CGIAR
INITIATIVE ON
NEXUS Gains

Agriculture on the banks of the Ganges River, India.
Credit: Neil Palmer/IWMI

CGIAR Research Initiative on
NEXUS Gains

Annual Technical Report 2024

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The Artificial Intelligence (AI) software ChatGPT was used to support the editing of parts of this report, specifically to improve clarity, grammar, and style. ChatGPT was not used to generate the content of the report. All edits made with AI assistance were reviewed and validated by the authors to ensure accuracy, coherence, and alignment with the original intent.

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Acronyms

AEPC	Alternative Energy Promotion Center (Nepal)
AMCOW	African Ministers' Council on Water
AU	African Union
BRIGHT	Building Resilience, Inclusive Growth, and Holistic Transformation (Sri Lanka)
CBD	Convention on Biological Diversity
CGE-W	Computable General Equilibrium-Water model
COP	Conference of the Parties
CSO	Civil society organization
DSS	Decision support system
DWRI	Department of Water Resources and Irrigation (Nepal)
EOIO	End of Initiative outcome
F2R-CWANA	CGIAR Initiative on Fragility to Resilience in Central and West Asia and North Africa
FABLE	Food, Agriculture, Biodiversity, Land-Use, and Energy
FAO	Food and Agriculture Organization of the United Nations
FES	Foundation for Ecological Security (India)
GESI	Gender equality and social inclusion
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (Germany)
GMIS	Groundwater Management Information System
GWP	Global Water Partnership
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICWC	Interstate Commission for Water Coordination (Central Asia)
IFPRI	International Food Policy Research Institute
IIASA	International Institute for Applied Systems Analysis
ILRI	International Livestock Research Institute
INMACOM	Incomati-Maputo Watercourse Commission
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IRRI	International Rice Research Institute
IRSA	Indus River System Authority
ITPGRSA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCMA	Inkomati-Usuthu Catchment Management Agency
IUCN	International Union for Conservation of Nature
IWMI	International Water Management Institute
KOBWA	Komati Basin Water Authority
LIMCOM	Limpopo Watercourse Commission
MSP	Multistakeholder platform
NGO	Nongovernmental Organization
Pywr	Python (language) water resources planning model
RHEIES	Rural Household Energy Insecurity Experiences Scale
SIC ICWC	Scientific Information Center of the Interstate Commission for Water Coordination of Central Asia
SWAT+	Soil and Water Assessment Tool
TIIAME	Tashkent Institute of Irrigation and Agricultural Mechanization Engineers
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCWA	United Nations Economic and Social Commission for West Asia
UNU-FLORES	United Nations University Institute for Integrated Management of Material Fluxes and of Resources
USAID	United States Agency for International Development
UTFI	Underground Transfer of Floods for Irrigation
WEEI	Women's Empowerment in Energy Index
WEFE	Water, energy, food, and ecosystems
WP	Work Package
WWF	World Wide Fund for Nature

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CGIAR Technical Reporting 2024

CGIAR Technical Reporting has been developed in alignment with CGIAR's Technical Reporting Arrangement. This annual report ("Type 1" Report) constitutes part of the broader CGIAR Technical Report. Each CGIAR Research Initiative/Impact Platform/Science Group Project (SGP) submits an annual "Type 1" Report, which provides assurance on progress towards end of Initiative/Impact Platform/SGP outcomes.

As 2024 marks the final year of this CGIAR Portfolio and the 2022-24 business cycle, this Type 1 Report takes a dual approach to its analysis and reporting. Alongside highlighting key achievements for 2024, the report also provides a cumulative overview of the 2022-24 business cycle, where relevant. This perspective captures the evolution of efforts over the three-year period. By presenting both annual and multi-year insights, the report underscores the cumulative impact of CGIAR's work and sets the stage for the transition to the 2025-30 Portfolio.

The 2024 CGIAR Technical Report comprises:

- **Type 1 Initiative, Impact Platform, and SGP Reports:** These annual reports present progress towards end of Initiative/Impact Platform/SGP outcomes and provide quality-assured results accessible via the CGIAR Results Dashboard.
- **Type 3 CGIAR Portfolio Practice Change Report:** This report provides insights into CGIAR's progress in Performance Management and Project Coordination.
- **Portfolio Narrative:** Drawing on the Type 1 and Type 3 reports, as well as data from the CGIAR Results Dashboard, the Portfolio Narrative synthesizes insights to provide an overall view of Portfolio coherence. It highlights synergies, partnerships, country and regional engagement, and collective progress.
- **Type 2 CGIAR Contributions to Impact in Agrifood Systems: evidence and learnings from 2022 to 2024:** This report offers a high-level summary of CGIAR's contributions to its impact targets and Science Group outcomes, aligned with the Sustainable Development Goals (SDGs), for the three-year business cycle.

The Portfolio Narrative informs the 2024 CGIAR Annual Report – a comprehensive summary of the organization's collective achievements, impacts, and strategic outlook.

Elements of the Type 2 report are integrated into the CGIAR Flagship Report, released in April 2025 at CGIAR Science Week. The Flagship Report synthesizes CGIAR research in an accessible format designed specifically to provide policy- and decision-makers at national, regional, and global levels with the evidence they require to formulate, develop, and negotiate evidence-based policies and investments.

The diagram below illustrates these relationships.

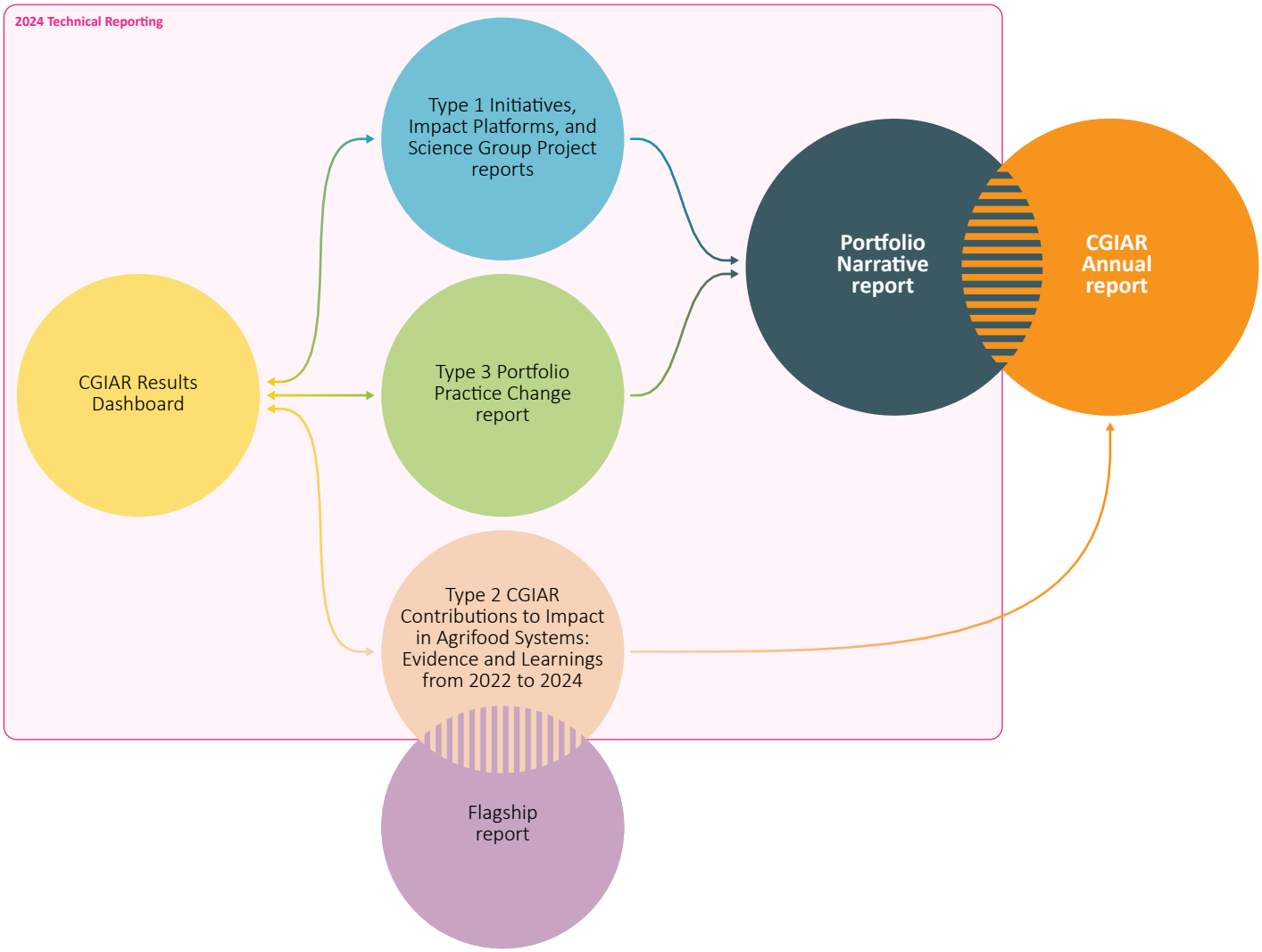

Figure 1. CGIAR's 2024 Technical Reporting components and their integration with other CGIAR reporting products.

Section 1: **Fact sheet, executive summary and budget**

Initiative name	NEXUS Gains
Initiative Lead	Matthew McCartney (m.mccartney@cgiar.org)
Initiative Co-lead	Claudia Ringler (c.ringler@cgiar.org)
Science Group	Systems Transformation
Start – end date	01 January 2022 – 31 December 2024
Geographic scope	**Regions** Central and West Asia and North Africa · East and Southern Africa · South Asia · West and Central Africa **Countries** Botswana · Eswatini · Ethiopia · India · Kyrgyzstan · Mozambique · Nepal · Pakistan · South Africa · The Republic of the Sudan · Uzbekistan · Zimbabwe
OECD DAC Climate marker adaptation score[1]	**Score 2: Principal** The activity is principally about meeting any of the three CGIAR climate-related strategy objectives – namely, climate mitigation, climate adaptation, and climate policy, and would not have been undertaken without this objective.
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OECD DAC Gender equity marker score[2]	**Score 1B: Gender responsive** On the top of the minimum requirements for 1A, the Initiative/project includes at least one explicit gender equality outcome, and the Initiative/project team has resident gender expertise or capacity. The Initiative/project includes indicators and monitors participation and differential benefits of diverse men and women.
Website link	https://www.cgiar.org/initiative/nexus-gains/

[1] The Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) markers refer to the OECD DAC Rio Markers for Climate and the gender equality policy marker. For climate adaptation and mitigation, scores are: 0 = Not targeted; 1 = Significant; and 2 = Principal.
[2] The CGIAR Gender Impact Platform has adapted the OECD gender marker, splitting the 1 score into 1A and 1B. For gender equality, scores are: 0 = Not targeted; 1A = Gender accommodative/aware; 1B = Gender responsive; and 2 = Principal.
These scores are derived from Initiative proposals, and refer to the score given to the Initiative overall based on their proposal.

EXECUTIVE SUMMARY

The CGIAR Research Initiative on NEXUS Gains aimed to improve nutrition and food security, poverty alleviation, gender equality, climate resilience, and environmental sustainability by addressing the complex interdependencies of the water–energy–food–ecosystems (WEFE) nexus. Traditional, single sector, approaches do not effectively tackle challenges such as food, energy and water insecurity, climate change, environmental degradation, and biodiversity loss. The Initiative championed integrated strategies to manage the interconnected resources of water, land, energy, forests, and biodiversity. This holistic approach is vital as governments and investors often struggle to identify trade-offs and synergies across sectors, leading to fragmented investments that fail to achieve broader objectives like preserving ecosystem services and supporting vulnerable communities.

NEXUS Gains focused on five river basins – the Aral Sea, Blue Nile, Ganges, Indus, and Limpopo/Incomati – while also engaging globally and nationally. Developing partnerships with governments, river basin institutions, international agencies, investors, universities, NGOs, and community organizations was critical for success. These partnerships ensured stakeholder participation in planning and implementing research, fostered demand-driven innovation and understanding, and facilitated uptake. A strong capacity development program, including gender and social inclusion, supported partners to implement solutions successfully.

End of Initiative outcomes (EOIOs)

The Initiative was structured around five EOIOs and achieved or exceeded all its original targets.

WEFE Innovation Prioritization (EOIO 1): By 2024, partners were equipped with tools to assess trade-offs and synergies among WEFE investments. These tools helped break down silos between researchers, implementation agencies, and other stakeholders. Partners are using these tools to support water allocation and investment decisions. A notable success was the agrobiodiversity solution hotspot tool – winner of the 2023 Food Planet Prize – used to address WEFE challenges in the Ganges Basin.

Enhancing Water Productivity and Storage (EOIO 2): Decision support systems (DSSs) co-developed with partners are being used in the Aral Sea and Ganges Basins. For example, the Government of India has adopted the Water Productivity Atlas to guide improvements in water productivity and address groundwater challenges. India also incorporated a novel water storage technique – Underground Transfer of Floods for Irrigation (UTFI) – into its national groundwater program. Comprehensive water storage assessments in the Blue Nile, Limpopo, and Ganges are informing investments.

Promoting Equitable Clean Rural Energy (EOIO 3): To highlight the gendered benefits of accelerating equitable access to clean rural energy, NEXUS Gains developed the Women's Empowerment in Energy Index (WEEI) and the Rural Household Energy Insecurity Experiences Scale (RHEIES). Both innovations have been integrated into research by other CGIAR programs. A major focus was on solar-powered pump irrigation, a potentially transformative technology for smallholders, including women. We evaluated a Ugandan program to improve its outreach, and co-assessed business models and institutional arrangements in Ethiopia to improve women's access. To address groundwater depletion from oversized pumps, we developed solar pump sizing tools that are now being promoted to governments and stakeholders in Nepal, Pakistan, and sub-Saharan Africa.

Strengthening WEFE Governance (EOIO 4): Effective governance is key to WEFE systems management. NEXUS Gains focused on inclusive groundwater governance, and multistakeholder platforms (MSPs) to strengthen river basin management. In India, partnerships with an NGO and the government supported implementation of behavioral games combined with technical tools, helping over 6,500 communities manage groundwater more sustainably. A journal special issue disseminated results of this and other approaches. Use of guidelines on MSPs have strengthened governance arrangements in Nepal, Pakistan, India, and Southern Africa.

Building Sustainable Capacity (EOIO 5): Significant investments in capacity strengthening empowered professionals in government, businesses, and NGOs to develop and implement sustainable and equitable WEFE approaches. Over three years, NEXUS Gains empowered 8,646 individuals (47 percent women) through targeted initiatives, such as the WEFE Nexus Leadership Program in Nepal and international workshops in Nepal, Jordan, Pakistan, South Africa, Ethiopia, and Uzbekistan. Moreover, NEXUS Gains co-created open-access WEFE training materials now integrated into university curricula, equipping future leaders with a deeper understanding of WEFE concepts.

Policy influences and broader impacts

NEXUS Gains informed policy and program development in several countries. In Nepal, the Initiative contributed to the revised Irrigation Policy and the draft Water Resources Bill. In Pakistan, our work supported implementation of the Punjab Water Act. In India, we contributed to several major government initiatives on water conservation and community-led groundwater management. Regional governments in Ethiopia plan to use NEXUS Gains information in planning and operating irrigation investments. In Southern Africa, NEXUS Gains informed dialogue on water allocation frameworks for the Incomati-Maputo Watercourse Commission (INMACOM).

Globally, NEXUS Gains raised the profile of practical WEFE approaches through contributions to the Montpellier Process; the Food, Agriculture, Biodiversity, Land-Use, and Energy (FABLE) Consortium; COP16 of the Convention on Biological Diversity; the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES); and UN climate conferences COP27, 28 and 29. This global recognition underscores the growing awareness of WEFE nexus approaches for equitable, sustainable development.

By fostering strategic partnerships, developing innovative tools, strengthening governance, and building capacity, NEXUS Gains has surpassed its goals and laid a strong foundation for future development in the CGIAR Science Programs.

	2022	2023	**2024**
PROPOSAL BUDGET	$8.72M	$11.24M	**$13.04M**
APPROVED BUDGET [1]	$6.22M	$6.56M [2]	**$7.41M** [2]

[1] The approved budget amounts correspond to the figures available for public access through the Financing Plan dashboard.
[2] These amounts include carry-over and commitments. The total amount disbursed over 3 years was USD 17.17M.

Section 2: **Progress towards End of Initiative outcomes**

Initiative-level theory of change diagram

This is a simple, linear, and static representation of a complex, non-linear, and dynamic reality. Feedback loops and connections between this Initiative and other Initiatives' theories of change are excluded for clarity. For further details on the various levels within the theory of change, please refer to the CGIAR Results Framework.

CHALLENGE STATEMENT

- Water, land, energy, forests, and biodiversity are deeply interconnected and play a crucial role in achieving key Sustainable Development Goals (SDGs) related to nutrition, health and food security, poverty alleviation, gender equality, climate resilience, and environmental sustainability. However, effectively managing the water-energy-food-ecosystem health nexus remains a significant challenge, especially in the face of climate change and the complexities of transboundary river basins. The absence of integrated governance and systems thinking often results in fragmented approaches that undermine sustainability and exacerbate conflicts.
- Governments, stakeholders, and investors face difficulties in coordinating efforts for ecosystem restoration, sustainable agriculture, irrigation, and clean energy. Investments in these areas are often disconnected, with water, agriculture, and energy policies failing to align with broader objectives such as promoting healthy diets or preserving ecosystem services. Vulnerable groups—including women, youth, and marginalized communities—are disproportionately affected by poorly designed systems, often facing additional barriers to development. These groups typically experience limited access to information, technology, and decision-making processes, preventing them from fully contributing to sustainable and inclusive development.
- The NEXUS Gains Initiative seeks to address these challenges by addressing trade-offs, fostering synergies, and driving systemic change across food, land, and water management. By promoting collaboration across sectors and strengthening governance, NEXUS Gains aims to create integrated solutions that enhance resilience, drive SDG achievement, and ensure that the benefits of these transformations are equitably shared, particularly among the most vulnerable populations.

SPHERE OF **CONTROL**

Work Packages

Work Package 1

Analyzing Water-Energy-Food-Ecosystems Nexus Innovations using Foresight and Trade-Off Methodologies.

Work Package 2

Boosting Water Productivity and Integrated Storage Management at Basin Scale.

Work Package 3

Energizing Food and Water Systems Sustainably and Inclusively.

Work Package 4

Strengthening Water-Energy-Food-Ecosystems Nexus Governance.

Work Package 5

Developing Capacity for Water-Energy-Food-Ecosystems Actors, Including Women Leaders.

Inspecting an irrigation channel in Dhap village, Nepal.
Credit: Tom van Cakenberghe/IWMI

SPHERE OF **INFLUENCE**

End-of-Initiative Outcomes

End-of-Initiative Outcome 1

1 ▶ Demand partners assess water-energy-food-ecosystems (WEFE) tradeoffs and synergies to prioritize WEFE innovations.

End-of-Initiative Outcome 2

2 ▶ Demand partners assess integrated water productivity or storage options to improve system-level water security.

End-of-Initiative Outcome 3

3 ▶ Private investors and policy makers, cognizant of systems linkages and gendered benefits, accelerate equitable access to rural clean energy.

End-of-Initiative Outcome 4

4 ▶ Policymakers and stakeholders identify ways to improve governance across water-energy-food-ecosystems (WEFE) systems.

End-of-Initiative Outcome 5

3 ▶ 5 ▶ Government, business, NGO, and CSO professionals in water–energy–food–ecosystems (WEFE) sectors use new capacities to co-develop sustainable and equitable WEFE approaches.

Action Area Outcomes

Systems Transformation

1 ▶ 2 ▶ 3 ▶ **1** · National and sub-national government agencies use CGIAR research results to design or implement strategies, policies and programs which have the potential to transform food, land and water systems contributing to livelihood, inclusion, nutrition, environmental and climate resilience objectives.

1 ▶ 2 ▶ 3 ▶ 4 ▶ 5 ▶ **2** · Implementation partners (e.g. NARES, NGOs, private companies) actively support dissemination, uptake, and implementation of CGIAR innovations.

2 ▶ 3 ▶ 4 ▶ **3** · National and local multi-stakeholder platforms are strengthened to become more effective and sustainable, addressing development trade-offs and generating strategies for effective food, land, and water systems transformation.

1 ▶ 2 ▶ 3 ▶ 4 ▶ 5 ▶ **4** · Global and regional institutions, such as funding agencies, international organizations, and coordinating bodies use CGIAR research evidence in the development of strategies, policies, and investments to drive sustainable transformation of food, land, and water systems contributing to livelihood, inclusion, nutrition, environmental and climate resilience objectives.

1 ▶ 2 ▶ 3 ▶ 4 ▶ 5 ▶ **5** · Research institutions, government analytical units, and scaling partners in the Global South have improved knowledge, skills, access to data, capacity to develop tools, innovations, and undertake research to support transformation of food, land and water systems contributing to livelihood, inclusion, nutrition, environmental and climate objectives.

SPHERE OF **INTEREST**

Impact Areas

Nutrition, Health & Food Security

2 ▶ 3 ▶ · End hunger for all and enable affordable health diets for the 3 billion people who do not currently have access to safe and nutritious food.

Poverty Reduction, Livelihoods & Jobs

2 ▶ 3 ▶ · Lift at least 500 million people living in rural areas above the extreme poverty line of US $1.90 per day (2011 PPP).

Gender Equality, Youth & Social Inclusion

3 ▶ 4 ▶ 5 ▶ · Close the gender gap in rights to economic resources on, access to ownership of, and control over land and natural resources, for more than 500 million women who work in food, land, and water systems.

Climate Adaptation & Mitigation

1 ▶ 2 ▶ 3 ▶ 4 ▶ 5 ▶ · Equip 500 million small-scale producers to be more resilient to climate shocks, with climate adaptation solutions available through national innovation systems.

Environmental Health & Biodiversity

1 ▶ 2 ▶ 3 ▶ 4 ▶ 5 ▶ · Stay within planetary and regional environmental boundaries: consumptive water use in food production of less than 2500 km3 per year (with a focus on the most stressed basins), zero net deforestation, nitrogen application of 90 Tg per year (with redistribution towards low-input farming systems) and increased use efficiency, and phosphorus application of 10 Tg per year.

Farmers working in a paddy field, Nepal.
Credit: Nabin Baral/IWMI

Summary of progress against the theory of change

The WEFE nexus concept emphasizes the strong linkages across water, energy, food, forests, and biodiversity. Attempting to enhance water, food, or energy security in isolation often compromises environmental security and the long-term productivity of the other resources. For example, subsidizing electricity to increase food production through cheaper irrigation can deplete aquifers, eventually reducing food and water security and increasing economic distress. The CGIAR Research Initiative on NEXUS Gains addressed these challenges by identifying trade-offs, generating evidence on their implications, fostering synergies, and driving systemic change across the WEFE nexus. As climate change accelerates, integrated governance and innovative systems thinking using new tools is required to reverse the decline of planetary systems and natural resources and curb rising food insecurity, malnutrition, and poverty.

NEXUS Gains partnered with governments, international agencies, research institutions, private companies, and communities to achieve its planned outcomes and lay the foundation for future progress. Many countries now perceive nexus approaches as critical for addressing "poverty–unemployment–equality" challenges. The Initiative developed and validated nexus decision support tools, initiated capacity building programs, and supported partners in adopting innovations. Its theory of change posited that creating partner networks is the best way to generate knowledge, create innovative tools, and enhance WEFE capacities. The Initiative worked with partners in five river basins – the Ganges, Indus, Aral Sea, Blue Nile, and Limpopo/Incomati – and at global and national levels. Five Work Packages (WPs) were organized around achieving five EOIOs.

EOIO 1: WEFE innovation prioritization

NEXUS Gains co-developed and implemented four modeling tools – the Soil and Water Assessment Tool (SWAT+), Python water resources planning model (Pywr), Computable General Equilibrium-Water model (CGE-W), and FABLE Calculator – to help partners identify the trade-offs and potential synergies among WEFE investments and overcome silos among researchers and implementation agencies. For example, a Pywr model, encompassing irrigation and hydropower generation, was co-designed with the Scientific Information Center of the Interstate Commission for Water Coordination (SIC ICWC) to support water allocation decisions in the Chirchik River Basin in Uzbekistan. Similarly, the Punjab Irrigation Department, Pakistan, now uses a Pywr model to optimize irrigation water distribution. In the Ganges Basin, an interactive modeling tool enables users to generate and visualize WEFE scenarios, aiding decision-making.

At the Government of Pakistan's request, we used a foresight hydro-economic model to analyze ways to reduce water scarcity by adjusting cropping patterns. In Southern Africa, we partnered with INMACOM to develop a DSS using Pywr to improve integrated management of the Basin's natural resources. In Ethiopia, a simplified scenario analysis tool helped policymakers and other actors understand the implications of choosing alternative food and land-use policies, and to analyze the implications of climate change for various agrifood systems interventions. The agrobiodiversity solution hotspot tool, which won the Food Planet Prize in 2023, was used in the Ganges Basin to address WEFE challenges.

EOIO 2: Enhancing water productivity and storage

NEXUS Gains co-developed and validated DSSs now used in the Ganges and Aral Sea Basins. Intensive stakeholder engagements led the Government of India to adopt the Water Productivity Atlas, a tool that supports decisions to enhance water productivity in food production and manage groundwater depletion (see Section 7). In the Aral Sea, a dashboard for optimizing the WEFE Nexus was designed to improve water productivity; engagements with stakeholders helped ensure that the tool is responsive and intuitive.

NEXUS Gains published water storage assessments for three river basins (Blue Nile, Limpopo, and Ganges) to determine the volume of water available in different storage types and its seasonal variation. In India, a novel managed aquifer recharge technique, UTFI, has been integrated into a national groundwater management program and we partnered with the Government of Uttar Pradesh under a national agricultural development program to rejuvenate the landscape in Bundelkhand (see Section 7). In the Limpopo River Basin, assessments of sand dams helped the Government of Zimbabwe understand their potential benefits and the Limpopo Watercourse Commission (LIMCOM) is considering broader implementation.

EOIO 3: Promoting equitable rural clean energy

EOIO 3 aimed to help private investors and policymakers accelerate equitable access to clean rural energy by highlighting systemic linkages and gendered benefits. NEXUS Gains supported the Government of Pakistan with solar suitability mapping, leading to plans for uptake in Punjab Province and elsewhere. In Nepal, studies on the equity and sustainability of solar-lift irrigation are being used to update government guidelines and investments, supported by a solar sizing tool developed with GIZ and the government. In India, where solar pump subsidies favor wealthier farmers, the government acknowledges that NEXUS Gains' findings on more equitable business and finance models can help extend support to poor marginal farmers.

Studies on gender and social inclusion gaps in Nepal have informed government, private sector, and NGO actions. In sub-Saharan Africa, our benefit analysis using the NEXUS Gains solar explorer for groundwater irrigation has stimulated considerable interest. Research in Ethiopia identified promising solutions to improve solar irrigation uptake, and in Nigeria, informed the Farmer-Led Irrigation Development subcomponent, which includes solar irrigation, under a World Bank project. We also identified improvements for Uganda's solar pump subsidy program.

NEXUS Gains developed the WEEI and RHEIES to assess gendered energy deprivation and strengthen access to and use of renewable energy equitably and sustainably. The RHEIES was integrated into other CGIAR studies in 2024, including the Impact Assessment of the Pro-Soil Project in India, and the Building Resilience, Inclusive Growth, and Holistic Transformation (BRIGHT) survey in Sri Lanka. We also co-supported piloting of business models to increase the availability of financial services for women and strengthen their agency through self-help associations.

EOIO 4: Strengthening WEFE governance

EOIO 4 aimed to improve WEFE systems governance, specifically concerning inclusive groundwater management and integrated river basin management. NEXUS Gains linked behavioral games with technical and policy measures to foster inclusive groundwater governance. Results were reported in a special issue on groundwater governance. The findings have helped reduce groundwater depletion in South Asia; for example, over 6,500 Indian communities have benefited from interventions implemented through the national groundwater program. In Pakistan, our knowledge, motivation, and agency framework guided the application of the Groundwater Management Information System (GMIS) (see Section 7).

NEXUS Gains and partners produced guidelines on MSPs and transboundary water governance that, combined with co-developed tools (e.g., the groundwater toolbox), have strengthened governance and management structures in a municipality in Nepal, at district and state levels in Pakistan, and at the national level in India and Nepal. In Southern Africa, establishing an MSP strengthened INMACOM's capacity to implement transboundary water-sharing arrangements. Related outcomes include the revised Nepal Irrigation Policy acknowledging the importance of a nexus approach to development and the Niger Basin Council of Ministers' adoption of a Nexus Investment Guidance document.

EOIO 5: Building sustainable WEFE capacity

NEXUS Gains prioritized capacity building to support governments, businesses, NGOs, and CSOs to develop and implement sustainable and equitable WEFE approaches. Baseline studies in Nepal, Uzbekistan, and Pakistan identified capacity gaps, informing the WEFE Nexus Leadership Program, which strengthened the leadership and technical capacities of professionals, especially women. This and other capacity development activities in Nepal resulted in improved knowledge, skills, and networks for over 580 (41 percent women) policymakers, mid-career professionals, and students. Open-access WEFE learning resources and training materials – including three postgraduate courses – co-developed and piloted with government, practitioners, and postgraduate students have been institutionalized in two universities' curricula. Other learning materials, available in a NEXUS Gains learning resource repository, have been used and disseminated by partners such as GIZ on its nexus knowledge hub. NEXUS Gains developed gender equality and social inclusion (GESI) modules, filling a critical gap in nexus resources, as demonstrated by the inclusion of a NEXUS Gains online learning module on GESI in GIZ training materials. NEXUS Gains' scorecards support monitoring of WEFE capabilities across research and academia, and professionals and government, and guide individual and institutional capacity-strengthening efforts.

In Nepal, government and CSO actors applied their new nexus knowledge to policy and program development and implementation, including in the design of Nepal's revised Irrigation Policy 2023 and Water Resources Bill. In Central Asia, Ethiopia, Nepal, and South Africa, trainings of trainers, workshops, high-level dialogues, Masterclasses, and international Winter and Summer Schools have equipped participants, including global and national communities of practice, to use WEFE nexus concepts. Over three years, 8,646 individuals (47 percent women) benefitted directly from the NEXUS Gains capacity building program.

Innovation and scaling

NEXUS Gains grew its innovation pipeline significantly, reporting 11, 13, and 19 innovations in 2022, 2023, and 2024, with average scaling readiness values of 3.7, 4.8, and 6.3 respectively. Two innovations were discontinued at the end of 2022. In 2024, NEXUS Gains also contributed to seven innovations reported by other CGIAR Initiatives. Two innovation packaging workshops conducted in 2024 in Pakistan focused on innovative software tools to estimate environmental flow requirements and on GMIS for sustainable groundwater management. Additionally, innovations like the environmental flow tool in Nepal, and the decision support tool for right-sizing solar-powered irrigation pumps in Africa and South Asia, advanced through less formal channels. All continued innovations surpassed Readiness Level 3 (Proof of Concept): 12 progressed to Levels 4-7 (Controlled Testing to Prototype) and five reached advanced stages (Level 8, Uncontrolled Testing or Level 9, Proven Innovation). The Initiative cultivated a robust culture of innovation portfolio management and established itself as a leader in implementing the CGIAR Innovation Packages and Scaling Readiness approach, equipping researchers with the skills to drive impactful, scalable solutions.

Global impact and recognition

The acceptance of WEFE approaches for systemic transformation is growing globally. The Initiative's contributions have been recognized by the Montpellier Process, IPBES, FABLE Consortium, and the Convention on Biological Diversity COP16. The Lancet Planetary Health–Earth Commission report incorporated nexus issues, and the IPBES Nexus Report was approved by 147 countries, highlighting that WEFE strategies are increasingly perceived as essential for sustainable development.

Progress against End of Initiative Outcomes

This infographic provides a concise summary of the Initiative's progress toward achieving its Theory of Change End-of-Initiative outcomes for the 2022-2024 period. By drawing on reported results, it offers a comprehensive synthesis of progress made against the established outcome targets, highlighting the Initiative's overall impact and key achievements at the conclusion of this three-year cycle.

EOIO 1

Demand partners assess water–energy–food–ecosystems (WEFE) trade-offs and synergies to prioritize WEFE innovations.

EOIO 2

Demand partners assess integrated water productivity or storage options to improve system-level water security.

EOIO 3

Private investors and policymakers, cognizant of systems linkages and gendered benefits, accelerate equitable access to rural clean energy.

EOIO 4

Policymakers and stakeholders identify ways to improve governance across water–energy–food–ecosystems (WEFE) systems.

EOIO 5

Government, business, NGO, and CSO professionals in water–energy–food–ecosystems (WEFE) sectors use new capacities to co-develop sustainable and equitable WEFE approaches.

NEXUS Gains and partners co-developed innovative models to analyze trade-offs and synergies, enabling more effective prioritization of WEFE interventions in the focal basins:

- In Punjab, Pakistan, a Pywr model was developed to support the Irrigation Department to optimize water allocation by precisely regulating canal flows and enhancing distribution efficiency.
- In the Indus Basin, at the request of the Government of Pakistan, a CGE-W model was used to analyze the potential of crop and fertilizer taxation as a strategy to reduce severe water scarcity without affecting dietary quality.
- In the Ganges Basin, NEXUS Gains combined the hydrological model SWAT+ and the FABLE Calculator to simulate WEFE scenarios. An interactive online dashboard allows policymakers and researchers to visualize trade-offs and quantify impacts, fostering collaboration by enhancing the transparency of WEFE interconnections.
- In the Chirchik River Basin, Uzbekistan, NEXUS Gains co-designed a Pywr model with SIC-ICWC to support daily inter-sectoral water resource allocation and decision-making.
- In the Eastern Nile, the economywide impacts of climate change on WEFE nexus solutions were assessed to inform adaptive strategies
- In the Aral Sea, Ganges, Incomati, and Indus Basins, communities of practice for SWAT+, Pywr, and CGE-W models are operational, fostering knowledge exchange and capacity building.

These modeling innovations strengthen decision-making, promote collaborative governance, and improve WEFE nexus management.

NEXUS Gains advanced DSSs to enhance water productivity:

- In Central Asia, NEXUS Gains and partners co-developed a dashboard to guide selection of optimal land management practices based on predefined criteria.
- In South Asia, NEXUS Gains and partners co-developed a Water Productivity Atlas, now officially integrated in a Government of India website.
- In Nepal, farmers in three irrigation schemes used insights from a tool designed to select optimal strategies for improving water productivity. The tool's findings have also informed policy development by the Government of Nepal.

The Initiative also advanced a water storage diagnostic tool and supported the promotion of novel water storage solutions:

- In the Blue Nile and Limpopo River Basins, decision-makers at multiple scales – sub-catchment, national, and basin – confirmed that water storage maps and analyses of temporal variations have influenced their water planning and management strategies.
- In Central Asia, water storage assessments of small transboundary tributaries were shared with key decision-makers.
- In India, managed aquifer recharge in the Ramganga sub-basin and Bundelkhand region raised groundwater levels, with significant positive impacts for farmers and communities.
- In Southern Africa, assessments of the impacts of sand dams are shaping strategies for enhancing water security in rural communities.

These tools are strengthening data-driven decision-making, supporting policy formulation, and enhancing sustainable water resource management across diverse landscapes.

NEXUS Gains collaborated with partners to co-produce many research products and findings that have directly informed government policies, NGO initiatives, and private sector strategies:

- In Nepal, research on solar-lift irrigation in the mid-hills was used to update government guidelines and investment strategies. Moreover, findings on equity and inclusion gaps in the energy sector have shaped policies and actions by the government, private sector, NGOs, and development partners.
- In Pakistan, research on solar-powered irrigation mapping and sizing has been adopted by Punjab Province, with plans for nationwide rollout.
- In India and Nepal, solar sizing tools are being used by government agencies to support clean energy expansion in agriculture.
- In Ethiopia, research on equitable clean energy transitions in rural areas influenced government programming and private sector actions and supported national engagement by the NGO Power for All.
- In India and Sri Lanka, the RHEIES, originally developed using qualitative data from Ethiopia, has been incorporated into quantitative data collection tools implemented by CGIAR programs.
- Globally, the Solar Irrigation Explorer is a widely accessed tool, supporting decision-making on solar-powered irrigation solutions.

These contributions are driving policymaking and supporting more inclusive, sustainable energy transitions in agriculture and rural development.

NEXUS Gains–supported governance innovations are being applied by partners at multiple levels to address groundwater crises and to support transboundary water sharing:

- The Nepal Parliamentary Infrastructure Development Committee incorporated key WEFE considerations into the draft Water Resources Bill now progressing through Parliament.
- Also in Nepal, a rural municipality has strengthened its capacity by using tools for groundwater governance.
- In Pakistan, an MSP for Groundwater Governance was established in Rahim Yar Khan District to address nexus issues. It has brought different sectors together, fostered collaborative decision-making, and integrated resource management among community members to tackle sharply depleting groundwater resources.
- The Punjab Irrigation Department in Pakistan is scaling out a GMIS to improve knowledge and motivate action on groundwater quantity and quality challenges.
- In India, a national program on participatory groundwater governance is adopting and integrating NEXUS Gains tools, including groundwater games, crop water budgeting, and water recharge planning, into public works programs.
- In Southern Africa, an MSP is strengthening the capacity of INMACOM for transboundary water management.
- In West Africa, the Niger Basin Authority integrated nexus analysis into its operational and investment planning, potentially benefiting over 160 million people.

These governance innovations are strengthening institutions, enhancing decision-making, and promoting WEFE nexus approaches across diverse regions.

In Nepal, NEXUS Gains developed the WEFE Nexus Leadership Program to enhance the leadership and technical capacities of professionals, especially women, to apply WEFE nexus approaches in their work:

- In 2023 and 2024, 71 professionals (36 women, 35 men) from over 10 institutions across the WEFE sectors participated in two editions of the program. Participants reported increased knowledge, skills, confidence, and professional networks, enabling them to implement WEFE nexus approaches. Additionally, they noted: 1) greater sensitivity to gender issues; 2) strengthened collective voice in the workplace; and 3) identification of key policy and institutional reform areas at the national level. Seventeen women were identified as "champions", committed to advancing WEFE nexus leadership within their organizations.

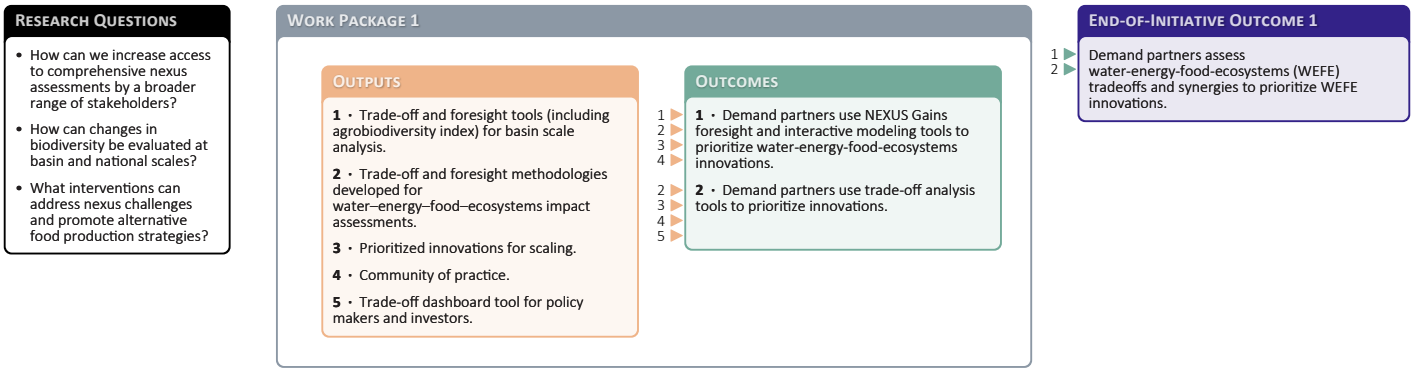
Beyond the Leadership Program, NEXUS Gains engaged 582 professionals (41 percent women) in Nepal from key ministries, NGOs, CSOs, and academia in capacity-strengthening activities, leading to the following outcomes:

- In a program evaluation, 68 percent of surveyed participants reported integrating the WEFE nexus approach into their work.
- With continued engagement from NEXUS Gains, government and CSO actors applied their new knowledge to policy and program development, directly contributing to Nepal's revised Irrigation Policy 2023 and draft Water Resources Bill.

These efforts are fostering a new generation of leaders and shaping evidence-based policy reforms to advance WEFE approaches in Nepal.

Section 3: **Work Package progress**

WP1: Analyzing WEFE nexus innovations using foresight and trade-off methodologies



Work Package 1 progress against the theory of change

WP1 aimed to achieve two outcomes:

- 1.1 demand partners use NEXUS Gains foresight and interactive modeling tools to prioritize WEFE innovations; and
- 1.2 the demand partners use trade-off analysis tools to prioritize innovations.

NEXUS Gains deployed four modeling tools (SWAT+, Pywr, CGE-W, and FABLE) to analyze WEFE nexus innovations using foresight and trade-off methodologies in India, Nepal, Pakistan, Uzbekistan, Sudan, Ethiopia, and Southern Africa. Our work enhanced understanding of trade-offs and potential synergies among WEFE investments and fostered collaboration between researchers and implementation agencies.

To achieve outcome 1.1, NEXUS Gains and SIC ICWC co-designed a Pywr model to support daily operations and decision-making on water allocation in the Chirchik River Basin in Uzbekistan. Similarly, the Punjab Irrigation Department, Pakistan, now uses the Pywr model to help regulate canal flows for improved water allocation. In India, NEXUS Gains developed an interactive modeling tool that enables users to visualize different WEFE scenarios. In addition, the agrobiodiversity solution hotspot tool, an innovation that won the Food Planet Prize in 2023, was used, with government partners, to assist WEFE decision-making.

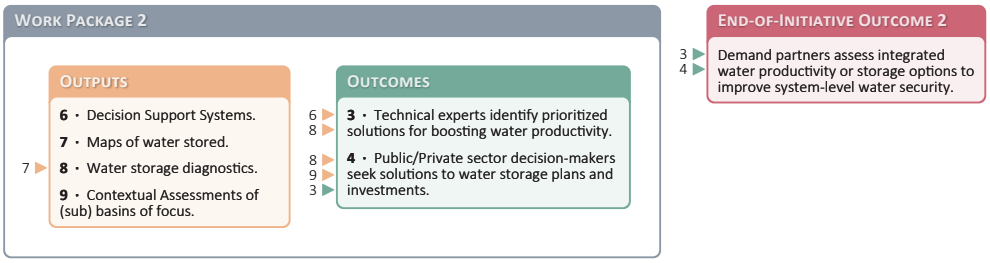
To achieve outcome 1.2, NEXUS Gains, in partnership with INMACOM, developed a basin-wide DSS using Pywr for integrated management of the Incomati's natural resources. In Pakistan, a foresight hydro-economic model, CGE-W, was used at the government's request to analyze potential WEFE interventions to reduce water scarcity by adjusting cropping patterns. In Ethiopia, NEXUS Gains developed a simplified FABLE-based scenario analysis tool that supports the government and other actors to understand the consequences of alternative food and land-use policies; we also analyzed the implications of climate change for a series of agrifood systems interventions using an economywide modeling framework. In Sudan, the Initiative evaluated hydropower and irrigation developments under climate change uncertainties and assessed the implications and trade-offs of alternative WEFE interventions.

NEXUS Gains supported the mainstreaming of environmental flows in Pakistan and Nepal. In Pakistan we undertook an environmental flow assessment of the Indus Basin, and organized an innovation packaging workshop with a broad group of stakeholders for the environmental flow toolbox. We collaborated with stakeholders to identify scaling barriers and developed strategies to overcome bottlenecks. In Nepal, we collaborated with the Department of Water Resources and Irrigation to promote environmental flow integration in water planning. A Science-Policy Dialogue was conducted with policymakers, along with a hands-on training workshop for water resources planners and managers on how to use IWMI's environmental flow tools. Additionally, communities of practice were established for the SWAT+, Pywr, and CGE-W models and are operational in four river basins – the Aral Sea, Ganges, Incomati, and Indus – ensuring sustained collaboration and knowledge exchange.

WP2: Boosting water productivity and integrated storage management at basin scale

Research Questions

- How much water is stored across different storage types, how does it change within and across years, and how can the available mix of existing storage types (across the grey to green spectrum) be better drawn upon to satisfy cross-sector water needs?
- How can integrated water storage and productivity tools be optimally integrated into existing institutional frameworks to realize their potential?
- What are the implications of alternative investments in water productivity for poor rural women and men? What tools can support improved decision-making to enhance water productivity?
- How can basin-level water resource productivity be improved through informed solutions for enhancing small-scale water productivity? How can these tools be made user-friendly so that adoption is achieved?



Work Package 2 progress against the theory of change

WP2 aimed to achieve two outcomes:

- 2.1 technical experts identify prioritized solutions for boosting water productivity; and
- 2.2 public/private sector decision-makers seek solutions to water storage plans and investment.

To achieve outcome 2.1, DSSs were developed, validated, and are now used in the Ganges and Aral Sea Basins. In the Ganges, the Water Productivity Atlas has been adopted by the Government of India after multiple engagements with end users to refine the platform. It supports decision-making on water productivity and groundwater management (see Section 7). In the Aral Sea, while not yet formally adopted, a dashboard for sustainable land management was developed that can be used to enhance water productivity; engagements with stakeholders have ensured that the tool is user friendly and relevant. In Nepal, a novel tool was developed and applied to identify barriers to enhancing water productivity in irrigation schemes. It has been used to guide the selection of interventions and to support national policy development.

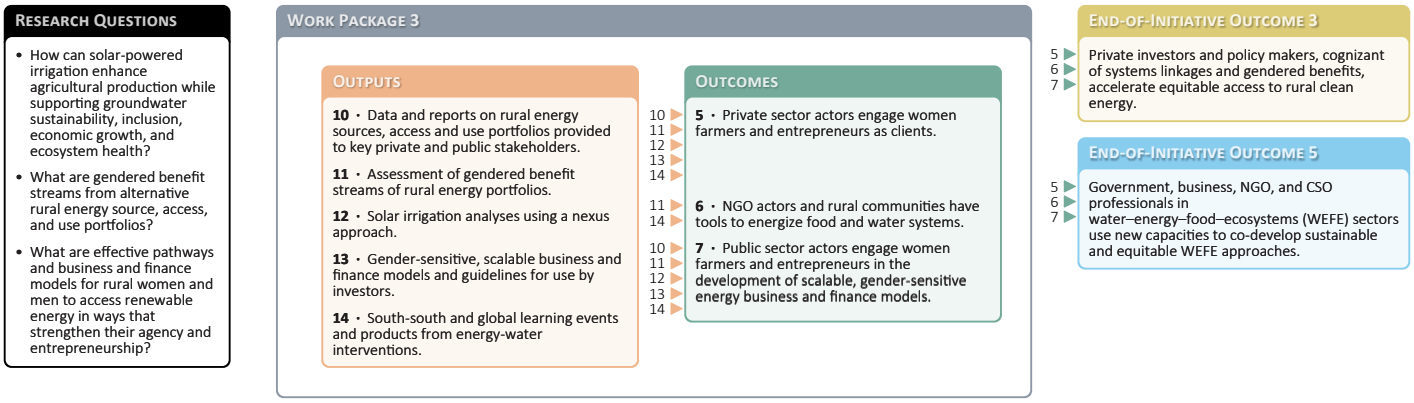
In India, NEXUS Gains assessed the water productivity improvements achieved by farmers in Haryana who transitioned from transplanted to direct-seeded rice and diversified crops to reduce irrigation demand. In Nepal, we partnered with the CGIAR Research Initiative on Sustainable Animal Productivity to enhance water productivity in milk production by improving livestock feed (see Section 7).

To achieve outcome 2.2, water storage assessments were conducted and published on three river basins – the Blue Nile (see also here), Limpopo, and Ganges. The tool estimates the volume of water available in different storage types and the variation in volumes across months. The practical implications of the assessments were packaged and disseminated through blogs and presentations to facilitate their use by partners and stakeholders. Outputs were also channeled through peer-reviewed publications (e.g., from India and Zimbabwe) and used in workshops to support planners and managers to strengthen their approaches to multisector water management. Involving partners in knowledge production and frequent interaction with government colleagues contributed to these outcomes.

Further, India has adopted the novel storage technique UTFI, a form of managed aquifer recharge. Supported by NEXUS Gains, the government has incorporated this technology into a national groundwater program. Additionally, NEXUS Gains, through ICRISAT, collaborated with the Government of Uttar Pradesh under the Rashtriya Krishi Vikas Yojana program to support landscape rejuvenation in Bundelkhand by enhancing groundwater storage (see Section 7).

Finally, in the Limpopo River Basin, assessments of sand dams have helped the Government of Zimbabwe to better understand the potential benefits of this innovation. The Limpopo Watercourse Commission has been an active partner in this effort and has indicated that it is considering applying it elsewhere in the basin.

WP3: Energizing food and water systems sustainably and inclusively



Work Package 3 progress against the theory of change

WP3 aimed to achieve three outcomes:

- 3.1 private sector actors engage women farmers and entrepreneurs as clients;
- 3.2 NGO actors and rural communities have tools to energize food and water systems; and
- 3.3 public sector actors engage women farmers and entrepreneurs in the development of scalable, gender-sensitive energy business and finance models.

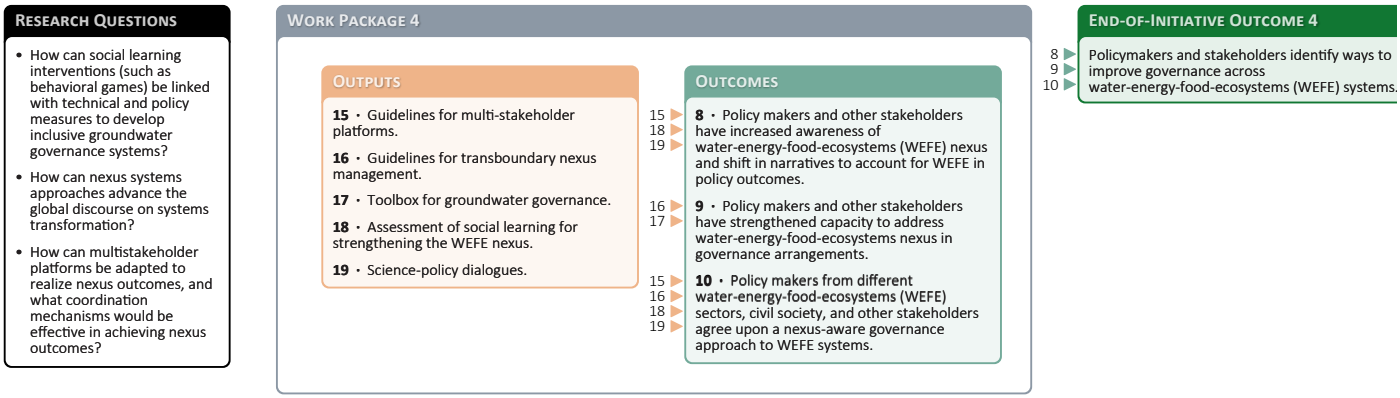
To achieve outcome 3.1, in Ethiopia, NEXUS Gains identified promising solutions to address challenges affecting the adoption of solar-powered irrigation as part of a private sector led cluster farming program that aimed to support one million farmers. NEXUS Gains also informed a planned USD 50 million farmer-led irrigation development including solar-powered irrigation under development by the World Bank in Nigeria, and identified improvements for an ongoing solar pump subsidy program in Uganda. Moreover, an updated version of the NEXUS Gains solar explorer for sub-Saharan African groundwater irrigation has stimulated interest with new, linked climate change and overall benefit analyses.

To achieve outcome 3.2, NEXUS Gains used a mixed-methods approach to qualitatively and quantitatively assess gendered energy portfolios and associated benefit streams in Ethiopia, India, Nepal, and Pakistan. In Nepal, in-depth studies on gender and social inclusion gaps have informed government, private sector, and NGO actions. Further, NEXUS Gains identified measures to improve the equity and sustainability of solar-lift irrigation systems in the mid-hills region. Findings on stronger community engagement, more sustainable financing, and better operations and management are being used to update government guidelines and investments. Finally, a solar sizing tool has been developed in collaboration with GIZ and the government.

To achieve outcome 3.3, NEXUS Gains developed the WEEI and RHEIES to better understand gendered energy deprivation and identify effective pathways to strengthen access and use of renewable energy equitably and sustainably. In 2024, the RHEIES was integrated into the evaluation of an agroecology intervention in India as well as into the Sri Lanka BRIGHT survey for further validation and evidence generation. NEXUS Gains also supported the Government of Pakistan with solar suitability mapping and solar sizing analyses. The results from these studies have been taken up by Punjab Province with plans for rollout across Pakistan. In India, where solar pump subsidies are skewed toward larger pumps and richer farmers, the government acknowledged that NEXUS Gains findings on more equitable business and finance models can advance its goals of reaching poorer and more marginal farmers.

Throughout its three years of operation, NEXUS Gains fostered South–South learning among young researchers, practitioners, and policymakers with the aim of equitably scaling out rural energy solutions using a WEFE systems approach.

WP4: Strengthening WEFE nexus governance



Work Package 4 progress against the theory of change

WP4 aimed to achieve three outcomes:

- 4.1 policymakers and other stakeholders' awareness of WEFE nexus increased and narratives shift to account for WEFE in policy outcomes;
- 4.2 policymakers and other stakeholders have strengthened capacity to address WEFE nexus in governance arrangements; and
- 4.3 policymakers from different WEFE sectors, civil society, and other stakeholders agree upon a nexus-aware governance approach to WEFE systems.

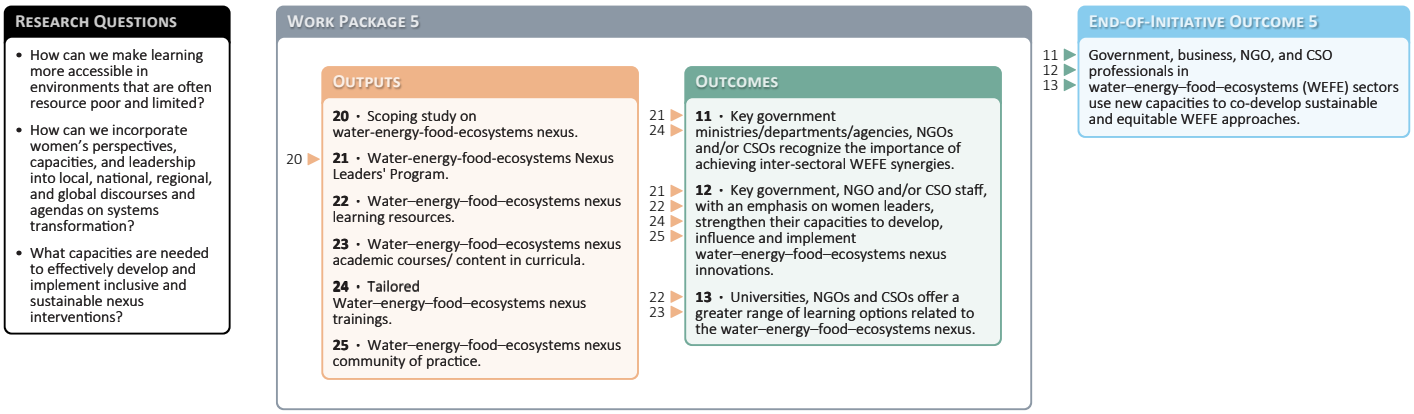
To achieve outcome 4.1, research on linking social learning interventions (e.g., behavioral games) with technical and policy measures to develop inclusive groundwater governance systems was published in journal articles, including a special issue on groundwater governance. The findings have been practically applied to address groundwater depletion in South Asia, with notable impacts including: 1) application of these tools in over 6,500 communities in India, including in the national groundwater program; and 2) application of the knowledge, motivation, and agency framework developed as a guide for the application of the GMIS in Pakistan (see Section 7). In Odisha, India, similar behavioral games were utilized to assist community members and other stakeholders to better understand the complexity of watershed management.

The value of WEFE systems approaches in the global discourse on systems transformation was recognized in the work with IPBES, and the FABLE Consortium. Notable Science-Policy Dialogues included participation of stakeholders in an event on advancing implementation of National Biodiversity Strategies and Action Plans and prioritizing water and nexus thinking at CBD COP16. The Lancet Planetary Health–Earth Commission report incorporated nexus issues, and the IPBES Nexus Report was approved by 147 countries, highlighting growing awareness and acceptance of WEFE nexus approaches.

To achieve outcome 4.2, research on adapting MSPs to realize nexus outcomes, and what coordination mechanisms would be effective, led to guidelines on MSPs and transboundary water governance. These, in turn, contributed to the formation or strengthening of governance arrangements at multiple levels. Partners' capacity to use the groundwater toolbox and guidelines for MSPs and transboundary governance was strengthened in Barahathawa Municipality and the Parliamentary Infrastructure Development Committee in Nepal; a new MSP in Rahim Yar Khan District and the Punjab Irrigation Department in Pakistan; and India's national groundwater program.

To achieve outcome 4.3, NEXUS Gains collaborated with parliamentarians, policymakers and other stakeholders. Key achievements include: 1) the revised Nepal Irrigation Policy acknowledging the importance of a nexus approach to development and encompassing nexus approaches in implementation; 2) the Niger Basin Council of Ministers adopting a Nexus Guidance document for planning; and 3) INMACOM establishing a multistakeholder platform and adopting recommendations for transboundary water governance.

WP5: Developing capacity for WEFE actors, including emerging women leaders



Work Package 5 progress against the theory of change

WP5 aimed to achieve three outcomes:

- 5.1 institutional recognition of the importance of achieving inter-sectoral WEFE synergies;
- 5.2 strengthened capacity, especially of women leaders; and
- 5.3 WEFE nexus options integrated into training programs.

To achieve outcome 5.1, NEXUS Gains conducted scoping studies in Nepal, Uzbekistan, and Pakistan as a baseline of capacities and needs of WEFE actors. These studies shaped the approaches adopted in WP5. Supported by continuous engagement with NEXUS Gains, researchers, governments, and CSO actors applied the nexus knowledge they developed through capacity strengthening activities (outcome 5.2) to policy and program development and implementation, including in the design of Nepal's revised Irrigation Policy 2023 and Water Resources Bill.

To achieve outcome 5.2, scorecards were developed to support the monitoring of nexus capacities in research and academia and among professionals and government agencies to guide individual and institutional capacity-strengthening efforts. In Nepal, the Nexus Leadership Program was designed to strengthen the leadership and technical capacities of professionals, especially women, to apply a WEFE approach. In 2023 and 2024, the program comprised 71 participants (36 women, 35 men) from over 10 institutions at the federal and provincial levels. A post-program evaluation found that all participants reported improved knowledge, skills, and networks to implement WEFE nexus approaches. In Nepal, 582 participants (240 women, 342 men) from key ministries, NGOs, CSOs, and academia working across WEFE sectors reported improved knowledge and skills from other training activities. In Ethiopia, Nepal, Pakistan, South Africa, Uzbekistan, and beyond, training of trainers, workshops, high-level dialogues, Masterclasses, and international Winter and Summer Schools equipped participants (a total of 8,646 individuals, 47 percent women) with skills, and with networks including global and national communities of practice, to use WEFE nexus concepts.

To achieve outcome 5.3, NEXUS Gains developed open-access learning resources and training materials, including three courses on WEFE nexus approaches tailored for and piloted with governments, practitioners, and post-graduate students. WEFE approaches are now institutionalized in two universities' curricula, as the postgraduate course is being delivered by Tribhuvan University and the Agriculture and Forestry University in Nepal. Other learning materials, curated in a NEXUS Gains learning resources repository, have been used and further disseminated by partners such as GIZ on its nexus knowledge hub. Our training material on GESI has filled a gap in nexus resources, as demonstrated by the inclusion of a NEXUS Gains online learning module on GESI in GIZ training materials. In Ethiopia, NEXUS Gains established and periodically convened an inter-institutional Technical Working Group as a sustainable platform for government agencies to lead model updates, pathways, and commitments for each sector.

Work Package progress rating summary

WORK PACKAGE	PROGRESS RATING & RATIONALE
1	On track All expected targets were met or exceeded. • 1.1 Number of demand partners using WEFE modeling tools. Target: 2. Achieved: 4. • 1.2 Number of demand partners using trade-off tools. Target: 2. Achieved: 2.
2	On track All expected targets were met or exceeded. • 2.1 Number of Decision Support Systems informing solutions. Target: 1. Achieved: 2. • 2.2 Number of basins where storage diagnostics are used. Target: 2. Achieved: 3. In addition, some tools have not yet been applied by partners, but they are committed to doing so.
3	On track All expected targets were met. • 3.1 Number of actors using tools to bring in women farmers and entrepreneurs as a client base. Target: 2. Achieved: 2. • 3.2 Number of actors using tools to support women farmers and entrepreneurs in accessing energy technologies. Target: 2. Achieved: 2. • 3.3 Number of actors engaging women in the development of energy business and finance models. Target: 3. Achieved: 3.
4	On track All expected targets were met or exceeded. • 4.1 Number of policy statements that incorporate WEFE nexus. Target: 2. Achieved: 4. • 4.2 Number of partners with capacities to use toolbox and guidelines for multistakeholder platforms and transboundary governance. Target: 2. Achieved: 5. • 4.3 Number of basin-specific sets of recommendations adopted for better governance of WEFE systems. Target: 1. Achieved: 1.
5	On track All expected targets were met or exceeded. • 5.1 Number of policy documents, programs, or projects that refer to WEFE nexus. Target: 1. Achieved: 1. • 5.2 Number of nexus leaders with capacities to develop and implement WEFE nexus innovations. Target: 40. Achieved: 71. • 5.3 Number of key partners use integrated WEFE nexus learning resources in their courses, programs or projects. Target: 2. Achieved: 4. into account progress over the 3 years.

Definitions

On track

- Progress largely aligns with Plan of Results and Budget and Work Package theory of change.
- Can include small deviations/issues/ delays/risks that do not jeopardize success of Work Package.

Delayed

- Progress slightly falls behind Plan of Results and Budget and Work Package theory of change in key areas.
- Deviations/issues/delays/risks could jeopardize success of Work Package if not managed appropriately.

Off track

- Progress clearly falls behind Plan of Results and Budget and Work Package theory of change in most/all areas.
- Deviations/issues/delays/risks do jeopardize success of Work Package.

Section 4: **Quantitative overview of key results**

This section provides an overview of results reported and contributed to, by the CGIAR Initiative on NEXUS Gains from 2022 to 2024. These results align with the CGIAR Results Framework and NEXUS Gains's theory of change. Further information on these results is available through the CGIAR Results Dashboard.

The data used to create the graphics in this section were sourced from the CGIAR Results Dashboard on 04 April 2025. These results are accurate as of this date and may differ from information in previous Technical Reports. Such differences may be due to data updates throughout the reporting year, revisions to previously reported results, or updates to the theory of change.

Overview of results by category

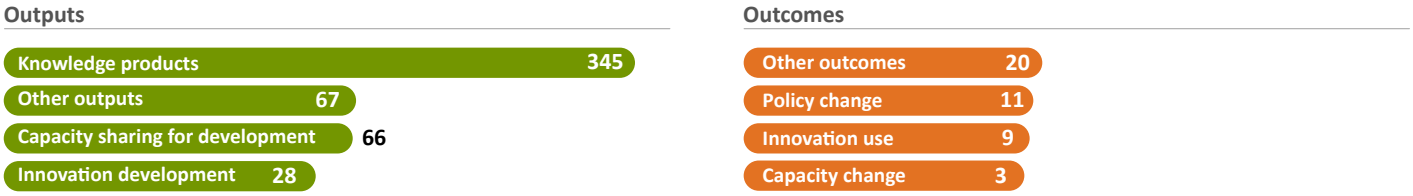


Diagram 4.1 shows the total number of results reported by category; of the 549 results reported, 501 were led by NEXUS Gains and 48 were led by other Initiatives or Impact Platforms.

Number of results by Impact Area contribution

- **2 = Principal:** Contributing to one or more aspects of the Impact Area is the principal objective of the result. The Impact Area is fundamental to the design of the activity leading to the result; the activity would not have been undertaken without this objective.
- **1 = Significant:** The result directly contributes to one or more aspects of the Impact Area. However, contributing to the Impact Area is not the principal objective of the result.
- **0 = Not targeted:** The result has been screened against the Impact Area, but it has not been found to directly contribute to any aspect of the Impact Area as it is outlined in the CGIAR 2030 Research and Innovation strategy.
- **Not applicable:** Pertains to 2022 reported results when only information on Gender and Climate impact area tagging was available.

Diagram 4.2 shows how NEXUS Gains results were tagged to CGIAR's Impact Areas. The Initiative contributed to all five Impact Areas, and most significantly to Environmental Health and Biodiversity, with 430 results (78 percent) tagged as "significant" or "principle"; and to Climate Change Adaptation and Mitigation, with 385 results (70 percent) tagged as "significant" or "principle".

Contributions to the UN Sustainable Development Goals

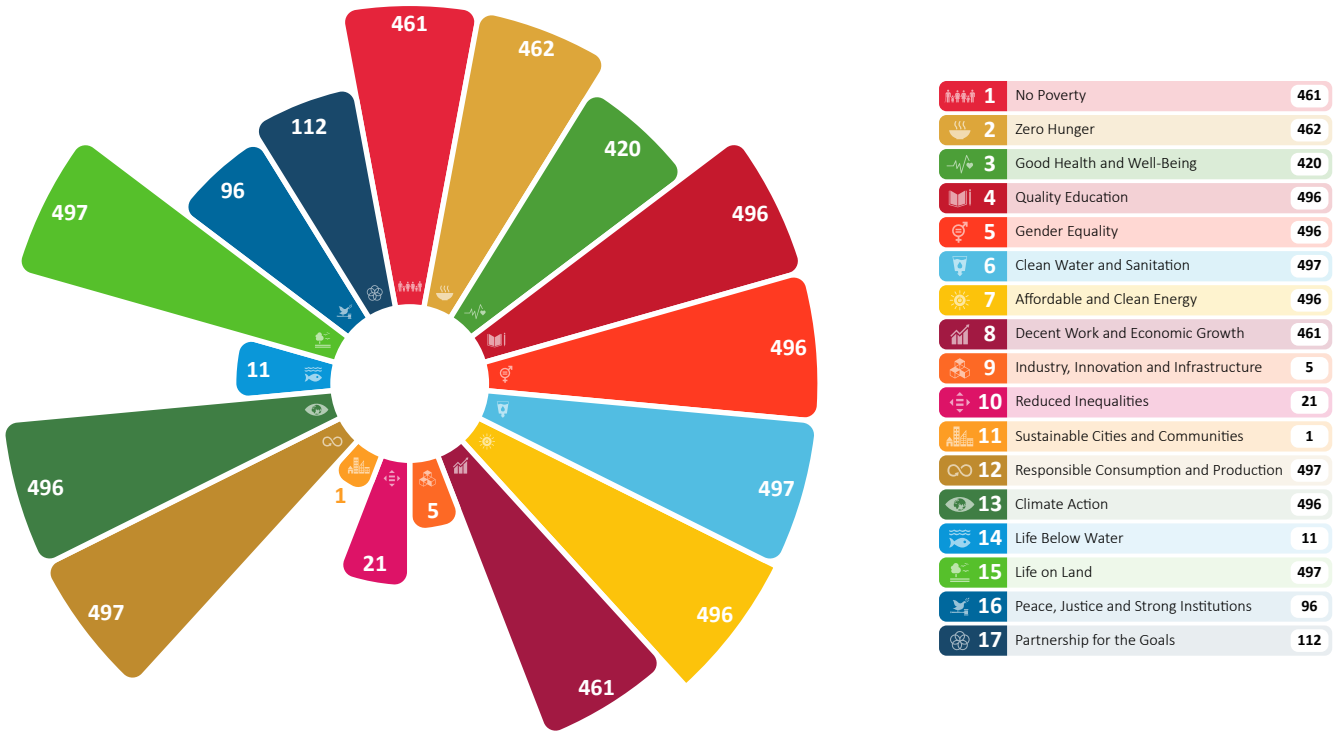


Diagram 4.3 shows how NEXUS Gains results align to the Sustainable Development Goals (SDGs). The data are based on the Initiative's theory of change, which tags all results to Science Groups, Impact Areas, and SDGs. SDGs 1, 2, 3, 4, 5, 6, 7, 8, 12, 13, and 15 are all supported by more than 400 NEXUS Gains results.

GEOGRAPHIC FOCUS OF RESULTS

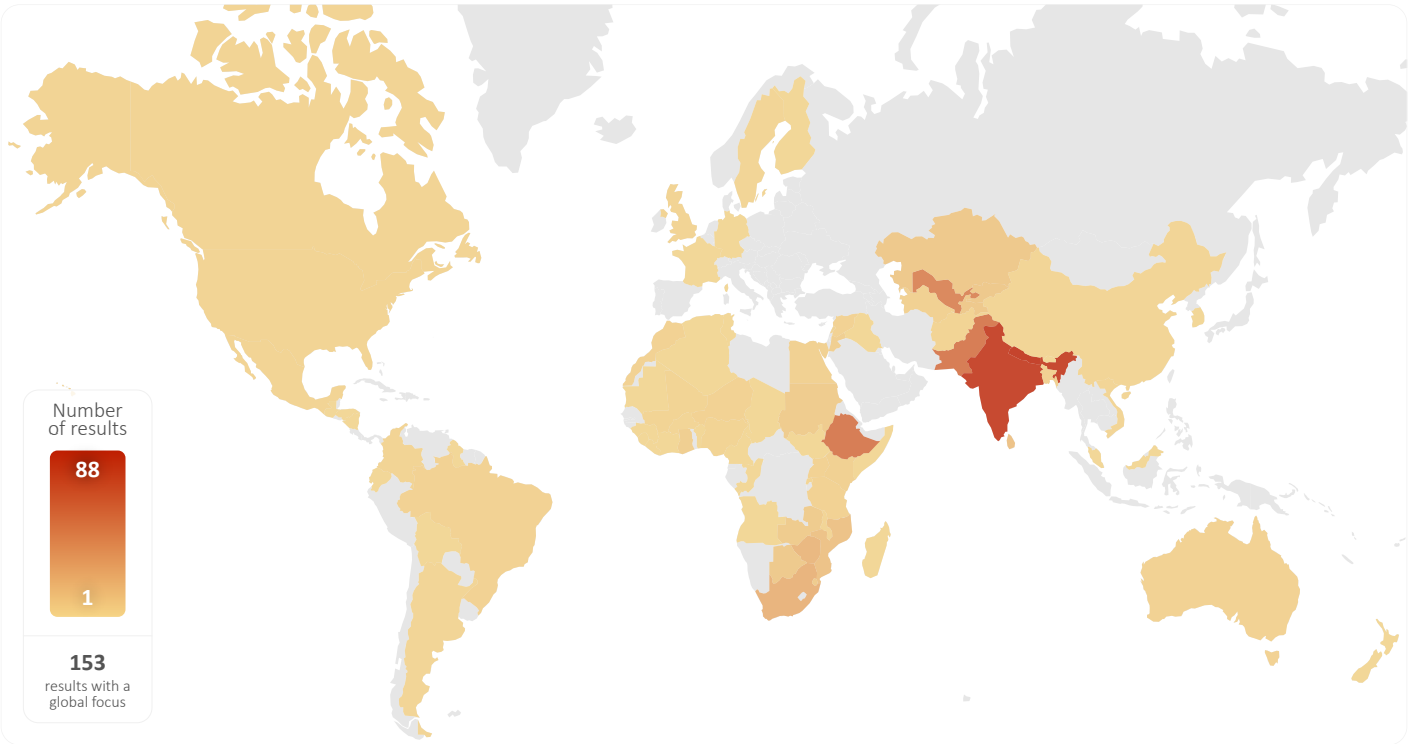
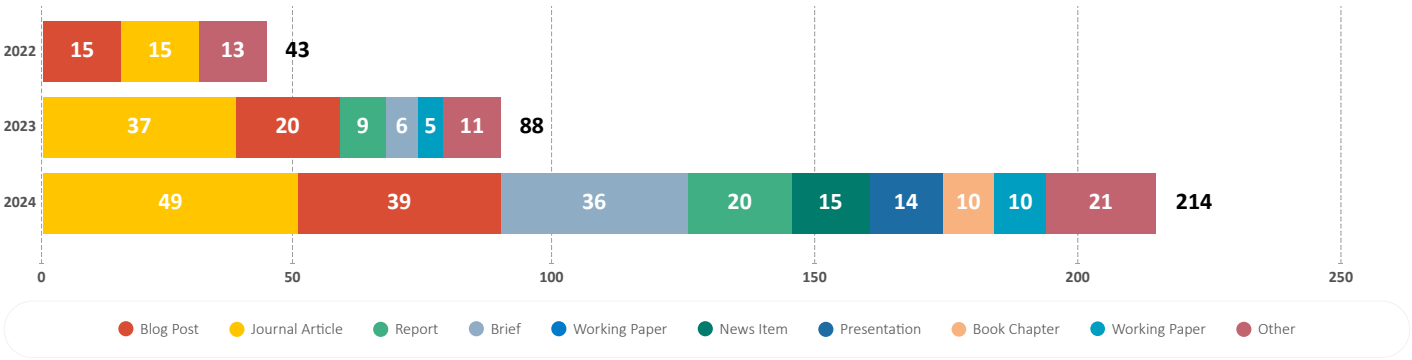


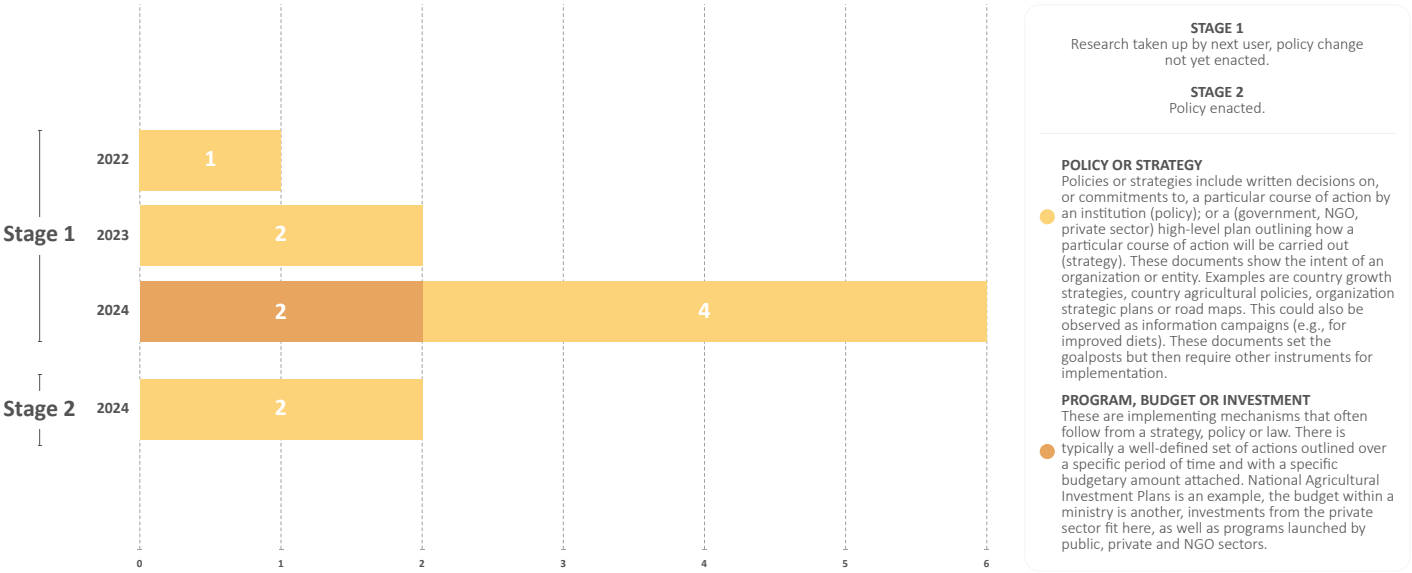
Diagram 4.4 illustrates the distribution of results with a notable focus on the Ganges, Indus, Aral Sea, Blue Nile, and Limpopo/Incomati basins. 153 reported results had a global focus.

Knowledge products by typology



The annual increase in knowledge products is evident in diagram 4.5, with a significantly higher number of results produced in 2024. In total, 101 journal articles were published over three years (345 in 2024), representing 29 percent of all knowledge products. These were followed by blogs (74, with 39 in 2024) and briefs (44, with 36 in 2024), both of which are important channels for communicating research results and outcomes.

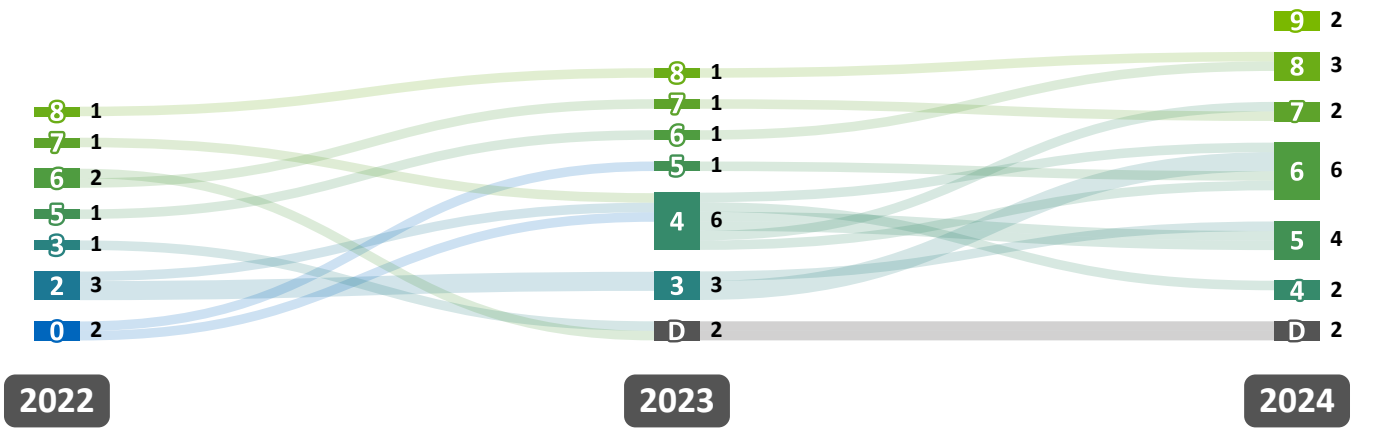
Policies by stage and by type



NEXUS Gains' influence on policy and strategy is illustrated in diagram 4.6. Over three years, the Initiative achieved nine Stage 1 and two Stage 2 policy outcomes.

Number of innovations and their readiness levels

		Pipeline overview # of innovations
9	**Proven Innovation** The innovation is validated for its ability to achieve a specific impact under uncontrolled conditions	3
8	**Uncontrolled Testing** The innovation is being tested for its ability to achieve a specific impact under uncontrolled conditions	4
7	**Prototype** The innovation is validated for its ability to achieve a specific impact under semi-controlled conditions	2
6	**Semi-Controlled Testing** The innovation is being tested for its ability to achieve a specific impact under semi-controlled conditions	10
5	**Model/Early Prototype** The innovation is validated for its ability to achieve a specific impact under fully-controlled conditions	5
4	**Controlled Testing** The innovation is being tested for its ability to achieve a specific impact under fully-controlled conditions	2
3	**Proof of Concept** The innovation's key concepts have been validated for their ability to achieve a specific impact	1
2	**Formulation** The innovation's key concepts are being formulated or designed	0
1	**Basic Research** The innovation's basic principles are being researched for their ability to achieve a specific impact	0
0	**Idea** The innovation is at idea stage	1



9 Proven Innovation · 8 Uncontrolled Testing · 7 Prototype · 6 Semi-Controlled Testing · 5 Model/Early Prototype · 4 Controlled Testing · 3 Proof of Concept · 2 Formulation · 1 Basic Research · 0 Idea · D Discontinued

These two diagrams show the range of readiness levels spanned by NEXUS Gains innovations. Diagram 4.7.1 shows that of 28 innovations, 19 have reached level 6 or above and three of these are now 'proven innovations (level 9). Diagram 4.7.2 shows the 21 innovations led by NEXUS Gains, 14 of which have reached level 6 or above and two were discontinued after 2022.

Section 5: **Partnerships**

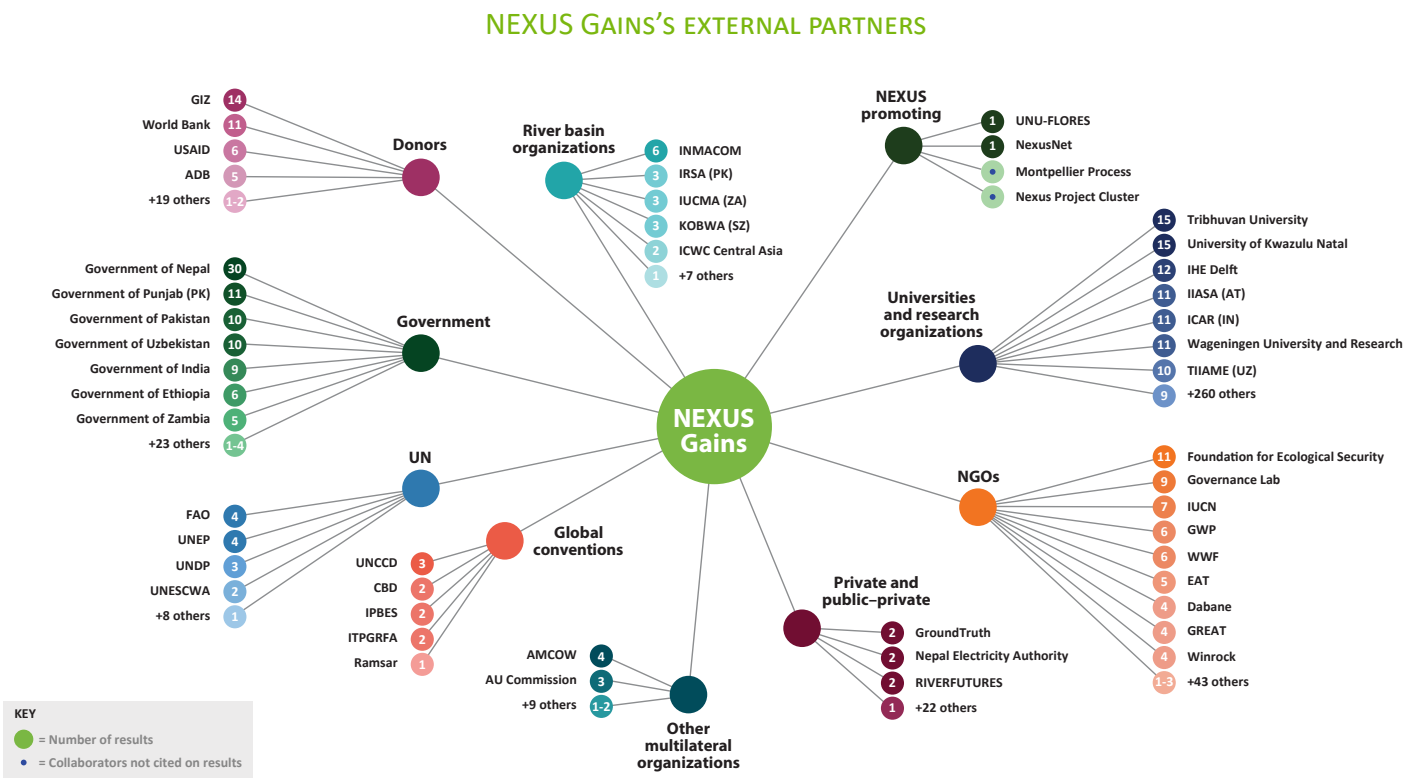


Diagram 5.1 shows NEXUS Gains' external partners, categorized by type, that were collaborators on multiple results from 2022 to 2024. NEXUS Gains collaborated with 492 partners.

Partnerships and NEXUS Gains's impact pathways

Building bridges within and between sectors is critical for comprehensive, data-driven and inclusive WEFE nexus planning. NEXUS Gains built strong partnerships with global, regional, and national partners across South Asia, sub-Saharan Africa, and Central Asia. These partnerships were instrumental in producing key outputs and enabling the Initiative to achieve its planned outcomes.

Global and regional collaborations

Collaboration with the IPBES helped integrate nexus issues into several key policy statements, including a global scientific evaluation, the Nexus Assessment. Engagement with the Global Water-Energy-Food Nexus Knowledge-Action Network and close collaboration with the Leibniz Center for Agricultural Landscape Research and university partners facilitated South–South learning. NEXUS Gains also contributed to the Montpellier Process, a collaborative learning alliance dedicated to designing transformative pathways across climate, biodiversity, health, and food systems. Finally, NEXUS Gains influenced global policy on transboundary water allocation, as its work in the Incomati Basin was featured in the United Nations Economic Commission for Europe's Transboundary Water Allocation Summary Handbook.

South Asia

In India, a long-standing partnership with the Foundation for Ecological Security co-developed experiential learning and other tools for groundwater governance. These have been adopted by a large-scale national program on participatory groundwater governance and have been used in over 6,500 communities. Collaboration with the Indian Council of Agricultural Research (ICAR) and the National Water Informatics Centre produced the Water Productivity Atlas, now available on the Ministry of Water Resources website (Section 7). Partnerships with the Ministry, the Rampur District Magistrate, and the Government of Uttar Pradesh enabled scaling of managed aquifer recharge approaches in both the Ramganga Basin and Bundelkhand.

In Nepal, partnerships with the Alternative Energy Promotion Center (AEPC), Ministry of Energy, Water Resources and Irrigation, and NGOs have facilitated rural clean energy expansion. In Nepal and India, NEXUS Gains also partnered with GIZ, AEPC, and ICAR to develop solar sizing tools. Partnerships with the Departments of Water Resources and Irrigation (DWRI) and Agriculture, National Agriculture Research Council, Water Resources Research and Development Center, and Water and Energy Commission Secretariat supported data collection with farmers on three irrigation schemes, influencing policy development. Engagement with the Parliamentary Infrastructure Development Committee led to WEFE considerations being incorporated into Nepal's draft Water Resources Bill.

To strengthen WEFE professional capacity, NEXUS Gains partnered with the Center for Water Resources Studies, Institute of Engineering, at Tribhuvan University (a demand, innovation, and scaling partner) to develop three WEFE nexus courses. The courses were piloted and institutionalized as part of the curriculum in two institutes of the university. The university also led training-of-trainers to scale the course to other universities, including the Agriculture and Forestry University, which now delivers the course as part of its curriculum.

DWRI is another demand partner engaged in multiple training courses. The Department requested support to incorporate the WEFE nexus into the implementation of Nepal's new Irrigation Policy (2023). In 2024, NEXUS Gains provided three stocktaking reports at DWRI's request. Government stakeholders confirmed that these will form a key element in their action planning for implementation.

Finally, GREAT International helped with the development, piloting, and delivery of the WEFE Nexus Leadership Program, mobilizing participants and mentors and integrating learnings into WEFE institutions.

In Pakistan, partnership with the Punjab Irrigation Department supported the development and rollout of the GMIS (Section 7). Collaboration with the department on solar sizing and solar suitability mapping was facilitated by the trust and collaboration developed from the outset of NEXUS Gains, while engagement with private sector actors such as Rabail Technologies supported the identification of solutions. We also collaborated with the Pakistan Council of Research on Water Resources to develop and implement a new environmental flows tool.

Sub-Saharan Africa

In Southern Africa, partnership with INMACOM led to the adoption of multistakeholder platforms and plans for transboundary sharing of waters. Partnering with the Dabane Trust, an NGO, was essential to understanding the impacts of sand dams and promoting their adoption. To foster adoption in Zimbabwe, NEXUS Gains collaborated with the Department of Water Resource Development and Utilization, the Zimbabwe National Water Authority, the Mzingwane Catchment Council, and the Shashe Sub-catchment Council, as well as LIMCOM.

In Ethiopia, partnerships with the Ministry of Water and Energy, Abbay Basin Administration Office, Amhara Region Irrigation and Lowland Development, and Federal Environmental Protection Authority strengthened equality in rural energy solutions. Collaboration with Power for All to chart energy and with private sector actors to support scaling solar-powered irrigation solutions expanded clean energy access for poor and remote households. We supported the establishment of an inter-institutional Technical Working Group to continue refining WEFE pathways; its members include a variety of government ministries and agencies.

Central Asia

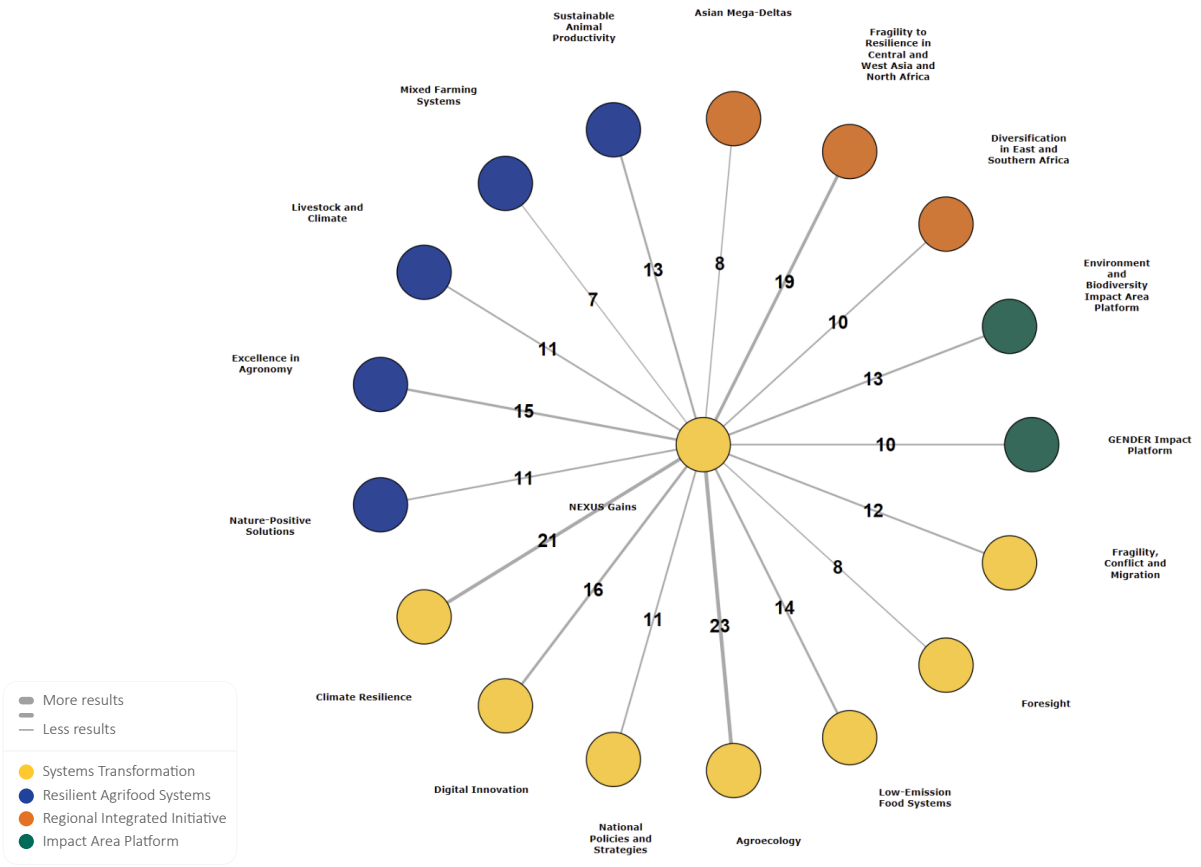
In the Aral Sea Basin, NEXUS Gains worked with SIC ICWC to apply the developed foresight methodologies for improved water and energy management.

Through these partnerships, NEXUS Gains fostered policy adoption, capacity building, and scalable innovations across multiple regions, advancing sustainable and equitable WEFE management.

Setting up a solar-powered water pump for groundwater in Ethiopia. Credit: Maheder Haileselassie/IWMI

Section 6: **CGIAR Portfolio linkages**

NEXUS Gains's internal network of collaborations



NEXUS Gains collaborated directly on at least one result with 30 out of 34 CGIAR Initiatives and four out of the five Impact Platforms. There were more significant collaborations across the Portfolio: Diagram 6.1 shows the Impact Platforms and Initiatives with which NEXUS Gains collaborated on seven or more results.

Portfolio linkages and NEXUS Gains's impact pathways

NEXUS Gains collaborated with researchers across most CGIAR Initiatives and Impact Platforms to jointly generate results and influence outcomes. The following are some key examples.

NEXUS Gains co-led a Community of Practice on MSPs alongside the Initiatives on Agroecology and Low-Emission Food Systems. This network includes 14 CGIAR Initiatives – on Nature-Positive Solutions, Climate Resilience, AgriLAC Resilience, Digital Innovation, Livestock and Climate, Aquatic Foods, Gender Equality, Mixed Farming Systems, Diversification in East and Southern Africa (Ukama Ustawi), and Fragility to Resilience in Central and West Asia and North Africa (F2R-CWANA) – and several bilateral projects. The Community of Practice developed a framework and research agenda on MSPs that contributed to NEXUS Gains output 4.1, Guidelines for Multistakeholder Platforms. It also contributed to the development or strengthening of MSPs in Pakistan, Nepal, and the Incomati/Maputo Basin.

Collaboration with the CGIAR Research Initiative on Agroecology around political economy identified strategies to enhance NEXUS Gains research impact by analyzing stakeholder interests and power relations that influence nexus governance. In India, NEXUS Gains partnered with the CGIAR National Policies and Strategies Initiative, Atal Bhujal Yojana, and the NGO PRADAN to develop a training module for village-level water leadership.

NEXUS Gains played a leading role in coordinating CGIAR's engagement in the Montpellier Process, a collaboration to strengthen the science–policy interface across global multilateral agreements impacting WEFE systems. By supporting the technical secretariat for IPBES, NEXUS Gains facilitated CGIAR input that helped shape the IPBES Nexus Assessment.

NEXUS Gains partnered with the CGIAR Climate Adaptation and Mitigation Impact Platform to contribute to the agricultural chapter of the 2023 Achieving Agricultural Breakthrough report. The Initiative worked with the Impact Platform and other Initiatives in three UN climate conferences (COP27, COP28, and COP29), supporting country engagement and promoting CGIAR approaches to address complex climate challenges.

The CGIAR Research Initiatives on Climate Resilience and NEXUS Gains collaborated to launch a version of the South Asia Drought Monitoring Systems Platform, the Zambia Drought Management System with the Government of Zambia, and with the CGIAR Research Initiative on Digital Innovation to develop a digital twin for water resources management in the Limpopo Basin.

In Uzbekistan, NEXUS Gains collected new data on the Women's Empowerment in Energy Score and collaborated with the Standing Panel on Impact Assessment, the CGIAR GENDER Impact Platform, and F2R-CWANA to integrate nexus analyses with gendered climate change assessments and an evaluation of the uptake of the country's

irrigation subsidy program. It also cooperated with F2R-CWANA and the CGIAR Research Initiative on Rethinking Food Markets to identify drivers and barriers to innovation adoption among farming households.

In Nepal, NEXUS Gains and the CGIAR Research Initiative on Mixed Farming Systems supported IWMI to put research into practice by advising a community and local government on the installation of a solar-lift irrigation system based on its research findings. We collaborated with the CGIAR Research Initiative on Sustainable Animal Productivity on a project to assess water use by dairy farmers and promote the commercialization of bio-fermented rice straw.

In Pakistan, the Fragility, Conflicts and Migration Initiative implemented an assessment of recent disasters (floods, drought, and water-borne diseases) on migration in Rahim Yar Khan District. This built on the biophysical modeling implemented by the NEXUS Gains project.

NEXUS Gains collaborated with the CGIAR Research Initiatives on Excellence in Agronomy, Ukama Ustawi, and West and Central African Food Systems Transformation to review the prioritization and operationalization of the African Union's irrigation development and agricultural water management strategy. NEXUS Gains was one of 21 CGIAR Research Initiatives or Impact Platforms to contribute to producing a paper led by Ukama Ustawi on Scaling Readiness, an evidence-based approach to co-design, implement, and monitor scaling strategies. We also worked with the CGIAR Research Initiative on Aquatic Food Systems and other partners to analyze the impacts of four dams in three continents on energy and food, ecosystem health, inclusion, and ultimately human health and wellbeing.

A partnership with the CGIAR Environmental Health and Biodiversity Impact Platform focused on developing and implementing integrated management strategies; specifically, NEXUS Gains contributed to the design of the Impact Platform action plan and the development of impact indicators. In 2023, we collaborated with the Impact Platform and partners to influence recommendations on biodiversity and climate change stemming from the Convention on Biological Diversity COP16; and supported the CGIAR Poverty, Livelihoods and Jobs Impact Platform to integrate RHEIES into the BRIGHT survey in Sri Lanka.

Finally, in 2024, ICRISAT became the seventh CGIAR Center to formally join the NEXUS Gains partnership (alongside IWMI, IFPRI, the Alliance of CIAT and Bioversity, IRRI, ICARDA, and ILRI). In India, ICRISAT built on existing government funded projects to enhance managed aquifer recharge and agricultural productivity, thereby breaking the cycle of rural poverty, in Bundelkhand, Uttar Pradesh and contributed to the groundwater governance workstream.

Irrigation canal in Tajikistan.
Credit: Madeline Dahm/IWMI

Section 7: **Key result story**

Holistic approaches effectively address South Asia's unsustainable groundwater use

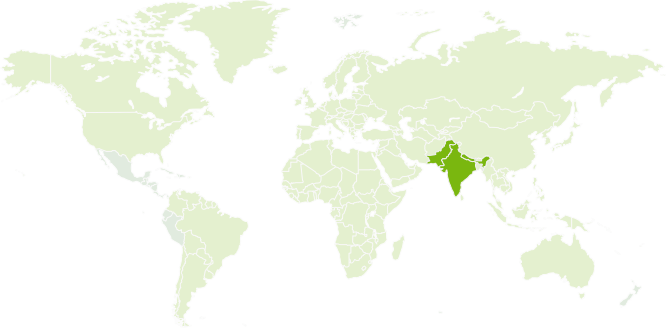
Innovations developed and tested by NEXUS Gains and partners are being adopted for sustainable, productive groundwater use in South Asia.

Groundwater games.
Credit: Richu Sanil/ Foundation For Ecological Security

Primary Impact Area

Other relevant Impact Areas targeted

Geographic scope



Regions: South Asia

Countries: India · Nepal · Pakistan

Contributing Initiative

NEXUS Gains · SAPLING

Contributing Centers

IWMI · IFPRI · ICRISAT · ILRI · IRRI

Contributing external partners

Punjab Water Services Regulatory Authority (Pakistan) · Punjab Irrigation Department (Pakistan) · Indian Council of Agricultural Research · Mahatma Phule Krishi Vidyapeeth, Rahuri · Government of Uttar Pradesh (India) · Foundation for Ecological Security · Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung/Federal Ministry of Economic Cooperation and Development (Germany) · Deutsche Gesellschaft für Internationale Zusammenarbeit/German Society for International Cooperation · Borlaug Institute for South Asia · Ministry of New and Renewable Energy (India) · Government of India · Alternative Energy Promotion Centre · Government of Nepal · Government of Pakistan

Groundwater depletion is a complex challenge threatening food security and livelihoods across South Asia. To address this, NEXUS Gains co-developed comprehensive, multipronged innovations that are being adopted and scaled throughout the region. These solutions include an aquifer recharge innovation and an online Water Productivity Atlas in India and a Groundwater Management Information System in Pakistan. Complementing these are packages of experiential games and technologies, used by NGOs and large government programs, to empower farmers and enhance sustainable groundwater management.

Groundwater over-abstraction in South Asia's breadbaskets is depleting aquifers (1), threatening long-term food security and increasing poverty. The expansion of solar-powered irrigation could worsen this problem (2), further complicating groundwater governance, which is already challenging due to its being an invisible common pool resource. Effective management requires a comprehensive, multipronged approach integrating knowledge (practical information), motivation (desire to change), and agency (ability to act on knowledge) (3). Governments and local communities are adopting institutional and technical innovations developed by NEXUS Gains and partners, integrating all five Work Packages, with positive impacts.

Groundwater Management Information System (GMIS). IWMI collaborated with Pakistan's Punjab Irrigation Department to develop a tool to monitor groundwater use and quality. By identifying depletion and contamination "hot spots," GMIS supports informed decision-making; it is being used to develop actionable road maps for sustainable groundwater management (4). A Technical Working Group established by IWMI and government departments is building capacity to expand GMIS to other provinces. The national government has linked it to its Pakistan Council of Research in Water Resources and UN Living Indus websites, enabling interventions that benefit farmers, consumers, businesses, and ecosystems. It is already being used (5-8).

Water Productivity Atlas. Co-developed with the Indian Council for Agricultural Research, the Water Productivity Atlas enables visualization of spatial and temporal variations in water productivity, cropping patterns, and consumptive water use. It supports testing of alternative cropping patterns with the potential to reduce irrigation demand in locations experiencing groundwater depletion (9-10). The Ministry of Water Resources has uploaded it to its website. Several states have expressed interest in using it, and the Asian Development Bank has proposed piloting it under the National Groundwater Management Improvement Program (11).

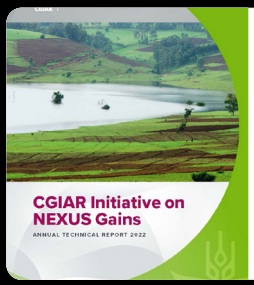
Underground Transfer of Floods for Irrigation (UTFI). Managed aquifer recharge has significant potential in South Asia (12). Developed by IWMI, UTFI diverts monsoon floods to ponds with recharge wells, replenishing groundwater. It is included in some district plans under the Prime Minister's national irrigation program (13). NEXUS Gains provides technical support to the government's National Water Conservation Program. This harnesses communities' actions to develop or rejuvenate multipurpose ponds, often accompanied by recharge wells, as recommended by IWMI. By the end of 2023, over 68,000 ponds were reconstructed (14). IWMI collaborated with the Government of Uttar Pradesh to improve implementation, including in urban areas, and evaluated the impacts of groundwater recharge efforts (15). Recharge in the Ramganga Basin has increased by 8 percent since 2015, helping to stabilize groundwater levels (16).

Crafting local governance solutions. Solving groundwater problems requires both government and community action. To strengthen local knowledge, motivation, and agency, the Foundation for Ecological Security (FES), an Indian NGO, and IFPRI co-developed games as experiential learning tools to help women and men farmers understand how their crop choices affect water resources (17-18). By late 2024, the games and complementary monitoring tools were applied in over 6,500 communities by FES, partner NGOs, and state governments (19-20). NEXUS Gains facilitated further uptake of these tools in government programs (21, 19) and consolidated the lessons learned (3).

Other interventions being tested. In Uttar Pradesh's Bundelkhand region, ICRISAT and the government co-developed a landscape management approach that raised groundwater levels by 1-2 meters and revitalized agriculture (22). NEXUS Gains recently incorporated additional climate resilience measures to enhance the program's effectiveness (23). In Haryana, some farmers are shifting from transplanted to direct seeded rice and cultivating other crops to reduce irrigation demand (24-26). In Nepal, ways to improve water productivity in milk production are being tested (27). Finally, NEXUS Gains and partners are supporting "rightsizing" solar groundwater pumps, helping minimize excessive pumping (28-30).

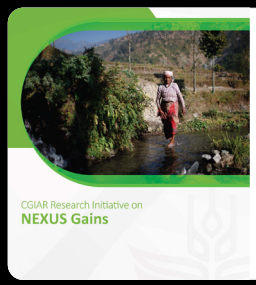
Conclusion. The next step is integrating these strategies into a long-term multiscale system transformation program (31). For example, GMIS and the Water Productivity Atlas can identify groundwater hotspots where UTFI can enhance recharge, and experiential games can be used to strengthen community governance. Partnering NGOs and communities with large-scale government programs is a pathway to transform groundwater management.

> Reliable data and innovative tools like IWMI's Water Productivity Atlas will redefine water management in agriculture, helping us address water scarcity and achieve sustainability goals.
>
> Debashree Mukherjee, Secretary of the Department of Water Resources, River Development, and Ganga Rejuvenation, Ministry of Jal Shakti, India. 18 November 2024; New Delhi



2022 key result story

The Niger Basin Authority has integrated nexus analysis into its operational and investment planning, potentially benefiting over 160 million people



2023 key result story

A revolution in Pakistan's groundwater management

CGIAR

INITIATIVE ON

NEXUS Gains

A farmer with her buffalo in Itahari, Sunsari district, Nepal.

Credit: Nils Teufel/ILRI