Irrigation is a key driver of economic growth as it improves agricultural production, strengthens rural development, and increases resilience to climate change by bridging the gap between crop water requirements and precipitation. Even though irrigated land represents only 36 percent (2.6 million hectares) of all agricultural land, approximately two-thirds of the country's agricultural output[15] is produced on irrigated lanc Moreover, irrigation could increase the country·s GDP by 0.8 percent per year through agricultural productivity gains (World Bank, 2022).

However, irrigation systems in Peru face a variety of challenges · low overall agricultural water use efficiency (WUE,)[16] at only 30 percent,[17] vulnerability of small-scale farmers, and low support capacity of local governments.[18] The low levels of WUE in irrigation systems are, in large part, due to the deteriorating condition of approximately 57 percent of Peru's existing irrigation infrastructure. Limited use of efficient on-farm irrigation technologies is also contributing to low water productivity, as they are not yet widely available or used throughout the country.

5 Agricultural output is defined as the total value of crops produced in economic terms, although it has also been used to denote (physical) crop yields.

6 Water use efficiency (WUE) is defined as the ratio between the volume of water used for irrigation and the volume extracted or derived from a water source for that purpose. It can be divided into storage, conveyance, distribution, and application efficiencies.

9 On-farm irrigation systems include drip or sprinkler systems. In sprinkler systems, water is led to a field through a pipe system under pressure, and artificial rainfall is created to water the crops.

Efficiency is also commonly improved through sustainable on-farm agronomic practices[20] that focus on soil moisture conservation, thereby reducing the need for irrigation water supply to fields.

Although subnational governments are the main financiers and implementers of irrigation investments, representing roughly 80 percent of the total budget for irrigation, these investments have not translated into significant improvements in irrigated area coverage or efficiency. On average, only 60 percent of irrigation investments were fully executed, with efficient irrigation systems installed in only about 1 percent.

Irrigation investments are often made without considering the broader hydrological and hydrogeological context.

This leading to water deficits in many basins and, hence intense competition for water resources among water users. Many irrigation systems have been established without detailed knowledge about water supply or demand in the respective watersheds.

As a result, the Government of Peru (GoP) prioritized the rollout of efficient irrigation interventions as part of its development agenda, given the direct impact of irrigation on reducing poverty and enhancing food security for Peru's poorest in rural areas. Public sector financing is required as the targeted beneficiaries have limited capacity to access efficient irrigation infrastructure and technology given their high capital cost and relatively low revenue from farmers· existing production. Accompanying sustainable agronomic practices are also expected increase the efficiency of water use by maintaining soil health and conserving its moisture, thereby leading to improved productivity and resilience to shocks.

Technical Assistance (TA) and training are necessary for ensuring the positive impact of technological adoption and technical sustainability of irrigation systems through their improved management, given the general lack of TA and training services for farmers in Peru[22]· reaching 11 percent of the total agricultural producers nationwide and 5 percent of small- and medium-sized farmers.[23] The Sierra Irrigation Subsector Project (P104760), which extended access to TA, training, and efficient irrigation systems to farmers in the Sierra regions, demonstrated the effectiveness of such investments on poverty reduction for rural populations in areas implemented.

Farmers can incorporate specific practices to manage crops, improve soil quality, enhance water usage, and improve the surrounding environment by focusing on the conservation and regeneration of water and soil resources.

[22] Reduced performance of technified irrigation infrastructure generally occurs due to a lack of sufficient training and TA for those who manage, operate, and maintain the schemes.

The Ministry of Agricultural Development and Irrigation·s (Ministerio de Desarrollo Agrario y Riego [MIDAGRI]) Sub-sectoral Irrigation Program (Programa Subsectorial de Irrigaciones [PSI]), serves as the irrigation subsector·s executing body at the national level. The PSI·s objective is to improve agricultural water productivity by: (i) expanding the use of efficient irrigation technologies and on-farm practices to promote the efficient and sustainable use of water for irrigation; (ii) supporting the development and strengthening of the management capacity of WUOs and of Farmer Groups (FGs) in irrigation hydraulic blocks.

Regional and Local Governments (·Gobiernos Regionales· and ·Gobiernos Locales·) are responsible for planning and promoting irrigation development [33] within their jurisdictions and managing both self and externally financed program resources. These subnational (regional and local) governments apply relevant standards and policies to the design and implement sector investments. Regional governments, specifically, are responsible for providing support to both local governments and irrigation service providers.

The National Water Authority (Autoridad Nacional del Agua [ANA]) oversees improvement of water resource management across the country and operates through its decentralized agencies.[34,35] This includes a deficiency in accounting for both upstream and downstream users of water, particularly those impacted by irrigation investments and

[25] De Nys, E., Hidrogo, C., Lajaunie, M., Chinarro, L. 2013.

28585, seeks to promote ·irrigation systems that allow the rational and efficient use of water to increase agricultural productivity·.

However, these also lack the resources to provide support when and where needed, causing a lack of skills and technological solutions to improve water management among users.

[35] Relevant information and management capacity provided by ANA at the local level remains limited. The constraints related to irrigated agriculture pertain to lack specific information on the water balances of irrigation schemes or their impact on respective catchments.

The term WUO describes three different types of hierarchically coordinated user organizations, namely (i) water user boards (junta de usuarios)[36] that oversee (ii) water user commissions and (iii) water user committees.[37] Users within each irrigation WUO share water and pool their financial, technical, material, and human resources for the MOM of water delivery systems under their control.[38]

21. WUOs have struggled to achieve operational efficiency as well as financial and technical autonomy. Although responsible for the MOM of over 1.4 million ha of irrigated land and serving almost three quarters of a million users, WUOs lack sufficient technical capacity, specialized equipment, and reliable information on the availability and use of water resources (supply and demand) to improve their operational efficiency in their respective areas.[39] WUOs also struggle to reach financial sustainability due to low water tariffs and collection rates.

Farmer Groups (FGs) (Grupos de Gestión de Riego Tecnificado [GGRT]) manage sub-projects and comprise producers at the lower-level sections of a hydraulic block. FGs are responsible for the management of irrigated water from the water intake structure to the application of water on-farm and report to PSI. FGs were established for the purpose of managing ·technified· irrigation at each sub-project level to ensure that the water needs of each farmer are met and that their section of the block remains in good condition.

After several years of discussion and planning, and a careful analysis of the above-mentioned challenges, the GoP decided to reinforce its engagement in modern irrigation water management and seek World Bank support in the form of the proposed Project, to assist them with investments in, and uptake of technified irrigation approaches. The Project also builds on the experiences from the World Bank·financed Sierra Irrigation Subsector Project (P104760). Farmers who participated in the Sierra Project reported 25 to 500 percent increases in net household income per hectare from improved water availability through advances in off-farm irrigation schemes and on-farm technology and agronomic practices used.

The Project is aligned with the following two policy actions: (i) promoting water security in agriculture through water storage solutions, water-efficient irrigation systems, and sustainable water management (considering social, productive, and environmental uses), while strengthening women´s status as agricultural producers; and (ii) strengthening environmental protection, disaster risk management, and climate change adaptation and mitigation.

The Project further responds to the MIDAGRI·s Multiannual Sector Strategic Plan (PESEM) 2015-2027 that has two objectives: (i) to manage natural resources and biological diversity within the competence of the agricultural sector in a sustainable manner

[36] The 43 Water User Boards (JUs) oversee the 130 sub-projects that mostly correspond to a single commission or committee. Thus, the total number of water user institutions involved in the proposed Project is 180.

[37] User Committees (Comités de Usuarios) represent the base level of all WUOs, organized around lower levels of distribution structures of hydraulic blocks.

[39] While PSI provides support to farmers who are members of WUOs, its budget program limits the adequate support and does not enable purveying the latest, sustainability-focused advances in irrigation interventions.

The Project is also aligned with the Ministry of Agriculture's (MIDAGRI) comprehensive national climate adaptation strategy for the agriculture sector, with measures related to building resilience and maintaining productivity, including investing in irrigation infrastructure and site-specific land-use planning to mitigate water scarcity.

The project is in-line with Peru's 2020 Nationally Determined Contribution (NDC) and 2021 National Adaptation Plan (NAP) for climate change mitigation and adaptation, identifying water as a priority sector for addressing climate change and limiting its impact. The Project puts an emphasis on implementing energy- and water-efficient irrigation systems, increasing water storage, and strengthening water resources management. The Project is also aligned with the public investment recommendation of Peru's Climate Country Diagnostic Report's (CCDR) to improve access to efficient irrigation systems to build resilience in the agriculture sector and boost economic growth while protecting vulnerable populations. Peru's CCDR also stresses the importance of adaptation to water-related shocks given the country's significant spatial and temporal rainfall imbalances and uneven development patterns across its territory (World Bank, 2022).

The Project is also aligned with the World Bank's mission of ending extreme poverty and boosting prosperity on a livable planet. By promoting water use efficiency and developing improved irrigation infrastructure, the operation is expected to enhance agricultural productivity and increase farmer revenues in targeted areas with positive impacts on water and food security.

The Project is also closely aligned with the World Bank's strategic framework for moving "From Crisis Response towards Green, Resilient, and Inclusive Development" (GRID) · directly supporting its Pillar 4: ·Strengthening Policies, Institutions, and Investments for Rebuilding Better,· and the goal of the World Bank Group's 2021-2025 Climate Change Action Plan of aligning climate and development goals while boosting growth. Moreover, the Project complements the Bank's ongoing and pipeline programs to support sustainable and inclusive growth in Peru and builds on the Bank's longstanding policy dialogues in these areas.

The PDO level indicators are the following:

PDO 1: Improve the sustainability and efficacy of water services for irrigation.

1) Water User Organizations that increase operational efficiency in their hydraulic blocks by 10 percent[4]. 1 (Percent)

2) Regional Governments (GOREs) that have at least 500 hectares of ·technified· irrigation projects in their respective multiannual investment portfolios.

3) Average increase of the tariff collection rate of FGs participating in the Project to generate resources for an

[3] For the purposes of the Project, sustainability encompasses technical, institutional, and financial dimensions as measured by PDO indicators 1 · 3.

[4] Operational efficiency evaluates the quality of the operation of the irrigation system between the intake of the water source and the input to the plots and is defined by the relationship between the water volumes distributed at the level of the users' plots and the volume extracted from a given water source.

PDO 2: Improve the productivity of water on family farms in selected areas that are vulnerable to climate change.

5) Increase in agricultural water productivity on family farms in areas vulnerable to climate change[42] (Percent)

6) Increase in efficiency of application of irrigation water on-farm in areas with ·technified· irrigation (Percent).

The proposed Project is a US$126.0 million Investment Project Financing (IPF) operation, financed by a US$100.0 million IBRD loan and US$26.0 million in counterpart funds.

Proposed interventions are grouped around the following three components: (i) Component A: Irrigation Investments for Climate Resilient Agriculture; (ii) Component B: Institutional Strengthening for Effective and Sustainable Irrigation Services; and (iii) Component C: Project Management and Interagency Coordination.[43]

32. Component A: Technified Irrigation Projects (US$ 106.7 million, of which US$89.5 million is financed by the IBRD). Component A aims to improve water delivery services for irrigation and agricultural water productivity in 130 selected and prioritized subprojects covering a total of 8,014.38 hectares · involving 130 FGs (GGRTs)[44] · and serving 7,767 producer households (thereby reaching an estimated total of 24,128 beneficiaries). Each subproject represents a hydraulic block that consists, on average, of 60 ha of land and serves around 60 farmers. Figure 1 below illustrates the main elements (points 1-10) of a hydraulic block. The investments comprise improvements to existing irrigation schemes.

Modernization of Communal (Off-Farm) Irrigation Systems. This subcomponent aims to modernize existing off-farm irrigation schemes within designated hydraulic blocks by converting open canals to pressurized gravity-based piped[46] networks in areas with natural slopes[47] (refer to points 1-5 in Figure 1).

Such modernization of off-farm irrigation infrastructure, coupled with their enhanced management is expected to improve the reliability of water supply to farmers, facilitate diversification toward higher-value crops, and increase resilience to water supply variability exacerbated climate change.

Water productivity can be assessed at the level of (i) total yields (biomass · kg/m^3), (ii) marketable yields (kg/m^3), and (iii) their market value (PEN).

[44] These 130 sub-projects are within the jurisdiction of 43 Water User Boards (JUs) and 4 User Committees (which are not part of the Water User Boards), distributed across 19 regions, 56 provinces, and 87 districts. To date, the 130 sub-projects include 85 projects declared viable (past feasibility stage) and 45 projects at the concept level (technical assessment stage).

[45] FGs oversee the management of irrigated water from the water intake structure (point 1 in Figure 1) to the application of water on-farm (point 10).

[46] As part of a ·technification· process, the conveyance systems will be adapted from open canals to pressurized gravity-fed piped systems, which naturally pressurize the water by mere use of gravity and without the need for energy. Piped systems are typically characterized by high water-use efficiencies due to negligible water losses from leaks/seepage and avoiding evaporation losses inherent to canals.

[48] Head water intake structures are used for water withdrawal from the original source for delivery to an irrigation network.

Irrigation Technology Improvement (On-Farm Irrigation Systems). This subcomponent aims to support farmers in increasing their agricultural water productivity by improving the efficiency of water applied to crops at the farm level through the installation of advanced on-farm irrigation systems. Activities include the following interventions on existing on-farm irrigation systems: (i) construction and provision of water-efficient field application systems (e.g drip irrigation, sprinklers, micro sprinklers), land leveling, lateral pipes, equipment for improved control and regulation of water flow, and flow rate measuring devices for improved monitoring; (ii) development of feasibility studies, detailed designs, and environmental and social instruments; (iii) monitoring and supervision of civil works; and (iv) implementation of the ESMP, including reforestation activities to improve soil moisture and environmental base flow, increase efficiency of sprinkler and micro-sprinkler systems, and increase the sustainability of the hydraulic blocks. This subcomponent will be financed through a cost-sharing arrangement with farmers following the National ·Technified· Irrigation Program (NTIP) guidelines.

Technical Assistance and Capacity Building to FGs (GGRTs). This subcomponent aims to strengthen the capacity of FGs participating in subprojects under Subcomponents A.1 and A.2 to ensure the sustainability of the investments in their subprojects and increase water productivity in their hydraulic blocks through TA, capacity building, and knowledge sharing activities. The assistance will be centered on the following three main areas: (i) MOM of the irrigation systems in the respective hydraulic blocks; (ii) strengthening the capacities of the farmers; (iii) improving the productive and efficient use of natural resources at their disposal by adopting sustainable agronomic practices;[51] and (vi) helping establish WUOs with a balanced representation and participation of female and male farmers to leverage economies of scale, strengthen commercial management, and connect with national and international markets.[52]

37. The combined investments in ·technified· irrigation systems, TA and capacity building as part of Component A are expected to increase farmers· resilience to water variability caused by climate change and avoid significant decreases in crop yields.[53] Adequate irrigation water delivery is critical for enabling farmers to cope with the climate-exacerbated occurrences of floods, droughts, and frost, to increase crop yields, and to grow higher value crops.

In addition to building water security, the proposed Project is anticipated to improve the food security and livelihoods of the mostly agricultural rural areas of Peru.

An analysis calculating GHG mitigation potential of the Project concluded that an estimated 5.562 tons CO_2-equivalent per year can be saved by the Project´s activities. In approximately 90 percent of the efficient off-farm irrigation systems, the Project·s will utilize natural topographic elevations for gravity-based, pressurized flow of water that eliminates the need for electricity or diesel to power water pumps. This is presumed to avoid GHG emissions by circumventing the need for energy generation using fossil fuels while providing highly efficient water conveyance, distribution, and delivery to farms. Additionally, the soil and

[49] The networks will include energy-efficient hydro-mechanical equipment and smart measuring devices, with their design considering resilience against climate change-exacerbated floods and droughts.

The main expected benefit is to help keep the soil structure intact, which helps maintain moisture content and thus reduce erosion.

[51] Regenerative or conservation agriculture focuses on ensuring soil health to increase the efficiency of water application and retention of moisture in the soil.

[53] Improved irrigation can increase the yields of most crops by up to 100 percent as well as improve grazing land and pastures.

Component B: Other Initiatives: Institutional Strengthening for Effective and Sustainable Irrigation Services (US$6.7 million, of which US$6.0 million is financed by the IBRD). To complement Component A·s interventions at the hydraulic block level, this Component focuses on providing scaled-up support to improve water services for irrigation at the local (scheme level), and subnational (regional government), and national levels.

Instead, it aims to strengthen the capacity of WUOs (water user boards, commissions, and committees) as well as of subnational governments to strategically support the newly created FGs and extend access to ·technified· irrigation solutions throughout Peru. Although the entry point to improving irrigated agriculture for individual farmers is through irrigation services, the multi-level character of this component ensures that water storage (including reservoirs), groundwater, and surface water management·key elements in adapting to climate change·are also considered at higher ·governance· levels.

Strengthening WUOs for Improved Management of Reliable and Sustainable Water Services for Irrigation. This subcomponent aims to support all participating WUOs5 [5] in ensuring equitable, reliable, and timely distribution of water to the hydraulic blocks under Component A. This subcomponent is designed to improve water management and administration by WUOs to mitigate climate-exacerbated floods, droughts, and frost in the WUOs· areas of influence, promote adequate O&M of their hydraulic assets, and support efficient use of water for irrigation through

4 These practices will focus on sustainably increasing productivity and income while helping mitigate and adapt to climate change impacts through carbon sequestration and increasing the efficiency of water use on-farm.

Specific focus will be placed on capacity building to monitor the potential impact of increased absolute water use savings derived from improved water use efficiency upstream to help avoid any negative impact on downstream users by inadvertently reducing return flows.

Specific activities include: (i) updating and implementing key technical instruments, including water distribution plans, O&M plans, asset management plans; (ii) the installation of water control and measuring devices coupled with TA on water efficiency and accounting assessments; (iii) the implementation of demonstration parcels to promote the conversion to ·technified· irrigation systems among other FGs; and (iv) development of potential water tariff restructuring strategies following improvements in services. Climate-related aspects such as drought and flood early warning systems and data collection for improved water planning towards climate risks will be considered in the water distribution plans.

Subcomponent B.2: TA to Subnational Governments for the Scaling Up of Improved Irrigation Investments. It aims to build the capacity of subnational governments to expand the use of ·technified· irrigation systems in the 19 regions where the 130 subprojects under Component A are located (see Map in Annex 3). Activities include: (i) capacity building in the management and administration of water resources for agricultural purposes; (ii) strengthening the ability of Regional Agrarian Departments (Dirección Regional de Agricultura [DRA]) and Planning Directorates (Dirección de Planificación) of subnational governments to carry out the O&M of ·technified· irrigation systems; (iii) strengthen capacities for the planning and management of regional ·technified· irrigation.[56]

43. To contribute to the achievement of a sustainable nexus between water resources management and sustained or increased agricultural productivity in new investments (scale-up), this subcomponent will consider specific measures to assist in: (i) the consideration of integrated water storage solutions and comprehensive water resources planning at the watershed level; (ii) the presentation of an irrigation smart subsidy program that focuses on small farmers in an effort to provide incentives for the adoption of ·technified· on-farm irrigation systems and water management practices that conserve soil moisture and reduce polluting effects of crop cultivation; and (iii) improving resilience-based planning with the use of hydro-agro informatics, generated by MIDAGRI's information systems that will allow performance or impact assessments of irrigation and agricultural systems in targeted sub-watersheds, also informing O&M irrigation assets.

The Project aligns itself with MIDAGRI´s sectoral policies, management and expenditure planning instruments, investment plan and budget program, and will provide lessons learned for their updating. This includes a close collaboration between the Project and respective sector entities to incorporate lessons learned from the Project·s implementation into the following activities.[57] (i) updating of irrigation policies to strengthen, among others, the integration of Water Resources Management at basin level as part of the scaling up of ·technified· irrigation; redesigning of Budget Program PP0042 to update its operational model and indicators of with a focus on integrality and complementarity at the basin level; (iii) the improvement of a geographic information system, which MIDAGRI is currently developing. The latter will be attained through the integration of data on water resources, the use of agricultural land and its characteristics, including the phenomena of floods and extreme droughts aggravated by climate change, in a single center for managing such knowledge so that it allows adequate planning of irrigation and ·technified· irrigation that can be used by the Project.

Component C: Project Management and Interagency Coordination (US$12.6 million, of which US$4.5 million financed by the IBRD).

The component will support capacity building on financial, environmental, social, and

56 These activities assist with strengthening the capacity for the regional and local governments to prepare and manage investments. A 2020 report from PSI shows the lag in project implementation at the Regional and Local governments, where it was reported that only 20 percent of the programmed investment was executed (Inversiones en Riego Tecnificado Parcelario 2012/2019. Since most of them have sufficient financial resources at their disposal, lack of capacity to prepare and implement the investments was suggested as the cause in the report.

In addition, this component will include activities to promote coordination between Project and existing government entities (e.g., ANA), other government programs (such as Sierra-Selva Exportadora, AGROIDEAS, AGRORURAL, et

The Project will directly benefit 130 FGs serving 7,767 farmer families cultivating 8,014.38 hectares (with the total number of beneficiaries is estimated at 24,128 persons) with improved irrigation systems and relevant capacity building.

The Project·s efforts to strengthen irrigation strategies at the regional and national levels, which will foster the extension of efficient irrigation solutions, are also expected to generate future benefits for residents living outside of the Project·s target areas. Many of these benefits will only be accrued after the closure of the Project.

The success of the improved irrigated water services (PDO1) directly contributes to the success of the improved agricultural water use productivity (PDO2), since without adequate provision of irrigated water, the on-farm investments would be rendered ineffective.

Improved irrigation technologies (subcomponent A.2) will allow farmers to utilize the improved availability of irrigation water service delivery more effectively. The improvement of irrigation schemes is expected to enable optimal usage of water (according to crop water requirements[illegible]1) and of other agricultural inputs and practices, thereby potentially facilitating increases in cropping intensity and changing of cropping patterns toward higher-value crops (in nutritional content and monetary value).

These investments are accompanied by technical assistance and capacity building to FGs (subcomponent A.3) and WUOs (subcomponent B.1), which are expected to allow for better management of water resources and investments in technified irrigation. As a result, farmers will increase their capacity to improve their production during the dry season, build their resilience to various climatic phenomena such as droughts, rising temperatures, and frost, and improve their incomes and livelihoods.

The Project·s critical assumptions include: (i) adequate availability of water for the irrigation schemes; (ii) that the TA activities will result in significant uptake by farmers in terms of utilizing irrigation schemes correctly and increasing their focus on productivity; (iii) that local contractors (construction and TA) will have sufficient technical capacity; and (iv) that counterpart funds from farmers will materialize.

The Bank is a key and long-standing partner for Peru's water and agriculture sectors and brings global knowledge, technical expertise, and innovative approaches to this proposed investment Project. In particular, the Bank team will share global knowledge on topics related to modernization of irrigation systems, governance, usage of regenerative agricultural practices, and improved monitoring of water usage through water accounting methods.

The Bank's experience in supporting the implementation of the Sierra Irrigation Subsector Project has provided the Project·s task team with concrete lessons and specific guidance on how to improve its support under this proposed Project. In addition, the Water Security Diagnostic for Peru 2 has provided the Bank team with detailed information and findings on the nexus between water security and irrigation in Peru that will help the team provide value beyond the immediate scope of the Project.

The Project design builds on the lessons generated from the successful implementation of the Sierra Irrigation Subsector Project (P104760), the Sierra Rural Development Project (P079165), and by the recently completed Peru Water Security Diagnostic (WSD) report (World Bank, 2022). The project extended access of farmers to efficient irrigation

2 World Bank.

The WSD identified the need to prioritize the upgrade and expansion of efficient irrigation and drainage systems, especially for small and medium-sized family farms in areas with high seasonal water variability.

To maximize on the impact and sustainability of the Project, technification of collective irrigation schemes as well as on farm are integrated within the same territory of a hydraulic unit (subproject) associating the irrigation modernization with WUOs. This way, sub-projects attend to an entire system from the intake structure, conveyance, and distribution systems to the field application systems. This approach learned from the Sierra Irrigation Subsector Project (P104760) is expected to have a greater impact and allow for more effective irrigation services improvement.

The Sierra projects showed that projects aiming to improve small-scale farmers· production and commercial orientation should encourage beneficiary engagement and build capacity among organizations such as FGs. The experience with the implementation of sub-projects within the Sierra Rural Development Project (P079165) pointed to the success of such a model and was integrated into the proposed Project.

This was later replicated under the Sierra Irrigation Subsector Project (P104760), where WUOs/FGs participated in the selection, design, execution of subprojects.

Both Sierra projects demonstrated that training and TA interventions are necessary for the technical sustainability of investments into irrigation infrastructure and to improve irrigation management.

Based on the lessons learned, the proposed Project aims to work with FGs to increase the technical sustainability of the investments in the medium and long term, including ensuring the funds for the maintenance and replacement of irrigation equipment and materials.

A portion of the TA provided to producers (through FGs/GGRTs) through demonstration plots as part of the Project includes (i) improving the efficiency of water management at the parcel level and (ii) agronomic management for both annual and perennial crops. Agronomic management through incorporation of climate smart and regenerative practices will allow for greater efficiency in the overall water management in the sub-projects (lowering the need for irrigation water by conserving soil moisture), resulting in greater yields, lower chemical inputs of fertilizers and pesticides, and, thus, lower impacts on ecosystems. This is based on the successes under the two previous Sierra projects (P104760 and P079165) of providing group-centered TA to beneficiaries for increasing the productive capacity of individual households and promoting the application of adequate agronomic practices for the overall performance and sustainability of agricultural production under irrigation.

Based on the experience from the Sierra Irrigation Subsector Project, the Project will adopt a watershed management perspective wherever possible.[6] The proposed Project recognizes the importance of considering downstream impacts of increasing irrigation efficiency upstream. This relates to the well-known challenge of a reduction in water available to downstream water users through reduced return flows from increases in water use efficiency in irrigation schemes upstream.

While previously, the ·lost· water might have functioned as an inflow to the water source downstream, this process could be undermined when ·freed-up· water in the upstream system is potentially repurposed for additional irrigation water, either by expanding irrigated areas or by growing crops with a higher water consumption.

To quantify the severity and magnitude of this challenge for the Project´s proposed subprojects, an analysis was carried out to quantify the potential water savings from increases in water use efficiency without negatively impacting downstream water users.

To put these figures into context, it is important to consider the water balance in the respective watershed to understand the potential impact of the environmental return flow of one single subproject with an average of 60 hectares. To the extent feasible, the Project will therefore consider estimating a water balance in the affected watershed(s) to understand the potential impact on the environmental return flow While disaggregated data on the respective local watersheds is not widely available, the Project will utilize the TA under Component B to coordinate with WUOs as well as ANA and its local entities, such as the Local Water Authorities (ALAs)[7] to identify pilot subprojects to carry out further analysis on the impact of increased water use efficiency.

Since its inception in 1997, PSI has carried out 680 technical irrigation projects that have benefited 10,497 farmers nationwide (PSI, 2017). The PSI to implement an irrigation program along the Costa that had the objective of improving the existing irrigation infrastructure, promoting efficient irrigation, and providing training to WUOs. In 2006, the PSI was designated as the governing entity of the irrigation subsector at the national level to encourage and promote the efficient and sustainable use of irrigation water.

7 Local water administration units (Administración Local del Agua [ALA]) are the local offices of ANA.

The PSI currently works nationwide through its seven regional offices 8 on the implementation of irrigation projects. The PSI is headquartered in Lima and has departments focused on: (i) administration and financing; (ii) infrastructure; (iii) irrigation management; and (iv) planning, budgeting and M&E.

The PSI will accompany the farmers in each of the stages, coordinating with MIDAGRI, ANA and its deconcentrated entities, regional and local governments, and the private sector.

These

engagements include the World Bank Sierra Project, which closed in 2017.

The Borrower proposed designating the PSI as the implementing agency given its local presence and experience with Bank-financed projects. The Bank team rates the PSI's current capacity (including technical, environmental, social, financial management (FM), and procurement) to implement the Project as moderate.

Specifically, the Project will support the involvement of the ALAs to strengthen the continuous monitoring of Project interventions, water consumption, related system parameters, and enforcement of effective regulatory instruments to manage water use.

In addition, the Project will coordinate with MIDAGRI's ongoing rural programs (AGROIDEAS, AGRORURAL, and Sierra-Selva Exportadora) and the INIA to provide specific thematic support as needed.

Given the need for strong coordination among various agencies, MIDAGRI, with the support of the Ministry of Finance (MEF), will create a Project Steering Committee to provide high-level guidance, oversight, and control of the Project as well as inter-institutional agreements with key agencies (i.e., ANA).

Project reports will be prepared and submitted to the World Bank on a bi-annual basis, no later than 45 days after completion of the semester. The report will cover: (i) the progress of each component, implementation of key features of the environmental management plan, key performance indicators, details of operation of Project facilities, and financial statements; and (ii) the annual work plan for implementation, annual funds required for implementation, an updated disbursement profile, planned actions for mitigating negative effects during construction, and target indicators for the coming year.

A mid-term review (MTR) of the Project will be carried out by the Borrower and the World Bank. The Borrower will submit its own MTR report no later than two months before the MTR and an implementation completion report to the World Bank no later than two months after the closing date of the Project.

ESF compliance will involve monitoring compliance with environmental and social safeguards policies as detailed in the environment and social safeguards instruments.

The Project design includes extensive capacity building at the FG and WUO level to ensure that the off-farm and on-farm irrigation systems are managed in a sustainable manner. The Project·s combination of hard and soft investments also builds sustainability from a financial perspective; the FGs· access to irrigated agriculture will permit more reliable production of higher value crops, and the development and implementation of business plans will encourage strategic planning to successfully connect with national and international markets. The FGs· increased income will increase their capacity to pay for the WUO·s irrigated water services (this will be amplified by greater willingness to pay given the Project·s investments to improve service), building the financial sustainability of the WUOs· operations as well.

The Project·s investments also build sustainability from a resource perspective given the focus on efficient water use. The efficient irrigation systems developed under the Project will build the capacity of FGs to produce crops utilizing less water, increasing the FGs· resilience to droughts and other climate change-induced events, and are projected to improve the system·s resilience against water stress and climate-induced disasters such as droughts by reducing average water deficits from -34 percent to zero.

Finally, the Project·s investments at the subnational and national level promote the scaling up of investments and the strengthening of sector strategies that will build their institutional capacity to provide support to FGs and WUOs after the closing of the Project.

Component A aims to improve water services for irrigation and agricultural water productivity in 130 selected subprojects with a total of 8,014.38 hectares, benefitting 130 FGs. This component is divided into three subcomponents: (i) construction and improvement of off-farm irrigation systems; (ii) construction of on-farm, efficient irrigation systems; and (iii) TA and capacity building for the user organization.

Currently, out of the 130 subprojects, 18 subprojects have detailed designs (Expediente Técnico), 5 have advanced feasibility studies (Ficha Técnica), 36 subprojects are at the level of feasibility study 35 are at the level of preliminary design plus feasibility study, and 36 are at the level of preliminary design.

From an infrastructure quality perspective, the subprojects with detailed designs are considered as suitable to be procured under a lump sum contract, considering that the designs, technical and graphic information, technical specifications, desegregated quantities, and itemization of the offer are well detailed.

The Bank reviewed the information provided for the Yocara-Puno subproject as part of the group of 5 subprojects prepared at the level of feasibility studies. The study utilized information related to all relevant technical, economic, and financial characteristics and provides a sound rationale for the expected benefits, in line with the Project·s objective.

In summary, the Project's immediate benefits are also expected to extend beyond the Project's targeted area in the long-term given the Project's support for the preparation and implementation of a portfolio of efficient irrigation projects with regional and local governments and the strengthening of national policies for efficient irrigation and water resource management. Project costs include capital investment costs, O&M costs of the irrigation systems, and crop production costs (inputs and labor costs).

The Project's immediate benefits are tied to the increase in productivity associated with the provision of efficient irrigation systems on over 8,014.38 hectares of agricultural land. With access to efficient irrigation systems and sustainable agronomic practices (known as climate smart, regenerative, and conservation agriculture) farmers are expected to utilize water more efficiently and better withstand climatic stresses (e.g., droughts, erratic rainfall patterns, frost). Additionally, it is expected that farmers will be able to grow higher-value crops, reduce labor costs, and thereby increase their incomes while ensuring food security. The quantifiable Project benefits are linked mainly to the additional income of producers that are impacted by the sub-projects (Component A).

Methodology used for the financial and economic (EFA) analysis.

A standard cost-benefit analysis (CBA)[70] was performed with a 20-year horizon to assess the financial and economic merit of the Project by quantifying all incremental costs and benefits directly attributed to the Project. Financial and economic benefits were assessed for important agricultural crops with the potential for the development of value chains. Moreover, as part of the elaboration of each subproject design, the PSI will carry out a CBA for each of the 130 subprojects during implementation.

As part of the economic and financial analysis, each of the sample subprojects considered 8 crops under their production schemes.[71] These eight crops comprise the cropping systems that will be improved through the Project·s implementation and will determine the financial profitability of each subproject.

70 A cost-benefit analysis will be carried out for each subproject as part of the feasibility studies as per national investment guidelines.

The model calculates incremental net benefits over a period of 20 years, holding constant the input and output prices t capture the effect of the change in production

Existing crop production techniques were assumed to be replaced by the introduction of sustainable and sustainable agricultural practices[72] in the Project areas. In the ·with project· scenario, it is assumed that the ... through the introduction of technologies and agronomic practices that reduce the use of external inputs. With this, it is assumed that the level of inputs (fertilizers, herbicides, and pesticides) needed will decrease by 5 percent. Also, a water fee per hectare per year is considered in the models for the O&M of irrigation systems.

For a 20-year horizon, the incremental economic benefit for the entire Project is estimated to be US$60.6 million, with an EIRR of 17.2 percent. The flow of annual incremental net benefits calculated over a 20-year period, considered an economic discount rate[74] of 8 percent that is compatible with the maturation time of principal investments. The economic analysis was applied to a sample of eight representative sub-projects (under of Component A). The CBA assessed the economic viability of the production models proposed by the Project, considering economic prices (shadow prices,)[75] and economic value of carbon

For the general economic analysis of the Project, economic flows were extrapo... Benefits across the total Project area were extrapolated from the cropping composition and relative size of each of the eight subprojects. The total cost of the Project is estimated at US$120.0 million.[77] For a 20-year horizon, the incremental economic benefit for the entire Project is estimated to be US$60.6 million (representing the net present value (NPV)[78] of agricultural production), with an EIRR of 17.2 percent.

To ensure the long-term robustness of the economic behavior of the Project, a sensitivity analysis was performed to evaluate how the economic indicators of the overall Project change with: (i) reductions in yields; (ii) delays in benefit generation; (iii) cost overruns; and (iv) changes in the shadow price of carbon. The results of the sensitivity analysis showed the Project's overall NPV still presenting a positive economic return even when considering a delay in the generation of benefits of 3 years, a significant cost overrun, or a 5 percent reduction of expected benefits.

In addition to the Bank·s economic assessment, the PSI prepared an economic evaluation to comply with Peru·s public investment system, InviertePE. The evaluation models profitability indicators based on the expected effects of the Project on the yields, the incremental investment costs, and O&M costs.

For the general economic analysis of the Project, economic flows were extrapolated.

[73] ... CBA compares the economic costs and benefits of a project and provides information about the real yield of a long capital investment.

[74] Discounting expresses future costs and benefits at today·s equivalent value to account for inflation and risk. The applied discount rate corresponds to ...

[75] Shadow prices reflect the true social and economic value to society of the goods and services that the project utilizes to generate its benefits.

[76] Net incremental benefits were summed across each of the production models, and then multiplied by a scaling factor, defined as the share of the total project area that these subprojects represent.

[78] NPV is used to evaluate the value of an investment based on the difference between the present value of cash inflows and outflows expected to be generated over the lifespan of a proposed project. NPV represents the difference between the present value of cash inflows - expected (quantified) benefits and of cash outflows - costs (of planning, preparation, and implementation) over a specified period.

A constant shadow price of US$7.17 per ton of CO[2] [19] Over the Project duration of 20 years, the Project is expected to lead to a net carbon reduction of 111,258 tons of CO2-equivalent (tCO2-eq).

Financial viability was determined as positive for the eight subprojects, with financial internal rate of return (FIRR)[20] between 12.7 percent and 25.2 percent. A CBA was applied to eight representative sub-projects of Component A, for which the flow of annual incremental net benefits over a period of 20 years was calculated (considering a financial discount rate of 12 percent), [21] holding constant the input and output prices to capture the effect of the change in production.

The Project's financial viability was examined to ensure the sustainability of the infrastructure works. The financial situation (and cost recovery) of the FGs and WUOs in the Project area, irrigation tariffs' collection, administering of water rights (if applicable), and other revenue sources were evaluated. The financial situation (and cost recovery) of the FGs and other WUOs in the Project area, irrigation tariffs' collection, administering of water rights (if applicable), and other revenue sources was also evaluated.[22]

94. A financial analysis of WUOs revealed that the WUOs have struggled to achieve financial sustainability due to, among others, low water tariffs and collection rates.

The success of the Project's investments hinges on having a strategic implementation approach given the large number of subprojects and wide territorial expanse.

[20] The financial internal rate of return (FIRR) is the most common metric used in financial analysis to estimate the annual rate of return on investment. It estimates the flow of net incremental benefits of the project based on two scenarios - with and without the project.

[22] If O M costs of the irrigation systems are not covered by the FGs and WUO's revenues, alternate financing sources or changes in current sources will be discussed with stakeholders to make sure all the costs are covered.

Estudio Socio Económico de los miembros (productores agrarios y/o usuarios) de las OUAs y Criterios de Priorización de las JUs

The total amount projected to be contracted under the first year is US$16 million.

The proposed project is not at risk of having negative impact on the country·s low-GHG emissions development pathways as the proposed project is supporting activities that will contribute to reducing the impact of climate variability and extreme events; increasing carbon sequestration; saving energy; reducing soil erosion and loss; and mitigating the impact of low temperatures.

The project aims to address these climate change vulnerabilities through investments to improve the existing off-farm and on-farm irrigation systems as an adaptation measure (such as technified irrigation including sprinkler irrigation systems and provision of adequate water storage to attenuate climate change impacts). These infrastructure investments will ensure the integration of climate-resilient design to enhance resilience against climate change-exacerbated floods and droughts which reduces the risk to an acceptable level. Considering the coverage of the Project, the increased frequency and severity of natural hazards and climate shocks may impact project activities with disruptions in service delivery for short periods of time, which may result in short delays in the implementation of activities (in particular, for the construction and improvement of irrigation systems) in certain areas.

Moreover, climate-related aspects such as drought and flood early warning systems and data collection for improved water planning towards climate risks will be considered in the water distribution plans.

The residual FM risk (after mitigation) is rated Moderate considering PSI·s previous satisfactory experience in managing World Bank-financed operations, and the existence of overall acceptable FM arrangements, which will be strengthened in terms of staffing, the information system, and the future preparation of the Project Operational Manual (POM). It is important to mention that Peru·s central government has sound public financial management systems, and the PSI will benefit from the use of such country systems in the areas of flow of funds, auditing, and the use of the financial information system SIAF for budgeting, and accounting.

As part of the mitigation measures, PSI will explore options to process a budget reallocation within its institutional budget to support the beginning of the Project.

The lack of a tool to support the preparation of reliable financial reports and the monitoring of implementation at subproject level. As mitigating measure, setting up a new monitoring system is included as a dated covenant.

The PPSD focuses on most important contracts to be executed within the scope of the Project and summarizes the operational environment in which the Project will be implemented, the market analysis, the risk assessment, and the analysis of different approaches to carry out the procurement for these activities.

C. Legal Operational Policies

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Legal Operational Policies	Triggered?

The Operational Policy 7.50 on International Waterways has been triggered for this Project as several of the subprojects are located along the transboundary Amazon River Basin and Titicaca Lake River Basin. However, all interventions under the Project comprise solely improvements to existing irrigation systems, including off-farm distribution and on-farm water application systems. No expansions of irrigated areas will be financed, and the Project will not cause appreciable harm to other riparian countries.

From the environmental perspective, project-related risks will mainly stem from civil works under subcomponents A.1 and A.2, including the construction of canals and water mains, rehabilitation and construction of small water reservoirs, installation of equipment, pipes, meters, pressure regulators, sprinklers, drips systems, and land leveling. It should be noted that Project activities will take place in previously disturbed areas, since the purpose of the Project is to improve existing irrigation systems; therefore, no significant risks or impacts to living natural resources are envisioned.

As such, the anticipated key issues derived from physical interventions while implementing civil works are: (i) consumption of water and raw materials; (ii) generation of construction-related wastes; (iii) nuisances related to traffic, dust generation, vibration, and noise; (iv) water overuse for irrigation purposes and reduction of return flow; (v) possible encounters of archaeological remains; and (vi) occupational health and safety hazards Given that, overall, the anticipated environmental and safety risks of the Project are not likely to be significant, and should be easily mitigated in a predictable manner, the task team has determined the Environmental Risk Rating to be moderate.

To adequately identify and manage the E&S risks and impacts, the Borrower has prepared an ESMF, which includes mitigation measures according to the scale and nature of the activities.

During Project preparation, the Task Team reviewed potential risks associated with the Project and confirmed the following conclusions and mitigation measures: (i) no concerns that existing water dams may affect anticipated subprojects due to unexpected failures caused by unforeseen events, as none of the planned subprojects will present flood risks; (ii) no concerns that implementation and operation of small water reservoirs may pose E&S risks, since the abrupt failure of reservoirs would not pose significant E&S risks or impacts, as the anticipated flooding exposure would be equivalent to the amount of water supplied to the irrigation area during a gravity-fed irrigation operation; and (iii) to address the ESF requirements of the Project, and in response to the complex inter-institutional arrangements required for the preparation and implementation of subprojects, the PIU will be staffed with two full-time E&S specialists at the central level; three socio-environmental specialists at the territorial level; three project management specialists, one E&S specialist, and one archeologist, focused on subprojects preparation; and three coordinators to deal with activities related to TA activities.

Under Component A, activities will be designed to increase productivity and economic outcomes for female farmers by: (i) raising awareness on the importance of incorporating women·s preferences in irrigation infrastructure design; (ii) targeting outreach to women in local/indigenous languages to inform them of available irrigation technologies; and (iii) training female farmers on MOM of irrigation technology/equipment.

The Project aims to ensure the participation of stakeholders and vulnerable individuals with the goal of improving the sustainability and effectiveness of irrigation water services and water productivity in family agriculture in selected areas vulnerable to climate change.

To reflect the growing threat of water scarcity considering climate change, the Project will focus on watersheds with low water availability and will ensure that efficient irrigation investments are integrated with Peru·s national instruments and policies on water resources management.

At the start of Project implementation, Project beneficiaries in targeted areas will be informed on the expected level of irrigation services provided.

Communities and individuals who believe that they are adversely affected by a project supported by the World Bank may submit complaints to existing project-level grievance mechanisms or the Bank·s Grievance Redress Service (GRS).

As detailed in the Implementing Agency Assessment below, the PSI, the entity responsible for overall implementation, has demonstrated its capacity to effectively execute irrigation projects. The institutional capacity risk, however, is rated Substantial given the scale of the proposed Project (six times the size of the successful Sierra Irrigation Project), the geographic scope (the intervention area spans all three of Peru's zones), and the necessity to coordinate with numerous agencies at a national and local level.

RESULTS FRAMEWORK AND MONITORIN

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PDO Indicators by PDO Outcomes

Baselin	Closing Perio
Sustainability and efficacy of water services for irrigation	
Water User Organizations that increase operational efficiency in their hydraulic blocks by 10%. (Number)	
Jan/202	Dec/202 9
8.0	16.0
Average increase of the tariff collection rate of Farmer Groups participating in the Project to generate resources for an adequate operation and maintenance of their respective irrigation systems. (Percentage)	
Jan/202	Dec/202 9
0.0	20.0
Beneficiaries report an increase in satisfaction with the improvements of irrigation services provided. (Percentage)	
Jan/202	Dec/202 9
0.0	80.0
Productivity of water on family farms in selected areas that are vulnerable to climate change.	
Increase in agricultural water productivity on family farms in areas vulnerable to climate change. (Percentage)	
Jan/202	Dec/202 9
0.0	50.0
Increase in efficiency of application of irrigation water on-farm in areas with improved/·technified· irrigation.	

(Number)	Jan/2023	Jun/2026	Jun/2028	Dec/2029
	0.00	30.00	70.00	130.00
Average increase in water use efficiency across subprojects. (Percentage)	Jan/2023			Dec/2029
	0.00			100.00
Farmers reached with agricultural assets or services (Number)	Jan/2023			Dec/2029
	0.00			24117.00
· Farmers reached with agricultural assets or services - Female (Number)	0.00			12058.00
Area provided with new/improved irrigation or drainage services (Hectare(Ha))	Jan/2023			Dec/2029
	0.00			8000.00
· Area provided with improved irrigation or drainage services (Hectare(Ha))	Dec/2022			Dec/2029
	0.00			8000.00
Producers trained and organized commercially apply the techniques promoted under the Project for the production and commercialization of crops (Percentage)	Jan/2023			Dec/2029
	0.00			80.00
Direct beneficiaries receiving improved water services for irrigation in climate-vulnerable areas. (Number)	Jan/2023			Dec/2029
	0.00			22,569.00
Component B: Institutional Strengthening for Effective and Sustainable Irrigation Services				
Percent of Water Distribution Programs (PDA) that are implemented in the WUOs in which the 130 'Technified' Irrigation Projects arelocated. (Percentage)	Jan/2023			Dec/2029
	0.00			100.00
Percent of the Water User Boards (Junta de Usuarios), with which the Farmer Groups interact in the territory, implement TA servicesreceived. (Percentage)	Jan/2023			Dec/2029
	0.00			60.00
Percent of the Demonstration Plots that show favorable indicators for production, profitability and efficiency in the use and application of water. (Percentage)	Jan/2023			Dec/2029
	0.00			90.00
Percent of the Water User Boards, with which FG interact, implement their Strategic Management Plan, incorporating new investment proposals.				

Increase in agricultural water productivity (Percentage)	
Description	Measured in kg crop yield per cubic meter water used.

Frequency	
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	

Monitoring & Evaluation Plan: Intermediate Results Indicators by Components

Component A: Irrigation Investments for Climate Resilient Agriculture

'Technified' irrigation projects implemented. (Number)

Description	Measures implementation of 'technified irrigation' subprojects executed under the Project.
Frequency	
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	

Average increase in water use efficiency across subprojects.

Frequency	Annually
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	

Producers trained and organized commercially apply the techniques promoted under the Project for the production and commercialization of crops (Percentage)

Description	Measures the uptake of TA activities promoted under Project among beneficiaries.

(Percentage)

Description	Measures the financial and managerial effectiveness of Farmer Groups.

The Implementation Arrangements and Support Plan is based on the Project·s scope and risk profile, as well as on the lessons learned from the implementation of the previous World Bank Sierra Irrigation Subsector Project.

The recipient of the IBRD loan will be the Republic of Peru, through the MEF, which will transfer the loan proceeds to MIDAGRI and PSI.

It will be chaired by the Minister of MIDAGRI or his/her designated representative and is comprised of members appointed by the Ministerial Resolution and acceptable to the World Bank.

The PSI has extensive experience in managing externally financed operations, and the proposed SC model reflects a similar arrangement to the one in place for the Integrated Water Resources Management in 10 Basins Project (P151851) and other World Bank financed projects in Peru.

The PSI will be responsible for the overall implementation of the Project and will serve the following key functions: (i) ensuring proper and timely implementation of Project activities; (ii) monitoring and supporting proper implementation of the Project·s ESF; (iii) prepare relevant technical and procurement-related documents in a quality manner; (iv) ensuring that procurement is carried out in the most expeditious manner, with technical input provided by relevant departments and/or expertise in the relevant area being financed, following World Bank rules; (v) monitoring contracts under the Project; (vi) presenting Project progress and financial reports on a timely basis as required by the World Bank; (vii) disseminating results in such a manner as to strengthen stakeholders· feedback; and (viii) hosting and facilitating World Bank support missions and working to optimize the operation·s results and impact. Two units · Unidad Gerencial de Riego Técnificado (UGERT), and Unidad Gerencial de Capacitación y Asistencia Técnica (UGCAT) will be responsible for Project implementation as outlined in the chart in Figure A 6 below.

As part of MIDAGRI, the PSI is the governing entity of the irrigation sub-sector at the national level, encouraging and promoting the efficient and sustainable use of water for irrigation in agriculture. It currently works nationwide through its seven regional offices and seven local units on the implementation of irrigation projects. The PSI is headquartered in Lima and has departments focused on (i) administration and financing, (ii) infrastructure, (iii) irrigation management, and (iv) planning, budgeting, and M&E. The PSI has a long experience of successfully implementing investment projects with development institutions.[87] The PSI also has extensive experience implementing projects supported by Peru's national investment program (InviertePE), the Inter-American Development Bank (IADB), the Agency for Japan International Cooperation (JICA), and the Global Environmental Facility (GEF).

The Bank team carried out an assessment of the PSI's current capacity (including technical, environmental, social, financial management (FM), and procurement) to implement the Project and rated it as Moderate.

The Project will also support the involvement of the Local Water Authorities (ALA) to strengthen the continuous monitoring of Project interventions, water consumption, related system parameters, and enforcement of effective regulatory instruments to manage water use.

In addition, the Project will require coordination with MIDAGRI's ongoing rural programs (AGROIDEAS, AGRORURAL and Sierra-Selva Exportadora) and the INIA.[38] Governance and institutional related activities under Component B will require strong collaboration between several of MIDAGRI's offices and the ANA. Given the need for strong coordination among various agencies, the PSI, with the support of MIDAGRI and MEF, will create a Project Steering Committee to provide high-level guidance, oversight, and control of the Project as well as inter-institutional agreements with key agencies (i.e., ANA, AGRORURAL, and AGROIDEA

Component C (US$12.6 million) will strengthen the Borrower´s capacity to carry-out Project activities. To this end, it will finance the provision of technical assistance, consulting and non-consulting services, training and goods to the four implementing agencies necessary for the effective implementation of the respective activities under their mandate. This Component will likewise support training aimed at qualifying professionals directly or indirectly involved in World Bank procurement policies, in the development of TORs, budget and costs, contract management, supervision, Project monitoring & evaluation, disbursement, and controls, as well as implementation of the environmental and social standards.

These partnerships are especially important to ensure that increases in productivity due to irrigation improvements are accompanied by integration into agricultural supply chains and connection to national and international markets.

Biannual World Bank implementation support missions will be complemented by continuous dialogue on Project progress and challenges. This interaction will cover technical and nontechnical aspects of implementation, including FM, procurement, and ESF.
The World Bank will continue to provide fiduciary, ESF and other Project-related training as needed.

At the halfway point of Project implementation, a midterm review will be undertaken with a view to making any changes to the design and implementation arrangements, including any changes to the Loan Agreement that would require a restructuring.
It is understood that any changes to the Project that require amendments to the Loan Agreement will require a formal request from the Government·s signatory.

Table A 2 and Table A 3 estimate the level of inputs and staffing that will be needed from the World Bank to provide implementation support to the proposed Project.

A Financial Management (FM) Assessment was performed in accordance with the FM Manual for World Bank Investment Project Financing, Bank Policy ·Investment Project Financing·, and Bank Directive ·Investment Project Financing·, to evaluate the adequacy of the Sub-sectoral Irrigation Program (Programa Subsectorial de Irrigaciones - PSI) FM arrangements for the implementation of the Irrigation for Climate Resilient Agriculture Project.

The PSI has been successfully implementing investment projects with development institutions for many years. These engagements include the recently closed World Bank Sierra Project (P104760).

The PSI also has experience implementing projects supported by Peru's national investment program (InviertePE), the Inter-American Development Bank (IADB), the Agency for Japan International Cooperation (JICA), and the Global Environmental Facility (GEF).

This is due to PSI·s previous satisfactory experience managing World Bank financed operations, and the existence of overall acceptable FM arrangements, which will be strengthened in terms of staffing, the information system, and the future preparation of the Project Operational Manual (OM). It is important to mention that Peru´s central government has sound PFM systems, and the PSI will benefit from the use of such country systems in the areas of flow of funds, auditing, and the use of the financial information system SIAF for budgeting, and accounting.

(i Potential delays in budget allocation, at the beginning of Project implementation (this is a usual issue for projects in Peru) and low budgetary execution, as evidenced by the low execution experienced by the central government budget which is a systemic matter in the Perú·s portfolio financed by the Bank. As part of the mitigation measures, PSI wil explore options to process a budget reallocation within its institutional budget to support the beginning of the Projec t

To manage this risk, the Bank will approve the terms of reference.

The lack of a tool that can support the preparation of reliable project financial reports and monitoring of implementation at subproject level, for which the mitigating measure is the implementation of a new system to be included as a dated covenant.

The FM Action Plan is provided in the table below:

Table A 4: Financial Management Action Plan.

Based on the assessment performed, the FM arrangements proposed in Table A 4 are considered acceptable subject to the successful implementation of agreed mitigating measures, aimed at enhancing PSI·s capacity for project implementation.

Such procedures will be complemented by specific processes and procedures established in the POM, such as the preparation of an annual operating plan, including all sources of financing (IBRD and counterpart funds). PSI will be responsible for: (a) budget formulation and timely requesting of resources for each year in accordance with the annual operating plan; (b) ensuring the allocation of disbursement requests to the appropriate designated account for the execution of the activities agreed under the Project; (c) proper recording of the approved budget in the new information system, following a classification by Project component/subcomponent; and (d) timely recording of commitments, and payments, to allow adequate budget monitoring and the provision of accurate information on Project commitments for programming purposes. While budgetary arrangements are acceptable, at the beginning of Project implementation there may be delays in budget allocation, as this is a usual issue for projects in Peru that results from the application of the country budget regulations.

Accounting · Information System: PSI will have to comply with Peruvian budget and public financial management laws, including the use of government SIAF and its general chart of accounts. Considering the nature of Project activities and information needs, PSI will use a tailormade financial information system (SISGA), funded under the Project, which is pending to be purchased and implemented. SISGA will have interface with SIAF to issue the financial reports and the preparation of statements of expenditures in US Dollars according to the Project components/categories. Even though, this system includes the basic standard modules, including budget, accounting, treasury, fixed assets, inventories, guarantee letters, and it is basically prepared to allow preparation of financial reports and, PSI will require to the provider the enhancement of system functionalities, and to adjust and complement those modules to respond to PSI·s and the Project specific needs. Those adjustments include: i) a subproject module ii) a financial reporting module from which IFRs can be issued, in the formats and content agreed with the Bank; and iii) a module for preparation of Statement of Expenditures (SOEs) that allow the proper recording of the payments/disbursements made in accordance with the flow of funds arrangements defined for the Project.

It has been agreed that the system to manage Project funds will be fully implemented and become operational six months after Project effectiveness. Such commitments will be reflected as a dated covenant under the legal agreement.

The OM will reflect processes, procedures, and internal control mechanisms for the new Project, chart of accounts according to the functional classification of the Project, preparation of the IFRs, terms of reference of the additional financial management staff, the flow charts that describe the procedures, roles and responsibilities, and specific internal controls to be followed for the implementation of the Project. Therefore, this chapter, as with the entire POM, must be satisfactory to the Bank as an effectiveness condition.

Financial Reports: Interim Financial Reports (IFR) should specify sources and uses of funds, reconciling items (as needed) and cash balances, with expenditures classified by category and component, and a statement of investments reporting the current semester and the accumulated operations against ongoing plans with footnotes explaining the important variances.

The scope of the audit would be defined by PSI, and the Bank, based on Project specific requirements and responding, as appropriate, to identified risks

Flow of funds and Disbursement Arrangements: Bank loan proceeds will follow the Bank·s disbursement policies and procedures as described in the Disbursement and Financial Information Letter. The Bank and the Borrower have agreed to use the Single Treasury Account as a disbursement mechanism for the Project and, hence, advances to the designated account will be made to the STA. The STA for the use of loan resources is in place in Peru according to the Legislative Decree No 1441. Funds of the loan will be identified with a segregated code or sub-account of the STA. The POM will include specific procedures to follow for PSI to manage the STA.

The specific protocols and applicable internal control arrangements for the payment processes and procedures will be reflected in the POM.

Supervision Plan: The WB plans to perform at least two supervision missions per year to the extent possible while also reviewing the annual audit reports and the IFRs.

An administrative specialist will perform financial monitoring of the investment programed for activity 2 (Technical assistance to the RGs for the institutionalization and promotion of investments in irrigation) as well as prepare monthly reports and financial reports on the implementation of this intervention. The following table presents the annual financial schedule of the Project.

For procurement involving National Open Competitive Procurement, and other methods, the documents will be agreed on with the World Bank.

The PPSD focuses on the most important contracts related to the execution of the subprojects to be financed under Component A of the Project.

During the first year, the bidding processes for a total of 24 subprojects are expected to be launched (Phase I). Of the 24 subprojects, 18 have detailed technical designs and are expected to be tendered at the beginning of the first year of implementation of the Project. Based on that, the 18 subprojects will be tendered in a total of 10 bidding processes, according to geographical distribution. For the other 6 subprojects to be tendered during the first year, a design building approach will be applied.

These subprojects will be launched from the second year of Project implementation, applying similar criteria for the grouping of subprojects and the level of the development of the technical designs. Regarding the consultant services related to the elaboration of technical designs and supervision of works, they are expected be carried out through consulting firms, and the procurement processes will be grouped with a similar approach to the works (i.e., geographical distribution).

drip irrigation, sprinklers, micro sprinklers).

Consulting services to be financed under the Project include the development of feasibility studies and detailed designs, the elaboration of environmental of and social instruments (Component A), as well as technical assistance and capacity building activities under Subcomponent A.3 and Component B, and consulting services related to the Project Management (Component C of the Project).

Goods and non-consulting services: Under Component A, the Project will finance the equipment for improved control and regulation of water flow (such as motors, pumps, valves), and flow rate measuring devices for improved monitoring.

Frequency of Procurement Supervision: In addition to prior review supervision to be carried out by the World Bank office, annual supervision missions will be carried out to visit the field and conduct post review of procurement actions.

Irrigation is a key driver for economic growth as it improves agricultural production,[89] thereby supporting rural employment and development, strengthening food security, and increasing resilience to climate change. Even though irrigated land represents only 36 percent (2.6 million hectares)[90] of all agricultural land, approximately two-thirds of the country's agricultural output[91] is produced on irrigated land[92]

2.

Adequate irrigation is critical for enabling farmers to cope with the climate-exacerbated occurrences of floods and droughts, to increase crop yields, and to grow higher value crops, both in terms of nutritional value and financial returns from their sale. Irrigation also encourages farmers to harvest higher-value crops, which are generally more sensitive to water stress.

Approximately 70 percent of cultivated land in the Costa is irrigated, allowing Peru to produce high-value crops that are exported to international markets. Most of the agricultural land in Peru·s Costa (along the Pacific Coast) is irrigated to sustain commercial agriculture.

Approximately two-thirds of the agricultural GDP is produced on Costa farmland.[93] However, it is completely dependent on irrigation due to low levels of annual rainfall as agriculture would be much less productive without irrigation. Overall, the availability of irrigation technology and cultivation high-value crops have had a major impact on Costa·s rural development, as the region has registered the strongest growth in agricultural productivity.

Crops tend to achieve substantially higher yields in the Costa (than in the Sierra or Selva) due to improved access to irrigation, more widespread mechanization, greater crop diversification (including towards more high-value crops), larger farm sizes, and proximity to consumers and export markets.

[91] Agricultural output is defined as the total value of crops produced in economic terms, although it has also been used to denote to (physical) crop yields.

In these water-stressed areas, only 11 percent of irrigated lands have efficient irrigation systems, most of which are primarily owned and managed by medium- to large-sized farms. Low-income, smallholder farmers have been unable to convert to more efficient, modern irrigation systems due to high capital costs that prevent these types of investments.

Inequitable distribution of land ownership also impacts agricultural productivity.

These are expected to transform the current off-farm surface irrigation schemes used by small-scale family farmers into ·technified·1 0 irrigation conveyance and distribution systems and installation of improved on-farm irrigation water application systems (Component A). The Project will also provide the necessary support to selected 130 FGs with the installation of the improved ·technified· irrigation systems (both off- and on-farm).

Each of the 130 subprojects was identified and formulated through a participatory process in which the farmers were supported by the PSI with their proposed concept of a hydraulic blocks for the enhancement of efficiency and sustainability through technification. Each of the 130 sub-projects· irrigation schemes are organized into several hydraulic blocks, each consisting of approximately 60 hectares of land on average and serving around 60 farmers. WUOs in Project areas · as water management-related entities · together with FGs, are included in planning and coordination to ensure that available water is distributed sustainably and effectively. The farmers and water users in each hydraulic block are organized into newly created FGs (GGRTs) that help ensure, with the support of WUOs, that the water needs of each farmer are met and that the block remains in good condition.

The selection of the 130 hydraulic blocks where the subprojects followed a selection methodology that includes poverty levels, vulnerability to climate-exacerbating conditions, such as exposure to droughts or frost or beneficiaries· plot size. Each of the 130 subprojects has further met the eligibility criteria set forth in the NTIP·s guidelines, which includes ensuring land ownership certification, water rights licenses, access to markets, and a commitment to cost sharing.

7 Producers who own large tracts of land are located mainly on the coast and have modern intensive systems with pressurized irrigation.

·Technification· includes provision of precision on-farm irrigation systems, such as sprinklers (including micro-sprinklers) and drip irrigation. Along the Costa, the Project will install on-farm drip irrigation (given its high-level of water efficiency performance of more than 90 percent), while in the Sierra and Selva, in addition to drip systems, the Project will also promote sprinkler and micro sprinkler systems.[121] Sprinkler systems are easier to operate and more economic than drip irrigation yet still increases water efficiency performance by 80 percent. In the highland areas, the installation of sprinkler systems, are also expected to help with the climatic hazards · frost (heladas) and extremes heat. The diagram below depicts a sub-project (hydraulic unit) managed by Water User Boards (JUs) overall as well as commissions, committees, and farmer groups.

Figure A 5: · Diagram of a Sub-Project (Hydraulic Unit)

[121] Drip irrigation is a type of localized irrigation where water is led to the field through a pipe system, with drops of water delivered to plants at or near the root. With sprinkler irrigation, water is led to a field through a pipe system, in which the water is under pressure, and artificial rainfall is created. The spraying is accomplished by using mechanized or non-mechanized sprinklers.

While these 8 sub-projects account for 5 percent (321.37 ha) of the total Project area, the geographic distribution of these 8 sub-projects provides adequate representation across the regions (from north to south) included in the total Project area (8,014.38 ha).

A standard cost-benefit analysis (CBA) was performed to assess the financial and economic merit of the proposed Project and to quantify all incremental costs and benefits directly attributed to the Project.

The following table highlights the Project·s costs and benefits. Due to the absence of information with reasonable reliability, there are a series of benefits the Project will promote that cannot be quantified. Financial and economic benefits were quantified for important agricultural crops with the potential for the development of value chains: potato, purple maize, peas (vetch), rye grass, oats, clover, oregano. Quantifiable Project benefits are mainly linked to the additional income of producers who are impacted by the sub-projects (Component A).

To verify the financial viability of Project activities, a CBA was applied to eight sample sub-projects part of Component A [considered representative of all sub-projects to be implemented]. The flow of annual incremental net benefits for the sample projects was calculated for a period of 20 years (considering a financial discount rate of 12 percent).

· · Various types of advanced irrigation systems (drip, sprinkler, micro sprinkler).

These eight crops comprise the cropping systems that will be improved through the Project·s implementation, determining the financial profitability of each subproject. For each crop, a productive on-farm model was developed based on the information provided by the PSI to represent the ·with· and ·without project· scenarios.

It is expected that the Project will improve both yields and, for some crops, the number of harvest cycles per year through investments in efficient irrigation systems, sustainable agronomic practices, and institutional strengthening for effective and sustainable irrigation services that will govern them. Existing on-farm cultivation techniques are assumed to be replaced by the introduction of sustainable agricultural practices (known as climate-smart, conservation, or regenerative agriculture) in Project areas. Additionally, a water fee per hectare per year is considered in the models for the O&M of irrigation systems.

The table below presents yields and output-price assumptions for the financial analysis.

The net present value (NPV) under the ·without project· scenario considered the current yields of each crop, the number of cultivated hectares, the sales prices, and the percentage of produce that is sold in the Project's intervention areas.

In the ·with project· scenario, the analysis considered the increase in irrigation efficiency and the impact of applying good agricultural practices when projecting yields. It is assumed that the investment will enhance the efficient use of natural resources and reduce the use of external inputs. It is assumed that the level of chemical inputs· use (fertilizers, herbicides, and pesticides) will decrease by 5 percent.

The financial analysis modeled the financial benefits at the sub-project level considering the corresponding crop to each sub-project. The model calculates incremental net benefits over a period of 20 years, holding constant the inpu and output prices to capture the effect of the change in productio . Ir Incremental net benefits were modeled first at the level of the eight sub-projects. Financial viability was positive for all eight subprojects, with financial internal rates of return (FIRR) between 12.7 percent and 25.2 percent. As shown in the table below, profitability indicators are the result of the product of the agricultural output price, yields (magnitude and number of cycles per year), and cultivated area, less input, labor, and management costs.

A cost-benefit analysis was performed to assess the economic viability of the production models proposed by the Project, considering economic prices (shadow prices) and economic value of carbon.

Table A 11: Economic conversion factor

Official Exchange rate (USD/S)	0.2631
Shadow Exchange rate (USD/S)	0.2841
Standard Conversion Factor	1.08
Shadow wage rate factor · unqualified labor	0.42
Output/Input conversion factor	0.85
Social price of Carbon (USD/tCO2eq	7.17

Source: InviertePE.

This methodology calculates the flow of annual incremental net benefits over a 20-year period, considering an economic discount rate of 8 percent (which includes inflation and risks), compatible with the maturation time of principal investments. The total cost of the Project is estimated at US$126.0 million. For a 20-year horizon, the incremental economic benefit for the entire Project is estimated to be US$60.6 million, with an economic internal rate of return of 17.2 percent (representing the net present value [NPV] of agricultural production). The economic analysis shows positive profitability indicators, with economic internal rates of return (EIRR) between 13.2 percent to 21.6 percent.

For the general economic analysis of the Project, economic flows were extrapolat Benefits across the total Project area were extrapolated from the cropping composition and relative size of each of the eight subpro jects. The subprojects represent the relative distribution of cropping area for each of the production models within the total Project area. Net incremental benefits were summed across each of the production models, and then multiplied by a scaling factor, defined as the share of the total Project area that these subprojects represent.

The implementation of the selected subprojects would allow for the recovery of water equivalent to 23 percent of the area irrigated from these subprojects (1,880 hectares). The value the volume of water recovered in economic terms was included in the flow of incremental benefits and costs of this equivalent area. The adoption of precision irrigation as well as sustainable agronomic practices promoted by the Project, will boost the productivity of the agriculture undertaken in the subprojects· areas and is expected to free up water for other uses or to be returned to the environment (return flows to surface water bodies as well as groundwater recharge. For this purpose, an estimation of the current situation (·without project·) in terms of water consumption and possible return flows, with the aim of estimating how much efficiency gains could be ·internalized· through intensification and potential expansion of irrigated areas (see the technical analysis below for further details).

Incremental economic benefits from the reduction of emissions and carbon sequestration were accounted for a period of 20 years. A constant shadow price of US$7.17/tCO2, following the requirement of the Government of Peru Over the Project duration of 20 years, the Project is expected to lead to a net carbon reduction of 111,258 tCO2-eq. The Project is also expected to provide a reduction of 5,562 tCO2-eq per year (see Climate Change and Greenhouse Gas Accounting) To quantify the resilience benefits, the economic assessment evaluated the productive losses (with- and without-project scenarios) from temperature changes and changes in water availability under water scarcity scenarios.

To ensure the long-term robustness of the economic behavior of the Project, a sensitivity analysis was performed to evaluate how the economic indicators of the overall Project changes with a variation of key variables: (i) reductions in yield; (ii) delays in benefit generation; (iii) cost overruns; (iii) changes in the shadow price of carbon.1 ·1 2 The table below shows that the Project·s overall NPV presents a positive economic return even when considering a delay in benefits· generation of 3 years, significant cost overruns, or a 5 percent reduction of expected benefits.

Guidance Note on shadow price of carbon in economic analysis: a range of US$40-80 per ton of CO2eq, with an annual incremental rate of 2.25 percent. This shadow price of carbon is consistent ·with achieving the core objective of the Paris Agreement of keeping temperature rise below 2 degrees·.

In addition, a scenario analysis was performed under a pessimistic scenario to evaluate the economic performance of the Project: reduction of 10 percent of the expected yield in with project situation, cost overruns of 10 percent of the investments, a shadow price of carbon US$0/t CO_2eq, and a delay in the implementation of the Project that would permit the generation of one-year benefits.

These results represent a robust performance in economic terms and, considering the productive and climatic impacts, create societal economic value.

The FG needs to charge a rate higher or equal to this cost to properly maintain and operate the system and reach financial viability. The FGs and WUOs will benefit from the TA activities planned under the projects to improve the design of tariffs, the commercial and operational efficiency. The financial sustainability of the irrigation systems to be financed under the Project will be attained only if the FGs charges their members a rate higher or equal to the cost of operating and maintain the systems, which for the sample of 8 subprojects results in S/571 per hectare per year in average.

Therefore, each farmer will need to pay the rate charged by WUOs in addition to the charge set by the FG for improving the irrigation systems. However, the charges will differ among the FG according to the type of irrigation system and tariff charged by the respective WUO. Both charges would be in average S/673 (US$ 177) per hectare per year, which seems achievable as the financial evaluation showed.

Table A 15: Costs of operating and maintaining the irrigation systems.

The financial performance of the WUOs is generally poor due, among other factors, to low tariffs and revenue collection rates. According to a diagnostic of the WUOs financed by PSI[122]3, 62.5 percent of the WUO has an operating cost recovery ratio lower than 50 percent, and 12.5 percent lower than 75 percent.

Only 12 percent of the WUOs disconnect the service in case of non-payment, the rest either send reports to local water authorities or negotiate alternatives for payment. The average tariff charged by WUOs in 2017 was S/198 per user per year, equivalent to S/101 per hectare per year. If this tariff remains constant, the total charge to be paid by the farmers must be at least S/673 per ha per year, which includes the operating cost of the irrigation system plus the charge made by WUOs to provide the water.

According to PSI analysis, the current efficiency of agricultural water use (measured by crop water use divided by water withdrawals) is only 35 percent. The proposed investments, through the improvement of the off-farm infrastructure and the installation of efficient on-farm irrigation systems (such as multi gates, drip, micro sprinkler, or sprinkler irrigation), will enable farmers to use less water and other inputs to their crops, improving irrigation performance, boost agricultural productivity, and increase agricultural water efficiency from 35 to 80 percent.

The adoption of precision irrigation, promoted by the Project, is expected to boost the agricultural productivity of the subprojects. Still, there is a need to estimate how water use efficiency measures will free up water for other uses without affecting return flow to the environment as recharge or drainage. For this purpose, an estimation of the current situation (without project) was carried out (in terms of water consumption and possible return flows), with the aim of estimating the efficiency gains that could be ·internalized· through agricultural intensification and potential expansion of irrigated areas without affecting return flow that might be used by other users downstream.

Based on the results, the amount of water saved from efficiency measures at a local scale depends on the context and characteristics of each subproject.

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But to properly account for the expected benefits from efficiency gains, and to avoid negative downstream consequences by reduced minimal return flow, interventions aimed at increasing irrigation efficiency must be accompanied by effective regulatory instruments, robust water accounting, and continuous monitoring of related system parameters, and enforcement of regulations to manage water use. For this purpose, the Project will promote the involvement of the Local Water Authorities (ALA) to monitor and follow up on the different Project interventions. To monitor the PDO level indicators, the Project will include, as part of the monitoring framework, different actions to measure water flows and volumes in specific locations and a temporary basis to calculate the following:

- the increase of operational efficiency of each irrigation system, and
- the increase in water productivity (US$/m3) measured as farm income per cubic meters of water consumed, or (kg/m3) measured as crop yield per cubic meters of water consumed.

The proposed investments are expected to enhance resilience to extreme events and other climate change impacts and improve the performance of irrigation and drainage services with positive impacts on the adaptation and mitigation agenda.

Moreover, the activities focused on strengthening the management capacity of WUOs and Farmer·s Groups to improve the O&M of a water delivery system would also allow an increase in operational efficiency of irrigation canal systems managed by participating WUOs by 10 percent (operational efficiency measures a reduction in physical water losses in canal systems).

The Project's immediate benefits are linked to the increase in productivity associated with the extension of efficient irrigation systems over 8,014.38 hectares of agricultural land. With access to efficient irrigation systems, farmers are expected to be able to grow higher-value crops, utilize water more efficiently, reduce labor costs, and better withstand droughts and erratic rain patterns. In addition, by supporting the implementation of FGs' business plans, the Project will directly increase farmers' capacity to market and sell their products effectively.

In addition to the immediate or direct benefits related to the improvement in efficiencies, the Project will generate, among others, the two following additional benefits: (i) reduction in degraded soils: efficient on-farm irrigation systems will reduce soil erosion, particularly in the Sierra region with high slopes; and (ii) potential expansion or productive intensification based on improved water use efficiencies. These were considered for the GHG analysis and the economic and financial assessment.

The integrated approach of the Project coordinates (i) improving water services through technified irrigation and (ii) agricultural water productivity through enhanced management of available water and soil resources to counter water-related risks and increase the resilience of agricultural production systems. This approach is adopted to increase the resilience of agricultural production (particularly to the impacts of climate change) and improving livelihoods of beneficiaries impacted. Such an approach enables the combination of measures for improving the technological efficiency of irrigation water management with maximizing use of the natural resource on the receiving end of water supply · soil.

To that end, a portion of the TA to be provided to producers (through FGs) in the 130 sub-projects (sub-component A.3) includes (i) improving the efficiency of water management at the parcel level and (ii) agronomic management for both annual and perennial crops. Agronomic management through incorporation of climate smart and regenerative practices (as part of the TA) are expected to allow for greater efficiency in the overall water management in the sub-projects and greater scale of impacts (beyond the installation of high efficiency on-farm systems and training farmers in their use).[104]

3. To enable such a comprehensive approach in each sub-project, TA module 2 will be implemented to: (i) strengthen the capacities of producers in the management of prioritized crop(s) in each sub-project; (ii) implement new packages for recommended techniques; (iii) develop adequate management in the pre- and post-harvest stages; and (iv) reduce environmental impact through the implementation of good agricultural practices. All the above seek to generate behavioral change in producers when it comes to the management of their respective productive units by promoting and developing improvements in the production of crops to obtain improvements in productivity and profitability.

The above is in-line with the goals the 3rd objective of the National Agricultural Policy (2021-2030) of Peru of improving the management of natural resources for sustainable agricultural production. This objective is to be accomplished through better management of natural resources used in cultivation (i.e., soil and water) and reducing the vulnerability of production systems to climatic events (with an emphasis on family farming).

Attention to soils, to which irrigation water is applied, represent a vital aspect in efficient water management and crop production. Strategically using soils as reservoirs that complements irrigation can lead to improved and well-timed irrigation scheduling that reduce reliance on irrigation water applications on-farm.[105]

6.

Combining soil moisture conservation with irrigation allows for greater overall on-farm water use efficiency.

Combining soil moisture conservation with irrigation practices allows for greater overall on-farm water use efficiency. It also helps increase the resilience of crop cultivation, particularly given climate change concerns, by sustaining

[104] The 2nd TA module is to be implemented to: (1) strengthen the capacities of producers in the management of prioritized crop(s) in each sub-project; (2) implement new packages for recommended techniques; (3) develop adequate management in the pre- and post-harvest stages; and (4) reduce environmental impact through the implementation of good agricultural practices.

[105] Soil water thresholds are used to determine when and how much irrigation is needed.

Thus, in addition to irrigation water application on fields, ensuring productive and resilient agriculture[111] requires changes in the management of natural resources that support it · both soil[112] and water · and ensuring greater efficiency in their use.[113] Practices that are part of climate-smart, regenerative, and conservation agriculture are important in keeping the soil water content in an optimal state for plant growth.

They allow for a decrease in water supply to irrigation, thereby maximizing the impact of the water used.

To that end, water management at a smaller scale must be embedded in the larger frame of catchment resource management.

Agricultural resilience can deliver measurable economic value in terms of cost-savings and risk reduction to farmers (and, by extension, their communities). Farmers can reduce their input costs and increased their bottom lines by choosing to invest in soil health.[114] As a result, more people can be fed at a lower cost, which is a major factor in alleviating the globa food crisis.

Moreover, better land and water management strategies at the farm level can also enhance carbon storage in soils, thereby contributing to the mitigation of climate change.

[114] Irrigation water productivity, as a ratio between the marketable yields and irrigation amount used during a growing season, can be used to determine economic profit.

A preliminary screening for climate change and disaster risks was conducted for the Project's two main components, and the Project's overall risk rating was found to be moderate.

The interventions include rational management of irrigation and other practices, which will contribute to reducing GHG emissions; increasing carbon sequestration; eliminating the need for energy; reducing soil erosion and loss; and alleviating the impact of low temperatures, water scarcity (including droughts), and landslides.

All activities under the program are on the Universally (Paris) Aligned list. 8 The Project is also aligned with the public investment recommendation of Peru·s Climate Country Diagnostic Report·s (CCDR) to improve access to efficient irrigation systems to build resilience in the agriculture sector and boost economic growth while protecting vulnerable populations. Peru's CCDR also stresses the importance of adaptation to water-related shocks given the country·s significant spatial and temporal rainfall imbalances and uneven development patterns across its territory (World Bank, 2022).

The project aims to address these climate change vulnerabilities through investments to improve the existing off-farm and on-farm irrigation systems as an adaptation measure These infrastructure investments will ensure the integration of climate-resilient design to enhance resilience against climate change-exacerbated floods and droughts.

Irrigation systems can be used to protect crops from frost injury. 0 Sprinkler irrigation systems represent one of the most economical and effective means of protecting crops from frost damage. Availability of low-temperature alerts and adequate management of ·technified· irrigation is expected to help producers attenuate the negative impacts of low temperatures.

Reservoirs that supply pressurized water to farm irrigation networks (within each sub-project) capture water from a micro-watershed or

7 Improved water management is usually associated with adaptation to climate change, not mitigation (unless it results in a significant reduction in GHG emissions during the crop production process.

During periods of insufficient rainfall (e.g., in the highland parts of the country), the risk of insufficient water availability for irrigation at the desired and recommended levels can be attenuated by water available in reservoirs.

Considering better management of irrigation water and soil protection practices, the Project will contribute to reducing soil erosion and loss. The Project·s activities of implementing precision irrigation systems and investment into technical assistance for improved agronomic practices (i.e., climate smart, conservation, regenerative agriculture)[121] is expected enable the recuperation of soils degraded by water erosion (in approximately four years).

Additionally, the flow of water to the fields purely based on gravity will avoid GHG emissions while conveying, distributing, and delivering water to farms in a highly efficient manner. The Project·s activities are also foreseen to contribute to the reduction of emissions: (i) reduction of the use of inputs (fertilizers, fungicides, and herbicides) by 5 percent; (ii) recovery of soils degraded by water erosion in approximately four years; (iii) reforestation (living fences around water sources corresponding to approximately a total of 20 hectares).

The Project·s activities establishing pastures,[122] tree crops,[123] and of forested areas surrounding the reservoirs in each subproject are expected to contribute to carbon sequestration through vegetation. The expected tree-planting activities and agronomic practices are expected to enhance the soil and vegetation carbon stock to mitigate climate change impacts.

Additionally, the beneficial agronomic practices to be introduced on-farm (through TA under subcomponent A.3) are expected to contribute to carbon sequestration.[125] Lastly, more frequent pasture rotations with sprinkler irrigation provided year-round (for more pasture growth) leads to more carbon sequestered.

This can improve the resilience of crop yields to variable rainfall and lower the need for irrigation.

[125] Using data from the eight subprojects (not including carbon sequestration from pastures and fruit trees), it was estimated that the implementation of precision irrigation systems and the TA for improved agronomic practices will allow the recuperation of the percentage of degraded soils by water erosion in approximately four years.

After the ratification of the Paris Agreement, Peru validated these objectives and they have served as the basis for the formulation of NDCs in the Agriculture Thematic Area, whose general objective is to reduce the negative impact of climate change on agricultural activity.

Greenhouse Gas Mitigation goal to be attained by 2030 is set at 20 percent, as part of a Business as Usual (BaU) scenario, also considering a conditioned scenario with an additional 10 percent reduction in emissions subject to the availability of international external financing and favorable conditions (MINAM 2016a; Peru 2015).

The Project·s GHG accounting analysis estimates a net mitigation potential of the Project is -5,562 Ton CO2eq per year.

The gross mitigation potential of the Project is -8,795 Ton CO2eq per year after 20 years of project execution. 8 Overall, the contribution of the Project represents 5.2 percent of the estimated and committed potential for 2030, which reflects an effective contribution to the number of systems and surface area intervened by the project.

8 Calculations for GHG reductions were based on a sample of 8 subprojects, while the estimated incremental economic benefits from the reduction of emissions and carbon sequestration were included over a 20-year period. A constant shadow price of US$7.17/tCO2 was applied.