, synergies and trade-offs) between components within and between food systems and other societal sectors (such as health or dependence on energy resources). The competitiveness between land use for agricultural needs, social and economic needs, and the environmental impact resulting from that land use, is an example of an increasingly complex trade-off effect[5]. To transform complex systems such as food systems, it is necessary to better understand the technological, political, economic and social dynamics that shape the food system and to identify the leverage points where intervention will be most effective [3,6–8]. The identification of these points necessitates a systemic approach in which multiple actors, governance levels and policy fields are taken into account.

Garcia-Martin et al.[9] showed that a landscape products lens can improve food systems by fostering sustainability strategies and standards that are place-sensitive, and as such can mitigate conflicts related to food production, social justice and the environment. This approach means the inclusion of both horizontal dimensions, that is, different fields of action, such as environment, health, infrastructure, and literacy, and vertical dimensions namely, all the different stages of the food value chain[10–12] Within a systems approach it is possible to better anticipate unexpected and undesired side-effects of technological interventions in other parts of the food system and to design portfolios of experiments that will reinforce each other e.g. at different levels and with regard to different thematic fields.

OBJECTIVES

The specific outputs of this report are:

1. To develop a conceptual diagram and systems map for WP 3 based on what is contained in the project document. Context-specificity, systemic linkages within elements of WP3 and with other relevant WPs and the role of adaptive scaling are highlighted

2. To conduct a scoping review and/or meta-analysis to map/identify gaps, opportunities and synergies across the governance of water, energy, food and eco-systems for the RII. The outputs of scholarly work were reviewed and systems maps were synthesised. Tailored recommendations for West and Central Africa are proposed for further discussion with stakeholders, following which the Theory of Change can be further elaborated and impact pathways strengthened with elements of systems leadership.

3. To integrate the WEFE nexus framing and the landscape approach for the RII-WCA. A framework based on the WEFE nexus is developed, to guide integration and implementation within the landscape for the RII-WCA. This will build on Deliverables 1 and 2, including reviewing other project plans to develop sustainable development and implementation pathways focusing on the interlinkages between water, energy, food, biodiversity and health at the landscape level.

In the next phase of this conceptual development, objectives 4 and 5 will be investigated.

4. To validate the framework developed in Deliverable 3 against its propensity for institutionalising interdisciplinarity and transdisciplinarity within RII-WCA (TAFS-WCA) project teams and stakeholders across the target countries

5. Based on the validated framework, develop a scientific paper that demonstrates how the framework (Landscape praxis in WCA: Cultures and communities, time frames, outcome spaces) has been applied in the Initiative

2.0 METHODS

2.1 USE OF METHODOLOGICAL PLURALISM

The problems faced in managing natural resources range from understanding fundamental biophysical processes to negotiating conflicts associated with delicate socio-economic priorities and controversial political decisions. Such real-world issues require an integration of the social and biophysical sciences, navigating both reductionist and holistic knowledge forms, ability to deal with risk and uncertainty and a capacity for wise political decision-making[13–15]. Interdisciplinarity and transdisciplinary practice is dynamic and in transition and, have undergone conceptual development to empower the convergence of science and its implementation [16–18].

This work reports the conceptual development undertaken to establish a systemic undertaking to identify, shape and define the relationships among the different Work Packages (WP). In this report, the project proposal document refers to the document titled: Transforming AgriFood Systems in West and Central Africa (TAFS-WCA). Special emphasis is taken into account to incorporate the component of upscaling as a systemic element to widen the Initiative's impact as laid out through the CGIAR's Scaling Readiness approach. The UN Sustainable Development Goals establish the global references that link local to global interactions and milestones that need to be achieved by 2030 for human well-being and biodiversity conservation. When considering SDG entity interactions, the need for scientific support is often highlighted to facilitate the creation of effective and coherent policy strategies. For this reason, but also for reasons of scientific interest in complex systems, the topic has attracted strong scientific interest [19–26] A variety of methods have been developed to systematically identify interactions.

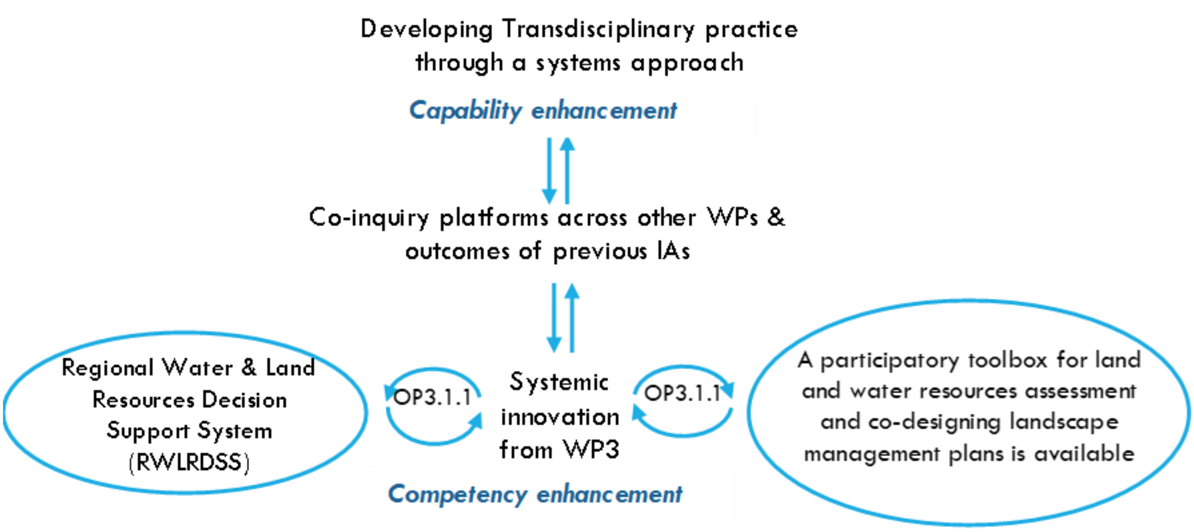

Figure 1: Starting point to develop a critical realist and systemic approach to identify the main components, drivers, dynamics and relationships that impact the entire value chain of the eco-agri-food system for the RII (OP: Output, WP: Work Package, IA: Impact Assessment)

It is established that implementation science requires a research-driven transdisciplinary framework. The RII therefore requires capability enhancement to in order to shape co-inquiry platforms across WPs and with previous Impact Assessments (IAs). To delve further within the WP3 components and its relationships with Output 3.1.2, the Regional Water and Land Resources Decision Support System (RWLRDSS) and Output 3.1.3 which is the participatory toolbox, systems archetypes were used to shape the underlying structure that the RII must espouse in order to deliver systemic desirable impacts. Competency enhancement within and across outputs are thus crucial.

2.2 SCOPING REVIEW

One of the essential components of The WP 3 is to embed the Water-Energy-Food nexus into the landscape resilience planning for enhanced production of nutrient-rich crops and fish. The objective is to develop a participatory toolbox for land and water resources assessment and co-designing landscape management plans. A scoping review was undertaken to improve the understanding of Water-Energy-Food nexus governance. Levels of integration captured in WEF nexus studies from a scoping review in ISI Web of Science Core Collection. The following search terms were used: water energy food nexus AND landscape* (Topic). The outputs were retrieved on 13 September 2022 (n=53). The title, abstract and full article were scrutinised to identify how the WEF nexus, and any other components were articulated. Following screening for relevance, 43 items were retained which consisted of original research articles, review articles and book chapters. As a means to introduce an audit trail, the references used in the scoping review results bear the numbered references of the papers used to establish the causal relationships.

2.3 SYSTEMS THINKING AND CAUSAL LOOP DIAGRAMMING

A qualitative systems dynamics approach was used to map out the linkages among three core ideas that are taken into account to problematise the research (i) priority setting (ii) capacity development and (iii) limitations to capabilities that could make the overarching aims become floating goals and hence, susceptible to systemic delays or worse, unachievable. System archetypes are the generic structures that are responsible for different types of well-described behavior trends produced in nature, business, and political systems [27,28]. It is important to identify and recognize these archetypes because their structures are used as references to guide strategy-making in research and in determining missing, ill-defined, or inconspicuous but pertinent links. In the real-world, a system's structure, comprising of its network of factors, interactions, feedbacks, and delays, dictates its behaviour, which is described by the system's performance over time [29]. For example, the Reinforcing Loop, sometimes called Reinforcing Growth, is one of the most fundamental archetypes. When system performance changes, the growing action is stimulated (positive sign), which further changes the system performance in the same direction (positive sign, +). Such a structure of relationships results in exponential growth or decay of the system performance which can be either virtuous or vicious[30]. A balancing loop is the cycle in which the effect of a variation in any variable flows through the loop and returns to the variable with a deviation opposite to the initial one[31], i.e. if a variable increases in a balancing loop the effect through the cycle will return a decrease to the same variable and vice versa. Balancing loops are typically goal-seeking, or error-sensitive, processes and are presented with the variable indicating the goal of the loop[30]. In the real world, a system consists of many loops and many interactions among those loops. It is that total system view that helps to achieve depth of understanding and real insight into the behaviours of complex systems. The intersection nodes – those that participate in two or more loops – are the core of system complexity, and they provide the greatest opportunity to discover side-effects, hidden influences, and unintended consequences[32].

3.0 RESULTS

3.1 CONCEPTUAL DEVELOPMENT ON PARTICIPATORY WATER AND LAND RESOURCES DECISION SUPPORT SYSTEM (WRDSS) STRENGTHEN LANDSCAPE RESILIENCE PLANNING

Figure 1 shows a conceptual representation of WP 3 based on what is covered in the project plan document. Synergies within elements of WP3 and, with other relevant WPs that need to be co-developed are listed. The project Core Unit refers to the clusters of case studies chosen for the project. The national/regional landscape represent higher hierarchical scales of operationalization. Working at the landscape scale is complex. It requires negotiated consultations and measurement of progress in interventions through adequate transdisciplinary and trans-sectoral research and design that start at the local landscape level. This implies working with stakeholders to generate the outputs of WP3. Starting with OP3.1.1, water quantity, quality, and risks data available from participatory approaches and citizen science will be collected and contribute to build OP 3.1.2 which is the Regional Water & Land Resources Decision Support System. The system will be made operational and accessible to stakeholders. The institutional and policy frameworks for this to take place need to be fully understood and suitably applied to ensure that such integration is possible given the many competing claims to natural resources. Thus, OP3.1.3. which is a participatory toolbox for land and water resources assessment and co-designing landscape management plans will be made available to all stakeholders. This information is used as basis to develop the methodological approach (Figure 1).

The setting up of a Water Resources Decision Support System (WRDSS) ought to operationalise feedback from different levels to ensure adaptive scaling for successful intervention scenarios. Scaling and contextual implementation are important to ensure that the specific requirements of stakeholder types are considered. The component of adaptive scaling are Innovation Packages and Scaling Readiness plans that will be designed and monitored through the Monitoring, Evaluation, Learning and Impact Assessment (MELIA) component of the project.

Landscape approaches are concerned with how conservation efforts impact and are impacted by other land uses and land users within multifunctional systems such as agricultural and food productivity, water use and governance mechanisms. The approach plan for the long-term, place people at the centre by ensuring contextual implementation, and therefore must be sensitive to issues of rights and access to resources, as well as making connections across sectors and scales such as Public Private Partnerships (PPPs) that have traditionally not interacted or even been more typically opposed to each other. In the RII such outputs are expected from Research Question 3.2 and Research Question 3.3 to be shaped through bundled innovations and building capacities on multisectoral(MS), system thinking (ST) and Onehealth approaches for addressing environmental, human and animal health challenges. The synergies and indicators to be used for the landscape level interventions are shown in Figure 2.

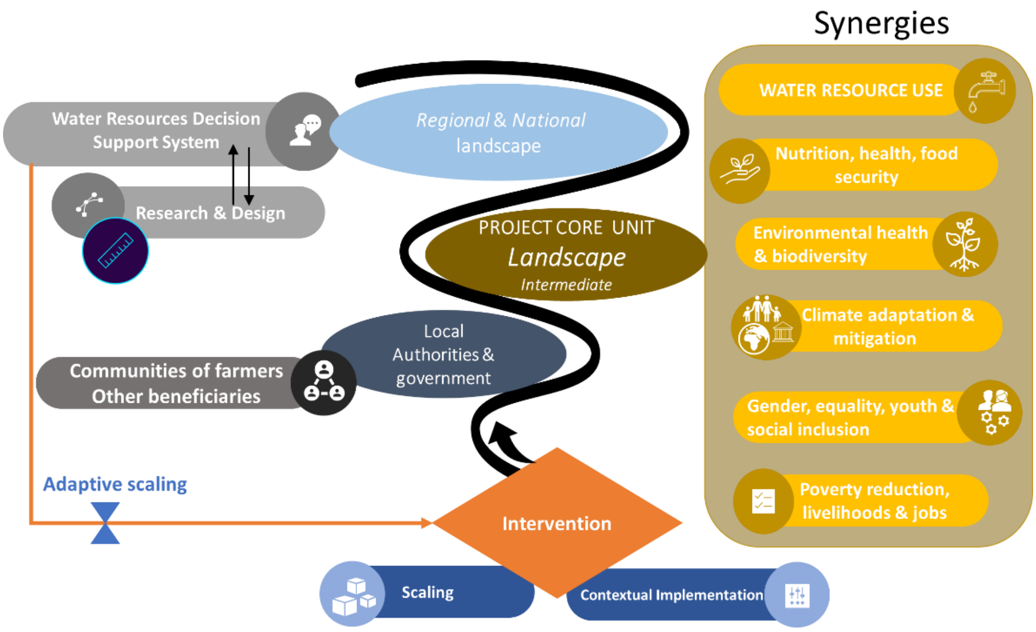

Figure 2. Landscape Management Plan for Agriculture and Food system transformation. These are longer-term process-oriented activities that are devised and negotiated in a collaborative and reflexive manner. The Water Resources Decision Support System will be co-developed and implemented by using the following research-driven criteria: water quantity/quality, water risk/scarcity, water security & water policies. The institutions involved will range from region to local scale to guide investment decisions to enhance resilience at different levels. Indicators used will be OP3.1.1: number of databases available , OP3.1.2:number of support systems available, OP3.1.3: number of land management plans, OP3.2.1: number of Integrated crop-livestock-GIFT production and practices at landscape, OP3.2.2: number of bundled GAPs, op .3.3.1: Number of knowledge products and number of PPPs, 3.3.2: number of circular bioeconomy innovations on agro-livestock productions, OP3.3.3 Number of training courses delivered and people trained to build capacity for robust integrated monitoring and management of One Health challenges

3.2 CHARACTERISATION OF RESOURCE NEXUS RESEARCH

3.2.1 UNDERSTANDING THE LEVELS OF INTEGRATION INVOLVED IN THE GOVERNANCE OF NATURAL RESOURCES FROM A NEXUS PERSPECTIVE

Finding a balance between ecosystem conservation and the production of goods and services that societies need to prosper is fundamental to the long-term sustainable development of any region, but this balance varies within the region's landscapes and the natural resource management approach used. The information captured from the scoping review indicate that it is crucial to understand how research on nexus approach are integrated for broader scopes of interventions. Figure 3 shows an Ishikiwa fishbone diagram with the most pertinent levels of integration that could be applied to inform the systematic conceptualization of resource nexus interconnections applicable for the TAFS-WCA Landscape. Categories of importance to conceptualise realist implementation include scale of intervention, the sectors and/or resources involved and the wider sphere of influence (domain). In terms of research-driven TD action, the academic focus and the tools and indicators used to assess sustainable resilience emerged as important knowledge base to be developed.

3.2.2 UNDERSTANDING THE DIVERSE NATURE OF NATURAL RESOURCE NEXUS

The scoping review indicate that the components of nexus research expand beyond the traditional water, energy and food sectors and span across a wide range of natural resource management types such as natural infrastructure, conservation and human wildlife conflict, sustainable future of village amongst others. These configurations of nexus situations arise because of micro-, meso- and macroscale processes that need to consider sustainability and transboundary considerations to improve resilience of people and nature. In the real-world, constraints arise in the cross-sectoral management of natural resources and when attempting to manage trade-offs. The unintended limitations can be observed as (i) the co-occurrence of economic resource nexus, (ii) the competing nature of governance approaches, (iii) the complex socio-technical /socio-ecological interconnections among different resource systems generated by specific activities or technologies or (iv) negotiations in transdisciplinary and co-production practices in sustainability and resilience research.

In essence, the notion of nexus thinking entails the deep structure of the natural resources and sectors, hence interlinkages, synergies and trade-offs have to be embraced Based on the scoping review outcome, three reinforcing loops have been identified to strengthen the framing of WEF nexus situations to inclusive landscapes (Figure 4). The positively reinforcing loop, R1 indicates that understanding the levels of integration is essential for a critical realist framing the research-driven TD practice. R2 highlights the importance of knowing how to set boundaries. In R3, the importance of methodological focus is highlighted. An inquiry about the level of integration under scrutiny improves the context-specific understanding of enabling conditions that need to be harnessed to co-design the TD space. Due to the complexity of inclusive landscape management initiatives, garnering sufficient stakeholder accommodation is essential in order to optimise the conceptual development of nexus interconnections and their relationships with other landscape sectors. Food systems are sustainable when they can meet human needs while maintaining the basic ecosystem services of agroecosystems and cultural landscapes in both a reproducible way and a healthy ecological state, at local, regional and global scales. This is essentially an axiological (value- based) definition and ought to involve a large research agenda to explore the operative criteria and indicators needed to know how to achieve this goal. This is why the rational boundary-setting is important to optimise the methodological focus and sharpen the emphasis that has to be laid on framing the initiative in the RII WCA context.

Since unintended consequences do occur intrinsically in complex cross-sectoral management of natural resources, a number of approaches can be used to leverage systemic bottlenecks such as (i) defining the co-occurrence of re-source use in economic sectors and supply chains, also referred to as the *resource nexus within the landscape approach* (ii) the governance approaches that promote goal-seeking coordination and harmonisation (iii) recognising the systemic interconnection among different resource systems generated by specific activities or technologies and (iv) negotiations in transdisciplinary and co-production practices in sustainability and resilience research.

The categorisation and formalisation of interconnections for inclusive landscape management are important to institutionalise the desired governance landscape (Figure 5). In terms of systemic leadership, the element of trust through effective stakeholder engagement and lobbying for partnerships become critical to leverage how optimal policy mixes or governance arrangements are constituted in WEF sectors. This implies that decision-making processes should be adaptive to enable (i) the rethinking boundaries of nexus analysis with respect to sectors and levels, for example with the option of being incorporated with larger sustainable transition system such as the inclusive landscape management approach to resilience as in the proposed RII for WCA (ii) the elaboration of shared principles that can guide decision making towards policy coherence or even appropriate forms of fragmentation in different contexts (iii) the consideration that policy coherence is a continuous process of changing values and perceptions rather than a fixed outcome.

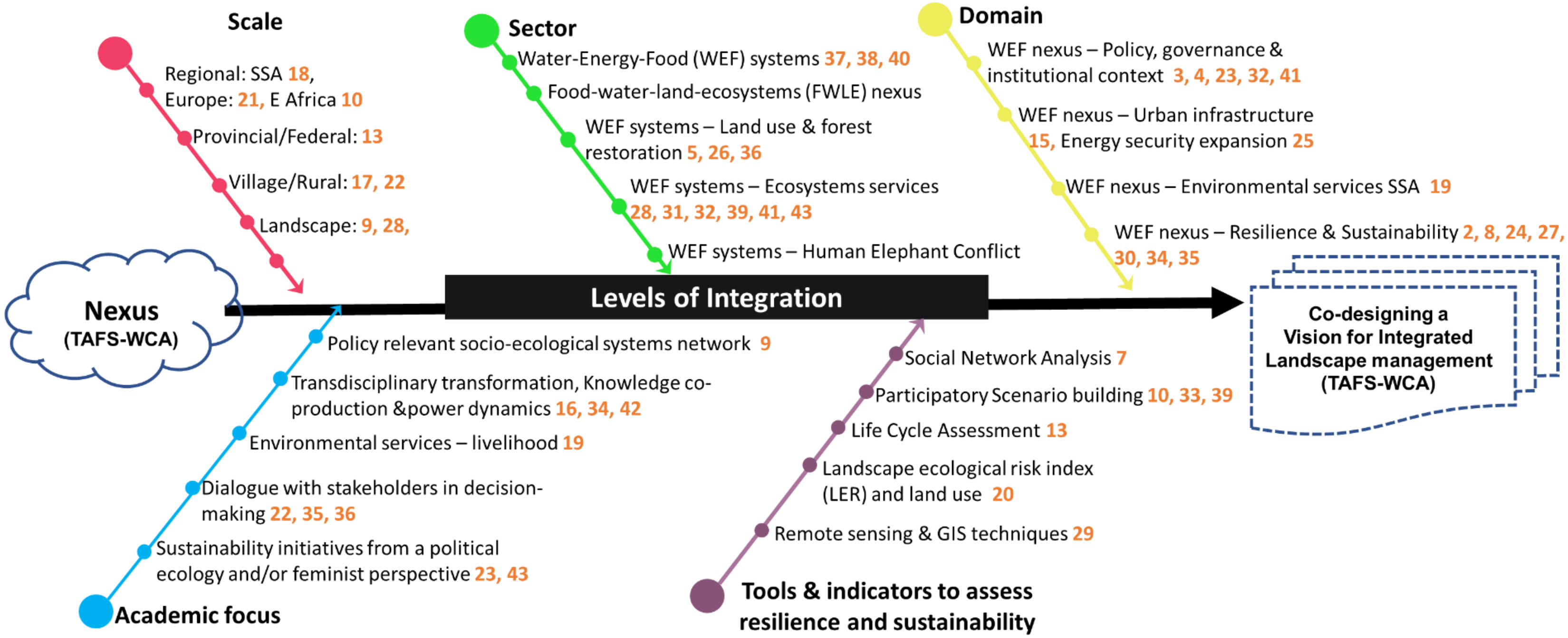

Figure 3: What would it require to shift from nexus vision to a landscape approach: shaping complexity through identification of levels of integration? (Numbers represent papers used in scoping review, See Appendix 2 for numbered references)

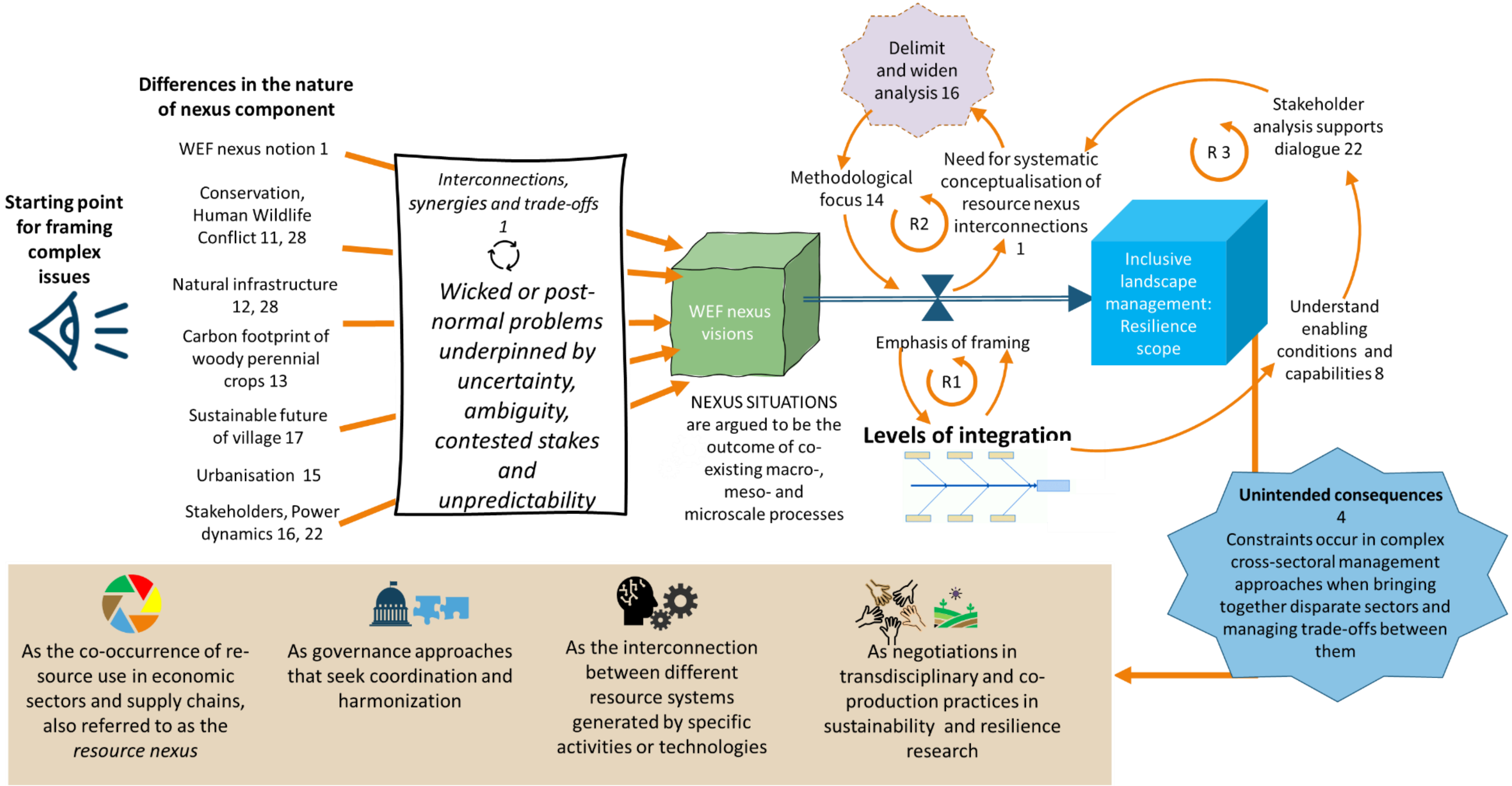

Figure 4: Systegram depicting the current literature on Water, Energy and Food nexus and showcasing its complex nature as (i) the co-occurrence of resource use, (ii) a governance approach that seek harmonised coordination, (iii) the interconnection between resource systems generated by exogenous or boundary socio-technical activity or technologies and, (iv) a transdisciplinary and co-production practice for sustainable and resilient research implementation. Emphasis is laid on the nexus components linked to the WEF nexus derived in the papers shortlisted in the scoping review (Numbers represent papers used in scoping review, See Appendix 2 for numbered references).

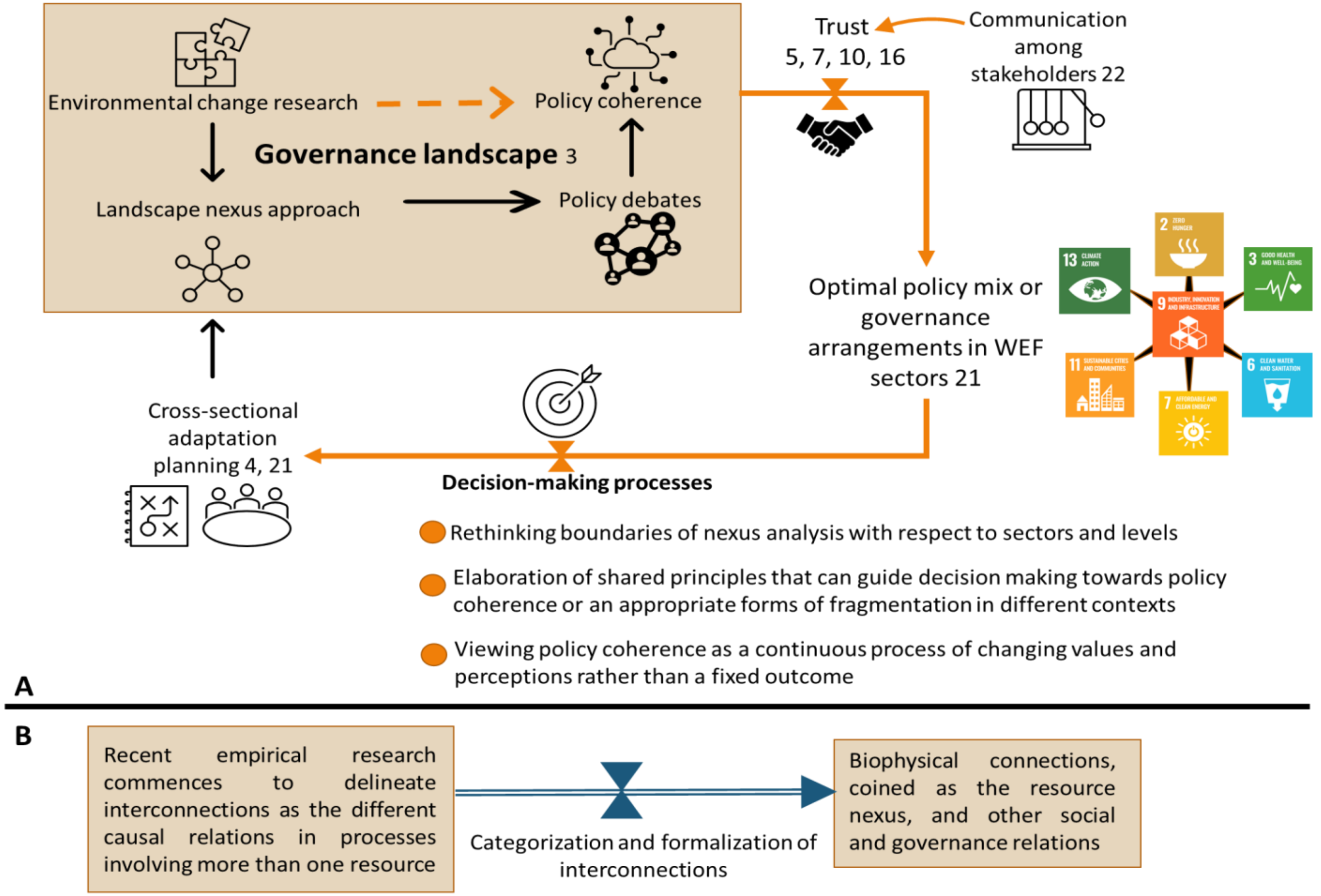

Figure 5: What type of dynamics ought WEF nexus decision-making processes focus on to shape a cohesive governance landscape (Numbers represent papers used in scoping review, See Appendix 2 for references)

3.3 SHAPING THE DEEP SYSTEMIC STRUCTURES IN THE RII FOR WCA

The systems maps generated integrate the causal loops that explain the causality that the RII is seeking from research to impact across the different WPs.

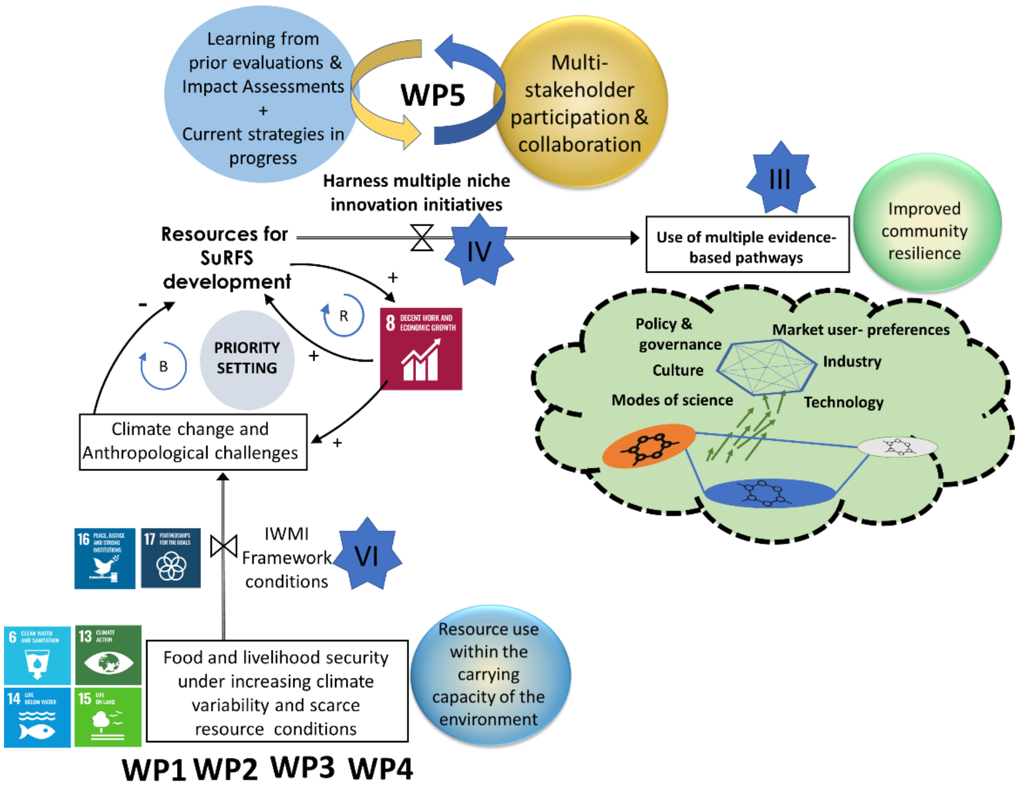

Figure 6. Setting priorities in co-designing food and livelihood security through the IWMI framework for the RII. Improved community resilience requires transitions at multiple scales through multiple perspectives, all gearing towards inclusive landscape management of socio-ecological and socio-technical systems. Links to measurable three-year expected outcomes are shown in roman numerals and can be referred to in Appendix 1. UN SDGS are shown as targeted goals that ought to be achieved.

In the balancing loop, B, decent work and economic growth (SDG 8) generate climate change and anthropological challenges that jeopardise the ecological integrity of resources to sustain resilient food systems. The ideal situation would be to achieve lasting and environmental-friendly socio-economic development. Hence, the strategic initiative is to modulate research within reinforcing loop (R) capable of unleashing stable socio-technical and socio-ecological transitions through the application of multiple evidence-based pathways. which is achieved by harnessing diverse niche initiatives. Learning lessons from prior Impact Assessments (system history) and Multi-stakeholder participation and collaboration (to enhance the research-driven TD process) are essential to effectively harness the proposed innovations as per the MELIA Plan in WP5.

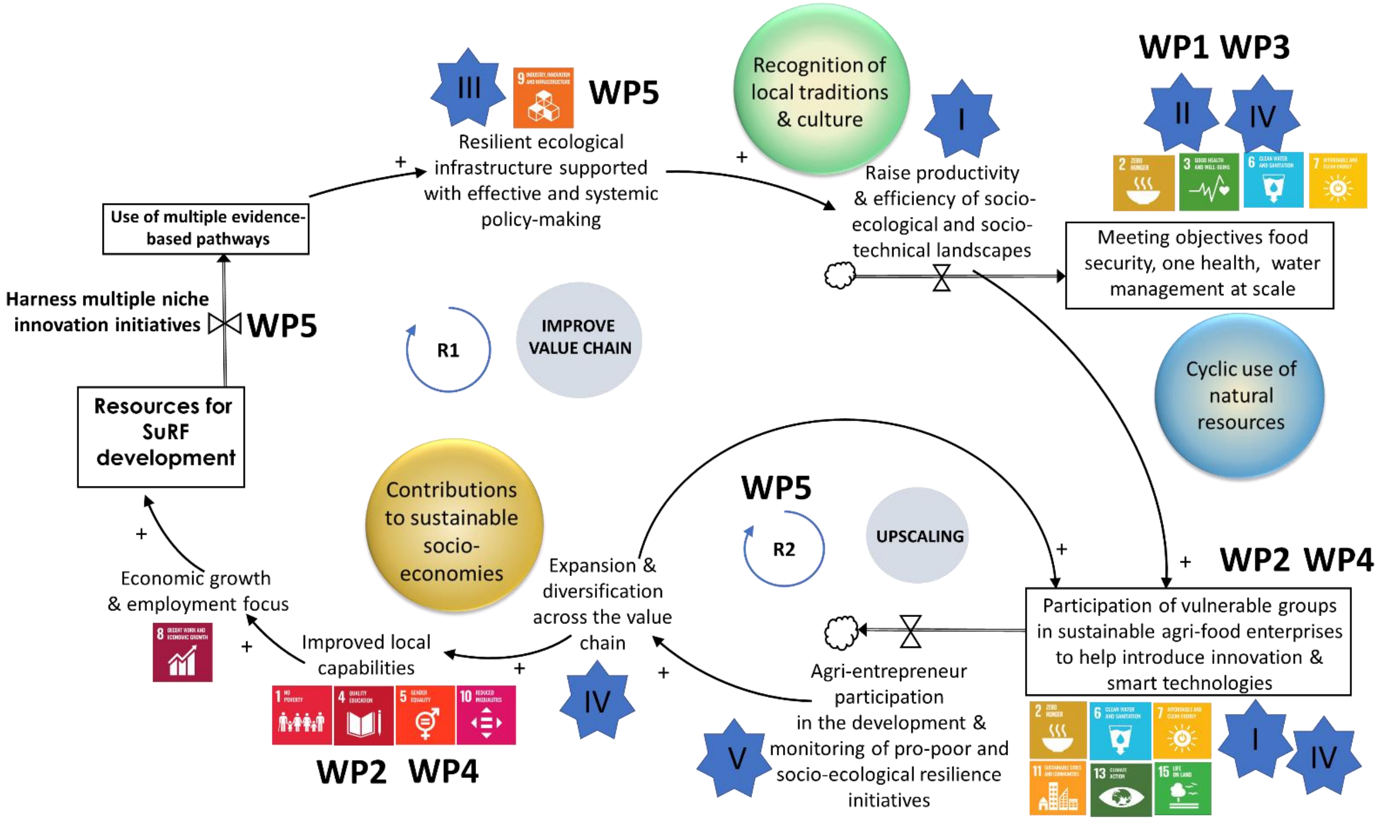

Figure 7. The WPs seek to deliver outputs that are going to be mutually reinforcing over time. Links to measurable three-year expected outcomes are shown in roman numerals and can be referred to in Appendix 1. The relevant interlinked components of an inclusive landscape management approach of Sayer et al. [33] are shown as the shaded circles. UN SDGS are shown as targeted goals that ought to be achieved.

The reinforcing loop , R1, demonstrates contributions to sustainable economies by way of harnessing multiple niche innovation initiatives. This implies that resilient ecological infrastructure ought to be supported with effective and systemic policy-making to meet the objectives of food security, One Health and water management at landscape level; all in harmony with local traditions and culture while supporting cyclic use of natural resources.

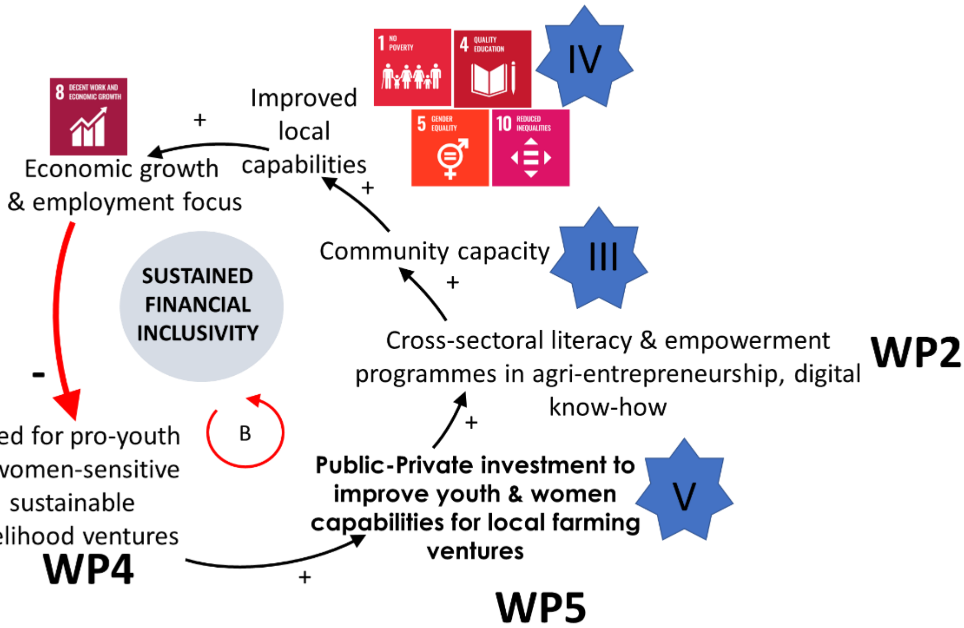

Figure 8. Seeking balance to promote sustained financial inclusivity to drive public-private investment to improve capabilities linked to local farming ventures. The RII seeks to shift the nature of the "Economic growth&employment → Need for pro-youth & women-sensitive sustainable livelihood ventures" causal link (red arrow) from negative to positive. In this way the loop will shift from a goal seeking one to a positively reinforcing one. Links to measurable three-year expected outcomes are shown in roman numerals and can be referred to in Appendix 1. UN SDGS are shown as targeted goals that ought to be achieved.

Often, the economic growth and employment focus do not attract career and livelihood in the agricultural sector [34–36] due to lack of pro-youth and women-sensitive sustainable livelihood ventures. Whether youth and women can seize agricultural opportunities also depends on their human capital development. WP4 aims at promoting and preparing youth and women in developing and managing agribusiness models for food value chains while addressing social barriers. Digital tools will increase their access to better input and output markets. To satisfy market demand, co-designed and gender-transformative innovations and to increase productivity and reduce postharvest losses. Youth and women will be linked to credit and insurance services through evidence-based policy options. Agribusiness hubs will help to build the capacities in technical knowledge and business skills of youth and women.

WP 5 will examine the tools, methods and achievements used by the other four WPs, and will provide the structure for ensuring integration across WPs and knowledge consolidation. To ensure the emerging findings influence policy direction, strong engagement with the system transformation Initiative Design Teams is envisioned, especially with Food Systems transformation for healthy, safe and affordable diets, building systemic resilience to climate extremes, and Leveraging gender and social equality. Knowledge sharing with all global resilient agrifood system Initiatives will be essential.

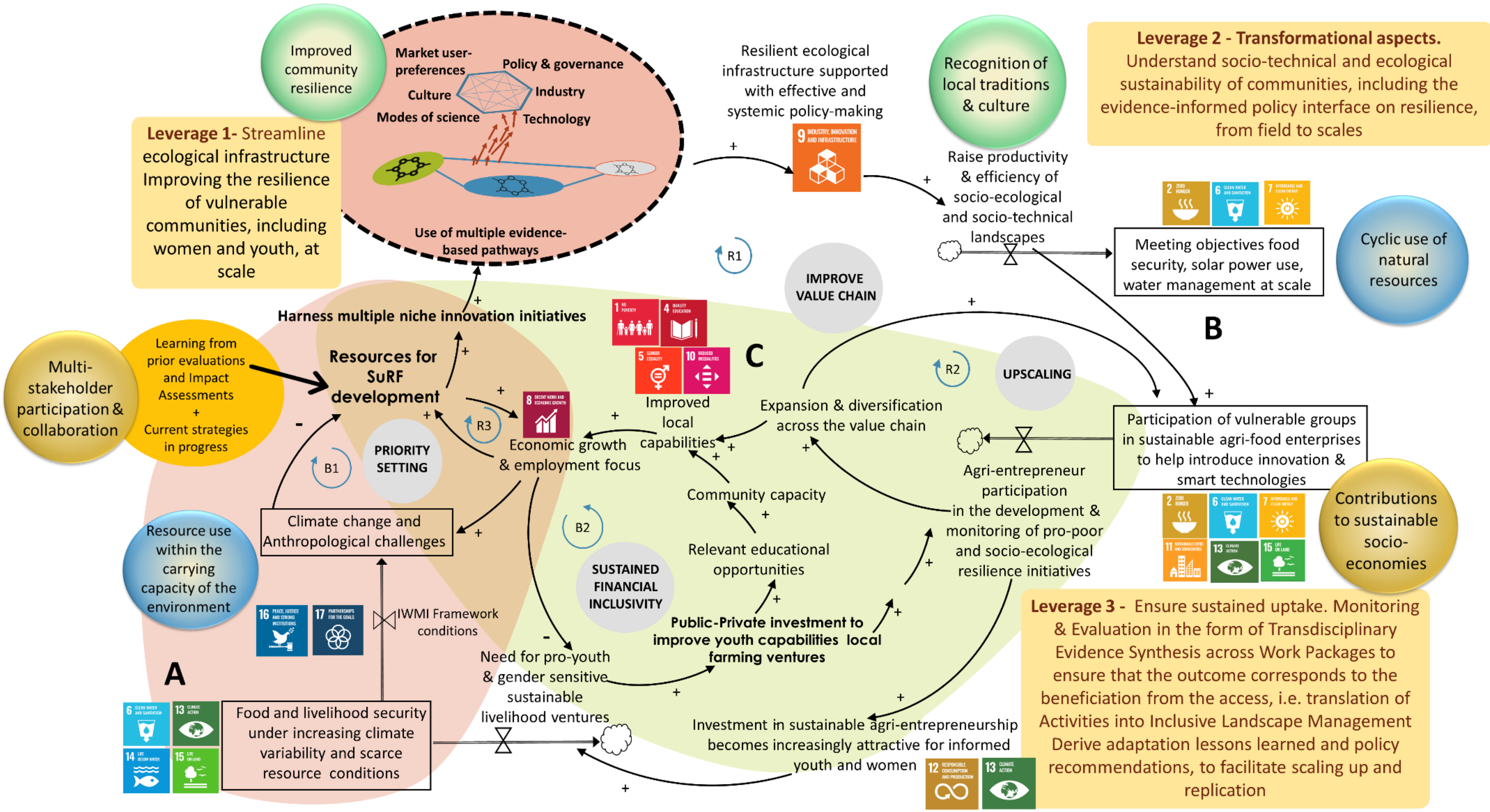

Figure 9. A "Growth and under-investment" system archetype [37] for the RII for WCA. Loop B1 illustrates the goal-seeking agenda of a paradigm shift toward Sustainable and resilient food system. Loop R1 is the main reinforcing loop that targets the improvement of the value chain. The balancing loop B2 highlight the areas where sustained efforts are required to promote investment in sustainable agri-entrepreneurship, especially for youth and women.

4.0 DISCUSSION

Transdisciplinary research processes are often structured in three core phases: a) problem identification and formation of a common research object; b) co-production of solution-oriented and transferable knowledge; c) embedding co-produced knowledge through transdisciplinary reintegration. The problem identification aspect is detailed in the TAFS-WCA Full Proposal Document. The present work seeks to develop the common research object to demonstrate the linkages within and across the WPs. Systems thinking was used as a framework for visualising the interconnections cutting across the objectives, outputs and expected impacts of the different WPs. The causal loop diagrams act as a tool for seeing and understanding challenges in the context of the whole system and the relevant 'structures' that underlie complex situations. Establishing boundaries and seeing the interconnected patterns and forces within those boundaries – and how they relate to the outside – can be a powerful simplification that generates new insights and solutions.

Despite existing scholarly guidance for the core trans-disciplinary process, the initiation phase often remains an uncharted area because of its strong context dependency. As a result, this presents a risk that project components could be vaguely conceptualised. Strong TD processes rely on complex co- designing which then become a roadmap to guide co-production to create a value system for the Initiative. The MELIA Plan act a robust tool to prioritise transdisciplinary monitoring and evaluation of the Initiative. Priority Area A is key to unleash Reinforcing loops R1 and R2 (Figure 9).

Priority A: Create a positive value system through relational intelligence, adequate resource allocation and supportive dynamic processes

Area of Action	**TAKING A LEARNING ORGANISATION APPROACH TO TRANSDISCIPLINARY ACTION**
Why is it important?	To create enabling conditions to inform RII management decisions and contribute to internal learning
This will be done by:	• Setting up a reflective and accountability-based MEL system • Promoting partnerships of key stakeholders

Type of MELIA study or activity planned	**Corresponding outputs**	**Anticipated year of completion (based on 2022-24 Initiative timeline)**	**Co-delivery of planned MELIA study or activity with other Initiatives**	**How the MELIA study or activity planned will inform management decisions and contribute to internal learning**
1. Ex-ante, baseline and/or foresight study (i) Baseline survey of the initiative	All outputs and outcomes	2022	EiA, Aquatic System Plant Health	Baseline data provide the benchmarks of outputs outcomes against which the team will measure progress towards the targets. It will contribute to decision regarding both MEL and IA
2. Tracing of scaling activities & policy advice for large scale impact studies	All outputs and outcomes	2022-2025	EiA, Aquatic System HER+	It will inform the management about the actual achievement on the projected future impact of the initiative and the potential large scale and long-term impact

(i) Panel study to monitor changes in the dynamics of adoption and impact of innovations				
3. Qualitative outcome study Mixed qualitative and quantitative assessments and Participatory MEL	All outputs and outcomes	2022-2025	EiA, Plant Health, Healthy Diets Aquatic system Nature-positive agriculture.	This will help to involve all actors including beneficiaries, innovations and scaling partners in participatory evaluation and adaptation of the ToC and for stage-gating decision making by the management
4. Causal Impact Assessment learning studies (i) RCT for assumptions testing and scaling method	Outputs 3.1.2; 4.1.1; 4.1.2	2023 and 2024	EiA ESA I: UU	Evidence from RCTs will help management to test assumption in the ToC for adaptation and to decide on innovations to be promoted and the appropriate scaling methods.
5. Scaling Readiness Assessment (i) Participatory assessment of scaling readiness with both innovation and scaling partners (ii) RCT for potential impact of innovation	Outputs 3.1.2; 4.1.1; 4.1.2	2023 and 2024	HER+; *ClimBeR; Plant Health* *S. intensif.* *ESA UU*	This will result in scaling domains / homologues and guidelines on how to update / prioritize innovations and in tables showing the innovation networks. It will also result in a tool to address bottlenecks, considering the management system architecture
6. Program evaluation or review (i) Mid-term review (ii) End-of-project external evaluation	End-initiative outcomes	2025	Not applicable	Midterm review will contribute to stage-gate decisions through the highlight relevance, effectiveness, efficiencies, and sustainability of the change processes.
7.Other MELIA activity (i) Annual outcome survey and routine MEL data (ii) Outcome case study	All output and outcomes	2022-2025	Not applicable	Data will be collected data on achievements and success stories this and will be used for annual internal performance, reviews, reporting and planning, contributing to stage-gate.

Inclusive landscape management, as in the WP3 objectives seek to achieve involves tackling both systemic and social complexity: the former due to multiple interacting entities, the latter due to incommensurable knowledge and value systems of stakeholders. Silo approaches can limit the ability to achieve a comprehensive understanding of the interconnected nature of the eco-agri-food system challenges. In the context of RII-WCA, an important role of using a systemic framing is to identify the main components, drivers, dynamics and relationships that impact the entire value chain of the socio-ecological and agri-food system. This helps make side effects and trade-offs visible, allows for identification of win-win situations, and uncovers synergies that can be realised through the implementation of public policies, public-private partnerships or other aspirational interventions. Propelling concepts into implementation in the real-world will require establishing an area of action to build cross-sectoral literacy of end-user beneficiaries and capacity in entrepreneurship (shown as a requirement for improving local capabilities in Figure 9).

Priority B: Develop and implement measures to promote the digital know-how, literacy, empowerment of women and youth

Area of Action		**BUILDING ENTREPRENEURIAL SKILLS**	
Why is it important?	Entrepreneurial-capacity empowerment Learning and achieving		
This will be done by:	• Cross-sectoral literacy & empowerment programmes in agri-entrepreneurship, digital know-how • Improve access to information and communication technology (ICT)		
Output	**Outcomes**	**Time Plan**	**Progress Reference**
• Engage with the education sector and with the private sector to integrate entrepreneurship, savings and investment culture in education • Creation of incentives to agencies and private sector partners engaging in microenterprise development for youth and women	Promote and support an integrated approach to self-employment, micro-enterprise and credit schemes	Quarterly reviews of progress	• Number of schools and training institutions using ICTs and offering ICT training as part of the curriculum for agribusiness studies • Types of resources for operating and replicating successful micro-financing schemes
Broaden access to secondary and higher education, making use of cost-effective means such as distance learning	Learning equitably Promote knowledge transfer through volunteering and mentoring opportunities, including promotion of indigenous knowledge.	Quarterly reviews of progress	• Evaluation of Learning and achieving across sectors • Coherent Training Route towards agripreneurship • Enhanced accreditation and identified pathways provided

Incentivise private sector development of ICT infrastructure	Train young people in the use of ICTs Provide learning opportunities, with relevant accreditation, for children and young people in the non-formal education settings	Semester reviews	

If sustainable landscape management is to evolve into a solution-oriented arena for WCA smallholder food production system by aiming to conduct "use-inspired research" that links both science and practice, new forms of co-management systems have to be explored. These measures ought to prioritise (Priority C) the integration of traditional ecological knowledge, modern applied sciences, effective unleashing of technology services and user empowerment through sustained financial inclusivity (Priority C) in order to secure diverse ecosystem services and values.

Priority C: Strengthen financial support systems and collaboration between key stakeholders in youth/women empowerment

Area of Action	**FINANCIAL INCLUSIVITY OF YOUTH AND WOMEN**		
Why is it important?	Emergence of entrepreneurial capacity to spearhead inclusive landscape management		
This will be done by:	• Creating or strengthening links ministries/departments of youth affairs, which should include arrangements for consulting young people and women interested in agri-entrepreneurship • Transforming the non-formal learning environment to improve participation of youth and women organisations		
Output	**Outcomes**	**Time Plan**	**Progress Reference**
Development of youth/women voice structures that meet the needs to embark on agri-entrepreneurship	Enhanced personal capabilities Increased participative action	Quarterly review	Delivery of Local Advisory Groups relevant for agri-entrepreneurship development Continuous updates on essential requirements that improve capabilities

Taking a transdisciplinary approach means that the researchers involved in the RII will need to act both in and out of their traditional disciplines and interact with stakeholders to frame their understanding of the inclusive landscape management in a broader and real-world perspective. In particular, the development of landscape approaches in WP3 introduces a shift of focus on sustainability problems, previously observed through reductionist lenses to include unleashing of climate smart technologies, the WRDSS, a participatory as management plan and components of One Health perspective for nutrition and food security. The system archetype is critically illustrated against its three-year measurable expected impact and include six of the ten principles for a landscape approach of Sayer et al. [33] that seeks to reconcile the ecosystems services derived from agro-ecosystems.

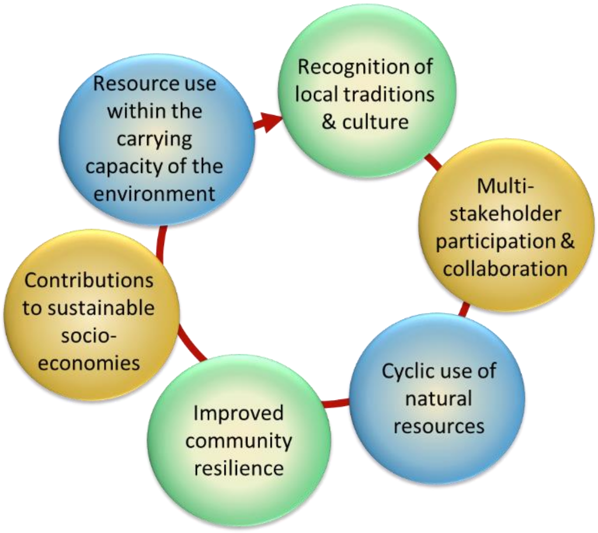

Figure 10. Six principles for a landscape approach to reconciling agriculture conservation, and other competing resource uses

5.0 CONCLUSION

The aim of the co-design process as initiated with this critical review of the full proposal document is to activate stakeholder and research-based conceptual development to create alternative futures and their associated timesteps. The latter are described as part of WP5 and in the MELIA Plan. The systems maps showcase how the landscape approach enable the emergence of embedded solutions, which broadens and improves conventional research. The process intends to provide policy-makers, researchers, and scenario facilitators with a strategic framework to activate solutions temporally with a stakeholder-defined suite of scenarios. Co-designing contexts for systemic sensibility requires that the proposed frameworks in this report be validated with stakeholders. Hence, the next step of the present work will involve a facilitated workshop.

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APPENDICES

APPENDIX 1 MEASURABLE THREE-YEAR (END OF INITIATIVE) OUTCOMES

The numbered measurable outcomes below are used in the causal loop diagrams.

I. At least 80,000 smallholder households (HH) will have access to climate resilient nutrient-dense crop varieties; with at least16,000 of them using 5 climate resilient, nutrient-dense crop varieties and 6 good agricultural practices.

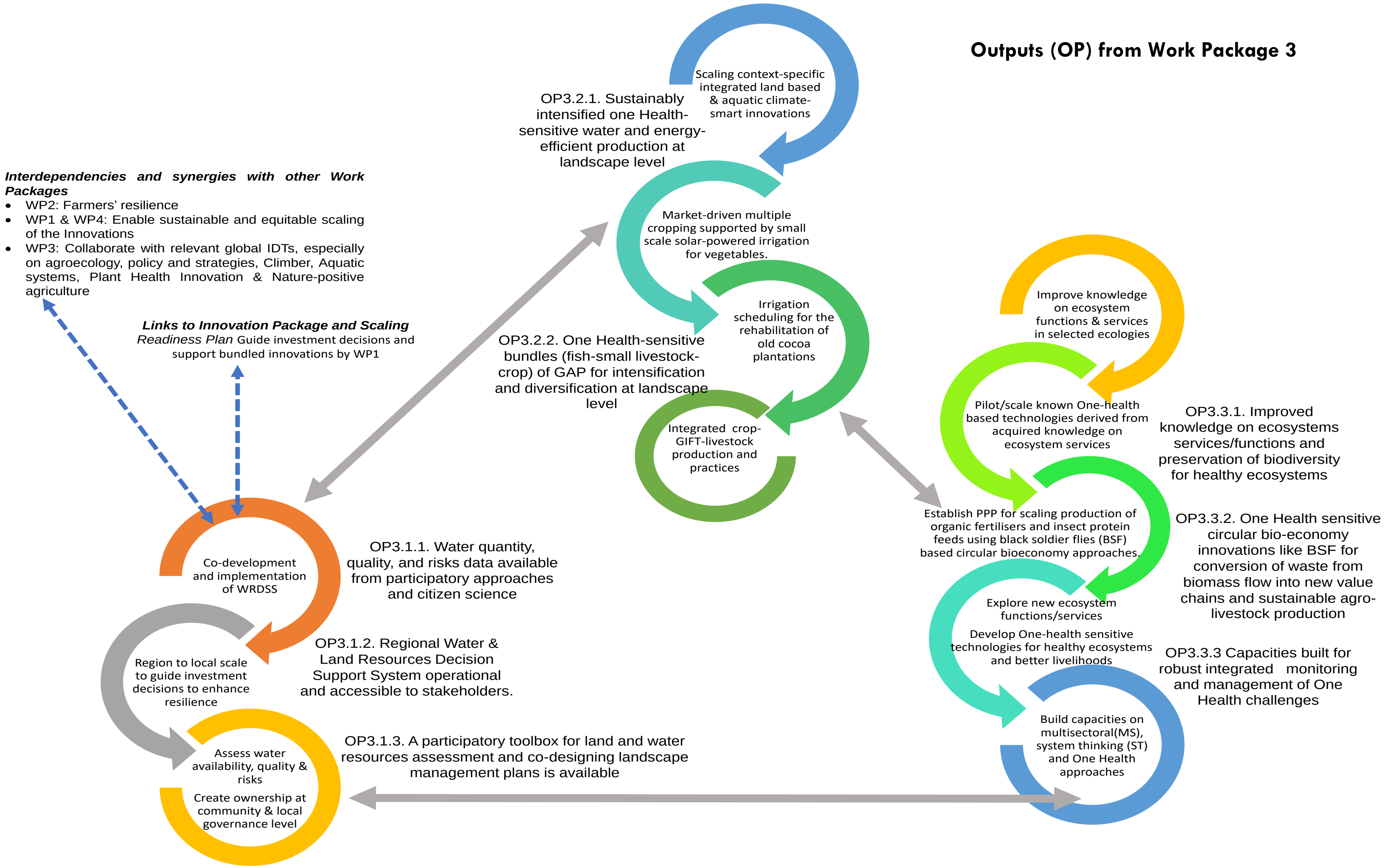
II. At least 30% increase in household dietary diversity scores will be attained.

III. 3 million farmers, 30 value chain actors, and 3 governments will be using timely climate information and early warning systems for improved decision making.

IV. At least 4 governments will use inclusive approaches towards landscape management and informed and inclusive land and water management plans will have been developed by 100 rural communities that will diversify income from agriculture and increase production that will create jobs and stability

V. At least 20,000 youth and 15,000 women will be engaged in value-added activities related to agriculture and at least 50% of these will have access to credit. At least a 20% increase in Women Empowerment in Agriculture Index (WEAI) will be attained.

VI. At least 10 key partners in the next phase implementation plans ($25 million investment) consistently using 3 validated scaling tools.


Outputs (OP) from Work Package 3
Interdependencies and synergies with other Work Packages
• WP2: Farmers' resilience
• WP1 & WP4: Enable sustainable and equitable scaling of the Innovations
• WP3: Collaborate with relevant global IDTs, especially on agroecology, policy and strategies, Climber, Aquatic systems, Plant Health Innovation & Nature-positive agriculture
Links to Innovation Package and Scaling Readiness Plan Guide investment decisions and support bundled innovations by WP1
Scaling context-specific integrated land based & aquatic climate-smart innovations
OP3.2.1. Sustainably intensified one Health-sensitive water and energy-efficient production at landscape level
Market-driven multiple cropping supported by small scale solar-powered irrigation for vegetables.
Irrigation scheduling for the rehabilitation of old cocoa plantations
OP3.2.2. One Health-sensitive bundles (fish-small livestock-crop) of GAP for intensification and diversification at landscape level
Integrated crop-GIFT-livestock production and practices
Improve knowledge on ecosystem functions & services in selected ecologies
Pilot/scale known One-health based technologies derived from acquired knowledge on ecosystem services
OP3.3.1. Improved knowledge on ecosystems services/functions and preservation of biodiversity for healthy ecosystems
Establish PPP for scaling production of organic fertilisers and insect protein feeds using black soldier flies (BSF) based circular bioeconomy approaches.
OP3.3.2. One Health sensitive circular bio-economy innovations like BSF for conversion of waste from biomass flow into new value chains and sustainable agro-livestock production
Explore new ecosystem functions/services
Develop One-health sensitive technologies for healthy ecosystems and better livelihoods
OP3.3.3 Capacities built for robust integrated monitoring and management of One Health challenges
Build capacities on multisectoral(MS), system thinking (ST) and One Health approaches
Co-development and implementation of WRDSS
OP3.1.1. Water quantity, quality, and risks data available from participatory approaches and citizen science
Region to local scale to guide investment decisions to enhance resilience
OP3.1.2. Regional Water & Land Resources Decision Support System operational and accessible to stakeholders.
Assess water availability, quality & risks
Create ownership at community & local governance level
OP3.1.3. A participatory toolbox for land and water resources assessment and co-designing landscape management plans is available

APPENDIX 2 – LIST OF PEER-REVIEWED PUBLICATIONS RETRIEVED FROM WEB OF SCIENCE FOR THE SCOPING REVIEW

1. Cabello, V.; Renner, A.; Giampietro, M. Relational Analysis of the Resource Nexus in Arid Land Crop Production. Adv. Water Resour. 2019, 130, 258–269, doi:10.1016/J.ADVWATRES.2019.06.014.
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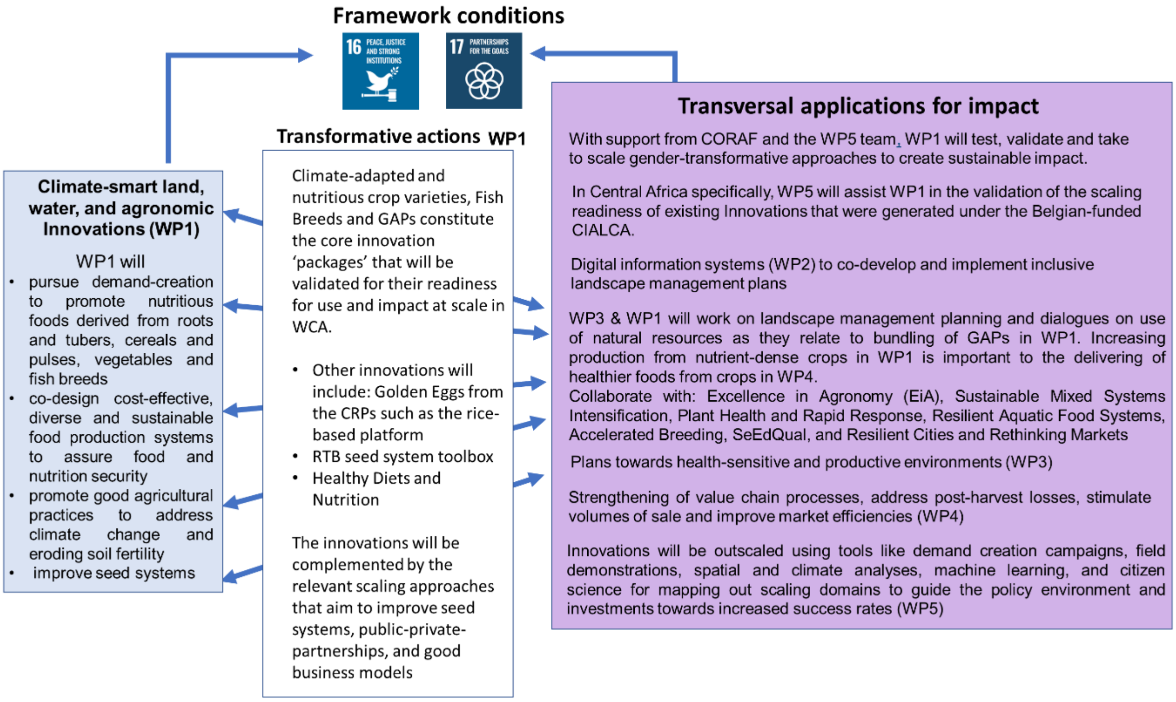
APPENDIX 3 - IDENTIFICATION OF LINKAGES ACROSS WORK PACKAGES

A conceptual framework was developed to identify the most salient features that overlap when seeking to distinguish overlapping features across the WPs. The figures below were used to identify causality across objectives, expected outputs and impact pathways of the different WPs.

WP1 and its transversal applications with other WPs

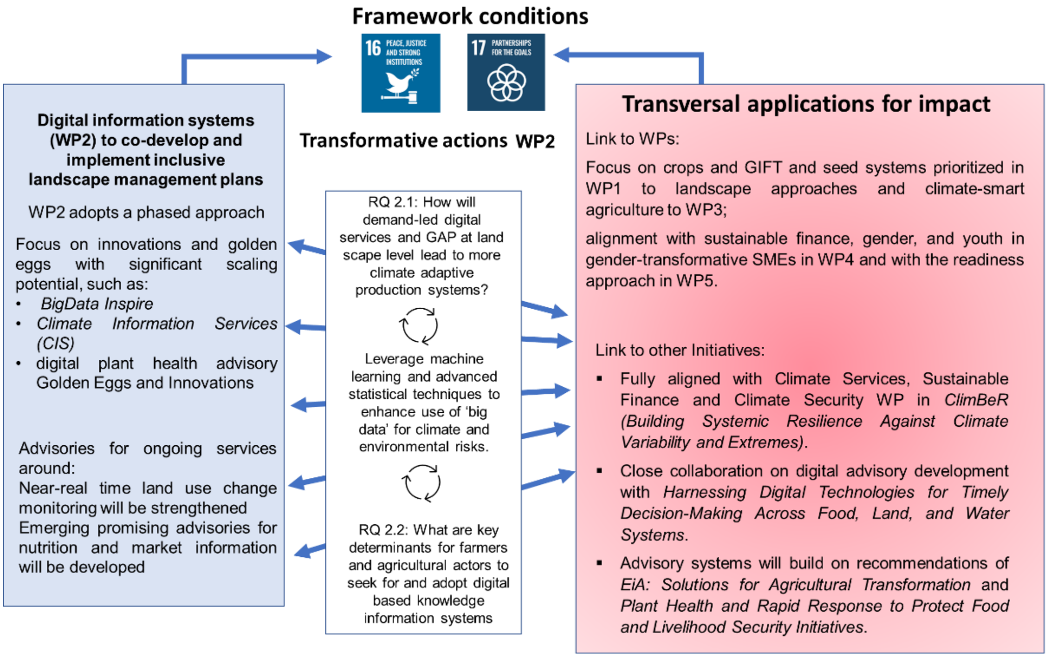


RQ1.1: What are the critical factors that incite consumer demand for biofortified and other nutritious foods (such as Traditional African Vegetables Varieties and fish)?

RQ1.2: How can smallholder farming systems be made more productive and adaptive to climate change?

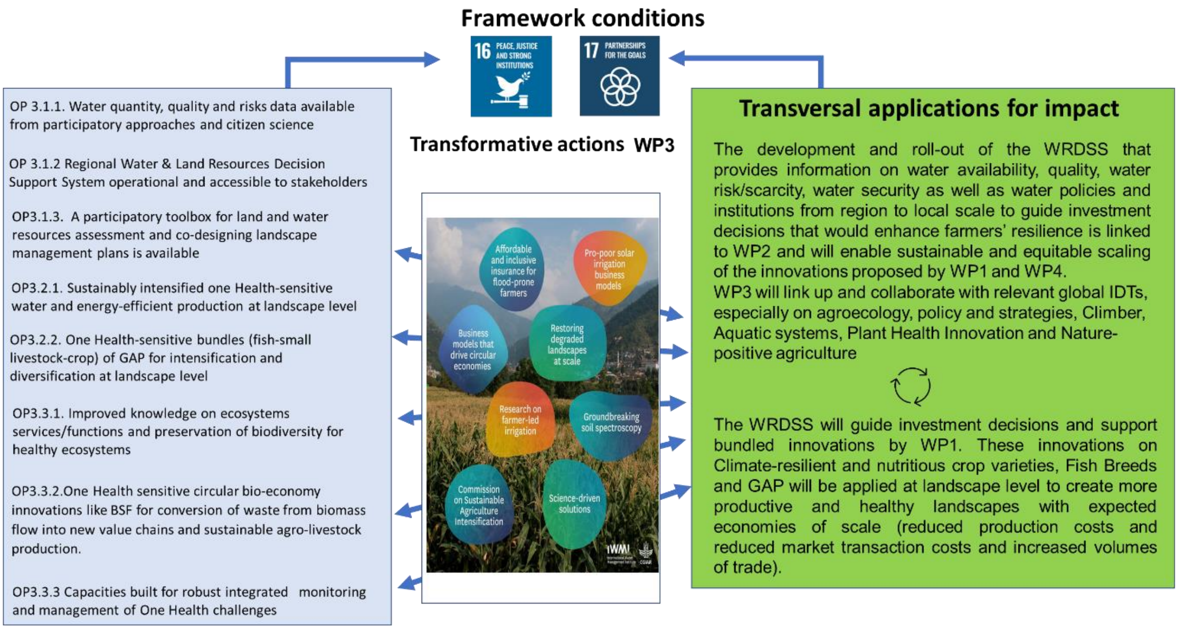
RQ1.3: Which institutional and capacity support mechanisms will enhance smallholder farmers' access to markets?

WP2 and its transversal applications with other WPs



WP2 is central to the ToC of the WCA Initiative and to scale digital innovations within the RII WCA and across Initiatives

WP3 and its transversal applications with other WPs

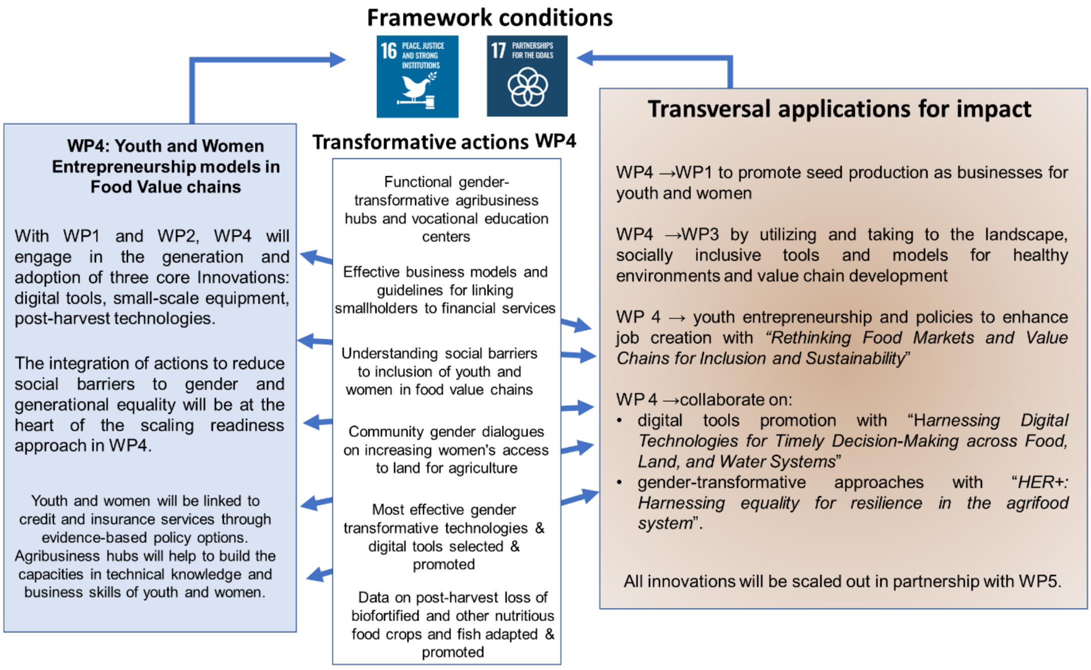


RQ 3.1 How can participatory water and land resources decision support system (WRDSS) strengthen landscape resilience planning for enhanced production of nutrient-rich crops and fish

RQ 3.2: How can innovations be OneHealth-sensitive and scaled to contribute to healthy and productive environment for livelihood improvement

RQ 3.3: How can ecosystem services/functions and biodiversity be sustained, management of water, soil and biomass flow improved, and resilient agrifood systems supported, for improved communities' livelihoods?

WP4 and its transversal applications with other WPs



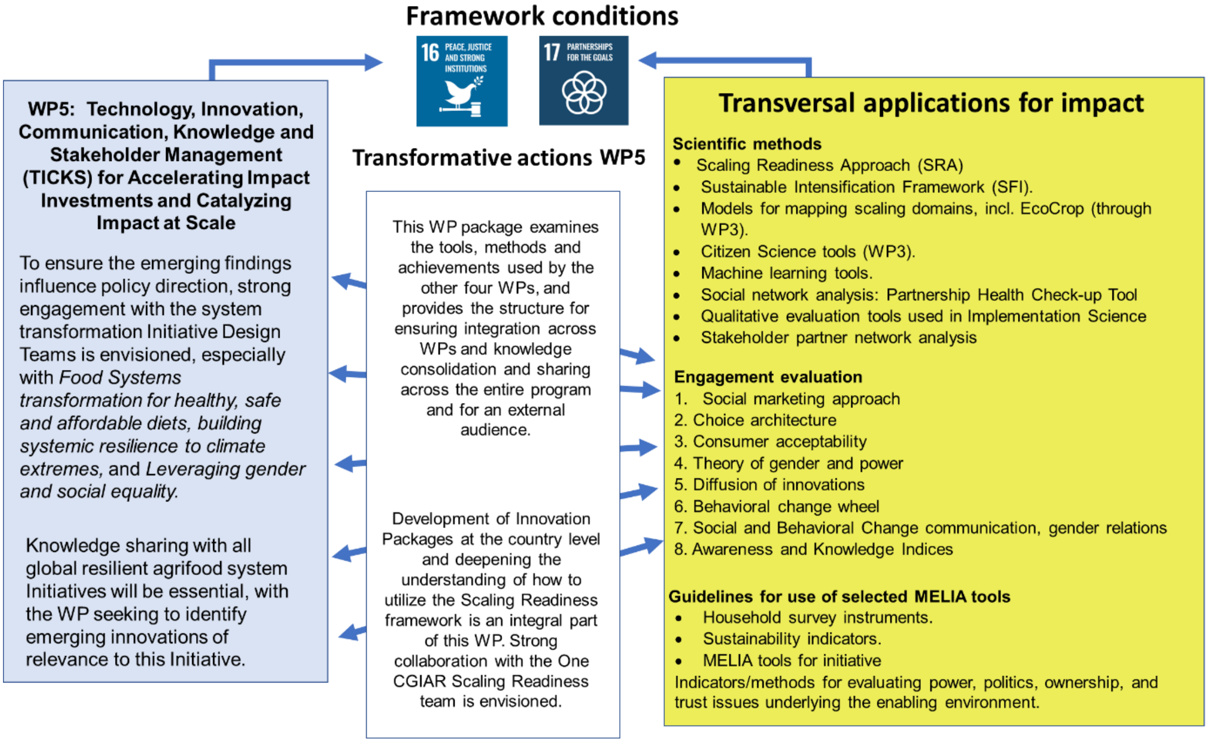
RQ 4.1: What are the appropriate mechanisms and policy advocacy tools to facilitate access to finance and market linkages to youth and women?

RQ 4.2: What are the social constraints to gender and generational equality that affect gender equality in agribusiness?

RQ4.3: What gender-transformative technologies and digital tools can enhance sustainability of women and youth agribusiness hubs?

RQ4.4: What are the efficient post-harvest technologies to reduce post-harvest losses in biofortified and other nutritious food crops varieties and fish?

WP5 and its transversal applications with other WPs



RQ5.1: Which management system architecture (workflows, methods, tools etc.) would increase the contributions of Scaling Readiness and partnership management tools to accelerate impact investments in research and innovation interventions and catalyze the impact of the R&Is at scale?

RQ5.2 Which are the most effective use of advocates and media systems for mobilizing knowledge and community engagement, stimulating demand and investment, and changing behaviors for reaching different target groups?

RQ 5.3: Which monitoring, learning and evaluation tools are most suited for rapid diagnosis and response to emerging concerns, and which contribute cost-effectively to monitoring progress, evidence building for impact, and designing future scaling efforts