




# CGIAR Research Initiative on **NEXUS Gains**

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Acronyms

|            |   |
|------------|---|
| AU         | African Union   |
| CBD        | Convention on Biological Diversity  |
| DSS        | decision support system   |
| DWRI       | Department of Water Resources and Irrigation (Nepal)  |
| EOIO       | End of Initiative outcome   |
| F2R-CWANA  | Fragility to Resilience in Central and West Asia and North Africa                                 |
| FABLE      | Food, Agriculture, Biodiversity, Land-Use, and Energy   |
| FCM        | Fragility, Conflicts, and Migration   |
| GESI       | gender equality and social inclusion  |
| GIZ        | Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Development Agency)          |
| GMIS       | Groundwater Management Information System   |
| GWP        | Global Water Partnership  |
| ICAR       | Indian Council on Agricultural Research   |
| ICARDA     | the International Center for Agricultural Research in the Dry Areas                               |
| ICWC       | Interstate Commission for Water Coordination of Central Asia                                      |
| 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   |
| IWMI       | International Water Management Institute  |
| MNRE       | Ministry of Natural Resources and Energy (Eswatini)   |
| MOPHRH     | Ministry of Public Works, Housing, and Water Resources (Mozambique)                               |
| MSP        | multistakeholder platform   |
| OECD DAC   | Organisation for Economic Co-operation and Development – Development Assistance Committee         |
| PCRWR      | Pakistan Council of Research in Water Resources   |
| PID        | Punjab Irrigation Department (Pakistan)   |
| Pywr       | Python (language) water resources planning model  |
| REMCO      | River and Environmental Management Cooperation  |
| SADC       | Southern African Development Community  |
| SIC ICWC   | Scientific Information Center of the Interstate Commission for Water Coordination of Central Asia |
| SWAT+      | Soil and Water Assessment Tool  |
| TNC        | The Nature Conservancy  |
| TOC        | theory of change  |
| UNCCD      | United Nations Convention to Combat Desertification   |
| UNEP       | United Nations Environment Programme  |
| UN-ESCWA   | United Nations Economic and Social Commission for Western Asia                                    |
| UNFCCC     | United Nations Framework Convention on Climate Change   |
| UNU-FLORES | United Nations University Institute for Integrated Management of Material Fluxes and of Resources |
| USAID      | United States Agency for International Development  |
| WEEI       | Women’s Empowerment in Energy Index   |
| WEF        | water, energy, and food   |
| WEFE       | water, energy, food, and ecosystems   |
| WP         | Work Package  |
| WWF        | World Wildlife Fund   |

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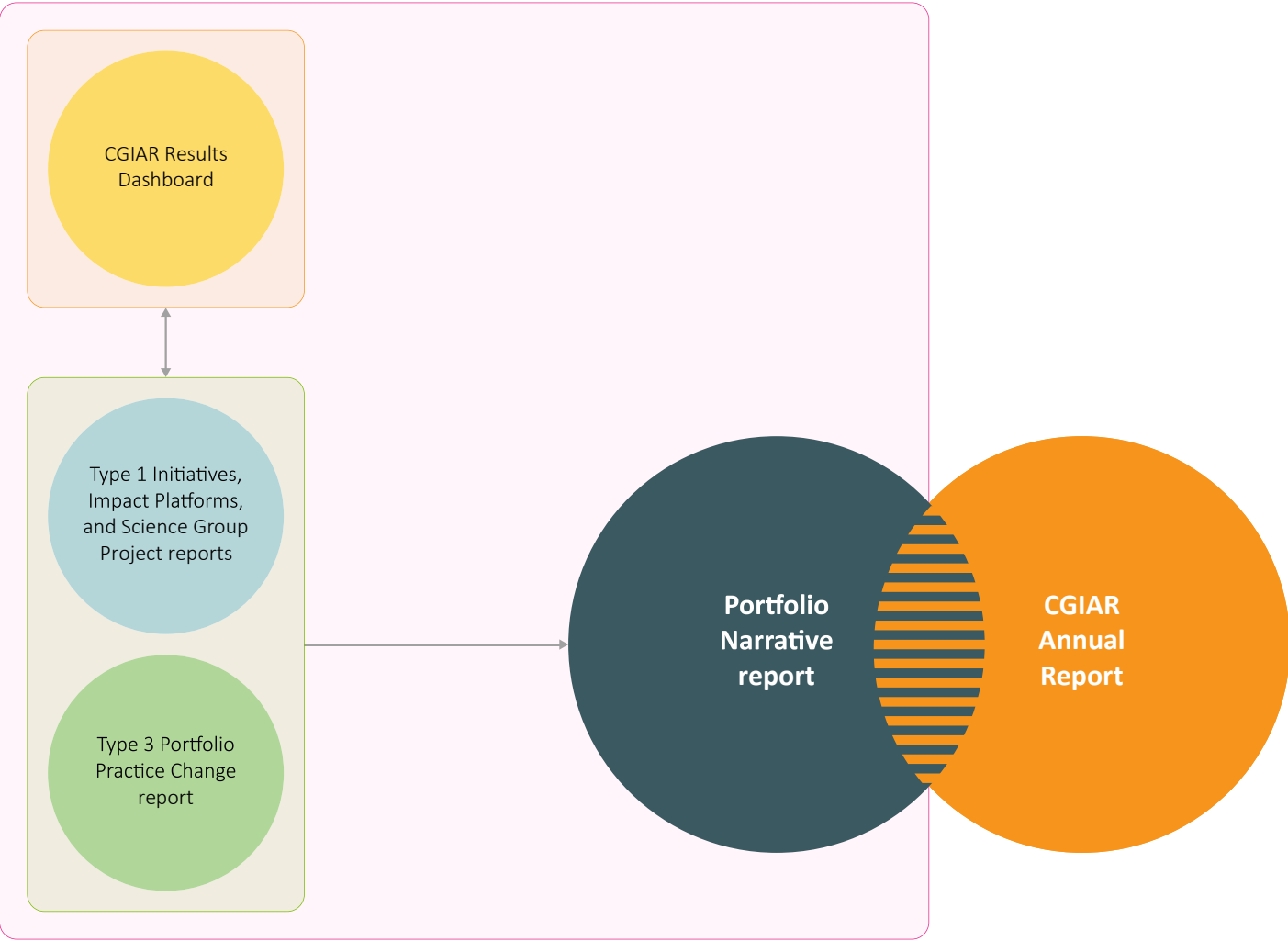
CGIAR Technical Reporting 2023

CGIAR Technical Reporting has been developed in alignment with the [CGIAR Technical Reporting Arrangement](#). This Initiative report (“Type 1” report) constitutes part of the broader [CGIAR Technical Report](#). Each CGIAR Research Initiative submits an annual “Type 1” report, which provides assurance on Initiative-level progress toward End of Initiative outcomes (EOIOs).

The [CGIAR Technical Report](#) comprises:

- Type 1 Initiative, Impact Platform, and Science Group Project reports, with quality assured results reported by Initiatives, Platforms and Science Group Projects available on the CGIAR Results Dashboard.
- The Type 3 Portfolio Performance and Project Coordination Practice Change report, which focuses on internal practice change.
- The Portfolio Narrative, which draws on the Type 1 and Type 3 reports, and the CGIAR Results Dashboard, to provide a broader view on Portfolio coherence, including results, partnerships, country and regional engagement, and synergies among the Portfolio’s constituent parts.

The CGIAR Annual Report is a comprehensive overview of CGIAR’s collective achievements, impact, and strategic outlook, which draws significantly from the Technical Report products above. For 2023, the Annual Report and Technical Report will be presented online as an integrated product.





Section 1: Fact sheet and budget

|   |   |
|---|---|
| Initiative name                                       | NEXUS Gains: Realizing Multiple Benefits Across Water, Energy, Food and Ecosystems  |
| Initiative short name                                 | NEXUS Gains   |
| Initiative Lead                                       | Matthew McCartney ( <a href="mailto:m.mccartney@cgiar.org">m.mccartney@cgiar.org</a> )  |
| Initiative Co-lead                                    | Claudia Ringler ( <a href="mailto:c.ringler@cgiar.org">c.ringler@cgiar.org</a> )  |
| Science Group   | Systems Transformation  |
| Start – end date                                      | 01/01/2022 – 31/12/2024   |
| Geographic scope                                      | <b>Regions</b><br>Central and West Asia and North Africa · East and Southern Africa · South Asia · West and Central Africa<br><b>Countries</b> <sup>3</sup><br>Botswana · Eswatini · Ethiopia · India · Kyrgyzstan · Mozambique · Nepal · Pakistan · South Africa · The Republic of the Sudan · Uzbekistan · Zimbabwe   |
| OECD DAC Climate marker adaptation score <sup>1</sup> | <b>Score 2: Principal</b><br>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.   |
| OECD DAC Climate marker mitigation score <sup>1</sup> | <b>Score 2: Principal</b><br>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.   |
| OECD DAC Gender equity marker score <sup>2</sup>      | <b>Score 1B: Gender responsive</b><br>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  | <a href="https://www.cgiar.org/initiative/nexus-gains/">https://www.cgiar.org/initiative/nexus-gains/</a>   |

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Though Eswatini and Mozambique were not in the proposal, they are a key part of the Southern Africa river basins where NEXUS Gains works.

These scores are derived from [Initiative proposals](#), and refer to the score given to the Initiative overall based on their proposal.

EXECUTIVE SUMMARY

Climate change is creating multiple challenges: extreme weather events, changing Earth systems, biodiversity loss, and growing food insecurity. Many investments focused solely on water, energy, food, or ecosystems fail to account for trade-offs and, worse, miss opportunities for synergies. The CGIAR Research Initiative on NEXUS Gains is pioneering a systems approach that breaks down disciplinary and institutional silos to find ways to reduce trade-offs and identify synergies in water, energy, food, and ecosystem (WEFE) investments. We work with partners to develop and test WEFE models and other tools in five sub-regions of Africa and Asia, identify opportunities to strengthen WEFE governance, and create capacities to plan and implement WEFE investments. In 2023, the Initiative generated 140 exciting outputs and innovations, including 80 new knowledge products, and remains on track to achieve all planned outputs and outcomes.

As water is the major connector across the WEFE nexus and central to building climate resilience, we focus much of our research on river basins. We are co-developing and co-testing practical decision support tools to analyze intersectoral trade-offs and identify priority nexus interventions (outcome 1). For example, we validated the Soil and Water Assessment Tool (SWAT+) to support policy decisions in a climate crisis in three basins and applied a hydro-economic model to explore, ex-ante, the likely results of proposed and current interventions in Pakistan, Ethiopia, and Sudan. We are collaborating with partners to develop, test, and apply tools to improve water productivity and integrated water storage in five river basins (outcome 2). We identified ways to improve water productivity in three Nepali irrigation schemes, assessed irrigation options in Uzbekistan, and implemented diagnostics to support integrated water storage in two river basins.

We analyzed the potential, and trade-offs, of expanding solar irrigation in four countries and co-tested innovative tools to support sustainable, inclusive solar irrigation investments in South Asia and sub-Saharan Africa (outcome 3). We further developed an innovative Women’s Empowerment in Energy Index (WEEI) and identified how Nepali government institutions can open pathways for rural women’s access to energy.

Effective use of WEFE tools requires improved governance and effective capacity development (outcomes 4 and 5). We expanded our guidelines on multistakeholder platforms and facilitated their development in Nepal and the Incomati River Basin; helped train 500 staff in India to use groundwater governance tools; and worked with Pakistan’s Punjab Irrigation Department (PID) to develop and implement a practical near-real-time scheme to monitor and respond to groundwater depletion – a critical threat to food security. With partners, we co-developed and co-implemented a variety of WEFE nexus training resources and programs. Examples include an international WEFE summer school in Uzbekistan, masterclasses in South Africa, and 11 well-attended NEXUS Gains webinars. The German Development Agency (GIZ) has integrated several of our training modules into its nexus training program, and a Nepali university has adopted a WEFE curriculum.

NEXUS Gains leads 13 innovations between levels 3 and 8 using the CGIAR Innovation Package and Scaling Readiness scale, four of which were added in 2023. The Initiative is a partner in another seven innovations.

We actively participated in and contributed to major global initiatives to share our insights on using a nexus approach to address climate change and WEFE challenges. Our scientists strengthened nexus understanding of, and approaches to, WEFE systems linkages at the UN Water Conference and UN Framework Convention on Climate Change (UNFCCC) COP28, where we also provided technical backstopping to three national delegations. We are important contributors to scientific panels of both the Convention on Biological Diversity (CBD) and Ramsar; the Montpellier Process, which seeks to enhance the uptake of scientific knowledge into policies; and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) “nexus assessment”. Finally, we are a major contributor to the CGIAR Environmental Health and Biodiversity Platform.

With its focus on producing practical tools, strengthened governance and capacity, and gender equality, NEXUS Gains is breaking down silos among specialized institutions and creating new partnerships to transform agricultural ecosystems.

|                              | 2022    | 2023                 | 2024                 |
|------------------------------|---------|----------------------|----------------------|
| PROPOSAL BUDGET              | \$8.72M | \$11.24M             | \$13.04M             |
| APPROVED BUDGET <sup>1</sup> | \$6.22M | \$6.56M <sup>2</sup> | \$4.99M <sup>3</sup> |

<sup>1</sup> The approved budget amounts correspond to the figures available for public access through the [Financing dashboard](#).

<sup>2</sup> This amount includes carry-over and commitments.

<sup>3</sup> This amount is an estimation of the 2024 annual budget allocation, as of the end of March 2024.



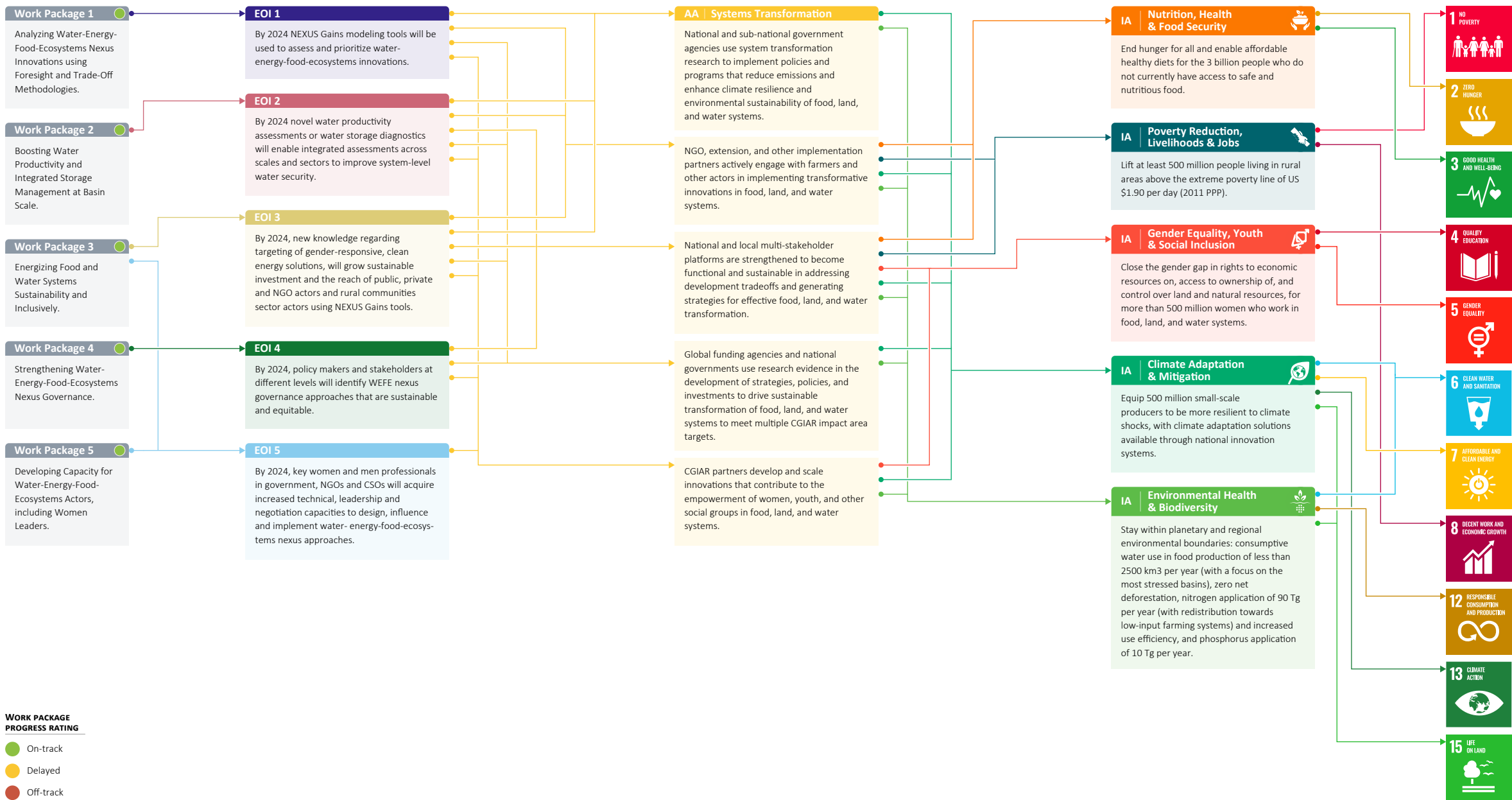
Researchers collect groundwater level, rainfall and temperature data in Ethiopia. Credit: Petterik Wiggers/Panos Pictures UK



# Section 2: Progress on science and 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.



EOI | End of Initiative outcome  
AA | Action Area  
IA | Impact Area  
SDG | Sustainable Development Goal

**Note:** A summary of Work Package progress ratings is provided in Section 3.





Farmers lay irrigation pipes on an onion farm in Limpopo Province, South Africa. Credit: Graeme Williams/IWMI.



Main canal from the Koga dam in Bahir Dar area, Ethiopia. Credit: Maheder Haileselassie/IWMI

## Summary of progress against the theory of change

The World Economic Forum’s [Global Risks Report 2024](#) highlights a deteriorating global outlook, with mutually reinforcing climate risks as critical challenges facing humanity: extreme weather events, critical changes to Earth systems, biodiversity loss, ecosystem collapse, and [growing food insecurity](#). Many countries remain unprepared and the [most vulnerable are being overwhelmed](#). Paradoxically, these challenges stem largely from endeavors to achieve water, energy, and food security. Therefore, solutions addressing the WEFE nexus are a prerequisite for building climate resilience. Nexus Gains works at global, regional, national, and local levels to identify and support the implementation of nexus solutions that contribute to adaptation and mitigation.

In 2023, we progressed considerably along our theory of change (TOC) by working with partners in five river basins and associated sub-basins: the Ganges, Indus, Aral Sea, Blue Nile, and Limpopo/Incomati. The Initiative is on track to achieve all planned outputs and outcomes across all five Work Packages (WPs).

NEXUS Gains is developing practical decision support systems (DSS) for analyzing nexus trade-offs and identifying priority nexus interventions in all five target river basins (EOIO-1). We validated the SWAT+ hydrological model to support policy decisions in three basins and applied a [hydro-economic model](#) to explore, ex-ante, a 15 percent reduction of water use for two high water-consumption crops, rice and sugarcane, in the Indus Basin and the impact of this on Pakistan’s future food security. This foresight study, along with those in [Ethiopia](#) and [Sudan](#), complete the planned EOIO-1 foresight monitoring, evaluation, learning, and impact assessment activity.

We also focus on developing, testing, and applying tools to improve agricultural water productivity and integrated water storage to adapt to climate change impacts (EOIO-2). Examples include the identification of ways to overcome [constraints to increasing water productivity](#) in Nepali irrigation schemes; an assessment of [irrigation innovation options in Uzbekistan](#); [livestock feed trials in Nepal](#) to improve water productivity and reduce greenhouse gas emissions of milk production; and an investigation of potential water [savings by](#)

[direct seeding rice in Haryana, India](#). Diagnostics to support integrated water storage were applied and shared with stakeholders in the [Shashe](#) (Limpopo) and Tana-Beles (Blue Nile) sub-basins.

We completed analyses of using [solar irrigation](#) in [Ethiopia](#), [Nepal](#), [India](#), [Pakistan](#), and [Uzbekistan](#). This is a potential game-changing technology to increase production while achieving groundwater sustainability, inclusion, economic growth, and ecosystem health, and NEXUS Gains co-tested [tools](#) to support its scaling in [sub-Saharan Africa](#) and [South Asia](#). We identified pathways for women to access renewable energy while strengthening their agency and entrepreneurship; produced a policy note on the [WEEI](#) and identified potential pathways for [Nepali government policies](#) to empower women.

Effective, inclusive governance is critical to identifying and implementing nexus-based investments (EOIO-4). We expanded our guidelines on [multistakeholder platforms](#) (MSPs) by publishing a review on community-based conservation of freshwater resources. We are facilitating MSPs in Nepal and the [Incomati River Basin](#). We also co-convene the emerging [CGIAR MSP Community of Practice](#). Groundwater is a critical but threatened resource. We helped train 500 staff from a major groundwater program in India to apply [groundwater governance tools](#) and published two articles on social learning from groundwater games<sup>(1, 2)</sup>. In Pakistan, PID has adopted a practical near-real-time methodology to monitor groundwater depletion, which will facilitate timely interventions (see section 8).

Capacity building is critical for implementing WEFE investments and policies (EOIO-5). Studies in [Uzbekistan](#) and [Nepal](#) identified the capacities and needs of WEFE actors and the barriers women professionals face, and prioritized entry points for addressing gaps. The [WEFE Nexus Leadership Program](#) was developed and piloted in Nepal with 22 professionals, including 17 women. We applied a [scorecard](#) to assess the nexus capacities of professionals, policymakers, and graduate students in Nepal. Two [University of Tribhuvan](#) departments will begin offering WEFE nexus curricula in early 2024 <sup>(1, 2)</sup>. An [e-learning module](#) on gender equality and social

inclusion (GESI) in nexus approaches, the [Power Walk activity](#), and other [GESI](#) resources were [integrated into GIZ’s nexus training platform](#). With national and global partners, we also implemented an [international summer school in Uzbekistan](#); training on the [Food, Agriculture, Biodiversity, Land-Use, and Energy](#) (FABLE) calculator and other nexus tools [in Ethiopia](#); and [high-level dialogues](#). We launched a Global Water, Energy and Food Nexus [Community of Practice](#) and hosted 11 well-attended [webinars](#).

In 2023, NEXUS Gains continued to advance innovations using the CGIAR Innovation Package and Scaling Readiness approach. There are now 13 NEXUS Gains-led innovations with [readiness levels](#) between 3 (proof of concept) and 8 (uncontrolled testing) in our innovation pipeline. Three innovation profiles <sup>(1, 2, 3)</sup> were published, bringing the total number of profiles to five. We co-conducted [innovation packaging workshops](#) for the [Environmental Flows Toolbox](#) (level 4) and [Solar Pump Sizing Tool](#) (level 6) in Nepal. NEXUS Gains is a partner in a further seven innovations.

We provided substantial support for and input to important global initiatives in 2023. These included: i) the UN Water Conference (March); ii) scientific and technical support to three NEXUS Gains focal countries, and active participation in UNFCCC COP28 (November) [to ensure WEFE systems linkages were featured in outcome documents](#); iii) input to the Informal Advisory Group on Technical and Scientific Cooperation of the CBD; and iv) support to the Ramsar Convention on Wetlands with contributions to the agriculture and wetlands working group of the Scientific and Technical Review Panel, input to [Ramsar’s fifth Strategic Plan \(2025-2030\)](#), currently being written, and guidance on mainstreaming wetland conservation to achieve the Global Biodiversity Framework

## Progress by End of Initiative Outcome

### EOIO 1: Demand partners assess WEFE trade-offs and synergies to prioritize WEFE innovations.

Our work contributes to understanding the trade-offs and potential synergies among WEFE investments, and to breaking down silos among researchers and implementation agencies. Communities of practice for the SWAT+ and Python water resources planning (Pywr) models are operational in four river basins (Aral Sea, Ganges, Incomati, and Indus). We worked with several demand partners (including the Indian Council on Agricultural Research [ICAR], Pakistan Council of Research in Water Resources [PCRWR]) and scaling partners (including the Bihar Water Resources Department, India, and PID, Pakistan) to apply foresight and trade-off methodologies. We used foresight hydro-economic models to i) respond to a request from the Government of Pakistan to analyze a potential intervention to reduce water scarcity; ii) analyze irrigation and hydroelectricity investments to reduce adverse climate change impacts in Ethiopia, in consultation with two ministries; and iii) assess benefit streams from the Grand Ethiopian Renaissance Dam for water, energy, and food security in Sudan to support Nile Basin cooperation. In the Incomati Basin and Aral Sea, we worked with national partners to build trust in the Pywr model. We established a technical working group to share the results of environmental flow assessments in the Indus River in Pakistan.

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

We are applying DSSs and identifying water management practices in the Ganges and Aral Sea basins to boost water productivity. In Central Asia, we are collaborating with stakeholders to validate a water productivity DSS and provide training for its use. In Nepal, we co-implemented a study of constraints to boosting irrigation productivity and supported the development of a new irrigation policy. In the Limpopo and Blue Nile basins, we completed and presented a diagnostic tool to support integrated water storage to address the growing gap between water storage and demand. A similar tool is at an advanced stage for the Ganges River Basin. Workshops have helped raise awareness on storage issues and we provided training in Ethiopia, India and Zimbabwe.



EOIO 3: Private investors and policymakers, cognizant of systems linkages and gendered benefits, accelerate equitable access to rural clean energy.

We developed new knowledge on gender responsive, clean energy solutions for public and private sector investments. Analyses in Ethiopia, India, Nepal, and Pakistan found fragmented, inequitable rural energy systems and suggested solutions. Our research confirmed that solar irrigation is a potential “breakthrough technology” but scaling it equitably and sustainably requires strong institutional and technical support. We completed development of a Solar Pump Sizing tool for South Asia and a Solar Irrigation Explorer Tool for sub-Saharan Africa. We published a policy note on the results of the WEEI. Our analysis of Nepali government institutions identified ways to enhance the benefits of their energy gender strategies. We participated in outreach and engagement events that raised awareness of and interest in our tools and results.

EOIO 4: Policymakers and stakeholders identify ways to improve governance across WEFE systems.

We expanded our MSP guidelines and are facilitating MSPs in Nepal and the Incomati River Basin. We contributed to training 500 staff from a major groundwater program in India to apply groundwater governance tools and piloted their application in Nepal. In Pakistan, we collaborated with PID to test a practical near-real-time methodology to monitor groundwater depletion which is being implemented province-wide. It is a step toward more informed decision making and governance. We were active participants in global forums, including the Montpellier Process, the UN Water Conference, CBD, IPBES, and UNFCCC COP28.

Our intensive collaboration with policymakers and others is beginning to have important outcomes. For example, the revised Nepal Irrigation Policy acknowledges the importance of a nexus approach, and stakeholders are increasingly receptive to addressing governance issues.

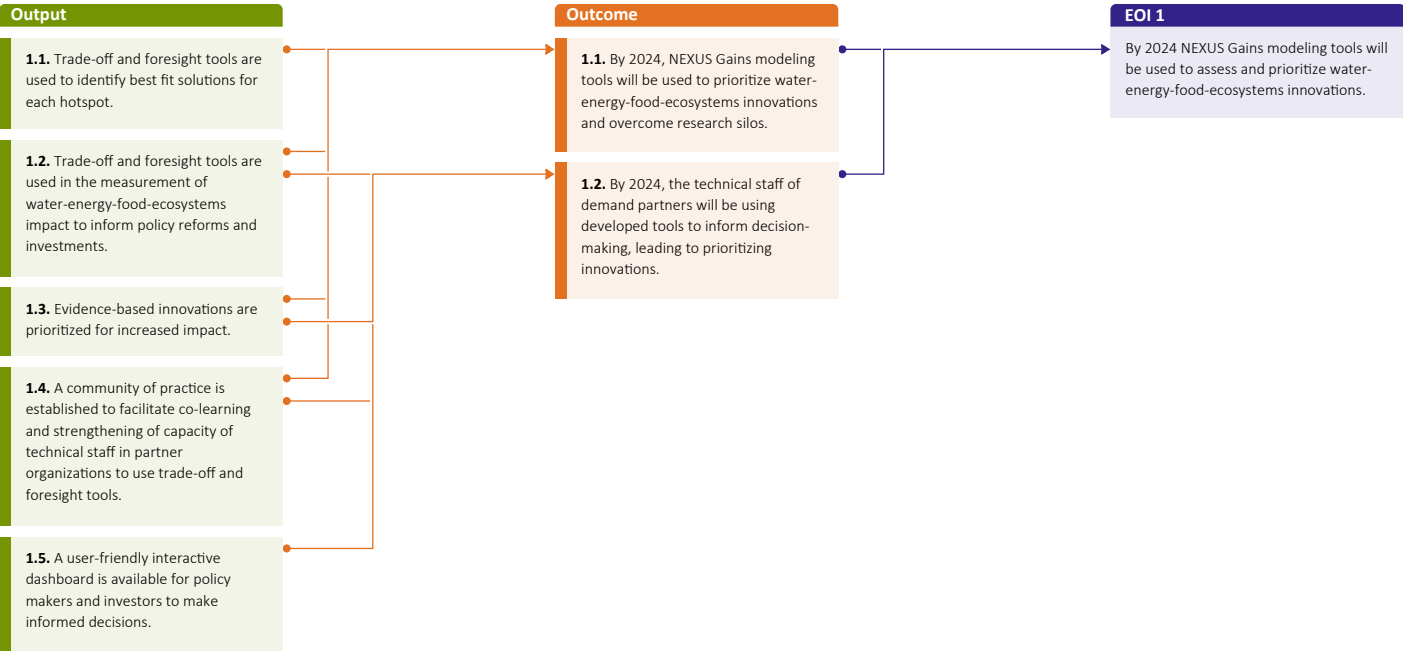
EOIO 5: Government, business, NGO, and civil society organization professionals in WEFE sectors use new capacities to co-develop sustainable and equitable WEFE approaches.

A scoping study in Uzbekistan identified the capacities and needs of WEFE actors and prioritized entry points for addressing gaps. With partners, we co-developed and piloted the WEFE Nexus Leadership Program in Nepal (including 17 women). Other NEXUS Gains learning resources are being used by partners, including an e-learning module on GESI in nexus approaches, which GIZ has integrated into its nexus training platform. In Nepal, three courses were developed with partners; two have been adopted by the University of Tribhuvan. We co-implemented high-level WEFE nexus training sessions for professionals in Uzbekistan and South Africa and high-level dialogues in Nepal. We contributed to the establishment of a Global water, energy, and food (WEF) Nexus Community of Practice.

### Section 3: Work Package progress

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

On track



#### Work Package 1 progress against the theory of change

Understanding and quantifying the cross-linkages across the WEFE nexus requires the simulation of scenarios. WP1 is on track to deliver all planned outputs and achieve its planned outcomes. We developed foresight modeling tools for five basins (Indus, Blue Nile, Ganges, Aral Sea, and Incomati), and applied the underlying hydro-economic model (innovation level 7) to analyze nexus issues in [Pakistan](#), [Ethiopia](#), and [Sudan](#). We also validated the SWAT+ hydrological model for three river basins ([Indus](#), [Ganges](#), and [Ganges-Karnali](#)) (output 1.1). The SWAT+ model runs future scenarios derived jointly with technical staff from government agencies to support policy implementation (output 1.2). The Pywr model is being tested with technical teams in three basins ([Indus](#), [Aral Sea](#), and [Incomati](#)). Communities of practice for the SWAT+ and Pywr models have been established and are functional in three river basins (Limpopo, Ganges [[Nepal](#)], and Aral Sea) (output 1.4). We are working with scaling (Bihar Water Resources Department, India, and PID, Pakistan) and demand (ICAR, India; PCRWR, Pakistan; and

the Scientific Information Center of the International Center of the Interstate Commission for Water Coordination [[SIC ICWC](#)]) partners, to apply the developed foresight methodologies in the Indus, Ganges, and Aral Sea basins, respectively.

We completed the environmental flow assessment work in the Ganges River Basin in [Western Nepal](#). For the [Indus Basin](#), we established a technical working group to share the results of [environmental flow assessments and manage its rollout in one reach of the Ravi River](#) (output 1.3). An [innovation packaging workshop was conducted in Nepal](#) for the environmental flow toolbox (level 7).

The [agrobiodiversity solution hotspot tool](#) innovation (level 4) ([winner of the Food Planet Prize in 2023](#)) is being validated with government partners in the Ganges Basin (output 1.3). This tool helps stakeholders identify and visualize the potential risks and opportunities of various measures to strengthen agrobiodiversity.

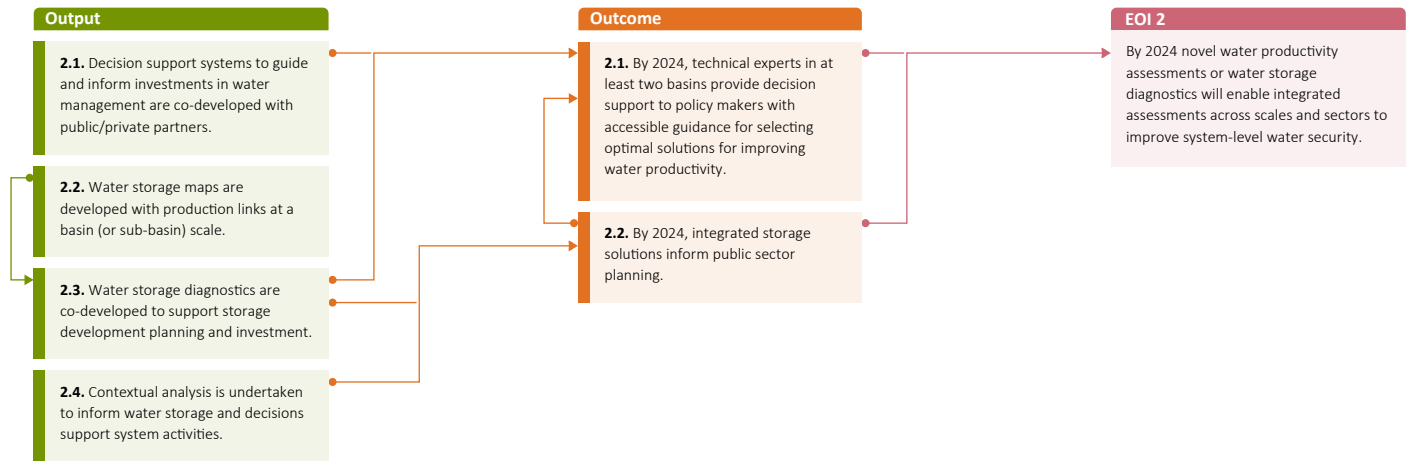


A farmer uses a solar irrigation pump in Nepal.  
Credit: Nabin Baral, IWMI



WP2: Boosting water productivity and integrated storage management

On track



Work Package 2 progress against the theory of change

Globally, strategies are required urgently to improve water productivity and storage in the face of climate change. Progress in developing tools to boost water productivity and support integrated water storage management has been good. DSSs have been developed or tested in the Ganges and Aral Sea basins to boost water productivity (output 2.1). In the Ganges, the International Rice Research Institute (IRRI) is collaborating with national partners to investigate the potential for saving water by direct seeding rice, rather than transplanting seedlings, in three districts of Haryana, and the International Water Management Institute (IWMI) is developing an atlas that presents water footprints across districts. The International Livestock Research Institute (ILRI) is conducting [feed trials in Nepal](#) to ascertain the impact on the water footprint of milk production as well as greenhouse gas emissions. In Central Asia, the International Center for Agricultural Research in the Dry Areas (ICARDA) has designed a [DSS based on a menu of practices](#) to improve water productivity. The next step will be consultations with stakeholders to validate it and provide training in its use.

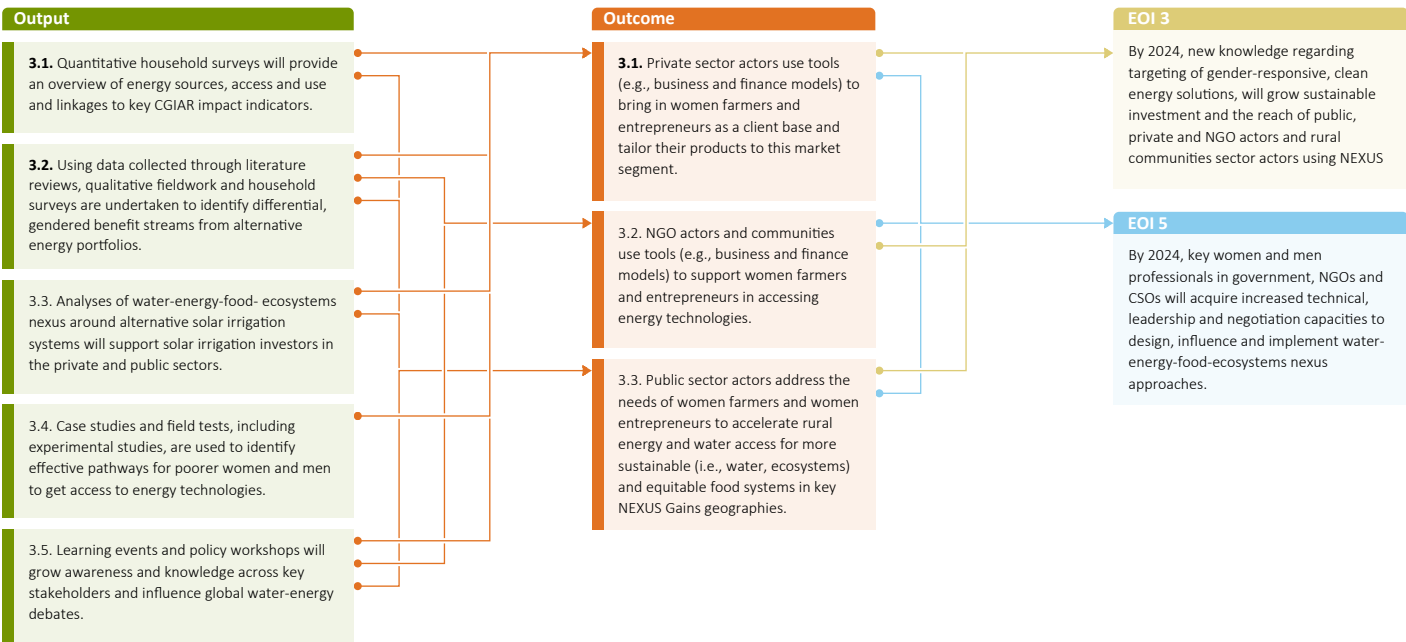
In Nepal, NEXUS Gains has identified [constraints, and pathways to overcome them](#), to boost agricultural productivity in three irrigation

schemes. Socio-economic and market conditions are the largest category of challenges across the three schemes. Timely access to and availability of fertilizers, water, and fair market prices are the most significant challenges. This work, [co-implemented with key Nepali government staff](#), supports [Nepal’s irrigation policy development](#).

Diagnostics to support integrated water storage have been completed and presented to stakeholders in the Shashe (Limpopo) and Tana-Beles (Blue Nile) basins (output 2.3). In the Shashe sub-basin (Botswana and Zimbabwe), the focus includes specific attention to the [potential of sand dams](#) for storing water in ephemeral rivers (output 2.4). In the Tana-Beles Basin, the study projected a [growing gap between water storage and demand](#) and advocated a nexus approach to enhancing storage. A water storage assessment and a tool to guide storage augmentation are at an advanced stage in the Ramganga Basin (Ganges) (output 2.3). Finally, there have been several important capacity development workshops in [Ethiopia](#), [India](#) and [Zimbabwe](#).

WP3: Energizing food and water systems sustainably and inclusively

On track



Work Package 3 progress against the theory of change

In 2023, WP3 made significant advances on all three research questions. For the question on what rural energy portfolios and business and finance models best support and accelerate rural clean energy access for food systems transformation and environmental sustainability, multiple analyses in [Ethiopia](#), Nepal, [India](#), and [Uzbekistan](#) found fragmented, inequitable rural energy systems. Suggested solutions include increased accountability, improved inclusion, and greater focus on social systems to achieve sustainable transformation (outputs 3.1 and 3.2). On a separate track, [alternative proteins](#) can also support food system transformation, although questions remain on energy use, as demonstrated by a major [CGIAR publication on achieving agricultural breakthroughs](#), to which NEXUS Gains contributed.

On the question of how solar irrigation can enhance agricultural production while supporting groundwater sustainability, inclusion, economic growth, and ecosystem health, a substantial body of work across [Nigeria](#), [Nepal](#), [India](#), and [Pakistan](#), tools for [sub-Saharan Africa](#) and [South Asia/Nepal](#), and a large number of [outreach](#) and

engagement events, including at [COP28](#), suggest that solar irrigation is a breakthrough technology that requires strong institutional and technical support for equity and environmental sustainability, including in [sub-Saharan Africa](#) (output 3.3).

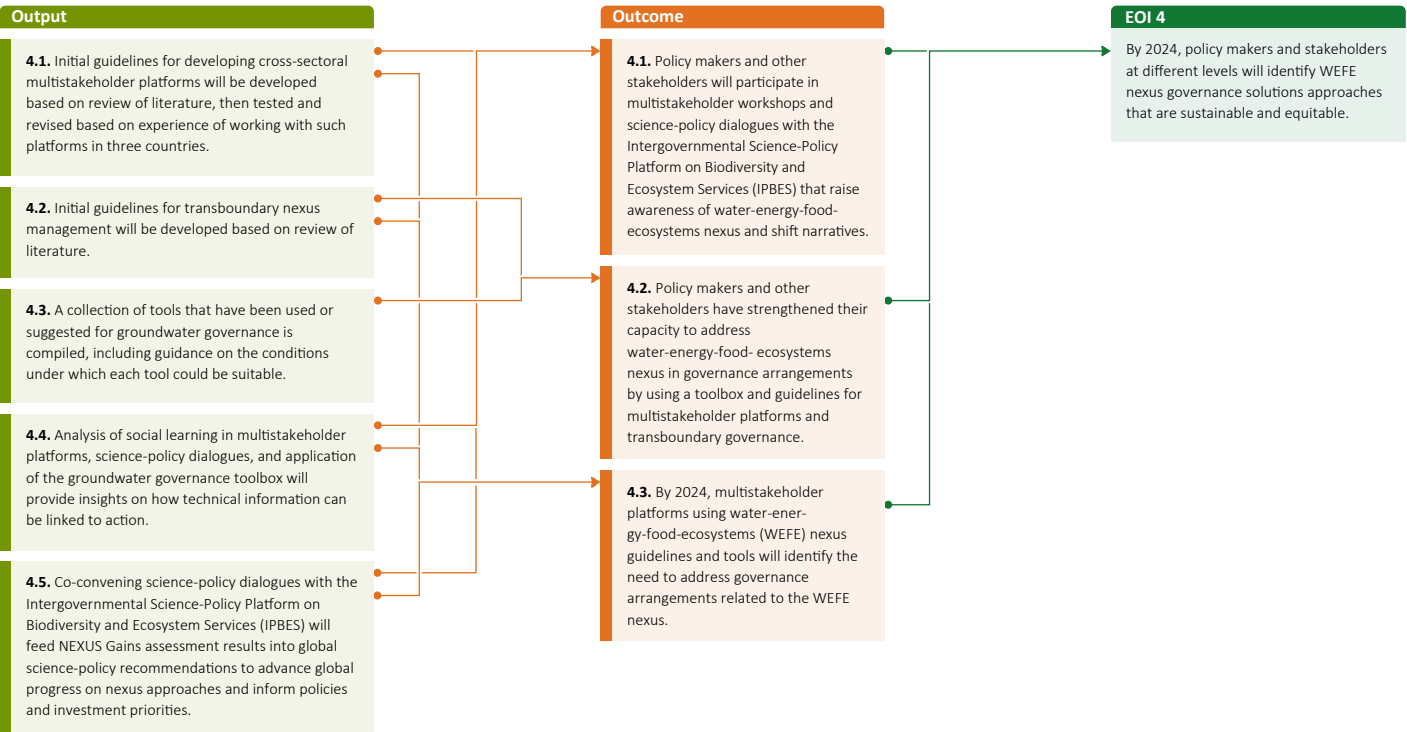
On the question: what are effective pathways for women to access renewable energy in ways that strengthen their agency and entrepreneurship? – an issue that few others are researching – we built on baseline survey data collected in key NEXUS Gains geographies to publish a policy note on the [WEEI](#). The WEEI helps identify levers to strengthen women’s agency in energy decisions for domestic and productive uses relative to men and traces women’s agency to broader energy benefits (output 3.4). We also [analyzed government institutions in Nepal](#) to strengthen benefits from existing gender strategies in the energy sector.

Finally, to strengthen WEFE nexus learnings and outcomes, we supported a South–South learning event in [Uzbekistan](#) led by WP5 (output 3.5).



WP4: Strengthening WEFE nexus governance

On track



Work Package 4 progress against the theory of change

The need for integrated governance and policy coherence across WEFE sectors is widely recognized. However, the treatment of governance in the nexus literature is superficial at best. NEXUS Gains is one of the few research programs with this as an explicit focus. We work with policymakers and stakeholders from community and municipal levels through to national and international arenas to identify how effective governance can address trade-offs and maximize gains across the WEFE nexus. For example, the revised Nepal Irrigation Policy [acknowledges the importance of a nexus approach to development](#) (outcome 4.1). While vested interests persist and can block governance reforms, stakeholders in the Ganges, Incomati, and Indus basins are receptive to addressing governance issues (toward outcome 4.3).

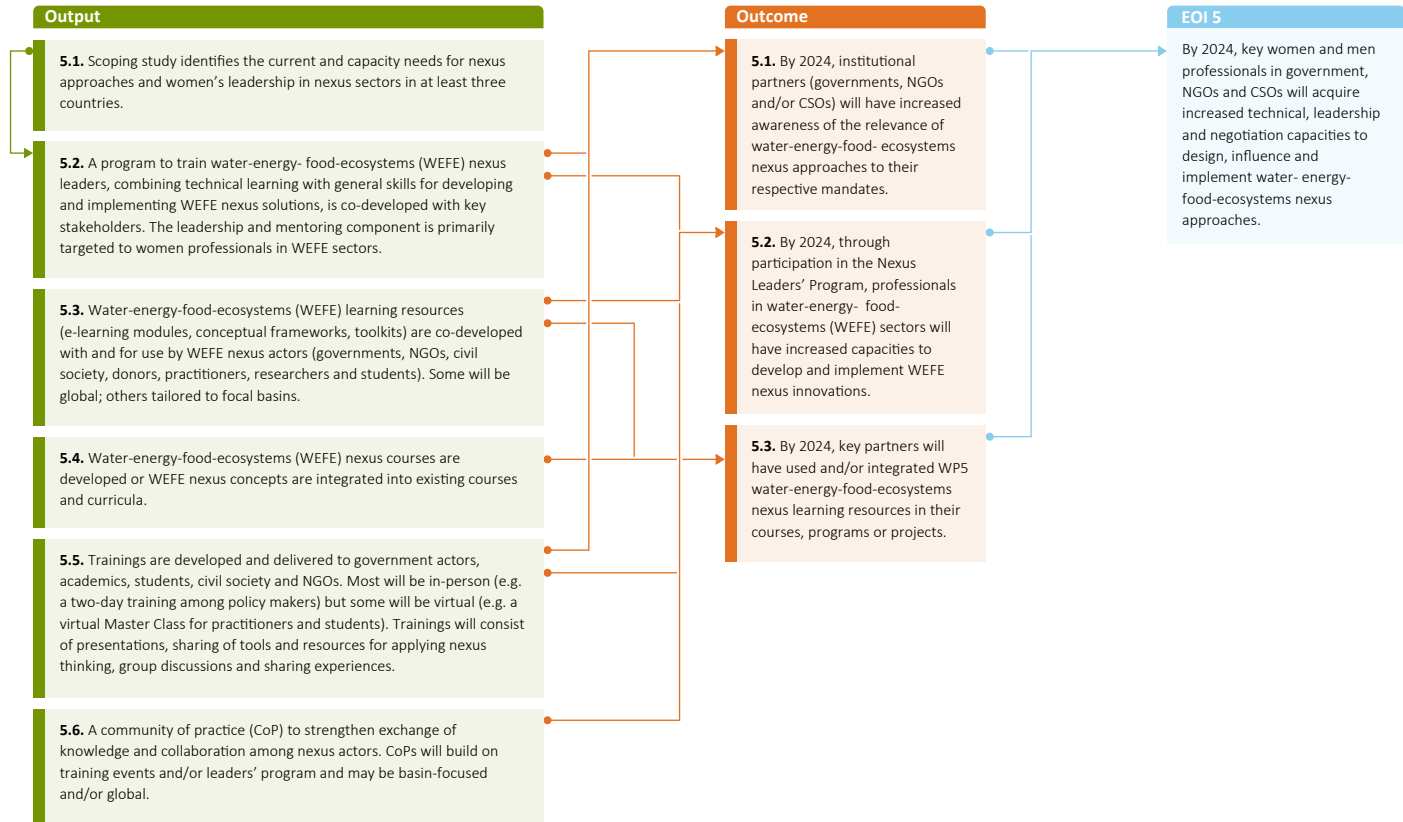
We expanded the [guidelines on MSPs](#) by publishing a review of community-based conservation of freshwater resources (outputs 4.1). We convened [multistakeholder workshops in Nepal](#), and in the Incomati River Basin, where we are supporting capacity building to develop an MSP linking the subnational water catchment agencies from Eswatini, Mozambique, and South Africa to strengthen water governance at a [transboundary level](#) (output 4.2). We continue to co-convene a community of practice on MSPs across 13 CGIAR Research Initiatives.

We contributed to training 500 staff from a major government program in India ([Atal Bhujal Yojana](#)) to apply [groundwater governance tools](#) (output 4.3) that link social learning with technical and policy interventions. We also published [two articles](#) on social learning from groundwater games (output 4.4) and piloted the application of the tools in [Nepal](#) (output 4.3). NEXUS Gains collaborated with Pakistan’s PID to test a practical, near-real-time methodology to monitor groundwater depletion zones. It is being implemented province-wide and tested in two other provinces (see section 8). The methodology is a step toward more informed decision making and governance (outputs 4.2, 4.3).

We advocated a nexus approach to systems transformation in global science-policy dialogues through the [Montpellier Process](#), helped strengthen climate–water–food systems linkages of [three UNFCCC COP28 country delegations](#), and contributed to the 2023 [UN Water Conference incorporating WEFE linkages](#). We also contributed to the scientific advisory groups of both the CBD and the [Ramsar Convention on Wetlands](#) and provided both written and external review inputs to the forthcoming IPBES thematic assessment of the [interconnections](#) between [biodiversity, water, food, and health](#) (output 4.5).

WP5: Developing capacity for WEFE actors, including women leaders

On track



Work Package 5 progress against the theory of change

In 2023, WP5 made significant progress in producing planned outputs and achieving TOC outcomes. A [scoping study](#) (output 5.1) conducted in Uzbekistan identified the capacities and needs of WEFE actors and prioritized entry points for addressing gaps. Globally, NEXUS Gains is one of the very few institutions considering GESI aspects in WEFE nexus solutions. A [journal article](#) based on a similar 2022 study for Nepal highlighted the barriers women professionals face in the WEFE sectors and approaches to overcome them. The [WEFE Nexus Leadership Program](#) (output 5.2), a key WPS innovation that addresses some of these challenges, was developed with partners. It was piloted in Nepal with 22 professionals, including 17 women, moving the WP toward its first outcome.

Other WEFE nexus learning resources (output 5.3) were developed, piloted, and used by partners. These included an [e-learning module](#) on GESI in nexus approaches which was [taken up by GIZ](#) and integrated into its [WEF Nexus Training Platform](#), along with other GESI-focused resources, including the nexus-centered [Power Walk](#)

[activity](#). A [nexus capacity scorecard](#) was created and piloted to assess nexus capacities in academia. Three courses were developed with partners in Nepal: one for WEFE professionals, another for policymakers, and a third for graduate students (output 5.4). The [latter was approved by the University of Tribhuvan for delivery](#) by two departments starting in 2024, leading to the curriculum change outcome described in the TOC.

Several WEFE nexus trainings took place with national and global partners (output 5.5): an [international summer school in Uzbekistan](#); two trainings on the FABLE calculator and other integrated modeling nexus tools in [Ethiopia](#); five [high-level dialogues](#) to strengthen capacities of government and civil society organizations in Nepal; and a virtual [WEF nexus masterclass](#) and an in-person WEF [winter school for professionals](#) in South Africa. The latter created the foundation for a [community of practice](#) among WEFE actors (output 5.6), which was launched at a special [NEXUS Gains session at the WaterNet Symposium](#).





Canal water is used to irrigate rice in rural Nepal.  
Credit: Nabin Baral/IWMI

Work Package progress rating summary

| WORK PACKAGE | PROGRESS RATING & RATIONALE  |
|--------------|--|
| 1            | <div><div></div><div>Progress rating</div></div> <div>We have progressed on all outputs and outcomes in 2023 and expect to meet all targets in 2024.</div>   |
| 2            | <div><div></div><div>Progress rating</div></div> <div>We have made very good progress in producing planned outputs and are well on our way to achieving all planned 2024 outcomes.</div>                 |
| 3            | <div><div></div><div>Progress rating</div></div> <div>We have achieved all major outputs in 2023 and are making progress on outcomes, with a good likelihood of successfully meeting 2024 targets.</div> |
| 4            | <div><div></div><div>Progress rating</div></div> <div>We have made progress on all outputs and outcomes in 2023, with a good likelihood of successfully meeting targets in 2024.</div>                   |
| 5            | <div><div></div><div>Progress rating</div></div> <div>We have made strong progress on all outputs and outcomes in 2023 and are on track to meet outcome targets in 2024.</div>                           |

Definitions

|  |   |   |
|--|---|---|
| <div><div></div><div>On track</div></div> <div><div><div></div><div>Annual progress largely aligns with Plan of Results and Budget and Work Package theory of change.</div></div><div><div></div><div>Can include small deviations/issues/delays/risks that do not jeopardize success of Work Package.</div></div></div> | <div><div></div><div>Delayed</div></div> <div><div><div></div><div>Annual progress slightly falls behind Plan of Results and Budget and Work Package theory of change in key areas.</div></div><div><div></div><div>Deviations/issues/delays/risks could jeopardize success of Work Package if not managed appropriately.</div></div></div> | <div><div></div><div>Off track</div></div> <div><div><div></div><div>Annual progress clearly falls behind Plan of Results and Budget and Work Package theory of change in most/all areas.</div></div><div><div></div><div>Deviations/issues/delays/risks do jeopardize success of Work Package.</div></div></div> |
|--|---|---|



Section 4: Key results

This section provides an overview of results reported by the CGIAR Research Initiative on NEXUS Gains in 2023. These results align with the CGIAR Results Framework and NEXUS Gains’ theory of change. Source: *Data extracted from the [CGIAR Results Dashboard](#) on 29 March 2024.*

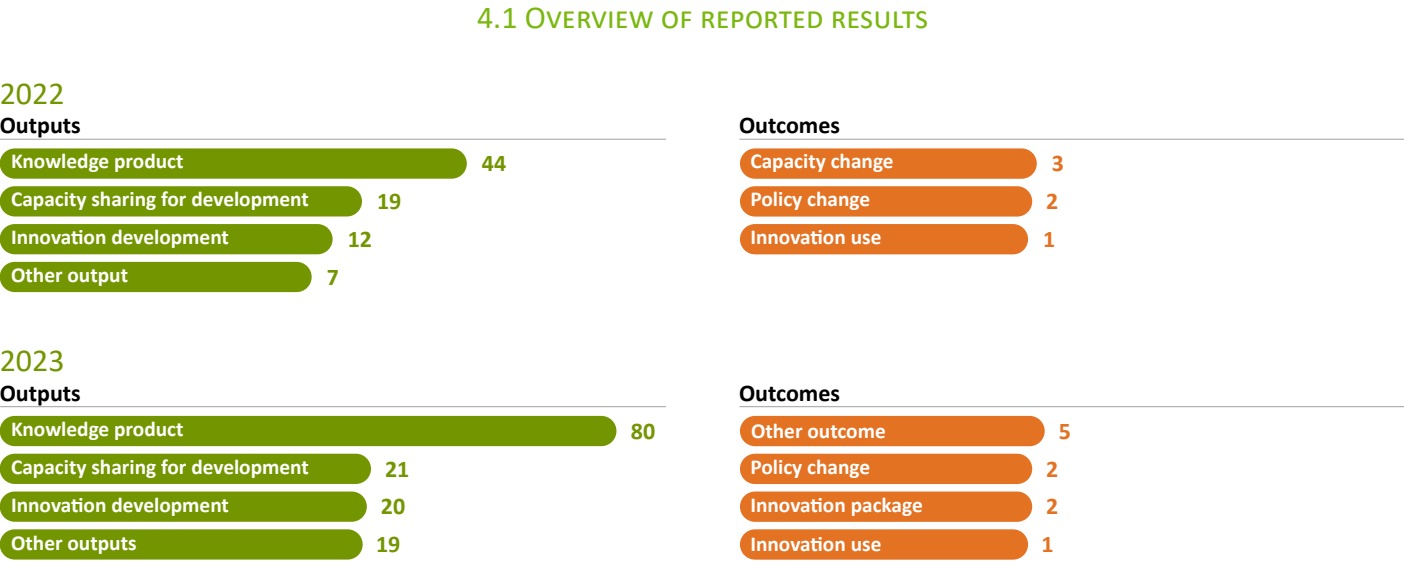


Diagram 4.1 compares the breakdown of 2022 and 2023 results by category, as per the [CGIAR Results Framework](#). Of the 150 outputs reported in 2023, 130 were led by NEXUS Gains.

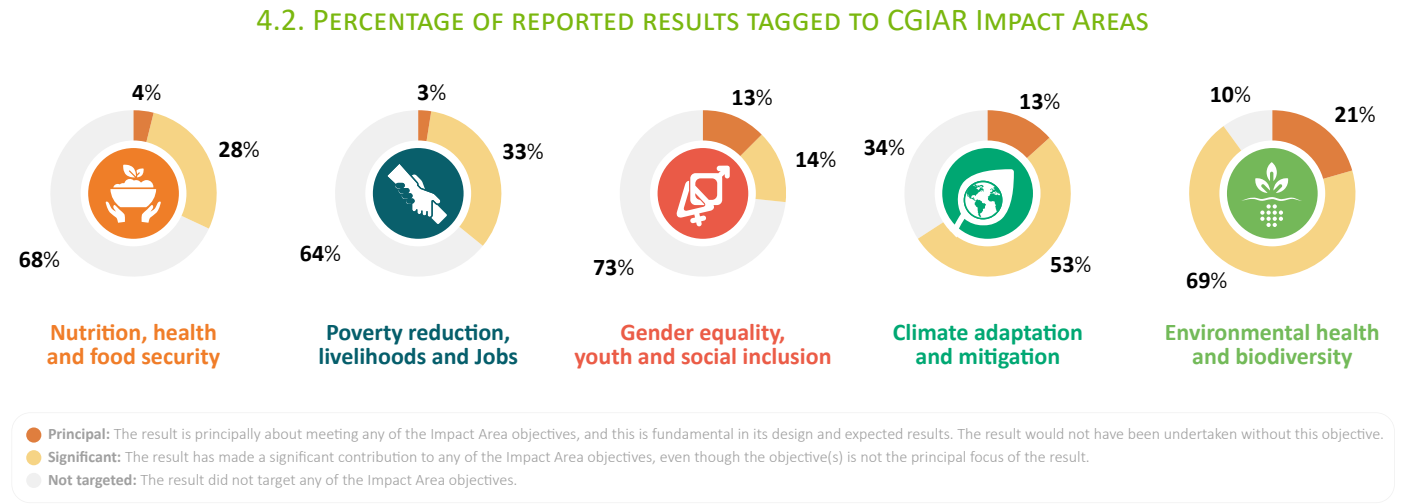


Diagram 4.2 shows how NEXUS Gains’ 2023 results were tagged to CGIAR Impact Areas. The Initiative contributes most significantly to Environmental Health and Biodiversity, with 135 results, and to Climate Change Adaptation and Mitigation, with 99 results.

4.3. CONTRIBUTIONS TO THE UN SUSTAINABLE DEVELOPMENT GOALS

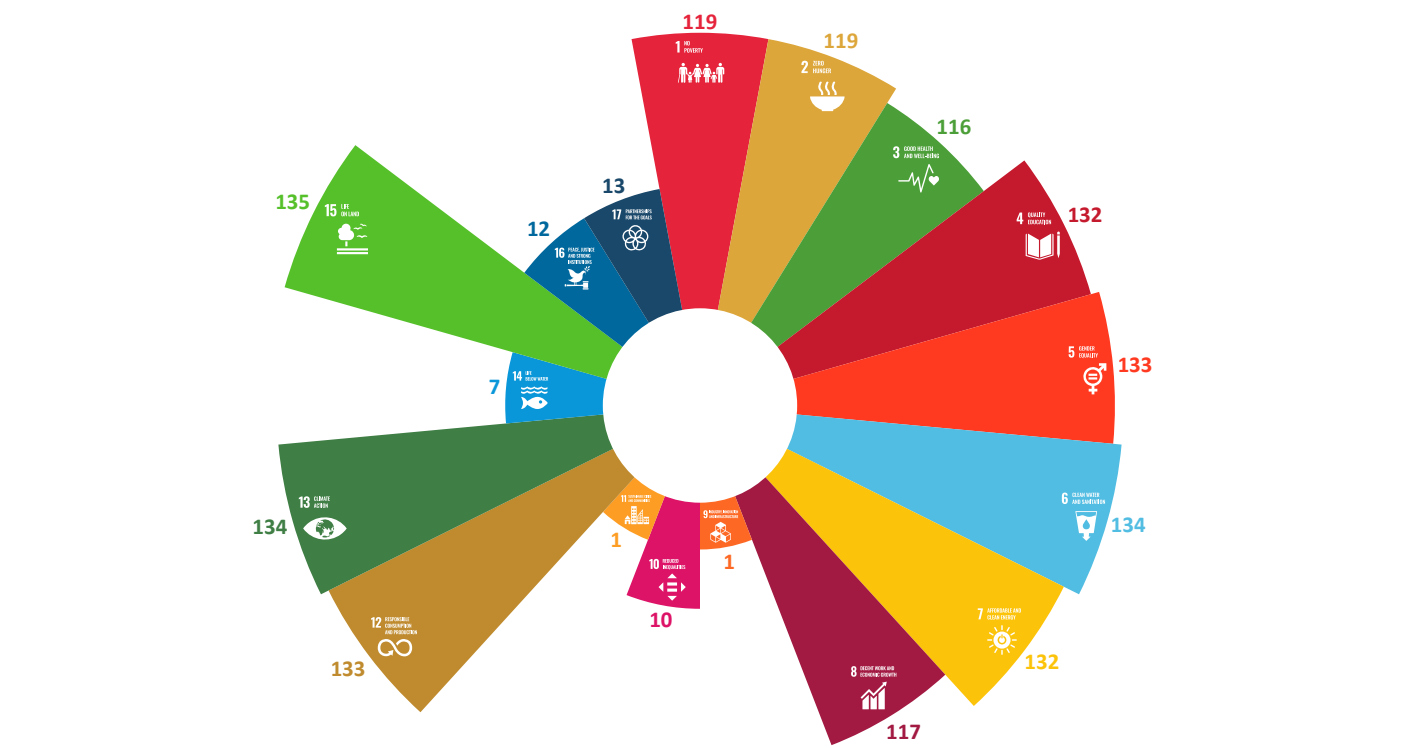


Diagram 4.3 shows how NEXUS Gains’ 2023 results align to the Sustainable Development Goals (SDGs). The data are based on the Initiative TOC, which tags all results to Science Groups, Impact Areas, and SDGs. SDGs 15, 13, 6, 12, 5, 4, 7, 1, 2, 8, and 3 all have more than 100 NEXUS Gains results assigned.

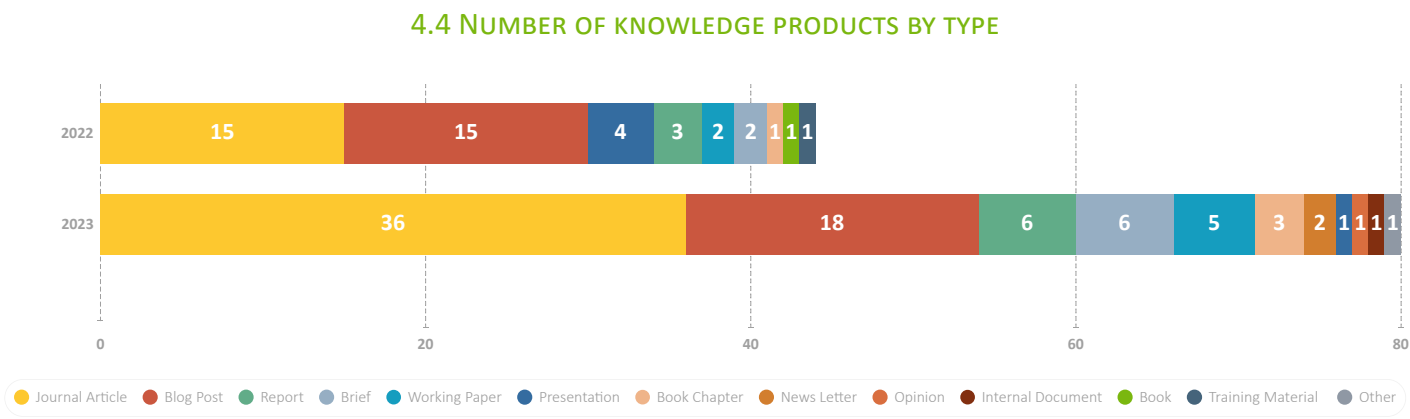


Diagram 4.4 shows reported knowledge products broken down by Typology, as set by the CGSpace community and outlined in the [CGCore](#) and international standards. The total knowledge products produced increased from 44 in 2022 to 80 in 2023. The number of journal articles reported in 2023 more than doubled compared to 2022; increases were also achieved in the other categories.



4.5 NUMBER OF RESULTS BY COUNTRY

Data here represents an overview of reported results in 2022 and 2023. One result can impact multiple countries and can therefore be represented multiple times.

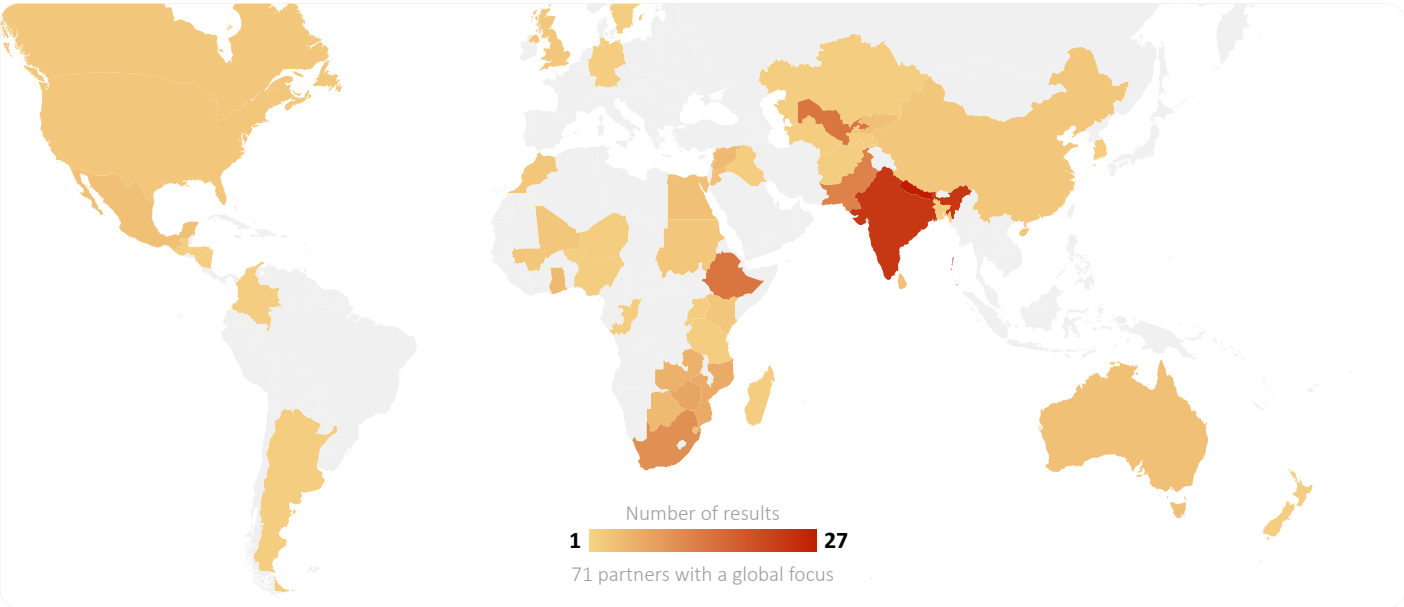


Diagram 4.5 shows the distribution of reported results by country. The map clearly shows the focus on the Ganges, Indus, Aral Sea, Blue Nile, and Limpopo/Incomati basins. 71 reported results had a global focus.

4.6 NUMBER OF REPORTED INNOVATIONS BY TYPE

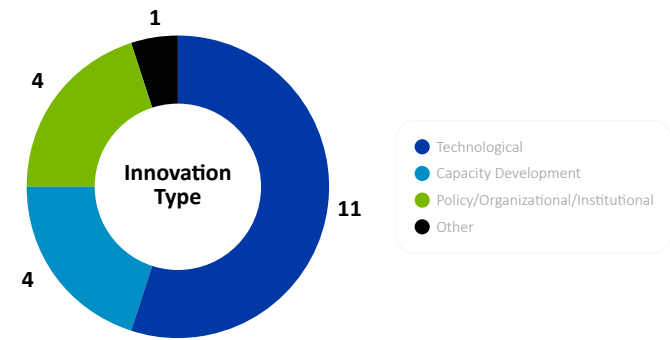
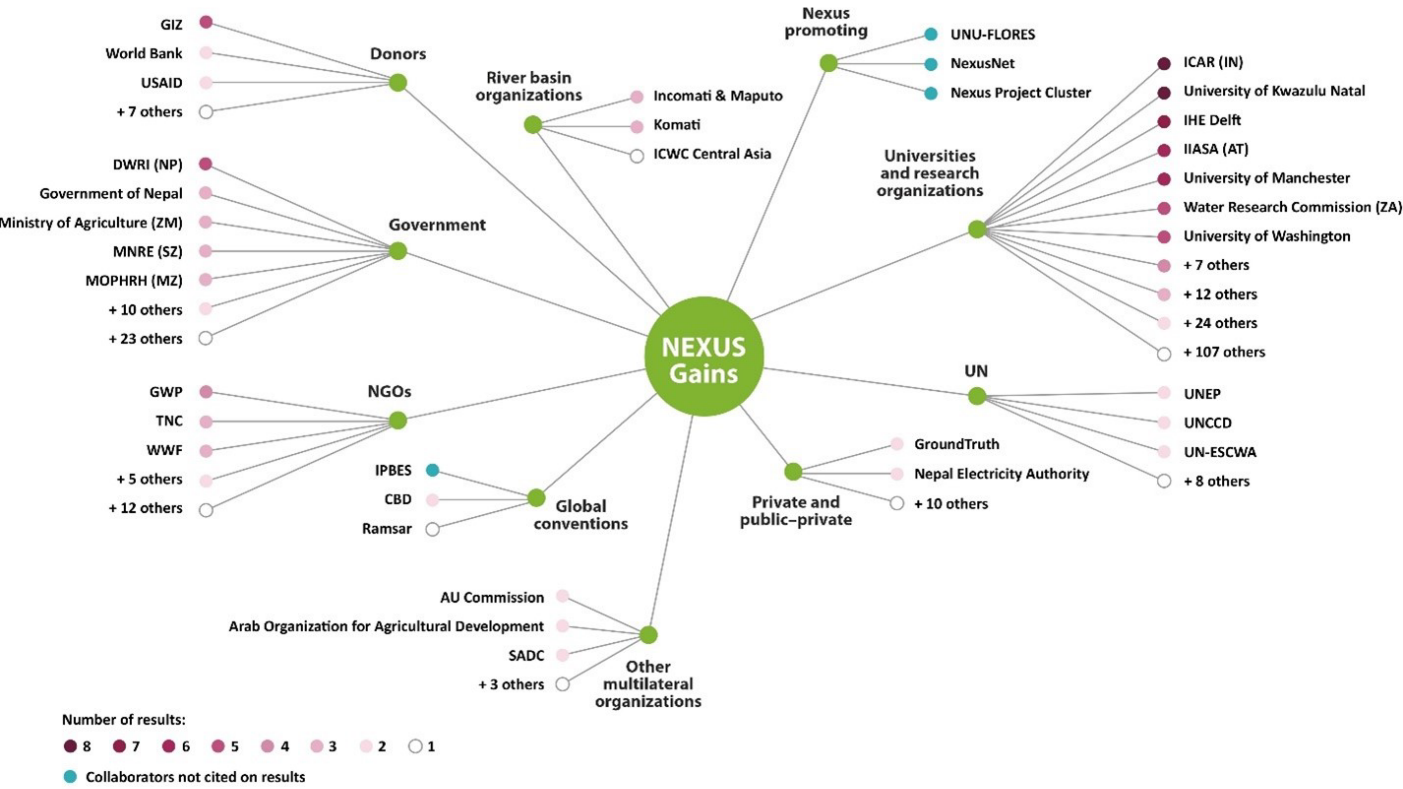


Diagram 4.6 shows 2023 innovations categorized by type. The innovations comprise the 13 led by NEXUS Gains and the 7 led by partner Initiatives. More than half of these were technological innovations.

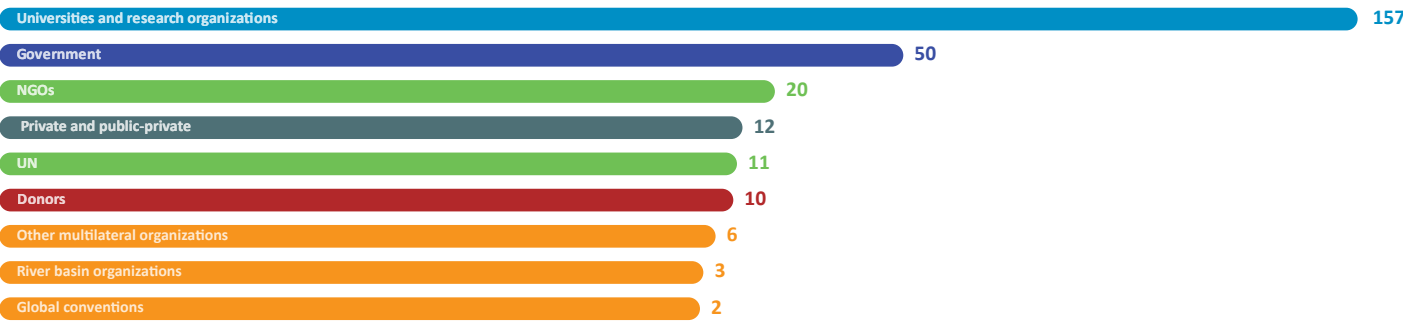
Section 5: Partnerships

NEXUS GAINS’ EXTERNAL PARTNERS



This diagram shows NEXUS Gains’ external partners, categorized by type, that were collaborators on multiple results in 2023. NEXUS Gains collaborated with 271 partners on 2023 results, compared with 110 in 2022.

PARTNERS CONTRIBUTING TO RESULTS IN 2023





Partnerships and NEXUS Gains’ impact pathways

NEXUS Gains has established very strong partnerships with national and regional strategic, boundary, and demand or scaling partners in South Asia, sub-Saharan Africa, and Central Asia.

We collaborated with the [PCRWR](#) to obtain historical information on groundwater quality for inclusion in Punjab’s groundwater management information system. PID co-developed and tested the system in one district and is now using it to identify groundwater hotspots province wide. PCRWR co-developed and tested a SWAT+ model for estimating water availability across the Indus Basin. The Punjab Agriculture Department’s [On-Farm Water Management](#) unit is co-developing water accounting and productivity assessments at the farm scale and developing technical and business models for promoting solar irrigation. We also collaborate with an NGO, the [South Asia Conservation Agriculture Network](#) in Pakistan, to co-develop and test water productivity tools.

In India, NEXUS Gains partners with the [Foundation for Ecological Security](#), an NGO co-developing and scaling groundwater governance tools. We also collaborate with Atal Bhujal Yojana, a large-scale government program that is applying tools and approaches from the NEXUS Gains groundwater governance toolbox. IRRI’s partners in the research on direct seeded rice for improving water productivity are the Haryana Agricultural University, and the Central Soil Salinity Research Institute.

In Nepal, we partnered with the Irrigation Department to support the inclusion of WEFE nexus considerations in its new irrigation policy. The [Alternative Energy Promotion Centre](#) is using NEXUS Gains research results to improve its solar irrigation program in the mid-hill region. We also worked with Tribhuvan University to develop academic WEFE nexus courses, which are offered beginning in 2024.

In Ethiopia, in addition to strong partnerships with the ministries of water and agriculture, we work with NGOs and private sector partners to scale out solar irrigation. These include [Power for All](#)

[Ethiopia](#), which co-developed business and finance models with NEXUS Gains for private sector-led solarization; and [Purpose Black Ethiopia](#), to identify entry points to sustainably and equitably scale solar irrigation systems.

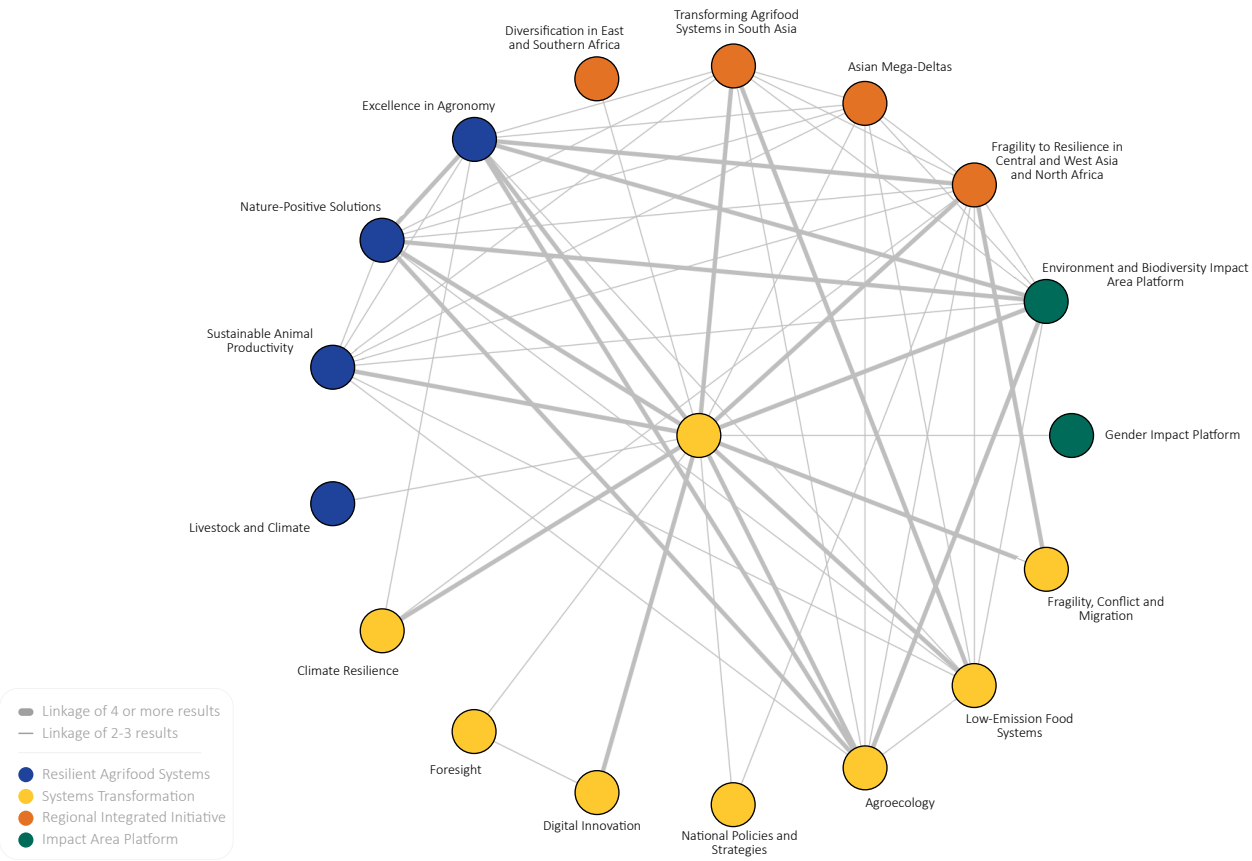
We have a close partnership in Southern Africa with the Incomati-Maputo Watercourse Commission ([INMACOM](#)). The Incomati Basin is shared by Eswatini, Mozambique, and South Africa. INMACOM is partnering with NEXUS Gains to develop a transboundary MSP as well as a basin-wide model using Pywr. The River and Environmental Management Cooperation ([REMCO](#)) is an informal transboundary multistakeholder forum that brings together catchment management agencies from the three basin countries. We are [exploring how it might link with INMACOM](#) to develop the transboundary MSP. The [Zambezi Watercourse Commission](#) and [Nile Basin Initiative](#) are sharing lessons to support INMACOM and REMCO. [IHE Delft](#) supported the development and delivery of the WEFE nexus masterclass and winter school in South Africa and the establishment of the course alumni community of practice. The Southern African Development Community (SADC) has requested assistance with implementing [WEFE nexus policies](#). As a forum for SADC countries, it offers strong potential for scaling.

Finally, in Central Asia, our partnership with SIC ICWC aims to strengthen research, data sharing, and knowledge dissemination, as well as the development of Pywr modeling for the region. The [Tashkent Institute of Irrigation and Agricultural Mechanization Engineers](#) (at the National Research University) and [ZALF Germany](#) were important partners in the international WEFE summer school in Uzbekistan.

Collaboration with these and other partners is resulting in uptake and adoption of a range of WEFE nexus tools and practices and enhanced implementation capacity.

Section 6: CGIAR Portfolio linkages

NEXUS GAINS’ INTERNAL PORTFOLIO NETWORK



The diagram shows the CGIAR Research Initiatives and Platforms with which NEXUS Gains reported at least two joint results in 2023. The highest number of linkages are with the Initiatives on Fragility to Resilience in Central and West Asia and North Africa (F2R-CWANA) and Agroecology, and the Environment and Biodiversity Impact Platform.

Portfolio linkages and NEXUS Gains’ impact pathways

NEXUS Gains co-leads the Community of Practice on MSPs with the CGIAR Research Initiatives on Agroecology and Low-Emission Food Systems; 10 other Initiatives also participate as well as bilateral projects (e.g., the CIAT-led [RUSTICA](#) project and the [Global Comparative Study on REDD+](#) led by the Center for International Forestry Research and World Agroforestry). This network provides resources for NEXUS Gains researchers developing MSPs in India, Nepal, Pakistan, and the Incomati Basin. In 2024, comparative analysis of MSP experience across CGIAR will offer lessons for CGIAR’s future research and innovation programs.

Our work on groundwater governance tools builds on collaboration with an IFPRI–International Crops Research Institute for the Semi-Arid Tropics bilateral project in India funded by GIZ on [scaling up experiential learning tools](#) for sustainable governance. This project is a major NEXUS Gains partner that provides training to a large Government of India program, Atal Bhujal Yojana, and is the source of some of the NEXUS Gains groundwater governance tools (see sections 3.4 and 6).

In Pakistan, the CGIAR Research Initiative on Fragility, Conflicts, and Migration (FCM) is assessing the impacts of recent disasters (floods, drought, and locusts) and water-borne diseases in Rahim Yar Khan District, an area where NEXUS Gains also works. FCM is

building on the biophysical modeling and socio-economic analyses conducted by NEXUS Gains. Under NEXUS Gains, IWMI carried out detailed hydrological modeling to understand water availability and conducted a detailed survey of more than 1,000 households to derive a socio-economic baseline. The FCM Initiative is using these results to assess the impacts of disasters, especially floods and droughts, on the communities.

ILRI’s work on livestock feed in Nepal is based on a partnership with the CGIAR Research Initiative on Sustainable Animal Productivity. IRRI’s research on direct seeding of rice is part of a NEXUS Gains collaboration with the CGIAR Research Initiative on Transforming Agrifood Systems in South Asia.

NEXUS Gains is partnering with the F2R-CWANA Initiative and the CGIAR Gender Impact Platform, to implement an intrahousehold survey in Uzbekistan that is also the first time that Women’s Empowerment in Agriculture Index data will be collected in the country. Moreover, a PhD student receives support from the [Standing Panel on Impact Assessment](#) to assess the impact of subsidies for advanced irrigation technologies and to implement complementary qualitative analyses. We also partnered with F2R-CWANA and FCM on a workshop and the development of a [policy](#)





[brief](#) on building resilience in fragile and conflict-affected agrifood systems.

NEXUS Gains and the Environment and Biodiversity Platform worked with the CBD to develop [recommendations on biodiversity and climate change](#) . We partnered with the CGIAR Climate Impact Platform to contribute to the agricultural chapter of the 2023 [Achieving Agricultural Breakthrough report](#). The CGIAR Research Initiative 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 Zambian government, and with the CGIAR Research Initiative on Digital Innovation to develop both a [Digital Twin](#) for water resources management in the Limpopo Basin and a suite of digital tools to map

the morphology of rivers to enable monitoring of changes due to river flow. We partner with [Ukama Ustawi’s Learning Alliance](#) both on an innovative approach for sustainable knowledge management, access, and dissemination between CGIAR, National Agricultural Research Systems, and farmers in East and Southern Africa; and on piloting solar irrigation in community gardens. Finally, the Low-Emission Food Systems Initiative and NEXUS Gains are collaborating on ways to structure the [complexity of integrated landscape approaches](#) to inform the development of evidence-based land use policy.

Joining forces across these CGIAR programs and Initiatives is more efficient and is generating new research questions that support multiple outcomes of all the collaborating programs.



Aral Sea, Centra Asia.  
Credit: Neil Palmer/IWMI

## Section 7: Adaptive management

| RECOMMENDATION  | SUPPORTING RATIONALE   |
|---|--|
| Prioritize achieving WP and End of Initiative outcomes, with focus on stakeholder engagement. | A key lesson from the 1.5 years of implementation is that progressing from outputs to outcomes requires dedicated time and investment. Workplans in each WP and basin have been reviewed in detail and approaches agreed on how to achieve TOC outcomes, via targeted stakeholder engagement by river basin teams, to foster buy-in and ownership. In 2024, we will further strengthen stakeholder engagement.   |
| Plan evidence gathering for outcomes.   | An important lesson learned to date is that attribution of outcomes is challenging, and particularly difficult if addressed retrospectively. It is not easy to demonstrate “use” of a tool or approach, especially when relying on the next user to provide the proof. We will discuss and agree on the type of evidence/documentation to be generated with relevant stakeholders early in 2024 and will work with them to ensure that the most exciting outcomes are adequately captured.   |
| Update risk framework.  | This year’s review of risks and management measures considers increased security concerns in some locations, in particular Ethiopia, Sudan, and Pakistan. Another concern is managing relationships and expectations of partners, given the current lack of clarity on the future of the existing CGIAR Research Portfolio and potential changes to come. There are also some updates to wording for clarity. We will review the framework periodically in 2024; one emerging risk that may be added is the likelihood that significant researcher time and effort will be diverted to developing the new Portfolio for 2025 onwards, causing a strain on human resources. |
| Adjustments to TOC.   | The TOC review revealed the need for one target adjustment and a small number of minor editorial updates for clarity. In output 1.5, “Trade-off dashboard tools applied for policymakers and investors”. the indicator was two dashboard tools. While we may develop two or even three of these tools, we will only move one through the process of testing and application. All other TOC outcomes and outputs are on track to be reached by December 2024. Editorial changes include ensuring that the title of output 4.1 aligns with the targets for this output. We will review all TOC details in April–May 2024 as per the replan process guidelines.               |



Section 8: Key result story

A revolution in Pakistan’s groundwater management

Pakistan’s Punjab Province is rolling out a practical, near-real-time information system to reverse the rapid deterioration of its groundwater.



Primary Impact Area

Other relevant Impact Areas targeted

Contributing Initiative

Contributing Center

Contributing external partners

NEXUS Gains

IWMI – International Water Management Institute

Punjab Irrigation Department, Pakistan · Punjab Water Services Regulatory Authority (PWSRA)

Pakistan faces an unprecedented water crisis, exacerbated by climate change. Groundwater is the country’s major source of irrigation, industrial, and domestic water; however, over-pumping, contamination, and waterlogging are existential threats. Improved groundwater management is crucial but hampered by a lack of useful data. Researchers from the CGIAR Research Initiative on NEXUS Gains collaborated with the Punjab Provincial Irrigation Department to test a practical methodology to obtain reliable, timely data. The Department is now implementing this methodology province-wide to enable data-informed, targeted interventions and ensure sustainable use of this vital resource.

Groundwater is an invisible collective resource, not confined within the boundaries of private land, provinces, or countries. Managing it sustainably and equitably is a complex challenge, particularly in low- and middle-income countries. In addition, pumping groundwater consumes an enormous amount of diesel fuel<sup>(4)</sup>, generating high greenhouse gas emissions. The CGIAR Initiative on NEXUS Gains is developing tools to support improved groundwater governance, but the challenge is daunting<sup>(2)</sup>. Surface and groundwater have historically been viewed as separate, but they are a single integrated resource.

At nearly 20 million hectares, Pakistan has the largest integrated surface irrigation system in the world. Seepage from the irrigation network and recharge from rainfall has created a reservoir of easily accessible groundwater. Farmers use this to supplement the surface water supply, enabling higher production. Groundwater also accounts for 90 percent of domestic water in rural areas (70 percent nationally) and more than 50 percent of agricultural water, especially in Punjab, the most populous province<sup>(3, 4)</sup>. Punjab also contributes 60 percent of Pakistan’s agricultural production, more than half of which depends on irrigation water supplied by private tubewells. Unregulated groundwater exploitation in Punjab and nationally has reduced groundwater levels and increased water contamination, waterlogging, and soil salinization. The Indus Basin aquifer, vital to the country’s water supply, is one of the most overstressed groundwater reserves in the world.

Groundwater degradation is an existential threat to Pakistan’s future, especially given rapid climate change, a large and rapidly growing population (which currently stands at more than 241 million people), and high levels of rural poverty and malnutrition: some 40 percent of its population, mostly in rural areas, live below the poverty line. Groundwater depletion may significantly reduce GDP<sup>(3, 4)</sup>. Recognizing the need for strong action, the National Water Policy 2018 and Punjab Water Act 2019 initiated significant institutional reforms and called for better groundwater management by actively managing critical groundwater depletion zones. However, this requires reliable, timely data<sup>(3, 5)</sup>.

PID has historically managed provincial surface water delivery through canals; these deliveries are monitored through its Water

Management Information System. The Water Act made the PID responsible for groundwater management. However, it had limited capacity to monitor groundwater. It had fewer than 10 operational piezometers (instruments to measure water pressure in observation wells) and these were randomly located and monitored manually twice a year. This was insufficient to provide the information needed to support strategic decision-making.

The PID therefore established a technical hub to support implementation of the new Punjab Water Act. At the 2021 NEXUS Gains stakeholder planning workshop, the PID invited the Initiative to help close the groundwater information gap by co-developing a groundwater management information system (GMIS). This was co-developed and co-tested in one district, Rahim Yar Khan, by monitoring a sample of domestic, agricultural, and industrial tubewells. The data collected includes the total number (80,000) and types of tubewells, their size, discharge, location, depth, and water quality. Depletion hotspots were demarcated using Principal Component Analysis and 40 new piezometers were systematically installed. They are equipped with submersible dataloggers which enable near-real-time daily monitoring of groundwater levels. Because the number of tubewells and their use is known, information not previously available – such as changes in groundwater level – can now be linked to abstractions. By providing near-real-time information, the approach is supporting the development of an actionable roadmap for sustainable groundwater management<sup>(6a, 6b)</sup>.

In 2022–2023, NEXUS Gains organized six technical workshops to share the findings of the GMIS and provided additional training to PID personnel. The Department is now implementing the GMIS throughout Punjab Province<sup>(7, 8, 9, 10, 11)</sup>, with continuing technical and training support from NEXUS Gains. For the first time, the PID can monitor and manage the entire water resource: rainfall, surface water, and groundwater. Better water management enhances adaptive capacity and climate resilience.

Collecting reliable timely data, integrated into an effective management information system, is a prerequisite for success. Based on the success of the GMIS in Punjab, we are now testing the GMIS in Pakistan’s Sindh and Baluchistan Provinces with support from the Asian Disaster Preparedness Center and the World Bank<sup>(12)</sup>. If it is implemented countrywide, this will provide Pakistan with the tools needed to manage water conjunctively.

NEXUS Gains is also supporting work to improve water productivity and energy management. Our interventions will enable higher agricultural production, better food security, and a reduction in malnutrition and infections from water-borne diseases. NEXUS Gains is making important contributions to enabling Pakistan to meet climate change and other challenges successfully and prosper in the future.

12. Asian Disaster Preparedness Center and the International Water Management Institute Contract. “IWRM Firm for Developing Groundwater Information System for Pakistan and Groundwater Atlas for Nara Canal Command, Sindh Province, Pakistan,” Confidential. 2024 .

Efficient groundwater management in Pakistan is imperative. NEXUS Gains/ IWMI collaborated with the Punjab Irrigation Department to test a practical methodology for collecting timely, reliable data. It is being implemented province-wide and tested in two other provinces. This will facilitate data-driven interventions to combat threats and ensure sustainable groundwater use.

Abdul Shakoor, Chief Engineer, Water Resources Zone, Punjab Irrigation Department





**Front cover photo**

Women in the area of the Mahakali Irrigation Project, Nepal, discuss gender roles in the management of local water resources.  
Credit: Manju Adhikari/IWMI

**Back cover photo**

Koga irrigation Dam, Amhara region, Ethiopia.  
Credit: Mulugeta Ayene/WLE



INITIATIVE ON  
**NEXUS Gains**