



NEXUS Gains

Realizing Multiple Benefits Across Water, Energy,
Food and Ecosystems (Forests, Biodiversity)

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Proposal
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Summary table

Initiative name	NEXUS Gains Realizing Multiple Benefits Across Water, Energy, Food and Ecosystems (Forests, Biodiversity)
Primary Action Area	Systems Transformation
Geographic scope	Ganges basin (India, Nepal), Indus basin (Pakistan, India), Eastern Nile basin (Ethiopia, Sudan) and Aral Sea basin (Kyrgyzstan, Kazakhstan, Tajikistan, Turkmenistan and Uzbekistan) If funding becomes available, NEXUS Gains will also work in the Limpopo (Botswana, Mozambique, South Africa and Zimbabwe) and Zambezi basins (Angola, Botswana, Mozambique, Namibia, Zambia and Zimbabwe) in collaboration with Foresight and Metrics, Harnessing Digital Technologies and U2 based on additionally expressed demand of stakeholders
Budget	US\$ 33,000,000

1. General information

Initiative name: **NEXUS Gains – Realizing Multiple Benefits Across Water, Energy, Food and Ecosystems (Forests, Biodiversity)**

Primary CGIAR Action Area: Systems Transformation

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2. Context

2.1 Challenge statement

Water, land, energy, forests and biodiversity are highly interconnected and critical to nutrition, health and food security (Impact Area, IA1), poverty reduction, livelihoods and jobs (IA2), gender equality, youth and social inclusion (IA3), climate adaptation and mitigation (IA4), and environmental health and biodiversity (IA5) at multiple scales through multiple pathways.^{1,2,3} Similarly, the SDGs are systemic, with interdependencies across goals mediated by water, energy, food and ecosystems.⁴

However, governments, stakeholders and investors struggle to manage systems change in the water-energy-food-ecosystems nexus and ensure changes are robust under climate change. NEXUS Gains addresses the challenge of optimizing trade-offs and building synergies to support SDG achievement through transformations in food, land and water systems nexus.

The transboundary nature of basins makes integrated and sustainable management of water, energy, food and ecosystems challenging (Figure 1; WEFE; note for ecosystems the particular focus on forests and biodiversity). Systems thinking helps avoid unintended consequences that would jeopardize sustainability and possibly exacerbate conflict. Good governance across boundaries and sectors requires strong institutions and actors willing to overcome silos and adopt new tools to support nexus approaches.^{5,6,7,8}

Governments, investors and local communities are uncertain about where or how best to maintain, restore and improve ecosystems and biodiversity, regenerate agriculture, and support sustainable irrigation, clean energy, and agro-processing needs.⁹ Investments are often not coordinated. For instance, investments in water or energy remain often disconnected from policy goals of healthy diets,¹⁰ re/afforestation often neglect ecosystem services across scales and socioeconomic development pathways. Women, youth and other vulnerable groups continue to bear the brunt of poorly developed WEFE systems.¹¹ They struggle to access information, technology and needed skills¹² and are under-represented in leadership and decision-making - a lost opportunity in terms of their contributions toward sustainable and inclusive development pathways.

South Asia's breadbasket basins Ganges and Indus (focus: India, Nepal and Pakistan) are increasingly challenged by ground and surface water abstractions (among the most unsustainable in the world), climate change (among the most vulnerable countries), deforestation, drastic pollution, severe ecosystem degradation and biodiversity¹³ and poor policies, putting 7% of the world's food production at risk, with potentially devastating impacts on the wellbeing, health and livelihoods of an estimated 1 billion people.¹⁴ Governments are calling for scaling sustainable and inclusive on-farm water management practices for improved livelihoods and nutrition, and jobs; renewable energy as a priority intervention; nutrition and gender equality in access to safe water for multiple uses are systemic challenges. However, policies are incoherent, fragmented and inefficient.

In the Blue Nile Basin (Ethiopia and Sudan) a rapidly growing population faces increasing food and nutrition insecurity from climate change, demographic change, severe ecosystem degradation and low productivity,¹⁵ lack of irrigation, and energy access. Transboundary conflicts over nexus resources are intense (e.g., GERD)¹⁶ and growing with development and climatic change.

Aral Sea Basin needs are similar, where glacial retreat, reliance on fossil fuels, and the depletion of the Aral Sea and other hydrological and ecological changes are aggravated by transboundary water conflicts, jeopardizing the region's future.



Figure 1: Schematic transboundary basin and illustration of WEFE systems.

All focal basins are global hotspots for multi-sector risks based on anticipated stresses from climate change and development paths for the water and energy sectors, crop yields and habitat degradation.¹⁷ These challenges are surmountable if water, energy, food and ecosystems are managed with an integrated approach.

Implementing NEXUS Gains' systems approach at basin scale

Nexus Gains examines WEFE systems in transboundary basins of significant international relevance. Upstream/downstream interdependencies will be quantified, and the complexity of intersecting sub-national boundaries for policymaking and management of WEFE resources addressed by building on existing institutional strengths. Dependencies of interventions from farm to watershed to river basin scales will be analyzed to support social equity, economic efficiency and environmental sustainability across scales, sectors and other divides with a focus on gender, age, income and ethnicity.

The Nexus approach is multicentric, not water centric like integrated water resources management. It aims to connect systems to optimize equitable economic and social welfare and environmental sustainability. Therefore, it considers a broad range of actors and stakeholders to overcome disciplinary and administrative silos. It requires a polycentric and multi-level governance framework, which makes co-development and implementation of nexus solutions challenging as it is interwoven with a complex political economy.

NEXUS Gains focuses on river basins that combine landscape elements and ecological regions connected by water flows. Water balance parameters as a basis for resource management can be quantified for basins. Natural and anthropogenic characteristics determine responses such as floods and droughts, soil surface and groundwater recharge, changes in water level, wetlands, reservoirs and nutrient and pollution fluxes. Digital models help us understand and quantify system interdependencies and predict future conditions in a changing climate under evolving environmental and societal changes (e.g., water availability for food systems, energy production, forests and other land uses, and Aquatic terrestrial ecosystems).

2.2 Measurable 3-year end-of-Initiative outcomes

NEXUS Gains will realize gains across water, energy, food and ecosystems with a focus on forests and biodiversity for the ecosystem component in selected transboundary river basins by leading global nexus thinking and providing tools, guidelines, training and facilitation for analysis and research for development. This will strengthen climate resilience and lead to tangible benefits for rural men and women.

By the end of 2024, NEXUS Gains will achieve:

EoI1. Basin policymakers, planners, researchers, demand and scaling partners are using results from foresight and interactive modeling tools to assess trade-offs and synergies and develop prioritized WEFE nexus innovations and policies in at least three focal regions.

EoI2. Public sector departments, international organizations, academia and public/private investors are using water productivity assessments and water storage diagnostics across scales and sectors to improve system-level water productivity through WEFE interventions in all target basins.

EoI3. Private investors and policymakers are using scalable gender-sensitive energy business and finance models to accelerate rural energy access for more sustainable (i.e., water, ecosystems) and equitable food systems in Ethiopia, India, Nepal, Pakistan and Sudan.

EoI4. Policymakers and stakeholders are using science-policy dialogues, multi-stakeholder forums, and a co-developed governance toolbox and guidelines to strengthen governance across WEFE systems facilitating cross-sectoral cooperation among and between public, private and civil sector organizations in all target basins.

EoI5. At least 40 emerging women leaders in government, private sector, academia and research institutions have increased capacity to identify, assess and implement one or more WEFE nexus innovations per focal basin.

2.3 Learning from prior evaluations and impact assessments (IA)

The main emerging themes from CGIAR commissioned evaluations call for more systems-focused research across “ecosystems, biodiversity, and livelihoods in agro-ecosystems” (WP1),^{18,19} more “multi-scalar research at spatial scales that range from the field to the river basin”(WP2)²⁰ spanning production and consumption, and frequent calls for investment “in training researchers in systems science” and for CGIAR to provide “capacity development programs, incentives, and awards for emerging researchers”²¹ and “encourage mentoring of young scientists.”²² These are reflected throughout the WPs, notably in WP5, which focuses

on capacity building for a new generation of women leaders in partner organizations and on mentoring junior scientists.

NEXUS Gains responds to calls for more impact assessment of CGIAR's water investment^{23,24} and to a recent systematic review noting a lack of rural energy access studies in Sub-Saharan Africa, particularly for solar energy (WP3).²⁵ The same review calls for studies on energy transitions' impacts on gender equity, the agriculture sector and forests and states that "these imbalances in the state of knowledge on energy intervention impacts impede policy-makers' ability to act on messages about potential solutions, and lead to potential conflicts with other SDGs"(WP1, WP3).²⁶

The main emerging themes from recent food systems research, the UNFSS,²⁷ and global agreements on biodiversity, climate and health,²⁸ flag the need for food systems framed within nexus approaches to meet global goals. Food systems must better recognize nutritional, climate, water and environmental security as operational goals (food within planetary boundaries)^{29 30 31} and build on production systems that regenerate environmental goods and services in line with global goals.^{32 33 34} Finally, a series of WEFE nexus reviews suggest a need for more implementation on the ground, which is well addressed in NEXUS Gains.

2.4 Priority-setting

Research questions, methods, innovations, selected basins and systems and other choices that define the WPs are based on comprehensive reviews of current literature, partner consultations and expert advice (see 2.6).

Addressing global priorities

Food systems do not operate in isolation, nor do any other WEFE systems (Figure 2). Achieving SDG2 requires accelerated technical, institutional and policy innovations that go beyond food systems and are connected to transformations in food, energy, environmental, and economic systems.^{35,36} These innovations must be robust under climate change and help build resilience to climate change. Therefore, nature positive³⁷ and nexus systems approaches are required to understand, mitigate and adapt to climate change and its impacts on water, land and food systems.³⁸

Selected geographies

The four river basins were chosen because:

1. WEFE resources directly support an estimated total of one billion people living in these basins.^{39,40,41}
2. All basins are characterized by low biodiversity intactness and ecological integrity; many areas within basins are hot spots of degradation and resource over-use.⁴²
3. All basins and riparian countries are under extreme climate stress, coping capacity is low, and food insecurity and climate change vulnerability is high.^{43,44,45}
4. Gender inequality is acute in all basins.⁴⁶ Entry points for synergistically enhancing gender equality and WEFE outcomes through equitable access, management and governance of WEFE systems are poorly understood and in need of transformative research.

Participating CG Centers and our demand, innovation and scaling partners bring decades of experience working in these basins ([WLE](#) and [CPWF](#)) and have extensive partner networks in place (section 2.6), which is a critical prerequisite for success along the impact pathways for system transformations. There are established public and private institutions and organizations, RBOs, NGOs, CSOs in all basins. However, national and regional institutions

struggle to take the integrated nature of nexus systems into account and mostly concentrate on single systems.

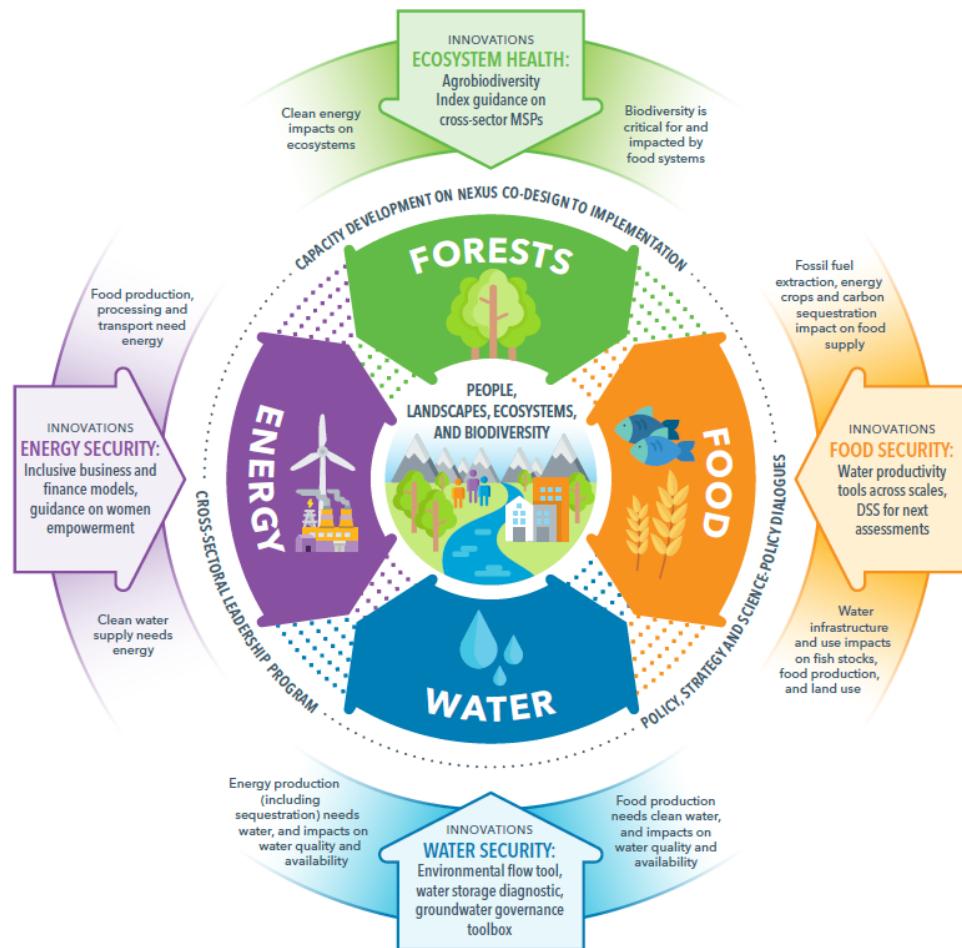


Figure 2: Interconnectedness of water, energy, food and ecosystems and NEXUS Gains' approach including examples of core innovations and activities (see section 3).

2.5 Comparative advantage

NEXUS Gains builds on decades of CGIAR research for development programs, including the Challenge Program on Water and Food⁴⁷ and three transformational Consortium Research Programs: Water, Land and Ecosystems⁴⁸, Forests Trees and Agroforestry⁴⁹, and Policies, Institutions and Markets⁵⁰ and many bilateral/multilateral projects in the target basins. It builds on solid systems understandings, good research infrastructure, empirical data sets and developed models^{51, 52} – all prerequisites for in-depth research and accelerating impact.

The program has an extensive network of partners for demand-driven research, innovation co-design, implementation and scaling that includes governments from federal to local levels, the private sector, river basin organizations ([Nile River Basin](#), [Indus](#), [Upper Ganga Basin Organization](#), [Interstate Commission for Water Coordination of Central Asia](#)), investors (e.g., World Bank, African Development Bank, IFAD), international organizations (e.g., FAO, IFAD, African Union) and NGOs (e.g., FECOFUN⁵³, SEWA, Zenab for Women in Development).

CGIAR has offices in each basin with experienced staff familiar with local/regional issues and the specific political, institutional, economic and geographic contexts. It is widely perceived as an independent, trusted broker with strong convening power (see 2.6).

NEXUS Gains will be implemented by a multidisciplinary team of experienced researchers with strong analytical skills, development professionals, and policy and decision-makers experienced in translating R4D results into policies and actionable decisions. This enables NEXUS Gains to assess synergies and trade-offs for alternative nexus futures, understand and quantify interdependencies, and work to implement and scale effectively. The Initiative goes beyond theoretical frameworks as noted in nexus reviews to focus on practical applications considering governance issues and political economy challenges.^{54, 55}

2.6 Participatory design process

NEXUS Gains leads and IDT members consulted widely throughout the Initiative preparation phase to ensure that important local, national and regional demands for research for development were identified to develop theories of change, key assumptions and risks, and identify partnerships that will lead to lasting transformation of food, land and water systems in a climate crisis.

Our consultations reached beyond Ministries of Agriculture to Ministries of water, irrigation, energy, environment and climate change and private energy investors, grassroots women's organizations engaged in strengthening member agency, and multilateral agencies tasked with accelerating poverty alleviation and economic development.

Most consultations were implemented through virtual meetings complemented with face-to-face meetings between CGIAR country representatives, researchers and national/regional agencies. These meetings built on decades of co-generation of knowledge, capacity building and advisory roles and helped more clearly articulate the needs of a wide range of stakeholders in the design process.

During these consultations, NEXUS Gains learned from and incorporated inputs from more than 500 stakeholders across the WEFE nexus in the Aral Sea, Indus, Ganges and Eastern Nile basins. Country consultations also included smaller breakout groups in [Pakistan](#), [India](#), [Nepal](#) and [Ethiopia](#) that queried theories of change, identified impact pathways, proposed additional partnerships and provided greater geographic granularity.

For example, [Indus meeting participants](#) agreed that WP2 (boosting water productivity) and WP4 (nexus governance) were key to achieving the country's vision of enhanced food, energy and water security. Participants suggested working in southern Punjab to alleviate poverty and water scarcity constraints and in the Delta where resource degradation and poverty levels are particularly high. Experts from the upper [Nile](#) and Ganges ([India](#) and [Nepal](#)) basins recommended smarter, more sustainable, integrated approaches to water storage and water productivity to underpin food security and more inclusive socioeconomic development. Better groundwater governance was considered a key element. In the Eastern Nile (Ethiopia and Sudan), participants voiced demands for interactive modeling tools and support to identify ways to accelerate rural energy access and solarize irrigation systems. Informal discussions were also held with stakeholders in Sudan (including with the Minister of Water and Irrigation) and early work on clean energy access and water productivity were identified.

The consultations covered all WEFE sectors and were very well-received with high-levels of participation, including ministerial and head-of-research system levels. The feedback, minutes and notes of discussions were carefully analyzed for guidance on the work and Innovation Packages ([Consultations Annex](#)).

We also co-organized UNFSS Dialogues on Water, Food and Energy Systems for the [Aral Sea Basin](#), [Egypt](#), [Pakistan](#) and [South Africa, Zambia and Zimbabwe](#) in addition to a [UNFSS Global Dialogue](#) that further supported identification of nexus innovations in support of food

system transformation. NEXUS Gains also directly supports the strategy for transforming [Africa High 5s](#) in the priority areas Light up Africa (WP3), Feed Africa (all WPs), and Improve the quality of life for the people in Africa (WP1, indirectly all WPs).

In addition to in-country and in-region consultations, we considered global dialogues and consultation processes in the Initiative design, including the UNFSS [Alliance for climate-resilient development pathways](#) and [IPBES](#). We also discussed capacity building needs with national agencies and universities in the Global South and North, and engaged with multilateral agencies, such as the World Bank, and grassroots organizations, such as SEWA or FES, on shared concerns around achieving water, energy and food security while improving rural livelihoods and ecosystem health.

2.7 Projection of benefits

The projections below transparently estimate reasonable orders of magnitude for impacts which could arise as a result of the impact pathways set out in the Initiative's theories of change. Initiatives contribute to these impact pathways, along with other partners and stakeholders.

For each Impact Area, projections consider breadth (numbers reached), depth (expected intensity of effect per unit) and probability (a qualitative judgement reflecting the overall degree of certainty or uncertainty that the impact pathway will lead to the projected order of magnitude of impact).

Projections will be updated during delivery to help inform iterative, evidence-driven, dynamic management by Initiatives as they maximize their potential contribution to impact. Projected benefits are not delivery targets, as impact lies beyond CGIAR's sphere of control or influence.

NEXUS Gains will contribute to all five CGIAR Impact Areas during 2022-2030. We anticipate synergies with other Initiatives as per our TOC (section 3). However, we have not assumed additional impact from these synergies in this set of projections, to ensure these are conservative and to avoid double counting of beneficiaries between Initiatives. We will be further developing the synergies and factoring these into future projections during the inception period.

2.7.1 Nutrition, health & food security

2.7.1.1 # people benefiting from relevant CGIAR innovations

NEXUS Gains expects to reach ~0.5 million farm households (HHs; 2.5 million people) substantially/directly (high likelihood) with clean irrigation and energy technologies and better governance (DALYs⁵⁶ and income impacts),⁵⁷ and at least 23 million people, that is ~2% of the target area population, perceptibly/indirectly with improved sustainable healthy diets via lower prices of (irrigated) horticultural crops,⁵⁸ reducing the share of 85% of the population in SSA and 76% in South Asia⁵⁹ that cannot afford healthy diets.

For Ethiopia, the small-scale irrigation potential increase is 1 million hectares (m ha) (2010 to 2030) for nutrient-dense crops and irrigated fodder for animal source foods (ASF) and with [IMPACT](#) projected business-as-usual growth 2020 to 2030 is 0.3 m ha.^{60,61} Based on this, we assume 0.5 m ha of added irrigation, supporting 1 m households (0.5 ha irrigated area/HH) with NEXUS Gains contributing 10% to this increase with water and energy efficient appropriate technologies, and improved governance (WP1-4), with a 68%⁶² permanent income increase; with lower investment in Sudan, 0.02 m households will be reached.

Aligned with our research for development intensity, and reduced area expansion in South Asia, we project benefiting 0.32 m HHs in the Ganges⁶³, and 0.1 m HHs in the Indus (all highly

conservative estimates). We also expect a direct health and income contribution from increased use of renewable energy⁶⁴ for postharvest processing and improved storage of perishables (e.g., bread stoves/milk coolers) and associated, reduced postharvest losses and improved food safety, directly reaching 20,000 households in Ethiopia, 5,000 in Sudan, 25,000 in the Ganges and Indus basins (conservative estimates).

Estimates will be further improved in 2022 Q1. The probability of achieving our conservative estimates is high with considerable confidence, based on prior CGIAR and partner research and policy uptake (e.g., ILSSI,⁶⁵ EEG⁶⁶); uncertainties will be further reduced through Scaling Readiness assessments.

2.7.1.2 # Minimum Dietary Diversity Score for women (MDD-W)

MDD-W measures women's diet diversity,⁶⁷ which is strongly and positively correlated with micronutrient adequacy⁶⁸ and can monitor, evaluate and guide programs that seek to improve diet quality in resource-constrained settings.⁶⁹ There is evidence that in Ethiopia MDD-W values of 8%⁷⁰ (varying across seasons)^{71, 72} grow 6 points (substantially) for women in irrigating households.⁷³ We estimate a conservative 3-percentage point increase linked to NEXUS Gains for women in irrigating families. Note that MDD-W improvements of non-irrigators in irrigating communities from increased availability/affordability of horticultural and ASF foods are likely also significant but were not calculated. The total across target countries is conservatively estimated at ~0.5 m women (see 2.7.1.1).

2.7.2 Poverty reduction, livelihoods & jobs: # people benefiting from relevant CGIAR innovations

We conservatively estimate that at least 0.5 million households or 2.5 million people are directly benefiting from improved access to irrigation and clean energy technologies with permanent increases in income^{74,75} above 50% for all target countries (substantial/high certainty) as described in the nutrition/health impact section (see 2.7.1.1). We also estimate that we create at least 0.5 m jobs in the irrigated horticultural and off-farm sectors based on WP1, 2 and 3.⁷⁶

We recently calculated the population assisted with exiting poverty for Uganda (not a phase 1 focal country) from NEXUS Gains innovations and we will expand this foresight approach to core focal countries in year 1 (see Table 6.3). The Uganda assessment⁷⁷ finds that a doubling of sustainable groundwater use could create >0.5 m jobs in the country's agrifood system and support >0.5 m people exiting poverty (values not included in the table), providing further indication of the high potential of NEXUS Gains activities in target geographies.

2.7.3 Gender equality, youth & social inclusion: # women & youth benefiting from relevant CGIAR innovations

NEXUS Gains reaches, benefits and empowers women and youth through gender-differentiated and youth-focused research leading to the development of guidance and tools, policies and institutions that support women and youth farmers and entrepreneurs to overcome well-documented exclusion and constraints in their involvement and agency in irrigation^{78,79} and clean energy technologies,⁸⁰ governance of natural resources,⁸¹ and cross-sectoral leadership.⁸² Given the size of the challenge, NEXUS Gains conservatively projects benefiting 0.4 m women⁸³ and 0.5 million youth (in target households and beyond) with access to improved technologies, management and governance. These estimates are in line with the conservative estimates of the number of people benefiting (see sections 1 and 2).

WP5 focuses on developing a leadership program and community of practice/network across emerging women and youth leaders that will further help ensure lasting benefits at policy and decision-making level. We also project a reduction in women's time-burden to collect water⁸⁴ through 1) improved water access, 2) reduced water competition, and 3) improved energy

access, supporting wellbeing. Both aspects give further credence to the projected benefit values.

2.7.4 Climate adaptation & mitigation:

2.7.4.1 # tons CO₂e averted

Of note, estimates of CO₂-e contributions and aversion of irrigation pumps vary dramatically by methodology, suggesting that a comprehensive study is currently lacking.^{85 86} This said, the potential for GHG reductions in South Asia is large (~5 million diesel pumps in India⁸⁷ and ~1 million diesel pumps in Pakistan).⁸⁸

Using our own approach detailed [here](#), we conservatively calculated the pumped area irrigated in the base year, the share of fossil fuel-based pumps, changes in pumped irrigated area to 2030, and the incremental contribution of NEXUS Gains to the change from fossil-fueled to clean energy pumps, assuming a conservative share of 10% of additional pumps only, which is well in line with advances by CGIAR and partners.⁸⁹ Our results suggest projected GHG aversion of 0.22 million tons CO₂-e averted for Ethiopia, 0.3 million tons CO₂-e averted Sudan, 1.46 million tons CO₂-e averted in India and 0.49 million tons CO₂-e averted Pakistan.

2.7.4.2 # people benefiting from climate-adapted innovations

The technologies and approaches NEXUS Gains focuses on directly support climate change adaptation, through improved water control and productivity during droughts with demonstrated permanent income impacts above 50%⁹⁰ for all geographies as explained in the nutrition, health and food security section (2.7.1.1). We therefore assume, with high confidence, that we will reach 2.5 million people with climate-adapted innovations based on the 10%-contribution of Nexus Gains to water, and energy-efficient irrigation.

2.7.5 Environmental health & biodiversity:

2.7.5.1 # change in consumptive water use (km³) during 2020-2030

We estimate global consumptive water use in 2020 at 2258 km³ across the agricultural, domestic and industrial sectors based on CGIAR's [IMPACT water models](#).⁹¹ meeting only around 80% of effective water demand, including 78% of effective irrigation demand. NEXUS Gains proposes to work in some of the most water-scarce breadbaskets, such as Pakistan, where only 59% of irrigation demands are met, and other areas where irrigation expansion potential is substantial (i.e., Eastern Nile). Under business-as-usual (SSP2-RCP8.5), we calculate a global increase in consumptive water use of 131 km³ during 2020-2030. The equivalent increase in consumption in NEXUS Gains focal areas is 46 km³, including 27 km³ for irrigation during 2020-2030.

NEXUS Gains projects to grow irrigation beyond business-as-usual by 10% during 2022-2030 in focal basins, which would add 11 km³ of water consumption over business-as-usual. With a calculated 5%-increase in effective water productivity (WP2) consumptive use declines instead by 14 km³ despite increased area. Pressure on water consumption will be further reduced through the integrated storage work of NEXUS Gains, focusing on more effective use of rainfall, increased but sustainable use of groundwater resources in areas with groundwater irrigation potential and additional reliance on distributed green and grey infrastructure (e.g., small reservoirs).

Taken together, the implementation of these measures in the focal basins of the Indus, Ganges, Eastern Nile and Aral Sea basin could reduce global average food prices by 0.5 to 1%, based on the same IMPACT modeling framework, improving access to more nutritious foods for many million consumers (see also the nutrition benefits section).

2.7.5.2 # ha under improved management

Based on the calculations above, we conservatively project an increase in area under improved management of at least 0.3 m ha (0.5 ha per household) with more water use and

energy efficient and solarized technologies that can withstand droughts, floods and heat stress events. WEFE nexus solutions around land restoration, re/afforestation, and wastewater reuse are expected to lead to additional improvements in key ecosystem functions (e.g., through better soil health and fertility, biodiversity) over time that will be reflected in additional, projected area improvement, not yet reflected in the projected benefits table, following Scaling Readiness assessment and other analyses.

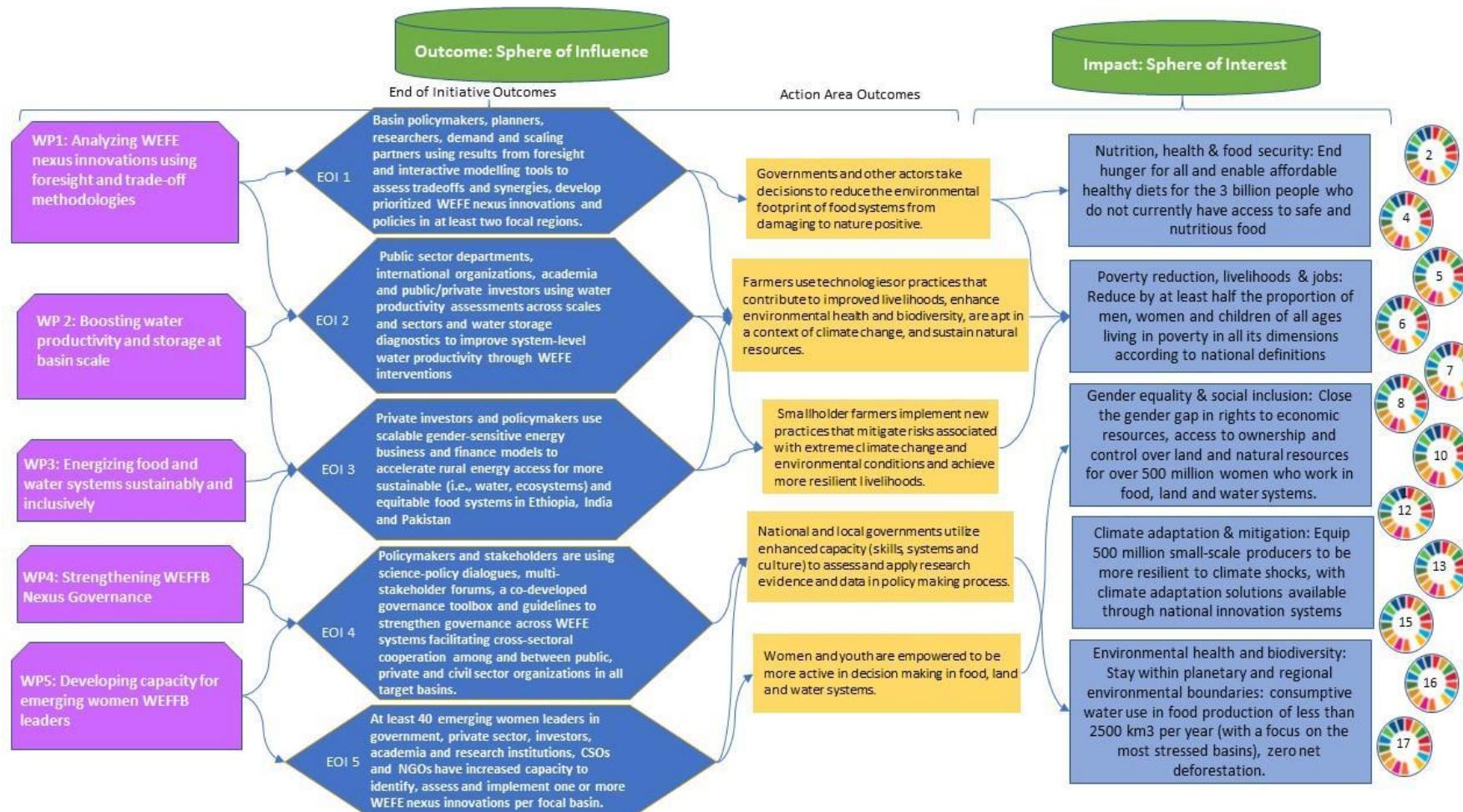
Table 1: Projected benefits

Impact Area	Indicator	Breadth	Depth	Probability
Nutrition, health & food security	# people benefiting from relevant CGIAR innovations	2.5 million people	Substantial (health & income, at least a 50% permanent income impact)	High: 50%-80% expectation of achieving these impacts by 2030
		~23 million people indirectly	Perceptible (small effective income increase and health benefits from lower food prices)	High: 50%-80% expectation of achieving these impacts by 2030
	# minimum dietary diversity score for women	~0.5 million women directly	Substantial (health impact through more diversified diets)	Medium: 30%-50% expectation of achieving these impacts by 2030, at this point
Poverty reduction, livelihoods & jobs	# people benefiting from relevant CGIAR innovations	2.5 million people	Substantial (permanent income effect)	High: 50%-80% expectation of achieving these impacts by 2030
Gender equality, youth & social inclusion	# women benefiting from relevant CGIAR innovations	~0.4 million women directly	Gender responsive (the different needs of men and women are identified and differentially met)	High: 50%-80% expectation of achieving these impacts by 2030
	# youth benefiting from relevant CGIAR innovations	~0.5 million youth directly	Substantial (permanent income effect)	High: 50%-80% expectation of achieving these impacts by 2030
Climate adaptation & mitigation	# tons CO ₂ e averted	2.5 million tons averted	Substantial (permanent income effect)	High: 50%-80% expectation of achieving these impacts by 2030
	# people benefiting from climate-adapted innovations	2.5 million people	Substantial (permanent income effect)	High: 50%-80% expectation of achieving these impacts by 2030

Impact Area	Indicator	Breadth	Depth	Probability
Environmental health & biodiversity	# change in km ³ consumptive water use during 2020-2030	14 km ³	Substantial: focus on some of the most water-scarce basins to improve water productivity and integrated water storage management	Medium: 30%-50% expectation of achieving these impacts by 2030, at this point
	# ha under improved management	0.3 million ha	Substantial: improvements in soil fertility health and biodiversity, additional ecosystem service improvements	Medium: 30%-50% expectation of achieving these impacts by 2030, at this point

3. Plans and associated theories of change (TOC)

3.1 Full Initiative TOC



NEXUS Gains aims to improve integrated management of water, energy, food, land, biodiversity and forests, for inclusive, sustainable development in transboundary river basins in a climate crisis. End-of-Initiative Outcomes (EoI) map to five CGIAR Action Area Outcomes (AAO) for systems transformation and all five CGIAR Impact Areas by reducing the cost of trade-offs across WEFE systems through interactive tools and foresight analyses, by improving water security through water productivity enhancement and water storage management, by accelerating renewable energy access in rural areas, by improving cross-sectoral governance, and by implementing a capacity building program for emerging women leaders. These workstreams will jointly contribute to outcomes for SDG 2 (zero hunger), 5 (gender equality), 6 (water), 7 (clean energy), 13 (climate action), 15 (ecosystem health) and 17 (partnerships) and, to a lesser degree, SDGs 8, 10 and 12. Our TOC is that if decision-makers have practical and easy-to-use tools and the capacity to use them (by building knowledge, skills, commitment, relationships at different levels) they will be incentivized to use evidence to inform decisions aimed at adapting and mitigating the impacts of climate change on WEFE systems.

WP1 (Trade-off analyses and foresight methodologies) supports the AAO on national and local governments using enhanced capacity to apply research evidence and data in policy and decision-making processes (assess and develop prioritized WEFE solutions). These tools are essential to advance progress across inter-related, but not always mutually reinforcing CGIAR Impact Areas and SDG targets.⁹² This assumes tools and processes used address real challenges policymakers face and motivates them to work collaboratively across sectors. Partners include the Foresight and Metrics Initiative, Griffith University, IIASA, and many others.

WP2 (Boosting water productivity and storage management) contributes to the AAOs on governments and other actors taking decisions to reduce the environmental footprint of food systems from damaging to nature positive and smallholder farmers implementing new practices that mitigate risks associated with extreme climate change and environmental conditions and the CGIAR Impact Area on biodiversity and ecosystem health and related targets for SDG 13 and 2. This assumes tools use state-of-the-art processes, data and methodologies, users have the required capacity, and the tools are trusted by end-users. We will work with IHE-Delft, the WB and national water and agricultural agencies in selected focal basins.

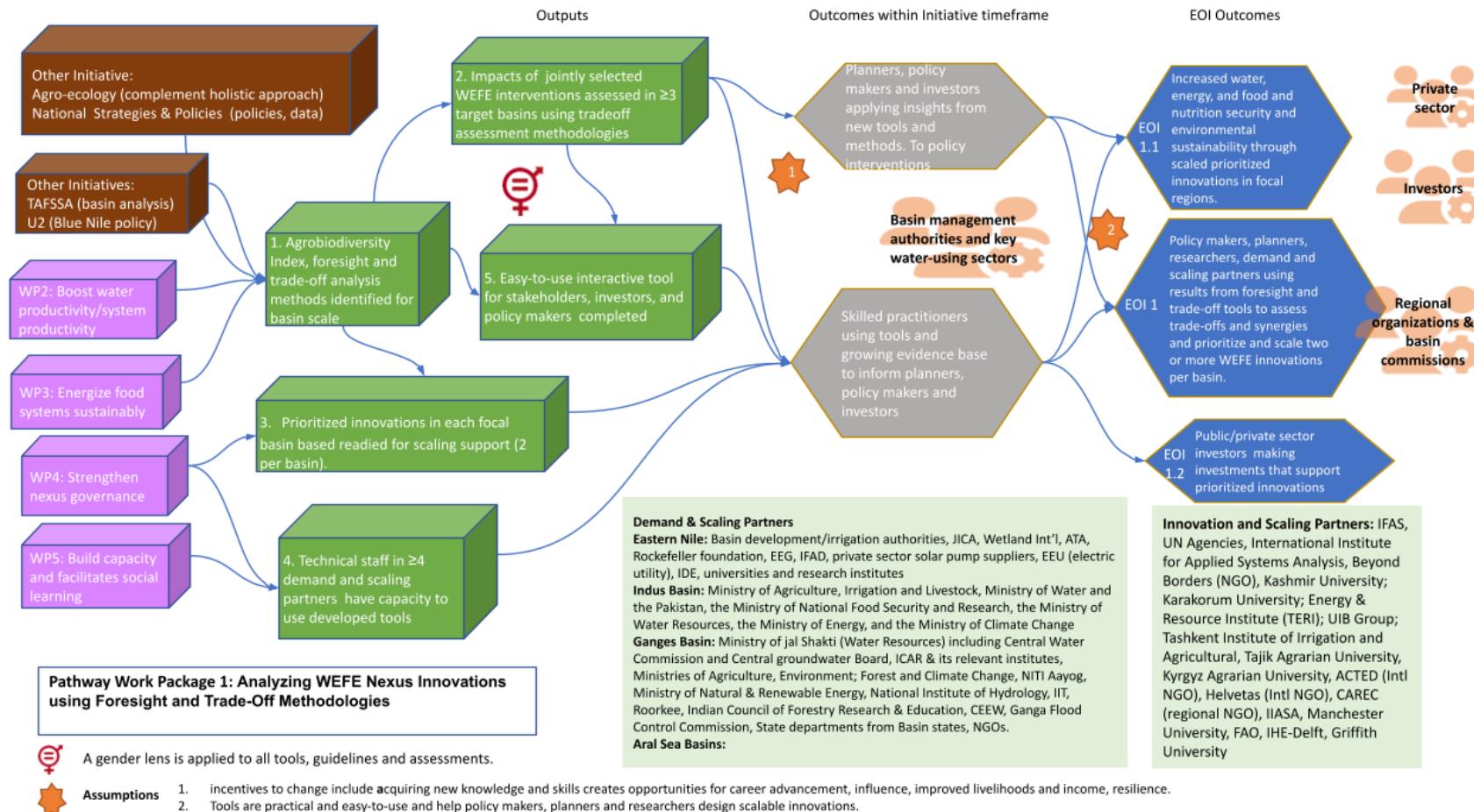
WP3 (Energizing food and water systems) also supports achievement of the AAO on governments and other actors taking decisions to reduce the environmental footprint of food systems from damaging to nature positive and links to the CGIAR Impact Area on climate adaptation and mitigation. This assumes that energy and agriculture actors can overcome current siloes to jointly develop clean energy portfolios for rural, productive uses with key private sector players. We will move this area forward with private-sector investors, such as WE4F, Power for All, Power Africa and the solar missions of Ethiopia, India and Pakistan.

WP4 (WEFE Nexus governance) contributes to the AAOs on national and local governments using enhanced capacity and farmers using practices that sustain natural resources and supports the CGIAR Impact Area on environmental health and biodiversity. The assumption for both bottom-up and cross-ministerial, transboundary research is that there is receptiveness for collaboration and strong national and regional collaborators to support processes along the way. NGO partners include FECOFUN (Nepal), FES (India) and Zainab (Sudan) and at national and transboundary levels we will work with long-term regional partners NBI and IFAS.

WP5 (Developing capacity for emerging women leaders) supports the AAO on women and youth empowerment for more active decision making in food, land and water systems. The assumptions are that qualified emerging women leaders are identified and have time to participate in the capacity building activities. Key partner organizations for the program are national and international academic institutes.

3.2 Work Package TOCs

Work Package 1: Analyzing WEFE nexus innovations using foresight and trade-off methodologies



<p><i>Work Package main focus and prioritization</i></p>	<p>Identify, assess, prioritize, and scale nexus interventions through comprehensive assessments, foresight and cross-sectoral trade-off analyses to balance losses and gains under business-as-usual and alternative development pathways (scenario analyses).</p> <p>Core innovations include an interactive tool that supports trade-off analysis (Innovation 1), environmental flow assessments (Innovation 2) and further development and scaling of the Agrobiodiversity Index (Innovation 3) to identify pathways to restore and enhance ecosystem functions and services for sustainable social and economic benefits.</p> <p>Results will support the co-development of guidelines and toolboxes for planners, managers and investors who will analyze larger-scale impacts to implement context-sensitive nexus interventions, resource use efficiency measures, and nature-based solutions (related capacity building: WP5).</p>
<p><i>Work Package geographic scope (global/region /country)</i></p>	<p>Ganges Basin: Whole basin with more detailed analysis of upstream areas in Nepal (Karnali-Mohana and Mahakali basins, Western Nepal) and India (Uttarakhand, Ram Ganga sub-basin) and the Eastern Gangetic Basin draining into Nepal Terai and parts of the East Indian Plains</p> <p>Indus Basin Southern Punjab, Pakistan (1st priority): Hotspot of groundwater over-use, poverty hub, water scarcity and loss of agro-ecological integrity.</p> <p>Indus Basin Delta, downstream Kotri Barrage, Pakistan (2nd priority): Most neglected area where poorest of the poor live; livelihood options limited; extremely vulnerable to climate challenges; integrated solutions needed for reclamation of degraded soil and nature-based solutions to combat climate challenges.</p> <p>Blue Nile in Ethiopia and Sudan: Whole basin with a special focus on Beles-Tana sub-basin.</p> <p>Aral Sea Basin: Whole basin-scale assessments.</p> <p>Limpopo and Zambezi Basins in southern Africa: Contingent on funding.</p>

The science

The complexity of the nexus and the challenge of understanding benefits and unintended consequences of interventions requires the development of new analytical tools to inform and guide nexus solutions and policies. To implement and scale such solutions requires assessment of highly interconnected ecological, social and economic processes using a systems approach. Systems (nexus) thinking helps identify critical linkages and interdependencies and feedback loops and trade-offs at different levels. This will make it possible to minimize unintended consequences that would jeopardize sustainability and food security and possibly cause or exacerbate conflict. For example, re/afforestation efforts to sequester carbon and halt land degradation such as the Ethiopian Green Legacy Program⁹³ (aim: restoration of 15 million ha degraded land; planting >6 billion trees) can have multiple co-benefits (e.g., reduce flooding and erosion, support ecosystems and generate income) and reduce downstream water availability for other uses with livelihood impacts (e.g., agriculture, industries, deltas).⁹⁴ Expanding groundwater use is essential for food security, but can cause resource degradation, reduce water access for the poor and undermine ecosystem health⁹⁵.

Successful design and implementation of nexus solutions require comprehensive assessment combining biophysical and socioeconomic dimensions (e.g., GHG emissions/ carbon sequestration, spatial-temporal changes of water, energy and biodiversity with livelihoods, equitable water/energy/ecosystem service access, growth, trade and jobs).⁹⁶ Nonlinearities and scale interdependencies of intervention impacts from farm to basin level are poorly understood.⁹⁷

Research questions	Scientific methods	Key outputs¹⁾
How can we increase access to comprehensive nexus assessments by a broader range of stakeholders?	<p>Co-development of an easy-to-use online tool to share comprehensive large-scale assessments (incl. WP2 results), raise awareness and build capacity (WP5).</p> <p>Iterative regionalized nexus systems dialogues (WP4) to develop stakeholder defined transformation pathways as input scenarios into WP1 foresight analyses.</p>	3 Interactive tools (Innovation 1) for stakeholders, investors and policymakers to plan and assess interventions and inform policies (dashboard with maps, time series, cost/benefit analyses etc.)
How can changes in biodiversity be evaluated at basin and national scales?	<p>Analyze biodiversity impacts via different ecosystem services and environmental flow methods and assess how to best serve domestic, industrial, agricultural and energy needs while safeguarding ecosystems.</p> <p>Further development and scaling of Agrobiodiversity Index integrating 22 indicators of agrobiodiversity use and conservation across the food system, and development of a support tool to analyze landscape threats to identify where to prioritize diversity-based interventions to alleviate pressure on local biodiversity, water resources, and soil.</p> <p>Spatio-temporal analysis of ecosystem intactness and</p>	<p>E-flow analysis tool coupled with CWatM and IMPACT (Innovation 2); alternative e-flow scenarios for at least 1 basin.</p> <p>Scaled Agrobiodiversity Index (Innovation 3) in 5 riparian countries to understand relationships across the food system, to analyze agrobiodiversity use and conservation, and to identify priority interventions.</p>

	integrity in line with CBD Goals and Targets.	
What interventions can address nexus challenges and promote alternative food production strategies?	<p>Integrated biophysical and socioeconomic intervention assessment at transboundary basin scale and selected sub-basin intervention hot spots using</p> <ul style="list-style-type: none"> • Community Water Model CWatM (fully distributed, bio-physically based, parameterized with latest Earth observation data) • Water Strategy (based on Python Water Resource Simulator) for combined basin and energy system modeling and participatory decision support • Scenario analysis of nexus between biodiversity, food, health and water included in IPBES Transformative Change Assessment • Social Accounting Matrices (SAMs) will be used to provide energy source assessments • Climate change impacts (RCP-SSP combinations) • Solar power suitability mapping • Integrated biophysical and socioeconomic analysis (i.e., IMPACT and RIAPA combined with CWatM and SWAT) • Other tools 	<p>Evidence base for assessing integrated impacts of scaling nexus interventions, e.g.:</p> <ul style="list-style-type: none"> • re/afforestation • groundwater development • expansion of solar irrigation • climate-smart agriculture • water reuse in agriculture • land conversion, restoration and regeneration of ecological integrity in agriculture • soil and water conservation • bioenergy • integrated landscape analysis • food production and productivity • food prices • diets <p>Analyze scenario parameters to optimize basin investments including:</p> <ul style="list-style-type: none"> • water balance parameters and water resources (i.e., water consumption) • gender, livelihoods • crop suitability and potential • biomass, yield and yield gaps • forest cover changes • hydropower potential • trade-off and cost-benefit analyses (multi-criteria analyses)

¹⁾ Research papers and policy outputs will be published in each category. Illustrative examples will be used for learning modules in WP5.

Theory of change

WP1 identifies, assesses, prioritizes, adapts and scales interventions using foresight methodologies⁹⁸, and trade-off analyses^{99,100} to provide basin-specific guidance and tools for planners, managers and investors to sustainably implement prioritized nexus interventions.

Our TOC assumes that if decision-makers have practical and easy-to-use tools and the capacity to use them (by building knowledge, skills, commitment, relationships at different levels) they will be incentivized to use evidence to inform decisions aimed at adapting and mitigating the impacts of climate change and other stressors through scaling of WEFE nexus solutions.

The main constraints include the complexity of the relationships among and between nexus elements; the difficulty in predicting how climate change will affect the vulnerability of households, communities and nations; deeply entrenched gender and social inequalities, and the difficulty in obtaining and using up-to-date quality data.

Demand, innovation and scaling partners will co-develop and adapt foresight methodologies and trade-off and analyses to support social learning, policy analysis, and trade-off and investment decisions. Environmental flow assessments (Innovation 2) and further development and scaling of the Agrobiodiversity Index (Innovation 3) will inform technical and policy interventions for enhanced ecosystem functions and services (WP2 and 3).

Cooperation with the Regional Integrated Initiatives U2 and TAFSSA and the Foresight and Metrics and Harnessing Digital Technologies Initiatives will support integrated modeling and comprehensive analysis. As co-hosts of the Technical Support Unit for the IPBES Transformative Change Assessment, we will coordinate global assessments of nexus challenges, while leading scenario analyses in nexus regions. Scenarios are derived in collaboration with UNFSS/IPBES national focal points using dialogue sessions with diverse knowledge holders to produce transformative change narratives (WP4)¹⁰¹. The Agroecology Initiative's holistic framework will complement basin-scale assessments. These inputs will inform the co-development of tools and assessments.

Based on joint assessments and considering previous (WLE, CCAFS) and bilateral projects, partners will prioritize interventions for scaling to align with national policy reforms in Pakistan, Nepal, India, Ethiopia, Sudan, Uzbekistan and international agreements. Main partners include basin management authorities, regional/international organizations (ICIMOD, IFAS, UN Agencies), innovation partners (IIASA, universities) and public organizations from the main water-using sectors. The research will focus on identifying interventions to address nexus challenges and how a broader range of stakeholders can access and use these tools, including the UNFSS Alliance on Climate-Resilient Development Pathways.

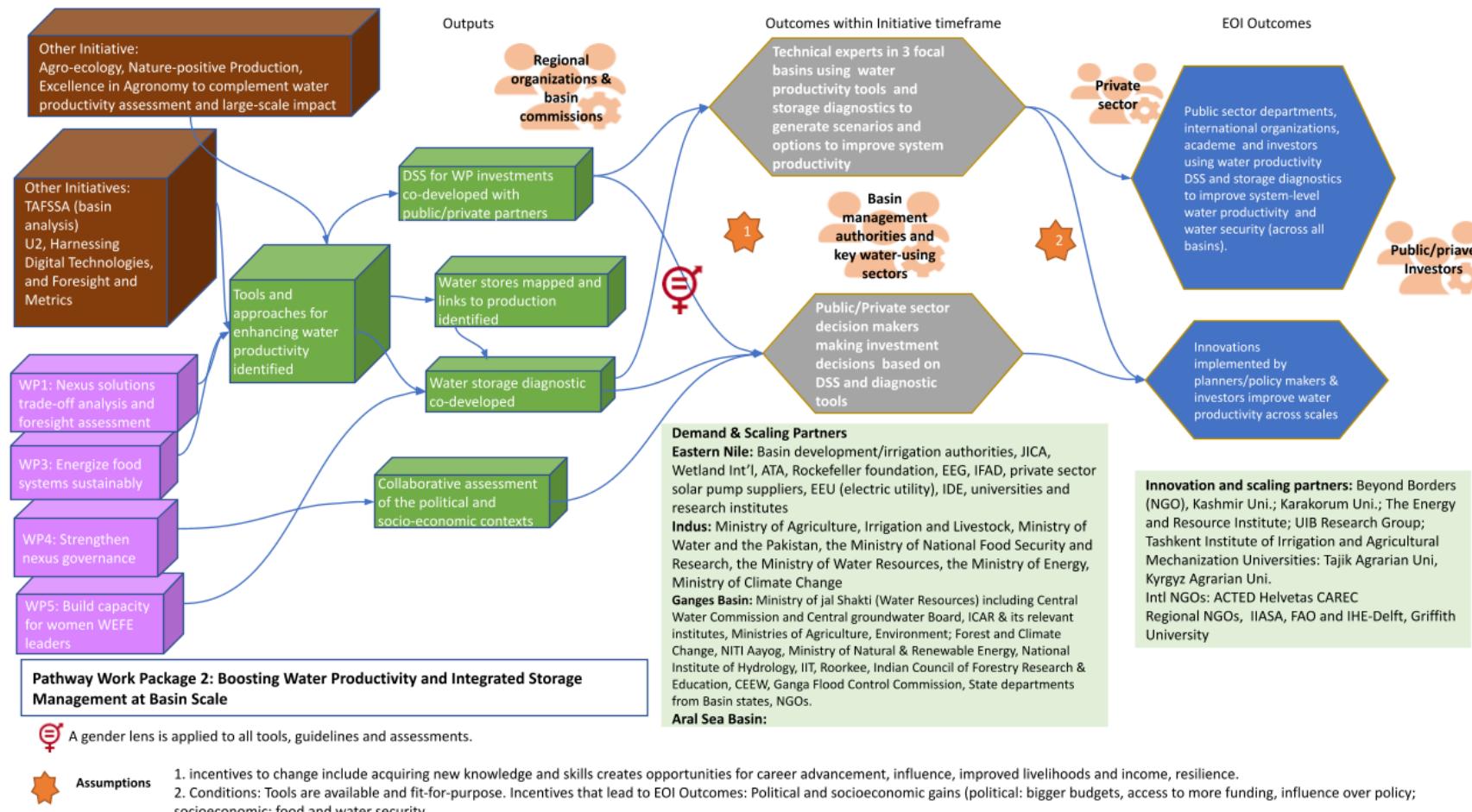
The results will inform co-development of guidelines and toolboxes (WP4) for planners, policymakers, resource managers and investors who will now have access to an interactive tool (Innovation 1; dashboard with maps, time series, cost/benefit analyses, etc.) to assess impacts of implementing basin and sub-basin interventions, resource use efficiency measures, and nature-based solutions. Quantifying trade-offs and cost-benefit analyses will guide policies and investment programs. This assumes that i) partners engage/co-develop/adopt developed tools after seeing their utility and benefits, and ii) investors and decision-makers find value in reducing the uncertainty and risk of investments.

These outputs create the conditions for stakeholders to collaboratively assess, prioritize and scale nexus interventions, share the results of comprehensive WEFE nexus assessments across sectors, and test and scale nexus solutions to achieve EIO 1.

As a result of these changes, deliberate water use becomes more productive, contributes to national priorities and regional/transboundary equity, and national/sub-national stakeholders lead food, land and water system transformations because they have the means to advance livelihoods, nutrition, environment and inclusion objectives (AA EOIs).

The resulting research evidence base will inform next-level policymaker and investor/donor decisions about the potential impacts of scaling WEFE interventions, costs/benefits of solutions, alternative e-flow scenarios, and relationships across the WEFE systems.

Work Package 2: Boosting water productivity and integrated storage management at basin scale



<i>Work Package main focus and prioritization</i>	Improving water productivity and integrated water storage management improves food and nutrition security and underpins socioeconomic development in water-scarce regions. Knowledge and tools will be co-developed, i.e., a DSS for water productivity interventions at different scales and a water storage diagnostic tool. These tools address nonlinearities in productivity at system level and a mosaic of all forms of water storage options (surface and below ground; natural and engineered). WP2 supports the development of these tools at different scales, ranging from the transboundary to the national and local levels and will consider appropriate institutions for their implementation that are pro-poor and generate benefits for women, youth and people in marginalized communities.
<i>Work Package geographic scope (global/region/country)</i>	<p>Ganges Basin: Eastern Gangetic Plains, Haryana, western UP in India; Western (with TAFSSA Initiative) and Eastern Nepal</p> <p>Indus Basin: Southern Punjab and Rodkohi (DG Khan) in Pakistan</p> <p>Blue Nile Basin: Ethiopia (i.e., Beles-Tana basin) and Sudan (Gezira irrigation scheme)</p> <p>Aral Sea, Limpopo and Zambezi Basins: Contingent on funding.</p>

The science

Climate change, particularly climate extremes causing floods and droughts, require integrated management of water, energy and food systems, particularly in water-stressed regions.¹⁰² Given the integrating role of water across the nexus,¹⁰³ enhancing water productivity, maintaining environmental flows and securing storage across sectors and scales is a prerequisite to unlocking NEXUS Gains. Fragmented productivity research and development approaches mean that landscapes and basins are not managed sustainably, thereby jeopardizing ecosystem health and undermining water, food and energy security. This contributes to wasting natural resources and lowers water, land, energy and labor productivity which too often lead to competition and conflict between resource users, weaken rural livelihoods and produce adverse spillover effects¹⁰⁴.

Research questions	Scientific methods	Key outputs¹⁾
How much water storage do we have, how has it been changing, how effectively has it supported productive uses, and how much of what types will we need in the future?	<p>Assess water storage of all possible stores and spatial and temporal trends at basin level (to be defined indicators).</p> <p>Map water productivity using latest Earth observation data (Sentinel data,¹⁰⁵ FAO-WaPOR,¹⁰⁶</p>	Maps of all water stores (natural, engineered, mixed infrastructure) and temporal evolution. A strategic diagnostic to design, evaluate and implement integrated water storage solutions to build WEFE nexus and climate resilience (Innovation 4).

Research questions	Scientific methods	Key outputs¹⁾
	<p>Digital Earth Africa¹⁰⁷ and field observations for pattern analysis (e.g., land-use changes, past agricultural interventions; various system productivity indices), evolution of biomass and water use over time.</p> <p>Coupled with socioeconomic data to assess current/future storage service needs and co-development of future development pathways.</p>	
How can WEFE interventions improve water productivity at local/farm, watershed and river basin scale considering whole-system productivity?	Literature reviews of existing tools to assess system-level water productivity. Develop DSS to analyze water productivity interventions across agriculture, (agro)forestry, livestock, fisheries and industries across scales. Mapping of system productivity characteristics (water, energy, land, labor).	User-friendly DSS to support (bundled) interventions to boost water productivity from farm to basin scale considering system productivity, synergies and trade-offs (Innovation 5) to guide planning, policies and investments.
What are the implications of alternative investments in water productivity for poor rural women and men?	Analyzing pathways for water productivity enhancements considering gendered impacts for different sectors/uses and whole system productivity and sustainability.	<p>Comprehensive stocktaking of tools, approaches, interventions and experiences in basin water productivity improvement.</p> <p>Improved understanding of gendered impacts of alternative water productivity pathways.</p>
How can basin-level water resource productivity be optimized for cross-sectoral benefits (WPs 1, 3 and 4)	Analysis of the political and socioeconomic contexts and policy frameworks in each basin.	Reports co-developed for each basin outlining development pathways supported by DSS and

Research questions	Scientific methods	Key outputs¹⁾
and enhance climate resilience through understanding the political economy, harmonizing institutions, and formulating effective policies and incentives?	Cross-border assessment methods will be based on transboundary water facility projects. ¹⁰⁸	water storage diagnostic to motivate change within complex cross-country and cross-sector contexts.

¹⁾ Research papers and policy outputs will be published in each category. Illustrative examples will be used for learning modules in WP 5.

Theory of change

Major constraints for boosting water productivity at systems level and sustainable management of water storage in the context of climate change and other challenges are i) the lack of capacity for nexus thinking and coordination regarding productive water use and storage, ii) the difficulty of gathering high-quality data for decision and policy-making considering complex trade-offs, iii) deeply entrenched gender and social inequalities, and iv) the science-policy gap that is seldomly bridged by technical solutions alone. Our TOC assumes that policymakers will be motivated to work more collaboratively across sectors when they have practical and easy-to-use tools and processes that address the day-to-day challenges they face.

Following a nexus approach, WP2 partners will co-develop a decision support system (DSS) to enhance water and system productivity, maps of existing water stores with links to current and future needs by sector, a water storage diagnostic tool, and conduct political economy analyses and socioeconomic assessments.¹⁰⁹

Different priority issues are addressed with different partners in each basin (see TOC figure, consultation reports). The assumptions are that technical partners will be motivated by the opportunity to co-develop and use nexus tools and public sector partners by the chance to acquire up-to-date planning and guidance tools that improve water and system productivity. The main risk is that while the resulting DSS and diagnostic tools are technically robust, they do not meet the needs or match the capacities of planners and policymakers, or that data availability/quality prevents confidence in results in certain areas.

The research will focus on how changes in cross-sectoral water use can optimize basin water productivity considering agriculture as well as other sectors, how nexus interventions can boost water productivity at different scales benefiting rural men and women, how to best manage water storage options now and in the decades ahead, and how to engage planners, policymakers and investors.

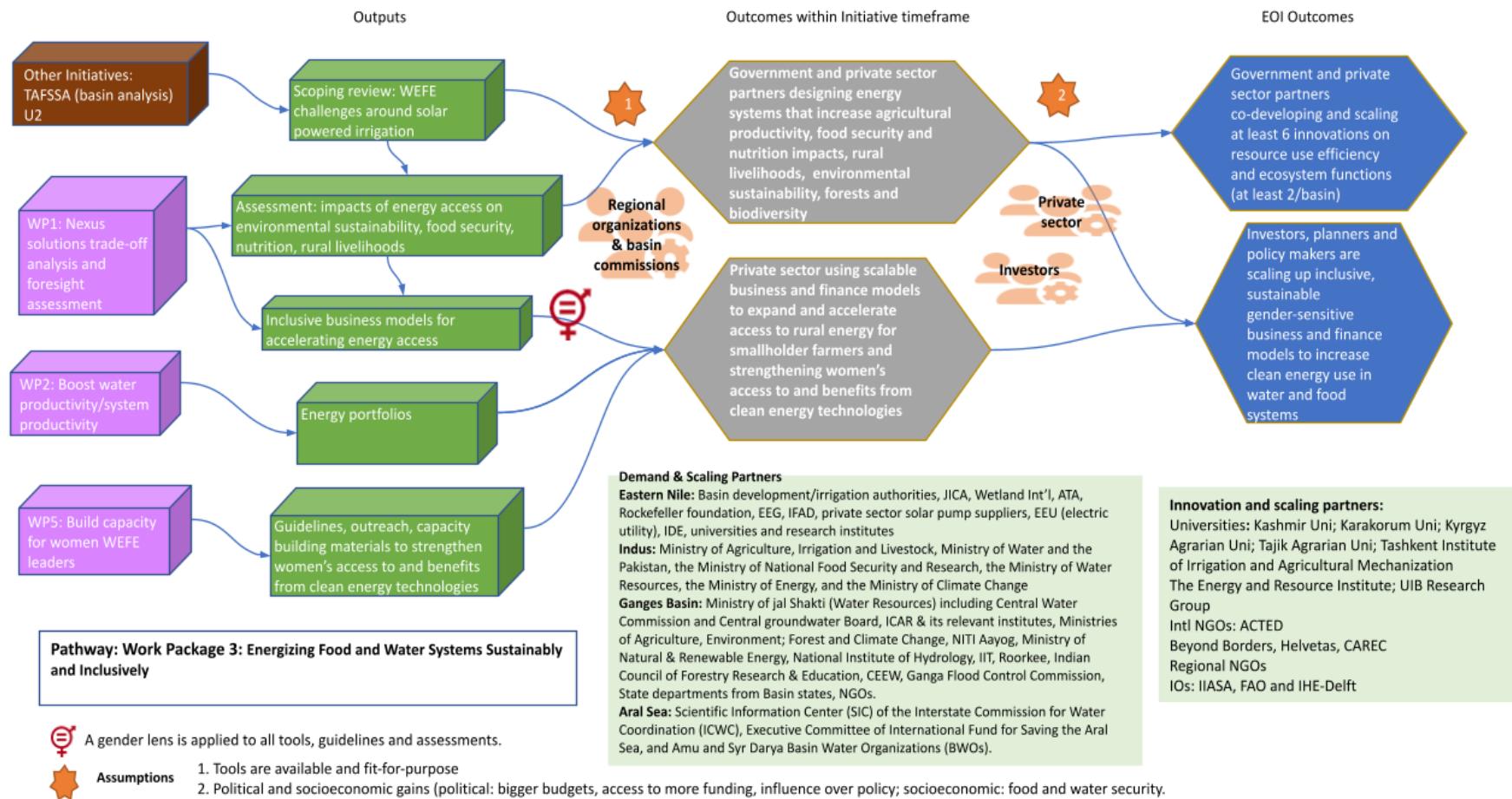
The main research outputs are a comprehensive stocktaking of tools, approaches and experiences in basin water productivity improvement, a user-friendly DSS to plan and test interventions to boost water productivity at basin scale, and a diagnostic tool to design, evaluate and implement integrated water storage solutions to build resilience to climate change. Capacity development (WP5) ensures women, youth and marginalized groups are involved in developing and using DSS and diagnostic tools.

Scaling requires that planners and policymakers understand how these tools have practical applications in terms of improving water use and integrated storage management and can reliably inform investment decisions. Scaling strategies will be informed by continuous Scaling

Readiness monitoring to support uptake (see section 4). Research shows one proven approach is to involve them early in the development process through science-policy dialogues (WP4) and innovation platforms.¹¹⁰ Involving planners and policy-makers is based on an assumption that, “*Evidence use is inherently political. It is often constrained in low and middle-income countries by authoritarian, politicized and fragmented institutions, which are hobbled by financial constraints [and] low technical or policy experience among civil servants*”.¹¹¹

Assuming the science-planning/policy gap can be bridged, the intention is to co-develop at least two nexus solutions on resource use efficiency supporting ecosystem functions in each target basin and to have generated evidence for effective basin-specific approaches to continued improvements to water productivity to achieve EoI Outcome 2. Next-level outcomes include the use of tools for planning, management and investment decisions in other basins of Africa and Asia.

WP3: Energizing food and water systems sustainably and inclusively



<p><i>Work Package main focus and prioritization</i></p>	<p>WP3 co-develops scalable business and finance models for accelerated inclusive access to clean energy for food and water systems with a focus on women and other marginalized groups. It will work in rural areas of the eastern Nile and Indus/Ganges regions and assess systems impacts of alternative energy solutions.</p> <p>The private sector plays a central role in co-developing and scaling innovations, while policymakers provide an enabling environment. Energy investors will benefit from guidance on identifying productive users and uses (i.e., irrigation/agro-processing) and on strengthening inclusion and sustainability.</p>
<p><i>Work Package geographic scope</i></p>	<p>Ganges Basin: Learning from and deepening the solar irrigation development in India (0.2 M solar pumps, ~10 million electric/diesel pumps). In Nepal, focus on how renewable energy (micro-hydro, solar and biomass) can support gender equality and women's empowerment.</p> <p>Indus Basin Southern Punjab and Balochistan, Pakistan: Groundwater over-use, hotspot regions using dirty fuels (1.0 million diesel pumps, close to zero solar pumps) and a poverty hub. Focus on sustainable groundwater management and clean energy access for the agriculture sector.</p> <p>Blue Nile: Ethiopia with very limited rural electricity access, around 30%, which affects food production and rural growth; Sudan to support solar irrigation development for small-scale farmers (Gezira irrigation scheme and possible other schemes).</p> <p>Aral Sea Basin: Contingent on funding</p> <p>Limpopo and Zambezi Basins in southern Africa: Contingent on funding</p>

The science

Lack of energy access hampers agricultural productivity, stymies agri-businesses, stunts agricultural growth, limits the production of nutritious, high-value foods, disempowers women, leads to deforestation and GHG emissions, and jeopardizes overall ecosystem health and biodiversity.^{112,113,114,115} For example, in India, groundwater irrigation is estimated to account for 8-11% of total GHG emissions.¹¹⁶ However, the full system impacts of alternative energy portfolios in rural areas remain unknown.

Solar irrigation systems (on-grid and off-grid solutions) in parts of India have led to significant improvements in water access for smallholder farmers, reduced dirty fuel use, and increased rural incomes.¹¹⁷ However, expanded groundwater dependence has degraded resources and sometimes reinforced social inequity.¹¹⁸ This provides important lessons for other areas in Asia and Sub-Saharan Africa where solar pump use is growing rapidly from a low base. Moreover, evidence suggests that women are less likely to access, and benefit from, clean energy technologies.¹¹⁹

Mitigating climate change requires low-carbon development pathways for food and water systems¹²⁰ and clean energy solutions (e.g., solar, (micro)hydropower, wind or bioenergy) are paramount. However, ways to accelerate rural clean energy access while realizing social, economic and environmental co-benefits and minimizing trade-offs need to be identified and scaled.

Research questions	Scientific methods	Key outputs ¹⁾
What rural energy portfolios and business and finance models best support and accelerate rural clean energy access for food system transformation and environmental sustainability?	<p>Aiming for transformative change through action research (including co-developing and piloting models) supported by</p> <ul style="list-style-type: none"> ● econometric analysis to assess (gendered) impacts of energy access ● case studies of recent energy finance and business models and related policies and institutions ● choice experiments (consumer and provider preferences on finance and business models) ● simulation modeling of alternative rural energy portfolios¹²¹ 	<p>Understanding of impacts of rural energy access portfolios (comprehensive footprint analysis) for key 1CG IA indicators and rural livelihoods</p> <p>Case studies of guidelines in use by next users (at least one per basin)</p> <p>Field-tested and prioritized business and finance models and guidelines for use (Innovation 6)</p>
How can solar-powered irrigation enhance agricultural production while supporting groundwater sustainability, inclusion, economic growth and ecosystem health?	<p>This research involves:</p> <ul style="list-style-type: none"> ● pilot testing of interactive tools¹²² and business models¹²³ ● combined biophysical and economic simulation modeling using multi-criteria analyses ● qualitative & quantitative studies with women solar irrigators 	<p>Prioritized solar irrigation interventions that directly support at least 3 solar irrigation programs (e.g., WE4F, solar missions of India and Pakistan, etc.)</p> <p>Documented change of WEFE policies in at least one country</p>
What are effective pathways for women to access renewable energy in ways that strengthen their agency and entrepreneurship?	<p>Action research (innovation platforms), intra-household quantitative and qualitative analyses</p> <p>Comparative analysis and synthesis of case studies in Ethiopia¹²⁴, India, Nepal, Pakistan</p>	<p>Case studies to provide most significant change stories for policy support and capacity building (WP5).</p> <p>Guidelines for strengthening women's empowerment and entrepreneurship</p>

¹⁾ Research papers and policy outputs will be published in each category. Illustrative examples will be used for learning modules in WP 5.

Theory of change

The key challenge for accelerating clean energy access in rural areas is the siloed development of rural energy, agriculture and water systems. Energy actors do not coordinate with agrifood system and water sector actors and a large share of their clients, particularly poor rural women and men, are priced out of modern energy services and forced to continue relying on firewood, residues and cow dung (Sub-Saharan Africa, parts of South Asia) or on diesel pumps and generators (parts of South Asia). Our TOC integrates rural agrifood and energy and water development plans and portfolios through joint assessments of integrated, larger impacts and by strengthening women's agency and entrepreneurship.

For this, we work at the national level with nexus ministries, such as the Ministry of Water, Irrigation and Energy of [Ethiopia which has requested CGIAR support](#) to grow rural energy access for agriculture and agrifood systems, including solar irrigation. Sudanese agencies identified solar irrigation development needs in an earlier consultation¹²⁵. Pakistan's energy and water situation is precarious¹²⁶ and solar energy could reduce risks to water and food security. A particular emphasis will be placed on the potential of solar-powered groundwater irrigation systems building on CGIAR's experience in this area.^{127,128,129,130}

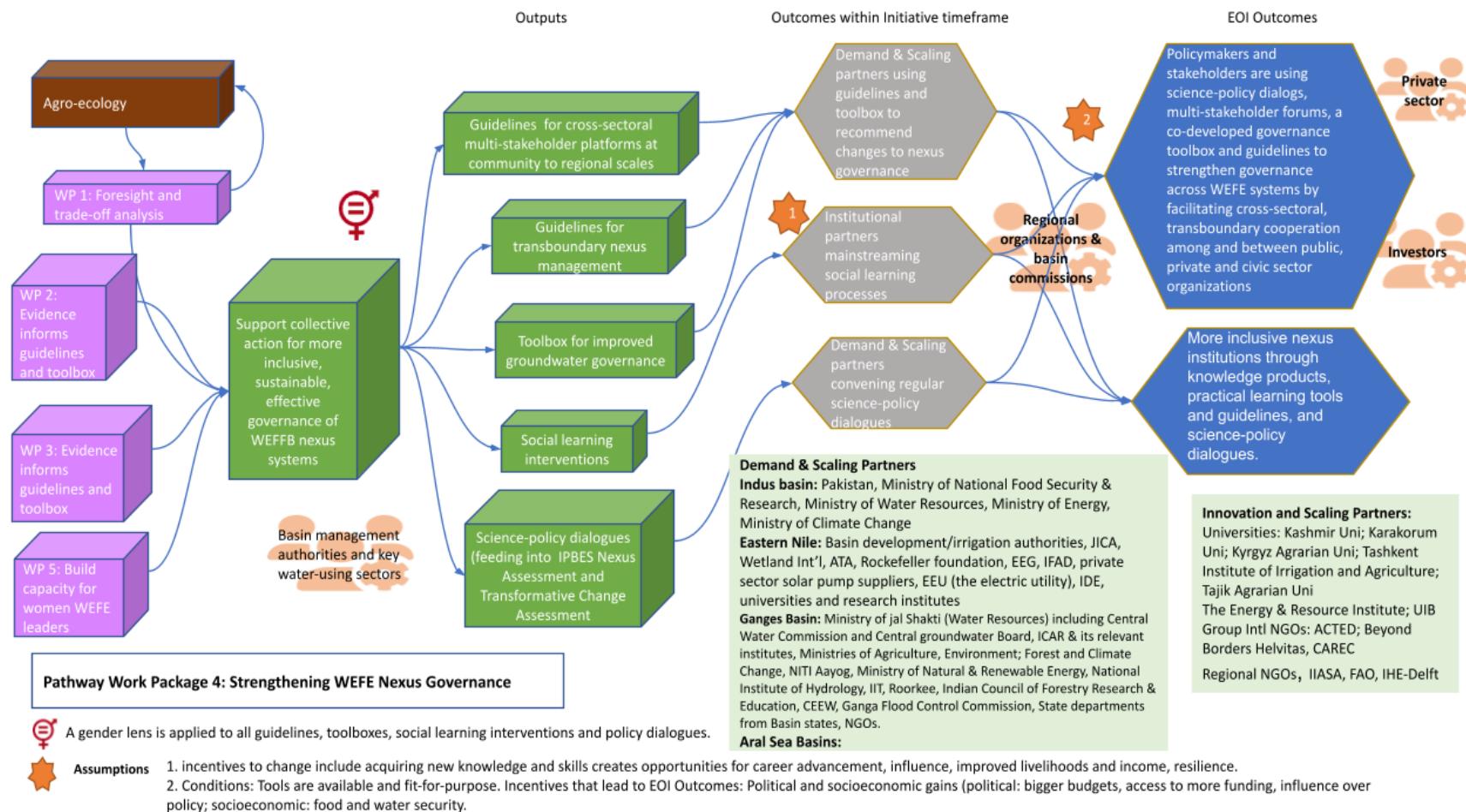
Case studies and gendered business models will be developed with local partner NGOs including, Rural Support Programs in Pakistan, SEWA in India, and with the Center for Energy Studies, Tribhuvan University and HIMAWANTI in Nepal and tested with various private-sector partners, such as WE4F and the national Solar Associations. Our TOC assumes that finance and business models that consider women's needs and constraints can increase their benefit streams from energy technologies. Government, private sector and NGO actors will co-design more optimal energy portfolios for productive agricultural uses assuming that current siloed approaches can be overcome.

Our TOC furthermore assumes that the methodologies used will reflect local, national and transboundary needs and that the business and finance models developed reach poor women and men farmers and entrepreneurs. Research will be coordinated with TAFSSA, U2, MITIGATE+ and CLIMBER and supported by activities and innovations developed in WPs 2 and 4 (see 4.1) to support the transformation of food systems while improving environmental sustainability and significantly increasing the use of clean energy in food systems by 2030. We plan to enroll women policymakers from the three countries in the WP5 leadership program and use the fieldwork as case study materials.

The WP3 scaling strategy (see 4.1) will support next users with a focus on the private sector, national governments and NGOs. At the end of the first three years of NEXUS Gains we expect private investors, policymakers and practitioners to be using scalable energy business and finance models in Ethiopia (Power for All, WE4F, Rockefeller Foundation, ATA, MOWIE), Sudan (Agriculture and Livestock Transformation Agency, Ministry of Water and Energy, NGOs), Pakistan (Pakistan Solar Association, Agriculture Department Punjab, Hisaar Foundation), India (SEWA, TATA Trust, CLARO Energy PVt. and SAARC Energy) and Nepal (government agencies).

Throughout this process, demand, innovation and scaling partners help produce outreach and capacity building materials to strengthen women's access to and benefit from clean energy technologies.

Work Package 4: Strengthening WEFE nexus governance



<i>Work Package main focus and prioritization</i>	WP4 supports collective action for more inclusive, sustainable and effective governance of nexus systems. Innovations include practical guidelines for cross-sectoral multi-stakeholder platforms across community, (sub)national and regional scales, behavioral games, a toolbox for improved groundwater governance, science-policy dialogues and guidelines for transboundary nexus management. NEXUS Gains will build on existing platforms to integrate systems and gender lenses and integrate mechanisms to strengthen the voices of poor people, women, resource-poor farmers, youth and members of marginal communities.
<i>Work Package geographic scope (Global/Region/Country)</i>	<p>Ganges Basin: Whole basin with more detailed analysis of upstream areas in Nepal (Karnali-Mohana and Mahakali basins in Western Nepal, cooperation with TAFSSA) and Koshi basin in Eastern Nepal) and India (Uttarakhand, Ram Ganga sub-basin) and the Eastern Gangetic Basin.</p> <p>Indus Basin Southern Punjab: Groundwater over-use hotspot using dirty fuels, livelihood options are very limited, extreme vulnerability to climate challenge, and poor WEFE security.</p> <p>Blue Nile Basin: Whole basin with parts in Ethiopia and Sudan, respectively</p> <p>Aral Sea Basins: Whole basin with particular focus on Uzbekistan.</p> <p>Limpopo and Zambezi Basins: Contingent on funding.</p>

The science

The lack of good nexus governance at all levels (community to international) leads to continuous degradation of water, food, land and ecosystems, and means that innovative solutions that generate tangible benefits across the WEFE nexus go unrealized. There is a critical need for evidence on how multi-stakeholder platforms and other institutions can improve governance of nexus systems and dismantle sectoral and disciplinary silos that inhibit cross-sectoral synergies and prevent the formulation of coherent policies and effective management across political boundaries.

Research questions	Scientific methods	Key outputs¹⁾
How can multi-stakeholder platforms be adapted to realize nexus outcomes, and what coordination	Work with stakeholders to formulate methods for inclusive collaboration across sectoral, national and other divides (e.g., gender, income level, ethnicity); methods should address who is involved and how, channels of communication, frequency of interaction, and decision-making	Context-specific roadmaps for inclusive stakeholder engagement that contextualize platform roles in advancing nexus innovations Knowledge and learning products (e.g., case studies)

Research questions	Scientific methods	Key outputs¹⁾
mechanisms would be most effective?	processes with periodic evaluation of progress; policy and civil society dialogues strengthen existing ¹³¹ institutions that support nexus innovations	Guidelines for inclusive WFEF-EFE nexus multi-stakeholder forums Established science-policy dialogues at national and regional levels Guidelines for inclusive transboundary stakeholder engagement
How can social learning interventions (e.g., behavioral games) be linked with technical and policy measures to develop inclusive groundwater governance systems?	Action research, such as behavioral games, together with accompanying impact assessment and monitoring of changes in water use to strengthen groundwater governance through bottom-up approaches	Groundwater governance toolbox (Innovation 7) piloted and measures developed to assess impact
How can nexus systems approaches advance the global discourse on systems transformation?	Contribute to IPBES Nexus Assessment ¹³² on the interlinkages among biodiversity, water, food and health in the context of climate change (input WP1); Engage in member state and stakeholder lead dialogues in IPBES Transformative Change Assessment to develop change trajectories (input WP1); Co-organize Science for a Water-Secure World (2022/2023) conference; Co-convene sessions at leading global science/policy meetings	Regional transformative change narrative reports and global IPBES assessments, including a summary for policymakers with related outreach and advocacy Co-host the Technical Support Unit for the IPBES Transformative Change Assessment Co-organized conference ‘Science for a Water-Secure World’ with related online platform; nexus approaches integrated into global research and development programs At least 6 global transdisciplinary science/policy dialogues co-convened with partners

1) Research papers and policy outputs will be published in each category. Illustrative examples will be used for learning modules in WP 5.

Theory of change

WP 4 aims to improve collective and coordinated action for more inclusive, sustainable and evidence-based governance of nexus systems, thereby facilitating policies and investments that enable the transformation of food, energy, and water systems to improve human welfare and regenerate environmental quality.¹³³ Our TOC begins by addressing the significant environmental footprint of agriculture with the aim of transitioning to regenerative practices that produce food and environmental goods (e.g., climate mitigation, reduced pollution, improved water storage). Any approach must consider household, community, and national vulnerability to a range of shocks and changes, entrenched gender and social inequalities, and the lack of timely access to data for decision-making and complex trade-offs.

A major barrier to the adoption of nexus solutions is the political economy surrounding potential solutions.¹³⁴ For example, at the transnational level, inequities in access to resources and economic development can challenge something as simple as sharing data.¹³⁵ At the national level, the political economy of farm subsidies and concerns for farmer livelihoods prevents water tariffs from reflecting the true scarcity value of water, although tariffs could limit or reverse over-use, inefficiency and resource degradation. Sectoral divisions and often contested mandates prevent agricultural, environmental, and energy ministries from working together. Our theory of change assumes that any reforms require a clear understanding of the evolution of nexus incentives and governance mechanisms, as the basis for Initiatives to build collaboration and learning across actors. At the community level, research suggests that social learning interventions can change mental models for managing nexus resources.^{136 137 138} This is particularly important for nexus domains, for example, solar-powered irrigation that removes variable costs of accessing (ground)water resources can lead to rapid depletion of water systems.

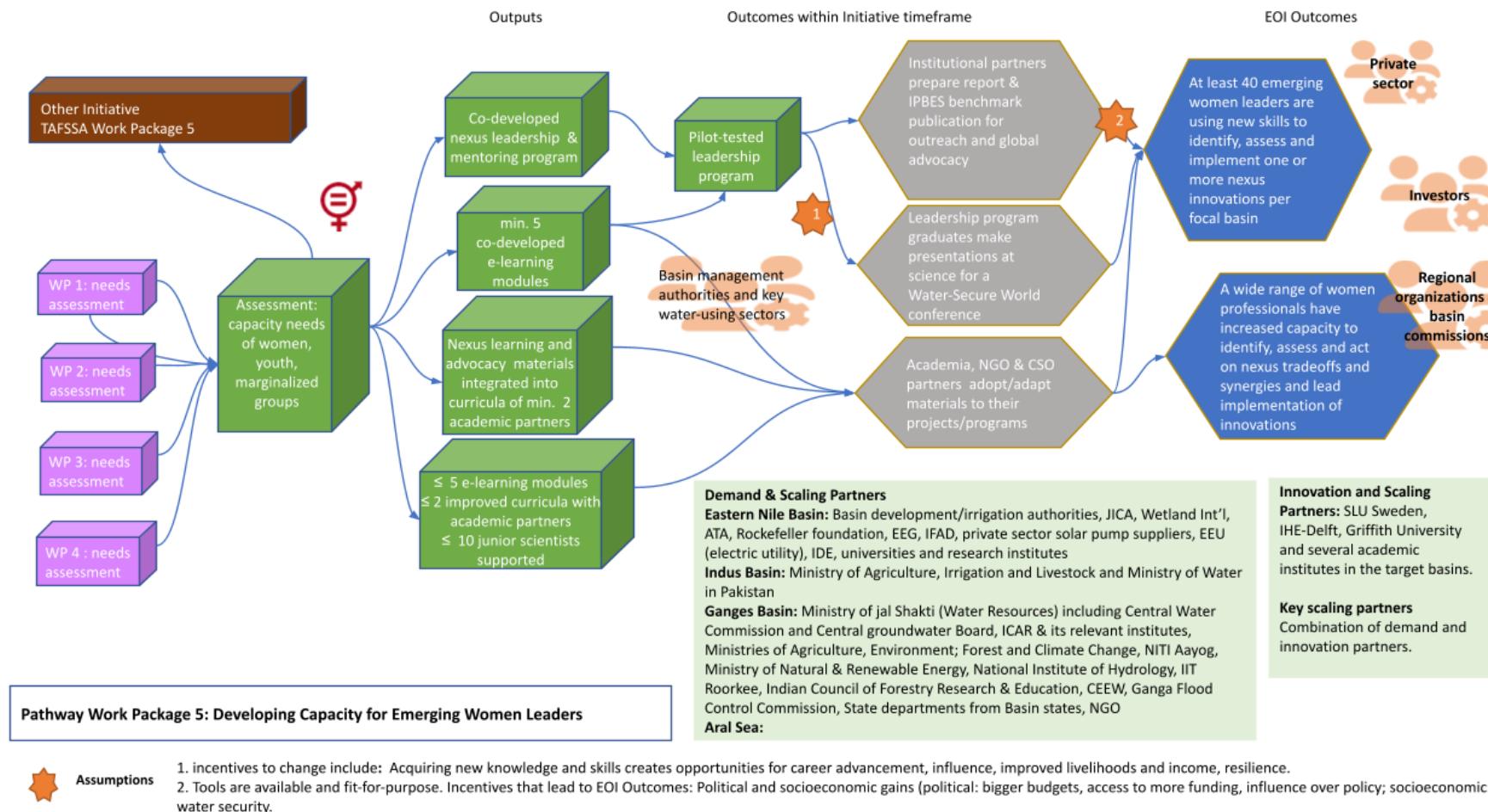
WP4 will support multi-stakeholder platforms and other social learning opportunities to bring together stakeholders across sectors¹³⁹ to co-develop narratives of change, guidelines for cross-sectoral and transboundary nexus management and (ground)water governance with a focus on addressing the differentiated needs of women, youth and members of marginalized groups. The results of this work are a main input to the scenarios proposed in WP1 at sub-basin and basin scale. The main partners are regional, national and local government organizations (agriculture, water, energy, forestry, environment and planning, water and energy), utilities, food system actors, farmer/women/youth associations, universities, the private sector and investors. Multi-stakeholder processes will be used by the public sector, companies, academics and research partners and are linked with tools and processes from WPs 1, 2, 3 and 5. Groundwater boards and communities will use the groundwater toolbox with measurable changes in (ground)water productivity and sustainability (crop yields, sustainable resource use, water quality, multiple-use, etc.), and regular science-policy dialogues are engaging more actors from civil society, including women, youth and marginalized people. We assume that social learning processes create the conditions for demand, innovation and scaling partners to adopt/adapt the toolbox and guidelines for collective action and engage in science-policy dialogues and multi-stakeholder processes.

Moreover, through contributing to the IPBES Nexus Assessment¹⁴⁰ on the links between biodiversity, water, food and health and engaging Member States and stakeholder in dialogues on the IPBES Transformative Change Assessment,¹⁴¹ NEXUS Gains results will feed into global science-policy processes and inform change trajectories for the scenario analysis of WP1. As a co-host of the Technical Support Unit for the IPBES Transformative Change Assessment,¹⁴² NEXUS Gains will work with national focal points from the [UNFSS National Food System Dialogues](#), and IPBES [National Focal Points](#) to coordinate consultations with diverse knowledge holders and develop country scale transformative change narratives. These narratives become inputs into WP1 models, which by iteration with national focal points support the development of evidence-based targets and policies on nexus domains. Through this collaboration with IPBES, the dialogues and assessment results directly feed into global

science-policy recommendations. Co-convening science-policy dialogues will provide an opportunity to advance global progress on nexus approaches and inform policies and investment priorities.

The resulting evidence base will inform WPs 1, 2 and 3 and contribute to measurably improved cross-sectoral groundwater management, a governance environment promoting adoption of nexus innovations, and increased involvement and influence of women, youth, and marginalized groups in nexus governance in the study areas and other basins (next-level outcome).

Work Package 5: Developing Capacity for Emerging WEFE Women Leaders



<i>Work Package main focus and prioritization</i>	WP5 works with researchers, practitioners, and policy- and decision-makers to build technical capacity in co-developing and implementing sustainable and inclusive WEFE nexus innovations, and strengthen women's agency and leadership in multi-stakeholder processes so nexus innovations better respond to the needs and priorities of women, youth and marginalized groups. We will build on current work under the CGIAR GENDER Platform on leadership, mentorship and coaching. WP5 will focus equally on developing technical and leadership skills for emerging women leaders.
Work Package geographic scope	<p>Indus Basin: Pakistan</p> <p>Ganges Basin: Nepal and India</p> <p>Blue Nile Basin: Ethiopia and Sudan</p> <p>Aral Sea Basins: Whole basin with particular focus on Uzbekistan.</p> <p>Limpopo and Zambezi Basins in southern Africa: Contingent on funding.</p>

The science

Lack of capacity is a major obstacle to achieving transformative system changes, particularly in the Global South.^{143,144} Without a combination of technical and soft skills and an enabling environment to implement sustainable and equitable nexus solutions, investments in this area are at risk, and successful scaling and policy design and implementation are unlikely. To develop, implement and scale nexus solutions, researchers, practitioners, and decision-makers need in-depth subject matter expertise as well as soft skills, such as leadership and negotiation capacities, to create an enabling environment for nexus approaches in their institutions. Solidifying skills to plan, implement and manage nexus interventions¹⁴⁵ is particularly important in complex situations characterized by resource limitations and multi-faceted political economies.

Research questions	Scientific methods	Key outputs¹⁾
<p>What capacities are needed to effectively develop and implement inclusive and sustainable nexus interventions?</p> <p>How can we make learning more accessible in often resource-poor environments?</p>	<p>Participatory research analysis of:</p> <ul style="list-style-type: none"> ● capacities needed to scale nexus approaches among key organizations and stakeholders ● impact of different types of capacity strengthening approaches on capacities to influence multi-stakeholder processes and decision-making related to nexus solutions ● experiences with gender-sensitive budgeting 	<p>Cross-sectoral nexus leadership program (Innovation 8)</p> <p>At least 40 trained professionals, with minimum 70% women, able to drive sustainable and equitable nexus solutions</p> <p>Community of Practice/network of professionals working on implementing nexus solutions</p>

<p>How can we bring women's perspectives, capacities and leadership into local, national, regional and global discourses and agendas on systems transformation?</p>		<p>Knowledge products: case studies, success stories, guidelines, advocacy materials, e-learning modules on designing, implementing and scaling integrated solutions</p> <p>At least two curricula of academic partners improved by strengthening nexus lens</p>
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¹⁾ Research papers and policy outputs related to the different research questions will be published.

Theory of change

Women professionals face difficult challenges in exerting influence and progressing in their careers due to cultural norms that persist in the workplace. For instance, women professionals, along with leaders of CSOs and elected women representatives in local government, continue to be marginalized from the process of knowledge production and policy and decision-making.^{146, 147, 148} In government and research institutions, women hit a glass ceiling, but the current narrative of gender equality is often focused on the number of women included rather than the roles they play.

This WP has two primary goals: i) to strengthen capacities to develop and implement nexus solutions among (men and women) stakeholders who have a critical role to play in this area; and ii) to advance gender equality by enhancing women professionals' influence and leadership in this arena. Our theory of change is not to simply 'give' emerging women leaders more knowledge and skills, but to develop a cadre of champions in each basin who have the required leadership and management skills needed to address the discourses of power that limit them. They will be globally connected to a network of change-makers¹⁴⁹ and champion change from local to transboundary scales.¹⁵⁰

Capacity strengthening efforts will target professionals working in ministries and local government organizations, the private sector, financial institutions and investors, agricultural extension services, NGOs and academia. Multiple channels and learning products, developed using user-centered design principles¹⁵¹ will be used to advance knowledge on sustainable and equitable nexus approaches, including online learning courses and curriculum development. The main partners will include SLU Sweden, and academic partners in the focal basins, such as Bahir Dar University in Ethiopia and Khartoum University in Sudan.

In addition, a nexus leadership and mentoring program will be co-designed with partners to support NARS and government officials in this Initiative's focal countries to develop, advocate for, negotiate, and implement sustainable and equitable nexus solutions. The program will include minimum 40 professionals, at least 70% of whom will be women, to advance the second goal of this WP. A participatory capacity needs assessment will help shape the program, and contribute to addressing the WP's research question. Building on and in collaboration with the CGIAR GENDER Platform-AWARD program,¹⁵² the program will include leadership training, mentorship, and coaching, and a component to strengthen technical capacities related to nexus approaches – including placing gender equality and social inclusion considerations at the center of nexus solutions. Participants will form the core of a network of nexus professionals (in each basin, but globally connected)¹⁵³ who will subsequently act as mentors for other practitioners. The network will be nurtured throughout the Initiative and anchored in one of the participating institutes by the end of the Initiative. The pilot program and its effectiveness in advancing nexus approaches in participants'

organizations will be adjusted for subsequent cohorts based on the learnings from its first phase.

The 40 participant professionals will champion at least two nexus innovations on resource use efficiency and WEFE security, and research will examine the efficacy of the espoused capacity strengthening approach for advancing nexus solutions. These emerging leaders will contribute to strengthened governance of nexus systems via social learning, citizen science and multi-stakeholder mechanisms (WP4). They will implement EOI 5, provide leadership in the focal basins, and lead efforts toward next-level outcomes.

4. Innovation Packages and Scaling Readiness Plan

4.1 Innovation Packages and Scaling Readiness Plan

The Scaling Readiness of Nexus Gains innovations varies ([Table 1 Annex 1](#)). Co-design will define the utility of new developments with scaling concepts considered from the beginning. Several innovations build on previous developments, e.g., the [Agrobiodiversity Index](#) (I3) has been promoted and a version of the [Environmental Flow Tool](#) (I2) is used by the UN to develop primary data to evaluate one SDG 6 indicator. [Research on groundwater governance tools](#) (I7) will be further developed and scaled.

NEXUS Gains concentrates on developing capacity and raising awareness about innovations and scaling activities. Innovation teams will articulate a common ambition level and success vision and develop an activity plan per basin. Synergies and co-investments with other Initiatives vary by innovation ([Table 1](#)).

Innovation profile sheets of the eight core innovations ([Table 1](#)) define innovation utility and guide context-specific implementation for basins and user-groups (flowcharts, demo examples, continuously updated; in 2022/2023). To contribute to Innovation Package design, interrelations (including innovations from other Initiatives and programs) will be analyzed and the enabling environment for scaling assessed to support system transformations. Plans to build capacity, inform policies and develop/use supporting technology/products will be outlined in 2023 & 2024. A gender lens is applied to all innovations.

Innovation Packages and Scaling Readiness plans will be continuously assessed using agreed metrics. Monitoring readiness and use levels will guide innovation management and address bottlenecks. Half-yearly reviews will inform activities (e.g., new/different capacity development, roll-out field testing, resource allocation and mobilization), implement supporting activities (e.g., policy briefs, science/policy dialogues) and guide decisions about innovations with low impact potential at scale.

NEXUS Gains will gradually integrate the Innovation Packages and Scaling Readiness approach to 70% of the portfolio following the [second wave](#) starting in Q4-2022. It allocates US\$560,000 to implement the Innovation Packages and Scaling Readiness plan (2022: US\$140,000; 2023: US\$210,000; 2024: US\$210,000). Dedicated activities, deliverables, indicators and line-items are included in the Management Plan, MELIA and Budget Sections.

5. Impact statements

5.1 Nutrition, health & food safety

Challenges and prioritization

NEXUS Gains addresses the underlying environmental, social and policy conditions that enable affordable healthy diets and safe nutritious food production. Healthy, sustainable diets become more widely available and affordable because trade-offs with underlying environmental systems are being assessed supporting more resilient production systems (WP1).^{154 155 156} Water productivity is improved (WP2),^{157 158} and use of clean energy is expanded in irrigation, storage and processing of perishable foods (WP3).¹⁵⁹ Higher and more stable irrigated yields and better storage and processing encourage smallholders to grow more nutritious, high-value crops such as vegetables and fruits for household consumption and sale and improves dietary diversity within households and communities;^{160 161 162} and reduces food loss through affordable cooling and storage facilities and safe food preparation.¹⁶³ More inclusive and sustainable water access, through improved groundwater governance (WP4)¹⁶⁴ increases agricultural productivity, makes food production more resilient and allows for multiple-use options.

Research questions (selected)

1. What interventions can address nexus challenges and promote alternative food production strategies?
2. What are the implications of alternative investments in water productivity for poor rural women and men?
3. What rural energy portfolios and business and finance models best support and accelerate rural clean energy access for food system transformation and environmental sustainability?

Components of Work Packages

WP1 supports planners, policymakers and public/private investors by providing customized foresight and trade-off analysis tools to plan, prioritize, assess and scale nexus interventions and trade-offs across water, energy, food, forest and biodiversity systems.^{165 166} This includes the Agrobiodiversity Index to guide food system sustainability and resilience and a DSS for identifying and prioritizing water productivity investments (WP2). WP3 creates energy portfolios and inclusive business models to expand access to the clean energy needed to expand irrigated food production and food storage and safe processing while maintaining or restoring the ecosystem functions and biodiversity that underpin food systems. WP4 addresses collective action for inclusive and effective governance of WEFE systems, and WP5 focuses on building leadership capacity so that more women, youth and marginalized communities can contribute to the governance of water for food systems.¹⁶⁷

Measuring performance and results

NEXUS Gains will measure changes in nutrition through collecting data on intermediate indicators through case studies, such as the MDD-W and permanent income changes from more productive irrigated production of more nutritious foods in target geographies. Other intermediary indicators measured include information on changes in water productivity, water storage, and changes in access to clean energy technologies for the production, storage and processing of nutritious food.

Partners (Note: more partner details are in the [Table1 in Annex 1](#))

Main partners include government agencies and private sector and grassroots organizations involved in monitoring uptake of NEXUS Gains innovations and changes in intermediary nutrition and health indicators.

Human resources and capacity development of Initiative team: NEXUS Gains will work with agrobiodiversity and nutrition experts, as well as modelers to support foresight and trade-off assessments that consider food security, nutrition and health.

5.2 Poverty reduction, livelihoods & jobs

Challenges and prioritization

NEXUS Gains' policy research and engagement in WEFE systems addresses rural poverty through increasing farm income through better access to clean energy (WP3), higher use efficiency (WP2, WP3), and generation of additional revenue opportunities for women, youth and people in marginalized communities (e.g., [combined irrigation/aquatic food systems](#), [reuse of wastewater](#), [solar power as a remunerative crop](#)).¹⁶⁸ Innovations in energy can generate jobs and income in food production (more irrigation, horticulture, multiple-use systems and food processing).¹⁶⁹ Better access to water and irrigation technology creates livelihood opportunities through more resilient food systems and higher dry-season incomes. Business and finance models (WP3) to scale nexus interventions strengthen entrepreneurship and generate jobs.

Research questions (selected)

1. How can solar-powered irrigation enhance agricultural production while supporting groundwater sustainability, inclusion, economic growth and ecosystem health?
2. What are effective pathways for women to access renewable energy in ways that strengthen their agency and entrepreneurship?
3. What are the implications of alternative investments in water productivity for rural women and men?

Components of Work Packages

NEXUS Gains examines the impacts of alternative rural energy systems on poverty alleviation, job creation and strengthening entrepreneurship. Increasing clean energy access in rural areas (WP3) can be a catalyst for reducing poverty, improving livelihoods and generating jobs.¹⁷⁰ Business and finance models will be developed to scale clean rural energy solutions inclusively and sustainably in close cooperation with the private sector and investors.

Analyses of productive use of water at farm and larger scales that consider other water-using sectors and minimize trade-offs can inform investments in development projects (WP2). Women, youth and people in marginalized communities are in greatest need of opportunities to increase and diversify revenue streams (e.g., water reuse, rice-fish systems, off-season income through irrigation, forestry, off-farm opportunities). The integrated water storage diagnostic (Innovation 5) supports water resources development activities by governments and investors in rural areas leading to jobs for building/rehabilitating infrastructure (grey and green) and operation and maintenance.

Measuring performance and results

NEXUS Gains will monitor policy documents and intermediary indicators to track the number of people benefiting from NEXUS Gains innovations with a focus on income and in Q1 and Q2 of implementation will assess job creation and the number of people assisted to exit poverty as a result of WP2, 3 and 4 using nexus computable general equilibrium models in target geographies (see 2.7).

Partners

Key partners include government agencies across the WEFE nexus committed to reducing poverty, private sector agents focused on providing irrigation and energy technologies, and grassroots organizations involved in improving rural livelihoods.

Human resources and capacity development of Initiative team

NEXUS Gains will work with policy analysts, science-policy interface specialists, livelihoods and specialists, governance specialists, biophysical scientists and macroeconomists to adequately demonstrate progress in this area.

5.3 Gender equality, youth & social inclusion

Challenges and prioritization

There are significant gender gaps in access to natural resources, such as land and water and to technologies, including irrigation and energy technologies.^{171, 172, 173, 174} Deeply entrenched gender and social inequalities exist, and a wide range of barriers need to be overcome to advance the social and economic inclusion of women, youth and people in marginalized communities.

Implementing and scaling WEFE interventions in ways that advance equity and inclusion requires the addition of a gender lens. Toward that end, NEXUS Gains will focus on women, youth and marginalized groups in its WP5 capacity and mentorship programs. Note that men are included in ‘youth’ and ‘marginalized’ groups. NEXUS Gains will also consider how to strengthen women’s agency in the development of guidelines and toolboxes focused on accelerating clean energy access, improving groundwater governance, and supporting cross-sectoral multi-stakeholder platforms building on earlier CGIAR and other work.^{175, 176}

Research questions (selected)

1. What are effective pathways for women to access renewable energy in ways that strengthen their agency and entrepreneurship?
2. How can social learning interventions be linked with technical and policy measures to develop inclusive groundwater governance systems?
3. How can we bring women’s perspectives, capacities and leadership into local, national, regional, and global discourses and agendas on systems transformation?

Components of Work Packages

Nexus assessment tools (Innovation 1) are designed to make results accessible to all stakeholders (WP1.) The water productivity analysis pays special attention to the socioeconomic impacts on poor rural women and men (WP2).

WP3 will analyze the impacts on poverty alleviation and gendered benefit streams of alternative rural energy systems. Improved energy access will support wellbeing and socioeconomic development including new jobs for women, youth and marginalized communities in renewable energy and agro-processing. Central components of the research ask to what extent increasing access in rural areas can support social inclusion and strengthen women’s empowerment and entrepreneurship. The program will co-develop inclusive business and finance models (Innovation 6) to scale clean rural energy solutions.

WP4 addresses how multi-stakeholder processes and science-policy dialogues can improve inclusive nexus governance (WP4). The capacity and mentorship programs in WP5 will be exclusively for women, youth and people in marginalized communities.

Measuring performance and results

NEXUS Gains WP5 will directly support at least 40 emerging women leaders in government, private sector, investors, academia and research institutions, CSOs and NGOs with new skills to identify, assess and implement one or more WEFE innovations per focal basin. The number of women benefiting will be tracked. Impact evaluations and choice experiments used to understand gendered impacts of the groundwater governance toolbox elements and gendered needs around energy finance and business models.

Partners

Partners include grassroots women's organizations who directly work with women farmers and entrepreneurs; ABC, which leads the capacity building program together with regional partners, the private sector that has shown a strong interest in strengthening women's agency through increased access to and benefits from energy and irrigation technologies; and governments that are committed to increased inclusion.

Human resources and capacity development of Initiative team

To ensure progress on gender equity, youth and social inclusion, NEXUS Gains will liaise with the GENDER Platform and HER + and will include two dedicated gender specialists, and all other researchers will be supported on strengthening gendered and youth-focused analytical approaches.

5.4 Climate adaptation and mitigation

Challenges and prioritization

Investments in climate-smart solutions require scientific evidence of the impacts across a range of sectors. Co-benefits and trade-offs need to be quantified in terms of water use, food production, energy use and ecosystem functions (e.g., carbon sequestration, biodiversity) as well as social impacts to ensure that climate investments are effective and do not jeopardize the sustainability and resilience of the whole system (WP1). This evidence informs National Adaptation Plans and Nationally Determined Contributions to support the Paris Agreement. Reduced fossil fuel intensity of water and food systems and increased access to clean energy solutions reduce GHG emissions. Innovative financial models are needed to scale inclusively and sustainably (WP3).¹⁷⁷

Increasing water storage is critical for climate change adaptation and resilience to floods and droughts, but storage capacity is shrinking due to ecosystem degradation and sedimentation of reservoirs (WP2). Effective investments are needed to address the increasing global water storage gap,¹⁷⁸ respond to societal needs and unlock socioeconomic development in rural areas.

Research questions

1. How much water storage do we have, how has it been changing, how effectively has it supported productive uses, and how much will we need in the future (WP2)?
2. How can basin-level water resource productivity be optimized for cross-sectoral benefits (WP 1, 3 and 4) and enhance climate resilience through understanding the political economy, harmonizing institutions, and formulating effective policies and incentives?
3. How can solar-powered irrigation enhance agricultural production while supporting groundwater sustainability, inclusion and ecosystem health?

Components of Work Packages

Climate change will increase water scarcity in all focal basins.¹⁷⁹ The right tools in the right hands can increase water productivity across scales and sectors (Innovation 5) and improve resource efficiency for adaptation (WP1, 2, 3). The water storage diagnostic (Innovation 4) will guide public/private investments in water storage technologies and management systems that can cope with the expected increase in hydrological variability and extremes while ensuring food, energy and water systems functioning for people and ecosystems.

Investment decisions are better informed through quantification of co-benefits and trade-offs of climate-smart solutions and making complex analysis results accessible for policymakers, planners and investors with customized assessment tools (Innovation 1; WP1). For example, the carbon sequestration potential of reforestation can be assessed in terms of the impacts on erosion control, land restoration, downstream water availability, nutrient budgets, biodiversity and livelihoods.

WP3 will analyze impacts on poverty alleviation and gendered benefit streams of alternative rural energy systems. Improved energy access will support wellbeing and socioeconomic development including new jobs for women, youth and people in marginalized communities in renewable energy and agro-processing.

Central components of the research explore how increasing access for rural areas can strengthen social inclusion and entrepreneurship by co-developing business and finance

models (Innovation 6) to scale clean rural energy solutions to reduce GHG emissions using solar irrigation systems, micro-hydropower and biofuels and increase the net carbon sequestration of agriculture and forest systems (WP3).

Measuring performance and results

The NEXUS Gains monitoring systems will track climate-adapted innovations in use, as well as changes in GHG emissions from the adoption of clean energy technologies, such as solar pumps. NEXUS Gains particularly focuses on benefiting women with more resource-efficient technologies and institutions that reduce resource access risks.

Partners

Partners include the ministries of environment and climate change agencies in all focal countries and regions. NEXUS Gains is reaching out to MITIGATE + and CLIMBER for integrative adaptation and mitigation measurements and will continue to engage with UN processes, including the Alliance on climate-resilient development pathways. Strong links with local NGOs, including those focused on forest uses, and private sector actors will support increased access to clean energy technologies.

Human resources and capacity development of Initiative team

NEXUS Gains will include or partner with hydrologists, climate scientists and energy economists as well as specialists in land-use planning and restoration, forest conservation, climate-smart agriculture

5.5 Environmental health and biodiversity

Challenges and prioritization

Retaining key ecosystem functions and services is essential for agro-ecosystems¹⁸⁰. To stay within planetary and regional environmental boundaries means i) optimizing consumptive water use in food production (>80% of freshwater withdrawals are consumed in agriculture) and increasing water productivity across scales, ii) contributing to net-zero deforestation and sustainable re/afforestation, and iii) minimizing agricultural pollution from agrochemicals (e.g., safe wastewater reuse or integrated landscape planning).¹⁸¹

Development and use of the latest Earth observation data and new digital tools are needed to support environmental sustainability and biodiversity. Co-design and developing capacity to use these tools are critical to effective uptake by planners and policy-makers responsible for national policies and strategies.

State-of-the-art tools are needed to monitor and manage biodiversity at the country and river basin scale. Environmental flow assessments 'ground-truthed' by local partners will offer insights into river biodiversity and identify potential pathways to satisfying domestic, industrial, agricultural and hydropower water needs while safeguarding ecosystems and biodiversity. An Agrobiodiversity Index offers insights into the relationships across the food system and helps identify priority interventions.

Research questions (selected)

1. How can changes in biodiversity be evaluated at basin and national scales?
2. How can WEFE interventions improve water productivity at local/farm, watershed and river basin scale considering whole-system productivity?
3. How can nexus systems approaches advance the global discourse on systems transformation?

Components of Work Packages

WP1 will develop tools to manage biodiversity outcomes at basin and country scale through developing and scaling an environmental flow assessment tool combined with integrated basin modeling (Innovation 2) and the Agrobiodiversity Index that integrates 22 indices across the food system (Innovation). Integrated foresight and trade-off analyses help prioritize and scale WEFE solutions and support policymaking and investment decisions.

NEXUS Gains will also directly contribute to the IPBES Nexus Assessment on the interlinkages among biodiversity, water, food and health in the context of climate change; and engage in the IPBES Transformative Change Assessment.

Measuring performance and results

NEXUS Gains will use foresight and trade-off methodologies to explore potential impacts on consumptive water use from alternative food system trajectories, in collaboration with Foresight and Metrics. The WaPOR and other tools will be used to trace actual changes in consumptive water use. Changes in biodiversity indicators will be tracked through engaging next users on the scaled Agrobiodiversity Index, and estimates of area with improved soil health and biodiversity will be undertaken in year 2. Government partners and river basin organizations will be engaged on the Environmental Flow Tool. Area under improved management will be tracked as will intermediate indicators on changes in uptake of energy and irrigation technologies.

Partners

Partners include public environmental agencies in all focal regions, as well as ABC supporting the Agrobiodiversity Index, the Agroecology Initiative, and the Foresight and Metrics Initiative. Collaboration with IPBES will further strengthen research breadth and impacts.

Human resources and capacity development of Initiative team

NEXUS Gains will work with ecologists, environmental flow specialists and hydrologists, remote sensing and GIS specialists, forestry specialists, agricultural economists, sociologists, science-policy interface specialists to achieve progress in this Impact Area.

6. Monitoring, evaluation, learning and impact assessment (MELIA)

6.1 Results framework

Impact Areas				
Nutrition, health and food	Poverty reduction, livelihoods and jobs	Gender equality, youth and social inclusion	Climate adaptation and mitigation	Environmental health and biodiversity
Collective global 2030 targets				
The collective global 2030 targets are available centrally here to save space.				
Common impact indicators that your Initiative will contribute to and will be able to provide data toward				
#people benefiting from relevant CGIAR innovations #change in Minimum Dietary Diversity score for Women	#people benefiting from relevant CGIAR innovations #people assisted to exit poverty	#women benefiting from relevant CGIAR innovations #youth benefiting from relevant CGIAR innovations	# tonnes CO ₂ equivalent emissions (WP3); # plans with evidence of implementation (WP1); # \$ climate adaptation investments (WP1, 3); #people benefiting from climate-adapted innovations (WP1-5)	# ha under improved management (WP2) # km ³ consumptive water use (WP2)
SDG targets				
2.1, 2.3, 2.4, 3.9	1.4, 8.2, 8.3	4.7, 5.5, 16.7, 17.9, 17.16	7.1, 13.1, 13.b	6.3, 6.4, 6.5, 6.6, 6.A, 12.2, 15.1, 15.2, 15.5
Systems Transformation				
Action Area outcomes and indicators				
<ul style="list-style-type: none"> ST 1 - Farmers use technologies or practices that contribute to improved livelihoods, enhance environmental health and biodiversity, are apt in a context of climate change, and sustain natural resources ST 3 - Governments and other actors take decisions to reduce the environmental footprint of food systems from damaging to nature positive ST & RAFS 1 - Smallholder farmers implement new practices that mitigate risks associated with extreme climate change and environmental conditions and achieve more resilient livelihoods 		<ul style="list-style-type: none"> STi 1.1 - Number of farmers using climate-smart practices disaggregated by gender STi 1.3- Measurable implications of adoptions such as production, profitability, input use, product quality and associated price, environmental and health damage avoided, livelihood, employment and so forth STi 3.2 Area under improved water use plans (or water use efficiency measures – more ambitious and longer term) STRAFSi 1.1 Number of smallholder farmers who have implemented new practices that mitigate climate change risks, disaggregated by gender and type of practice 		

- | | |
|---|--|
| <ul style="list-style-type: none"> • ST & RAFS 2 - National and local governments utilize enhanced capacity (skills, systems and culture) to assess and apply research evidence and data in policy-making process • ST & RAFS & GI 1 Women and youth are empowered to be more active in decision-making in food, land and water systems | <ul style="list-style-type: none"> • STRAFSi 2.1 Number of policies/ strategies/ laws/ regulations/ budgets/ investments/ curricula (and similar) at different scales that were modified in design or implementation, with evidence that the change was informed by CGIAR research • STi 1.1 - Number of farmers using climate-smart practices disaggregated by gender |
|---|--|

Initiative and Work Package outcomes, outputs and indicators ¹⁾											
Result type	Result	Indicator	Unit of measurement	Geographic scope	Data source	Data coll. method	Frequency /collection	Baseline value (O)	Baseline year (O)	Target value	Target year
Output	1.1 Interactive tool (I1)	Data Assets	Number	Ganges, Indus, E. Nile, Aral Sea basins	Policy documents		Semi-annually			4	2024
Output	1.2 E-flow tool (I2)	Data Assets	Number	Indus	Policy documents		Semi-annually			1	2024
Output	1.3 Agrobiodiversity Index (I3)	Data Assets	Number	Ganges, Indus, E. Nile	Policy documents		Semi-annually			5	2024
Output	1.4 ISI articles	Data Assets	Number	All basins	Repositories		Semi-annually			4	2024
EOI Outcome 1	Prioritized WEFE nexus interventions	Policies	Number	Ganges, Indus, E. Nile	Policy documents		Semi-annually	0	2021	3	2024
Output	2.1 Water storage diagnostic (I4)	Data assets	Number	Ganges, Indus, E. Nile	Reports		Semi-annually			3	2024
Output	2.2 Water productivity decisions support system (I5)	Data assets	Number	Ganges, Indus, E. Nile	Tools		Semi-annually			3	2024
Output	2.3 Gendered impacts of WP pathways	Data assets	Number	Ganges, Indus, E. Nile	Reports		Semi-annually			3	2024
Output	2.4 ISI articles on WP2 outputs	Data assets	Number	Ganges, Indus, E. Nile	Repositories		Semi-annually			4	2024

EOI Outcome 2	WP2 tools used by next users in 3 basins	Policies	Number of tools used	Ganges, Indus, E. Nile,	Policy documents		Semi-annually	0	2021	3	2024
Output	3.1 Business and finance models (16)	Data assets	Number of tools	Pakistan, India, Ethiopia, Nepal	Online documents		Semi-annually			3	2024
Output	3.2 Case studies of tested models	Data assets	Number	Pakistan, India, Ethiopia	Primary field data, econometric analysis	Household and investor data	Semi-annually			4	2024
Output	3.3 Inclusive solar intervention studies	Data assets	Number	Pakistan, India, Ethiopia, Sudan	Primary data	Qual & Quan surveys	Semi-annually			4	2024
Output	3.4 ISI articles on impacts of alternative energy portfolios	Data assets	Number	Various	Repositories		Semi-annually			3	2024
EOI Outcome 3	WP3 results in use in 3 basins	Policies	Number	Indus, Ganges, Eastern Nile	Policy documents		Semi-annually	0	2021	2	2024
Output	4.1 Guidelines for inclusive WEFE Nexus multi-stakeholder forums	Data assets	Number	Global	Online tool	Qualitative data	Semi-annually			1	2024
Output	4.2 Established science-policy dialogues at national/local levels	Institution	Number	Pakistan, Ethiopia, India, Nepal	Policy documents		Semi-annually			4	2024
Output	4.3 Guidelines for inclusive transboundary	Data assets	Number	Ganges, Indus, E. Nile, Aral Sea Basin	Online tool		Semi-annually			1	2024

	stakeholder engagement										
Output	4.4 Groundwater governance toolbox (I7)	Data assets	Number of tools used and impacts	Ganges, Indus, Ethiopia	Primary data	Community and household surveys	Semi-annually			3	2024
Output	4.5 IPBES report	Data asset	Number of reports, media hits	Global	Repositories, media	-	Semi-annually			2	2023
Output	4.6 ISI articles	Data assets	Number	all basins	Repositories	-	Semi-annually			4	2024
EOI Outcome 4	Policymakers and stakeholders are using governance tools.	Policies	Number of policies	Ganges, Indus, Eastern Nile	Policy documents, local governance rules, etc.		Semi-annually	0	2021	3	2024
Output	5.1 Cross-sectoral nexus leadership program (Innovation 8)	Capacity development	Number trained (women)	All basins	Internal documents		Semi-annually			40 (28)	2024
Output	5.2 Community of practice	Capacity development	Number participating (women)	All basins	Internal documents		Semi-annually			100 (50)	2024
Output	5.3 Curricula updated	Capacity development	Number of curricula updated	2 universities in the basins	Online documents		Semi-annually			2	2024
EOI Outcome 5	NEXUS Gains innovations strengthen capacity of female WEFE decision-makers	Policies	No. of policies	All basins	Policy documents, media, reports, various		Semi-annually	0	2021	3	2024

Innovation Package and Scaling Readiness Plan	Documented scaling ambition, vision of success and Scaling Readiness roadmap	No. of Core Innovations	No. of assessment reports	Ganges, Indus, E. Nile, ASB	Primary data		Once at the beginning of the innovation development			8	2022 (#2) 2023 (#3) & 2024 (#3)
Innovation Package and Scaling Readiness Plan	Evidence-based Scaling Readiness assessment reports and related scaling strategies for Innovation Package	No. of Initiative Innovation Packages	No. of assessment reports	Ganges, Indus, E. Nile, ASB	Primary data		Once per year			8	2022 (#2) 2023 (#3) & 2024 (#3)

¹⁾ Table provides only an overview of main outputs and outcomes due to space limitations.

6.2 MELIA plan

To support Monitoring, Evaluation, Learning and Impact Assessment (MELIA), NEXUS Gains will develop a detailed plan of activities and outputs during the first three months following the start of the Initiative, expanding on Table 6.1. This detailed performance management plan (a key element of the Plan of Work and Budget) will be used to report annual progress against Initiative's and Work Package Theories of Change, and every six months to reflect on achievements, identify learnings and needed course corrections, and then update theories of change, indicators, and planned outputs across pathways to impact using adaptive management (see also 7.1).

The process will focus on users, utilization and accountability to ensure efficiency and effectiveness and emphasizes adding value and creating space for learning. All MELIA activities will be integrated into each Work Package in each basin. NEXUS Gains will also contribute to the integrated online ICT and knowledge management platform expected to be in place from mid-2022 onwards. Risk monitoring is part of the annual reflection on theories of change. Assumptions and risks will be reviewed, refined and adjusted.

Partner and basin activity performance will be monitored using data on a) quantity and quality of research outputs; b) degree to which gender and social inclusion are mainstreamed in research activities; c) degree to which partnerships and capacity development are embraced; d) appropriateness and depth of engagement initiatives; e) appropriateness and quality of communication activities; and f) ability to mobilize resources that help deliver outcomes. The Initiative Program Management Committee will use MELIA results to redirect budget allocations to achieve objectives with the greatest efficiency.

Key process learning questions include:

- Do the proposed assumptions along Work Package impact pathways remain valid or need to be updated?
- To what extent do NEXUS Gains activities and outputs address demands expressed at national and basin levels on WEFE challenges?
- What interventions can strengthen women's agency in WEFE policies, planning and implementation?

NEXUS Gains has identified several in-depth studies that will form an integral part of the research process to test assumptions and explore theory of change pathways through foresight and review studies and impact assessment studies. These studies will complement CGIAR commissioned independent evaluations and impact assessment studies. We plan to develop synergies with TAFSSA, U2 and possibly other Initiatives once their planned study details become clearer.

Key evaluation questions include:

- What are the main policy processes through which cross-sectoral collaboration at national and transboundary levels can be strengthened?
- What is the impact of groundwater governance interventions in Ethiopia/Eastern Nile and Pakistan/Indus on food security and nutrition, women's agency, and water use??
- What are the outcomes (benefits, empowerment) from the NEXUS leadership program?

Data collected as part of WP activities will be used in future impact assessments, for example, on the impact of gender-sensitive clean energy finance and business models on women's agency and key CGIAR impact indicators.

6.3 Planned MELIA studies and activities

Type of MELIA study or activity planned	Impact indicators	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
Ex-ante, baseline and foresight study (WP3, linked to WP2)	# people assisted to exit poverty # women assisted to exit poverty # poor people benefiting from relevant innovations	Across the key intervention basins in 2022		These studies will use general equilibrium modeling tools to better understand the poverty reduction impacts of NEXUS Gains interventions to improve the projected benefit assessments. They will also support innovation design (business models, I6) and scaling plans.
Ex-ante, baseline and foresight study (WP1, links to WP2)	# people benefiting from relevant CGIAR innovations # women benefiting from relevant CGIAR innovations # youth benefiting from relevant CGIAR innovations	One in 2023 and one in 2024	We will engage with TAFSSA and U2 in these activities	These studies will directly inform prioritization of WEFE nexus interventions and guide innovation development (I1-3).
Impact assessment (WP2-4)	# people benefiting from relevant CGIAR innovations # women benefiting from relevant CGIAR innovations # people benefiting from climate-adapted innovations # tonnes CO2 equivalent emissions # ha under improved management (WP2) # km ³ consumptive water use in food production (WP2)	2024 and beyond	We will engage with TAFSSA on groundwater-related governance research in South Asia; a second study takes place in Ethiopia (see also 4.4 in Table 6.1)	Understanding the impact of groundwater governance interventions in Ethiopia and Pakistan will be complemented by learnings from activities in India and Nepal (Solar-SA) and answer key WEFE questions
Qualitative outcome study (WP1)	# WEFE nexus plans with evidence of implementation	One in 2024	We will engage with TAFSSA, U2 and national	This study will support scaling innovations (I1-3) and the development

Type of MELIA study or activity planned	Impact indicators	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
	# \$ climate adaptation investments		strategies and policies on this.	of phase 2 of NEXUS Gains.
Scaling Readiness assessments (WP1-5)	# people benefiting from relevant CGIAR innovations	4 in 2023 and 4 in 2024	We will engage with TAFSSA and U2 as well as Foresight & Metrics and Harnessing Digital Technologies for some innovations.	Scaling Readiness assessments underlie achievement of the theory of change and 2030 impacts and are used for internal learning, scaling improvement, and Initiative performance management.
Project review (WP1-5)	# km ³ consumptive water use in food production	2023/24	We will engage with TAFSSA for this review.	Assessment of implementation of e-flow assessment in the Indus basins; the basis for refinement of the methodology and up/out-scaling for NEXUS Gains phase II.
Ex-post impact assessment (WP5)	# women benefiting from relevant CGIAR innovations # youth benefiting from relevant CGIAR innovations	2024 and beyond	-	Analyze impact of leadership program; assessment of positions of participants (70% women) and qualitative assessment of their role in implementing nexus solutions.

7. Management plan and risk assessment

7.1 Management plan

NEXUS Gains will stagger Work Package implementation in the Aral Sea, Eastern Nile, Ganges and Indus basins between 2022-2024 in response to national government and other stakeholder demands. The Initiative is overseen by CGIAR^{182 183 184 185}.

The success of all WPs depends on strong collaboration with national governments, CSOs, the private sector, academia and international partnerships with universities, funders and investors. To ensure impact at scale, NEXUS Gains works with three regional Initiatives (TAFSSA,¹⁸⁶ U2¹⁸⁷ and CWANA¹⁸⁸) and several thematic Initiatives, including Agroecology, Foresight and Metrics, Harnessing Digital Technologies, MITIGATE+, HER+ and the Asian Mega-Delta Initiatives. Success will depend equally on active adaptive management to reflect changes in local conditions and global stressors, including near-term Covid-19 and political challenges (see 7.3 Risk Assessment). NEXUS Gains management will continuously monitor and evaluate ongoing research, research results and engagement and will adjust activities, outputs and budget allocations accordingly in conjunction with monthly reviews of MELIA plans and six-monthly reviews of Innovation Packages and Scaling Readiness assessments.

7.2 Summary management plan Gantt table

Initiative start date	01/2022	Timeline												Description of key deliverables	
		2022				2023				2024					
Work Packages	Lead & collab CG centers	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Work Package 1: Analyzing WEFE Nexus innovations using foresight and trade-off methodologies	CGIAR			1.1				1.2				1.3		1.1 Scaled and adapted Agro-biodiversity Index implemented in first two target countries (I3) 1.2 E-flow tool available for testing in Indus basin (I2) 1.3 Interactive tool designed for 4 target geographies	
Work Package 2: Boosting water productivity and integrated storage management at basin scale	CGIAR				2.1		2.2				2.3			2.1 Water storage diagnostic designed for application in three target areas (I4) 2.2 Water productivity decisions support system designed for application in 3 target areas (I5) 2.3 Gendered impacts of identified water productivity pathways assessed	
Work package 3: Energizing food and water systems sustainably and inclusively	CGIAR			3.1					3.2		3.3			3.1 Business and finance models designed for implementation (I6) 3.2 Four case studies of tested models completed 3.3 Inclusive solar intervention studies completed in four target countries	
Work package 4: Strengthening WEFE Nexus governance	CGIAR	4.1		4.2		4.3				3				4.1 Established science policy dialogues at national/local levels 4.2 Guidelines for inclusive WEFE Nexus multi-stakeholder forums developed from previous evidence 4.3 Groundwater governance toolbox tested in 2 geographies (I7)	
Work package 5: Developing capacity for emerging WEFE women leaders	CGIAR	5.1	5.2			5.3								5.1 Cross-sectoral nexus leadership program initiated (Innovation 8) 5.2 Community of practice established 5.3 Curricula updated	
Innovation Packages & Scaling Readiness	CGIAR	X (2)			X (3)				X (3)					Innovation Packages & Scaling Readiness activities, timelines & deliverables are provided in the detailed guidance that will be provided on Section 4.1; Milestones indicate assessment reports	
MELIA	CGIAR	X		X		X		X	X	X	X			Semi-annual learning and reflection meetings provide basis for project management & resource allocation; engagement with key partners to ensure co-design	
Project Management	CGIAR	1	2	3a		3b						3c		1 Start-up meetings in focal area and contracting 2 Set up of outcome studies and impact evaluations 3a, b, c Annual reports	

7.3 Risk assessment

Top 5 risks to achieving impact (note relevant Work Package numbers in brackets)	Description of risk (50 words max each)	Likelihood	Impact	Risk score Likelihood x Impact	Opportunities
		Rate from 1-5	Rate from 1-5		
Lack of meaningful partner engagement in co-design and implementation of nexus solutions (WP1-3) and multi-stakeholder processes (WP4)	Stakeholders and WEFE actors cannot overcome administrative or disciplinary silos to engage in co-design and implementation of nexus solutions, participate in multi-stakeholder processes, or make meaningful contributions to cross-sectoral policies	3	4	12	Organize workshops and showcase and discuss multiple cross-sectoral benefits of nexus solutions (including from other regions) and advantages of multi-stakeholder process; engage in discussion with high-level policymakers and operational staff
Inclusive business models for clean rural energy access do not gain traction (WP3, I6)	Possible lack of buy-in of private sector partners; no supportive/enabling environment to co-develop/scale inclusive business models because of short-term benefits and simultaneously scaling of non-inclusive business models	3	5	15	Engage private sector actors from the start in co-creation; ex-ante assessment and foresight study to optimize design of business and finance models; share evidence of successful inclusive business models from India with other regions/countries (peer-to-peer learning); reach out to policymakers to demonstrate importance of inclusivity in policies and necessary enabling environment
Failure to engage sufficient talents in leadership program (70% women, emerging leaders; WP 5)	Entrenched cultural norms and lack of buy-in from senior public/private leadership prevent attracting and engaging a sufficient number of emerging women leaders	2	4	8	Create an attractive, practical program (short-courses, on-the-job support, field visits, peer learning, etc.) for emerging leaders, mainly from partner organizations; offer continuous mentorship support during the program to gradually develop capacity, support application of skills and advance the careers of participants; make gender

Top 5 risks to achieving impact (note relevant Work Package numbers in brackets)	Description of risk (50 words max each)	Likelihood	Impact	Risk score Likelihood x Impact	Opportunities
		Rate from 1-5	Rate from 1-5		
					equity and inclusion central elements of the program
Travel restrictions or social tension/unrest hinder field work and implementation of nexus solutions and co-development of innovations (WP1-4, I6)	Political instability in the Indus region (i.e., recent developments in Afghanistan) and continued challenges in the Eastern Nile have led to significant migration and social tension/ unrest in target areas and hinders implementation and work at community level; inability to travel to study areas due to pandemic or other reasons (e.g., conflict)	2	4	8	Close cooperation with federal/local governments and continuously observe and adapt to the situation; and possibly move to other study areas if required
Insufficient funding to perform planned activities and to achieve agreed objectives	Inability to deliver results leads to loss of trusts of partners, frustration of all stakeholders and possible reputation damage	3	4	12	Conservative planning of activities and agreements with partners; continuously monitor program implementation and financial management; and adaptive management approach and continuous progress assessment (stage-gating)

8. Policy compliance, and oversight

8.1 Research governance

Researchers involved in the implementation of this Initiative will comply with the procedures and policies determined by the System Board to be applicable to the delivery of research undertaken in furtherance of CGIAR's 2030 Research and Innovation Strategy, thereby ensuring that all research meets applicable legal, regulatory and institutional requirements; appropriate ethical and scientific standards; and standards of quality, safety, privacy, risk management and financial management. This includes CGIAR's [CGIAR Research Ethics Code](#) and to the values, norms and behaviors in CGIAR's [Ethics Framework](#) and in the [Framework for Gender, Diversity and Inclusion in CGIAR's workplaces](#).

8.2 Open and FAIR data assets

Researchers involved in the implementation of this Initiative shall adhere to the terms of the [Open and FAIR Data Assets Policy](#). NEXUS Gains will align with the OFDA Policy's Open and

FAIR requirements, ensuring 1) generation of data using [research ethics protocols and code](#) relating to informed consent, and removing personally identifiable information; 2) findability of data, confirming with the [CGIAR Core Schema](#); 3) support to interoperability of data, as feasible; 4) accessibility of data by utilizing unrestrictive, standard licenses (e.g. [Creative Commons](#) for non-software assets) with a focus on improving data downloadability for those with more limited internet connectivity; and 5) the depositing of assets in open repositories, such as Dataverse or the CGIAR data portal.

NEXUS Gains will offer training on the generation of open and fair datasets to all researchers involved in the Initiative, including those at partner organizations, following a capacity needs assessment at the beginning of implementation. NEXUS Gains also requires, as for instance CGIAR already does, that each researcher obtains a certificate on human research ethics training at least every three years.

9. Human resources

9.1 Initiative team table

Category	Area of expertise	Short description of key accountabilities
Research	<p>Social sciences:</p> <ul style="list-style-type: none"> • foresight methodologies • political economy • sociology • agricultural economics • energy economics • gender and diversity • management and leadership • behavior change <p>Biophysical sciences:</p> <ul style="list-style-type: none"> • hydrology, agricultural water management (irrigation, rainfed) • WEFE systems modelling (biophysical/hydrological/energy/ecological) • remote sensing, data sciences (incl. big data, AI) and GIS analysis • programming (decision support system) and model integration • hydrogeology and soil science • ecology, environmental sciences • forestry sciences 	Co-design, development and management of research activities and innovation; integrated WEFE assessments; quantitative and qualitative field experiments (incl. design, data collection, analysis); scaling; knowledge synthesis; cooperation with partners to support policy and decision-making process; outreach and science-policy activities
Research (capacity building)	<ul style="list-style-type: none"> • Leadership training (co-design and implementation) • Curriculum development support 	Co-design leadership program (WP5), manage program in partnership with academic partners as well as demand, innovation and scaling and partners; support learning materials (external) and internal learning/development processes

Category	Area of expertise	Short description of key accountabilities
Research MELIA	MELIA specialists	Monitor, evaluate and document progress toward outputs and outcomes; indicator frameworks; document learnings and impact (including projections); oversee and support external evaluations reviews (including Scaling Readiness assessments)
Research support: Communications	<ul style="list-style-type: none"> • Corporate comms (comms with donors and stakeholders) • Internal comms • Social media • Website, blogs • Writing, editing • Publication support 	Set up and manage internal comms among and between teams and stakeholders; manage comms for reporting, mass media and digital comms (social media, websites); support researchers with writing, editing, copyright issues, etc.
Research support: Administration and secretarial support	<ul style="list-style-type: none"> • Program administration (HR and Finance) • Secretarial services 	Secretarial support of Initiative implementation (staff, consultants, investments); organization of meetings and support of Initiative management and governance; oversee procurement and compliance

9.2 Gender, diversity and inclusion in the workplace

Women are expected to lead 3 of the 5 WPs and hold half of the Initiative's senior management roles. The Initiative's governance structure will include national/regional partners from countries/basins in Sub-Saharan Africa and South and Central Asia. They will inform major decisions regarding direction and implementation. As a core principle, gender, diversity and inclusion will be discussed with the team at the onset of the Initiative, monitored throughout, and team members will be asked to take CGIAR's Panel Pledge to actively engage under-represented colleagues. Early-career scientists from CGIAR and partner institutions, particularly women and individuals from under-represented groups, will work with senior scientists to develop research and innovations, thereby strengthening their skills, professional experience and visibility.

WP5 focuses explicitly on strengthening the leadership skills of mid-career professionals. WP5 focuses on leadership training, mentorship and coaching. It will enhance capacities to develop future decision-makers and strong negotiators, increase their influence and support their career progression. The program will encompass professionals from Sub-Saharan Africa and South and Central Asia, at least 70% of whom will be women.

We expect to recruit some new staff for this Initiative. Recruitment and selection strategies will encourage the integration of social diversity in the Initiative team, particularly in management and project design and implementation roles.

Note: 'Professional roles' includes staff in senior management (research), senior management (non-research), scientists and post-doctoral fellow categories.

'Under-represented group' means a group defined by a common physical trait, belief or other distinctive characteristics that are few in number in CGIAR's workplaces and who have previously had minimal access to power or little or no influence on decisions that affect them.

9.3 Capacity development

NEXUS Gains confirms that:

1. Initiative team leaders and managers will complete training on inclusive leadership within 3 months of launch.
2. Within 6 months of launch, Initiative team members will complete training on gender, diversity and inclusion, including on whistleblowing and how to report concerns.
3. The Initiative kick-off will include an awareness session on CGIAR's values, code of conduct and range of learning opportunities available within CGIAR.
4. Development opportunities will be made available for junior-level Initiative team members, partners and stakeholders including for example, mentorship (also part of the leadership program outlined in WP5, internships/scholarships with representation of emerging professionals from under-represented groups, conference attendance, trainings etc
5. The Initiative team will meet CGIAR's gender target of a minimum of 40% women in professional roles and is composed of individuals from diverse backgrounds.
6. NEXUS Gains will liaise with CGIAR's Gender Platform.

10. Financial resources

10.1 Budget

10.1.1 Activity breakdown

USD	2022	2023	2024	Total
Cross Cutting across Work Packages	1,560,000	2,173,333	2,746,667	6,480,000
WorkPackage1	1,790,000	2,473,333	2,856,667	7,120,000
WorkPackage2	1,690,000	2,153,333	2,746,667	6,590,000
WorkPackage3	1,290,000	1,420,000	1,610,000	4,320,000
WorkPackage4	1,770,000	2,160,000	2,260,000	6,190,000
WorkPackage5	480,000	650,000	610,000	1,740,000
Innovation Packages & Scaling Readiness	140,000	210,000	210,000	560,000
Total	8,720,000	11,240,000	13,040,000	33,000,000

10.1.2 Geographic breakdown

USD	2022	2023	2024	Total
Pakistan	2,100,000	2,883,333	3,066,667	8,050,000
Ethiopia	1,760,000	2,583,333	3,066,667	7,410,000
India	1,800,000	2,253,333	2,486,667	6,540,000
Global (not specific country)	1,530,000	1,420,000	1,470,000	4,420,000
Nepal	800,000	950,000	1,050,000	2,800,000
Sudan	330,000	550,000	1,200,000	2,080,000
Aral Sea Basin mainly Uzbekistan (CWANA)	400,000	600,000	700,000	1,700,000
Total	8,720,000	11,240,000	13,040,000	33,000,000

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