vulnerabilities consist primarily of flooding and, to a smaller extent, reduced water availability and erosion. The resulting water security[9] challenges affect agricultural production and crop yields, thereby impacting livelihoods and food security.[10]

5. **Women are generally affected more adversely, both individually and as caretakers, by the impacts of climate change and natural disasters**. During droughts, for example, women and girls tend to eat less and spend more time collecting water.[11] It is estimated that women of childbearing age constitute 43.9 percent of the population potentially vulnerable to natural phenomena of very high recurrence.[12]

B. Sectoral and Institutional Context

Sectoral Context

6. **The agricultural sector represents approximately six percent of Peru's GDP and 16 percent of the country's total exports**.[13] Almost a quarter of the total labor force, and more than half of the labor force in rural areas are employed in the agricultural sector (World Bank, 2022). The agriculture sector is also Peru's biggest water user, accounting for 89 percent of water withdrawals in the country.[14]

7. **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 land. Moreover, irrigation could increase the country's GDP by 0.8 percent per year through agricultural productivity gains (World Bank, 2022).

8. **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.

9. **More efficient on-farm irrigation systems[19] enable farmers to use less water for their crops, thereby improving the overall irrigation performance, increasing agricultural water efficiency, and boosting agricultural productivity**. Only 13 percent of irrigated farmland employ modern on-farm water application methods (defined by the timely application of

[9] Water security is defined as the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production, coupled with an acceptable level of water-related risks to people, environments, and economies (Peru Water Security Diagnostic, 2022).

[10] The FAO (2002) defines food security as 'a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.' Peru has become the most food-insecure country in South America, with 51 per cent of the population is living in moderate food insecurity (FAO, 2021).

[11] The United Nations Framework Convention on Climate Change, 2022. Dimensions and examples of the gender-differentiated impacts of climate change, the role of women as agents of change, and opportunities for women.

[12] Ministerio de la Mujer y Poblaciones Vulnerables, 2016. "Convirtiendo los escenarios de desastre en oportunidades para la construcción de nuevos escenarios de igualdad. El MIMP ante el Fenómeno de El Niño". https://www.mimp.gob.pe/files/direcciones/dcteg/Folleto-desastres-ctp.pdf

[13] World Bank Group. 2022. Peru Country Climate and Development Report. CCDR Series. World Bank, Washington, DC.

[14] INEI, 2020, Perú: Brechas de Género 2020 Avances hacia la igualdad de mujeres y hombres.

[15] 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.

[16] 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. It is measured by crop water consumption per water withdrawals. Water consumption refers to the amount of water that is depleted and thus unavailable for further use. Water withdrawal refers to the amount of water removed (or diverted) from a surface water or groundwater source.

[17] The 30 percent overall irrigation water use efficiency in Peru is notably lower than those in Mexico (44 percent) and in Brazil (48 percent).

[18] Source: Format No. 4-A, Gap Indicator "Percentage of agricultural land without technified irrigation", approved by Ministerial Resolution 0374-2021-MIDAGRI.

[19] On-farm irrigation systems include drip or sprinkler systems. Drip systems lead water through a pipe system to the field, with drops of water delivered to plants at or near the root. In sprinkler systems, water is led to a field through a pipe system under pressure, and artificial rainfall is created to water the crops.

water in the volumes required). 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.

10. **Small- and medium-sized family farmers are among the most vulnerable groups and are particularly limited by both the lack of access to technological irrigation solutions and training on their effective use**.[21] Fifty percent of family farmers – defined as holding less than two hectares of land – possess no or limited irrigation capacity for their plots. In addition, many lack information and training necessary to grow their businesses and gain improved access to markets. Nearly two-thirds of small- and medium-scale farmers have indicated that they need information on crop management practices and half reported needing information on managing plant disease and pests to further develop their businesses.

11. **Subnational governments have limited capacity to design and implement irrigation investment projects.** 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. Little is known about the quality or impact of these investments given the lack of a sound monitoring and evaluation (M&E) system that would allow for performance assessments of schemes.

12. **Irrigation investments are often made without considering the broader hydrological and hydrogeological context.** Water resources for agriculture are generally inadequately distributed and managed across many of the most densely and economically active areas of Peru such as the *Costa* and the *Sierra.* 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.

13. **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.

14. **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.

15. **Gender gaps persist in Peru's agriculture sector**. Women comprise nearly half (46 percent) of agricultural producers in rural areas and manage approximately 29 percent of farms, compared to 71 percent managed by men (PSI, 2023).[24] Due to the temporary work migration of men to urban areas, women are typically responsible for most of the tasks related to agricultural production, while irrigation administration is the responsibility of men. Although women play a critical role

[20] Agronomic practices are those associated with the field production of crops for food, fiber, and fodder. 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.

[21] *Estrategia de Emprendimiento de la Mujer Rural e indígena, 2022.*

[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.

[23] The TA and training services in Peru reached 230,070 farmers, which accounts for 11 percent of the total agricultural producers nationwide (and 5 percent of small- and medium-sized farmers), of which 21 percent were women. Source: PSI. (2023). Social and Gender Assessment (SGA).

[24] Additionally, a Peruvian female farmer typically manages an average of 1.8 hectares of agricultural land, while a male farmer – 3 hectares. Source: Peru: Gender Gaps 2020 – Progress towards equality for women and men (May 2021).

in how water is used, saved, and managed,[25] they are generally excluded in the decision-making processes related to irrigation management and represent, in general, a small fraction of the water users. Moreover, women have limited earning potential in agriculture.[26] They are also often under-represented in irrigation institutions both as members and leaders.[27] Their limited participation in Water User Organizations (WUOs) impacts their voice in decision-making processes about the management of irrigation systems (INEI, 2020),[28,] only representing 13.6 percent of the board of directors of Peru's 43 Water User Boards (*Juntas de Usuarios*) as of 2021.[29] This is partially because women prefer not to accept unpaid leadership positions, instead choosing to engage in income-generating productive activities to support their families.

16. **Women also have less access than male farmers to irrigation technology, TA and training, financing,[30] and information about markets to improve their agricultural productivity**. Female producers face time barriers due to diverse responsibilities (e.g., multiple family care activities and tasks related to cultivating the land).[31]Women's low education levels[32] also limit their understanding of offers for technical agricultural training, as these offerings are not typically designed to accommodate their learning limitations.

Institutional Context

17. **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. PSI will serve as the project implementation unit (PIU) for the proposed Project.

18. **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.

19. **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

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[25] De Nys, E., Hidrogo, C., Lajaunie, M., Chinarro, L. 2013. Empowering women in irrigation management: the Sierra in Peru. Washington DC; World Bank.

[26] An estimated 43.5 percent of women in rural areas do not generate their own income rendering them economically dependent on men. Moreover, female farmers tend to focus less on market-oriented agriculture compared to male farmers. Consequently, 52.6 percent of rural women are poor, compared to only 15 percent of men. Source: INEI, 2020, Perú: Brechas de Género 2020 Avances hacia la igualdad de mujeres y hombres.

[27] Within Peru's 43 Water User Boards (Juntas de Usuarios), only 13.6 percent of the board of directors elected for the period of 2021 to 2024 are women. Of the 944 elected directors or board members, 128 are female directors. Of these, 5 women are presidents and 9 are vice-presidents of the Water User Boards. *Source*: PSI. (2023). Social and Gender Assessment (SGA).

[28] USAID, 2020: Gender Analysis - PERU, 2019. Gender gaps in the management of natural infrastructure and water in Peru: Research Summary.

[29] WUOs (Law of Water Users' Organizations 30157), by establishing that the WUOs´ Boards should have at least three women members.

[30] Per the 2012 census, out of the total number of female agricultural producers, only 6.4% obtained a loan, compared to 10.4% of men (CENAGO, 2012).

[31] When it comes to the average weekly hours spent on unpaid domestic work, women spend 39.28 hours on average, while men's average is 15.54 hours.

[32] Women account for 61% of adults without primary education compared to 23% of men. The percentage of illiterate individuals over 15 years of age is also more than double for women at 8.7% compared to men's 3%. *Source*: PSI. (2023). Social and Gender Assessment (SGA), draft version.

[33] Examples of irrigation development include those that fall under the concept of "technified Irrigation" (*riego tecnificado*), which, as defined by Law No. 28585, seeks to promote "irrigation systems that allow the rational and efficient use of water to increase agricultural productivity".

[34] Technical support is provided through ANA via its 3 types of decentralized agencies (*órganos desconcentrados*): Administrative Water Authorities (*Autoridad Administrativa del Agua*, AAA), Local Water Authorities (*Autoridad Local del Agua*, ALA), and Water Resources Basin Councils (*Consejo de Recursos Hídricos de la Cuenca*, CRHC). 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.

interventions, and water quality (e.g., polluted run-off water from fields). ANA oversees water user organizations (WUOs).

20. **Water Users Organizations** (**WUOs**) **are responsible for distributing water among users as well as the management, operation, and maintenance (MOM) of irrigation schemes and the collection and administration of water tariffs**. 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.

22. **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. They work together with commissions and committees that report to ANA. FGs are also considered able to assume the commitment to make counterpart contributions to the Project.

23. **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.

C. Relevance to Higher Level Objectives

24. **The Project is well positioned to contribute to Peru's General Government Policy (2021–26) for a more sustainable and inclusive growth model.** 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.

25. **The Project is likewise aligned with national policies and strategic plans.** The National Agricultural Policy (2021-2030) that aims to improve competitive agricultural development by 36 percent by 2030, as attributed to a reduction of family farmers at subsistence level, and improved management of natural resources for sustainable agricultural production. The policy's target population includes both family and corporate farming agricultural producers. 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. Correspondingly, each of the 130 subprojects corresponds to a single FG, which cover mostly 1 commission or committee. In 7 cases, a single FG encompasses more than one commission and 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.

[38] In accordance with Peru's Water Resources Law, WUOs are civil associations whose purpose is the organized participation of water users in the multisectoral management and sustainable use of water resources. They operate under the auspices of Peru's National Water Authority (Autoridad Nacional del Agua, ANA) – the highest technical and regulatory body for the management of water resources in the country.

[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.

and (ii) to increase agricultural competitiveness and market insertion, with emphasis on small agricultural producers. 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.

26. **All activities of the Project are consistent with several national and global commitments related to climate change.** 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).

27. **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 proposed operation is also aligned with the WBG Country Partnership Framework for Peru FY23-FY27, discussed by the Board of Executive Directors on January 31, 2023 (Report No. 179046), specifically Objective 5: Enhance climate-change mitigation and adaptation under the High-Level Outcome 3: Increased resilience to shocks.

28. **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. Lastly, the Project supports the Sustainable Development Goal (SDG) number 2 to end hunger and achieve food security.

II. PROJECT DESCRIPTION

A. Project Development Objective

PDO Statement

29. The Project development objective (PDO) is to improve the sustainability[40] and efficacy of water services for irrigation and the productivity of water on family farms in selected areas that are vulnerable to climate change.

PDO Level Indicators

30. 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[41] (Percent).
2) Regional Governments (GOREs) that have at least 500 hectares of 'technified' irrigation projects in their respective multiannual investment portfolios. (Number).
3) Average increase of the tariff collection rate of FGs participating in the Project to generate resources for an

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

[41] 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' properties or plots and the volumes extracted or derived from a given water source.

adequate operation and maintenance of their respective irrigation systems (Percent).

4) Beneficiaries report an increase in satisfaction with the efficacy of water services for irrigation provided. (Percent).

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).

B. Project Components

31. **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.** The Project will be implemented over a five-year period. 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. Of the total, 73 percent of the subprojects are in the *Sierra*, 22 percent in the *Costa*, and 5 percent in the *Selva*. 120 subprojects are in climate-vulnerable areas. This component is divided into the following three subcomponents supporting off-farm and on-farm irrigation infrastructure and TA to the administering FGs.[45]

33. **Subcomponent A.1. 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). Use of gravity naturally pressurizes water in the pipes without the need for energy use and reduces losses from evaporation and seepage from open canals (i.e., improving efficiency). 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.

34. **Activities under this subcomponent include**: (i) construction of new and improvement of existing head water intake structures[48] from the original source of water supply to the main derivation canals and on to loading chambers or storage reservoirs, from which water is conveyed to the existing off-farm delivery networks (main and distribution levels); (ii) grit removal works between the water intake and storage reservoir to remove impurities that water from a derivation canal may contain (which can clog lower level systems); (iii) construction of water main and distribution piped networks from

[42] Water productivity refers to the ratio of yield (marketable portion) to water consumed by the crop plants, expressed in price (PEN) per cubic meter (PEN/m^3). 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).

[43] Annex 2 presents additional project details, while Annex 3 displays a map with the intervention areas.

[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.

[47] Out of 130 subprojects, around 115 – 120 (around 88-92 percent) have the necessary topographic conditions for gravity-fed pressurized systems without the need for pumps powered by electricity produced from diesel. The rest are expected to continue utilizing fossil fuels.

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

the intake structure up to the farm gates (outlets);[49] (iv) development of feasibility studies, detailed designs, and environmental and social instruments to identify and manage risks; (v) monitoring and supervision of civil works; and (vi) implementation of the respective Environmental and Social Management Plan (ESMP), including reforestation[50] activities to improve soil carbon storage, reduce erosion, and increase the overall long-term sustainability of the hydraulic blocks.

35. **Subcomponent A.2. 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**.**

36. **Subcomponent A.3. 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. Irrigation water application is especially effective when used in combination with agronomic practices that support healthy soils and their capacity to conserve moisture, thereby allowing for greater overall on-farm water use efficiency and productivity while building resilience to climate change (please see Annex 5 for more details). 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.

38. **The component is also expected to produce positive climate mitigation impacts**. 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.

[50] 1-2 percent of the land surrounding the 130 reservoirs is expected to be reforested. 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.

[52] The latter will be done in alliance with main actors in the agrarian public sector. These agrarian public sector institutions include INIA, SENASA, AGROIDEAS, Sierra- Selva Exportadora, AGRORURAL and other public and private entities.

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

vegetation carbon stock will be increased due to the tree-planting activities as well as the use of vegetation cover and sustainable agronomic practices (e.g., climate smart, regenerative, conservation agriculture).[54] No substantial changes in existing cropping patterns are expected, thereby not resulting in significant effect on GHG emissions.

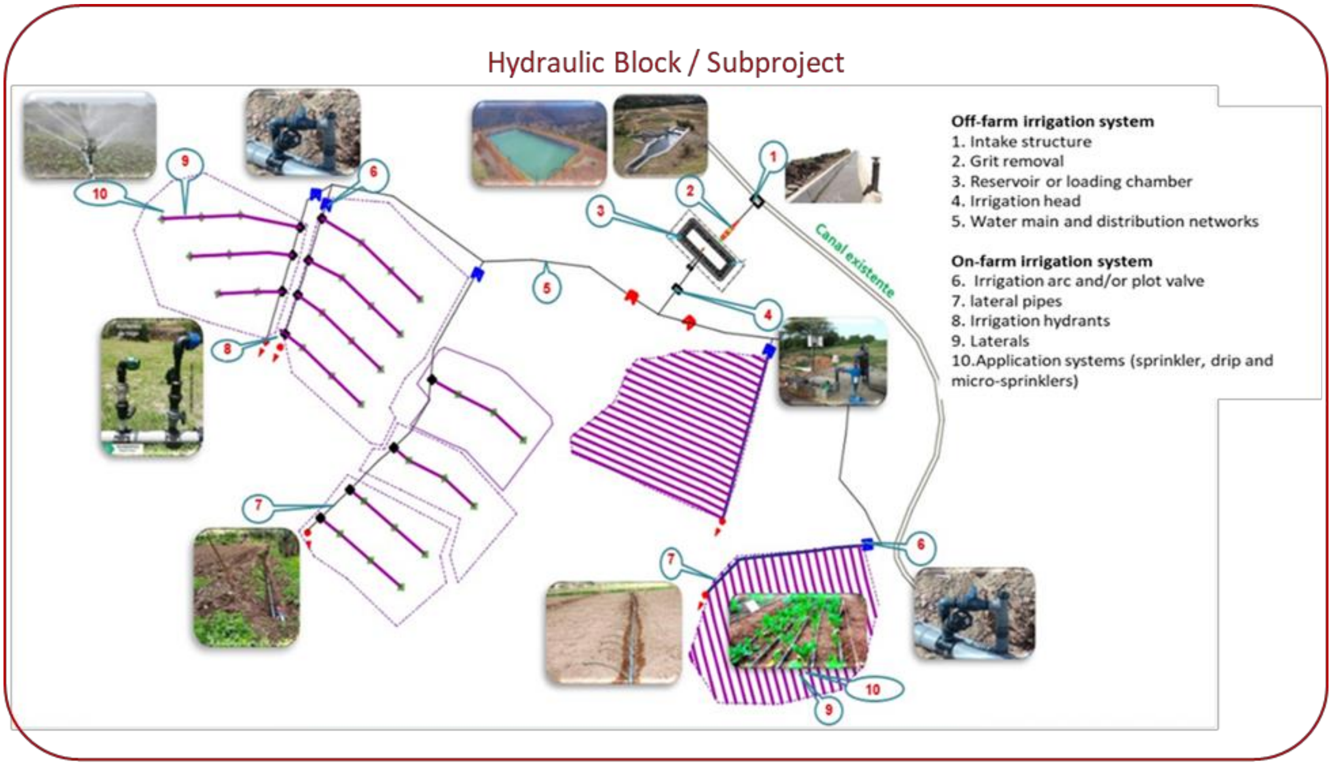

Figure 1: Schematic layout of a subproject associated with the off-farm sub-component (A1) and the on-farm sub-component (A2).

39. **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. Component B does not include any infrastructure works. 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. Correspondingly, this component is divided into the following two subcomponents.

40. **Subcomponent B.1. Strengthening WUOs for Improved Management of Reliable and Sustainable Water Services for Irrigation**. This subcomponent aims to support all participating WUOs[55] 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

[54] 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.
[55] This includes commissions and committees from 43 Jus/GGRTs and 4 commissions that are not part of those JUs in Project areas.

water monitoring and accounting tools. 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.

41. **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.

42. **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.

44. **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. It is expected that this system will be ready for use at the beginning of the third year of project implementation and will contribute to a renewed policy framework to be elaborated in cooperation between MIDAGRI and ANA.

45. **Component C: Project Management and Interagency Coordination (US$12.6 million, of which US$4.5 million financed by the IBRD).** This component includes activities to support the administration of the Project and the strengthening of the PSI – the PIU. 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. PSI, Lima, 2020). 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.
[57] These activities will not be financed with loan proceeds of the Project.

technical management as well as M&E. 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, etc.), and programs that involve NGOs, farmers associations, and universities. Selection criteria and draft templates for the corresponding cooperation arrangements between the Project and ongoing programs will be detailed in the Project Operation Manual.

C. Project Beneficiaries

46. **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. Project activities are expected to strengthen the resilience of farmers' agricultural operations to climate change-exacerbated risks and promote opportunities for greater economic gain.[58] In addition to exposure to climatic risks, most of these beneficiaries currently live in poverty and face significant challenges to their livelihoods and well-being.[59]

47. **The Project will include capacity building and TA that will benefit a total of 180 WUOs[60] (encompassing water user boards, commissions, and committees), 19 regional governments, and the national government.** 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.

D. Results Chain

48. **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**. 'Technified' irrigation systems and agronomic management will help farmers increase their resilience to climate-exacerbated floods, droughts, and frost by producing more crops with less water (including a second or third harvesting cycle), thereby reducing the impact of droughts and lessening the risk of over-watering during floods.

49. **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[61]) 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).

50. **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.

51. **The projects Theory of Change (ToC) is shown below. 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.

[58] Peru: *Perfil Sociodemográfico, Instituto Nac. de Estadística e Informática* (INEI), 2017 lists the average number of household members in rural areas as 3.2.

[59] The average Human Development Index (HDI) in the Project area is 0.579, considerably below the national average of 0.777.

[60] 180 WUOs are distributed as follows: (a) 130 WUOs (Commissions and Committees) are directly linked to the 130 Farmer Groups (FGs) or GGRTs benefitting from technical irrigation projects; and (b) the 43 JUs that cover the 130 technical irrigation projects.

[61] Crop water requirement (CWR) is defined as the depth of water in millimeters needed for the crop's consumption through evapotranspiration (ET_c) as influenced by its growth stages, environmental conditions, and crop management). A water deficit may be experienced where precipitation is lower than crop ET requirement.

52. **The theory of change is aligned to the World Bank's corporate commitments on climate change, gender, and citizen-engagement**. The shift from using diesel/electric pumps (where applicable) to gravity-fed pressurized systems, as well as the cumulative impact of the improved irrigation systems will reduce GHG emissions in the long-term. On gender, the Project includes a series of direct actions to increase productivity and economic results for female farmers as well as to increase the representation of women in decision making positions in WUOs. Regarding citizen engagement, the Project includes a variety of mechanisms to ensure that beneficiaries are consulted throughout the project cycle as well as a PDO-level indicator to track beneficiaries' satisfaction.

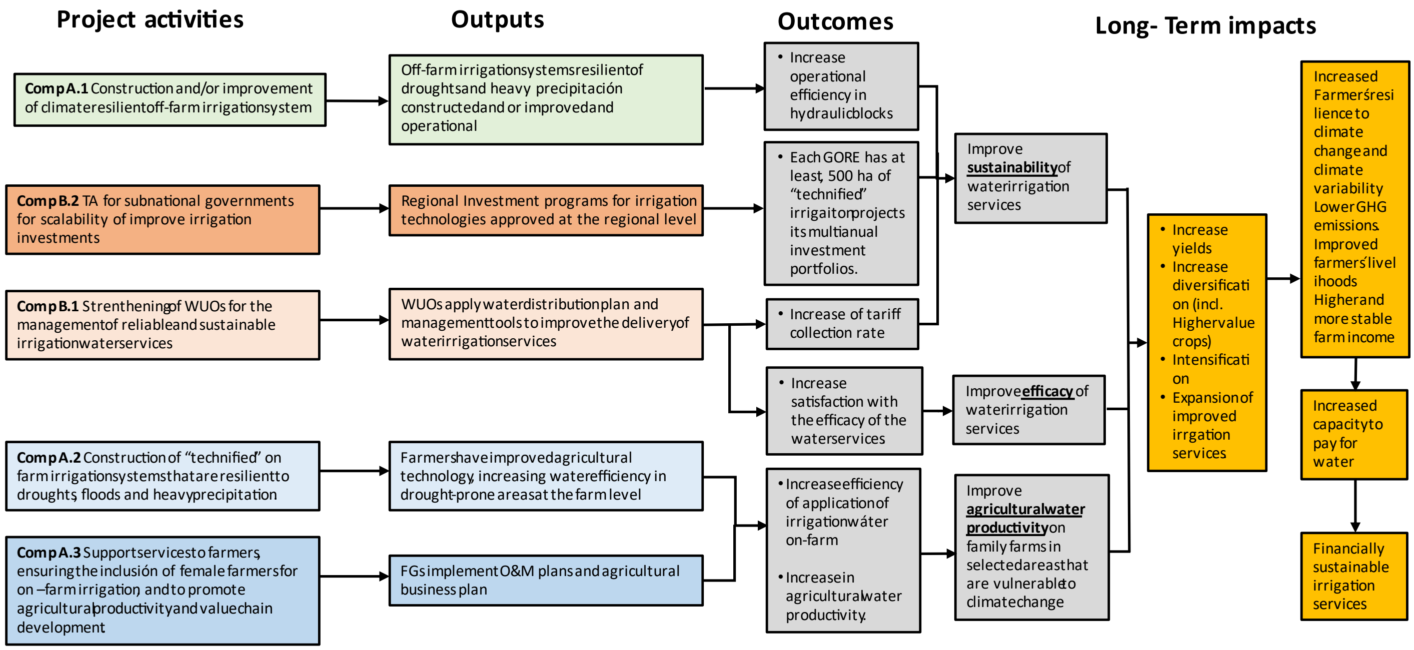

Figure 2: Theory of Change.

E. Rationale for Bank Involvement and Role of Partners

53. **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.

54. **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[62] 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 Bank will also help ensure that the Project maintains a strong focus on citizen engagement, gender, as well as climate change.

F. Lessons Learned and Reflected in the Project Design

55. **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

[62] World Bank. 2023. Peru: Strategic Actions Toward Water Security. Water Security Diagnostic. Washington, DC: World Bank.

systems in the Sierra and facilitated their access to training and TA. 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.

56. **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.

57. **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. These sub-projects were organized either in communities or in organizations composed of small-scale producers and played a critical role in identifying, preparing, and carrying out the subprojects. For most beneficiaries, the opportunity to carry out subprojects on their own was a novel and intensive learning experience. These grassroots organizations exceeded their achievement of goals set, showing that by working in the interest of farmer groups and their families, organized producers take the lead and assume the responsibility for planned activities. This was later replicated under the Sierra Irrigation Subsector Project (P104760), where WUOs/FGs participated in the selection, design, execution of subprojects. Based on these past experiences, farmer groups (FGs) were formalized under PSI for the proposed Project to further foster collective capabilities and actions.

58. **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.** By extending access to training and TA, these past projects demonstrated the effectiveness of capacity building on poverty reduction for rural populations. 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. Additionally, recognizing the important role women hold in agriculture, the Sierra Irrigation Subsector Project (P104760) developed training tailored to women's specific needs and effectively increased female participation in the management of WUOs, which will be replicated in the proposed Project.

59. **Gender gaps will be addressed by the proposed Project to increase engagement of female irrigation users in project activities**. A Social and Gender Assessment (SGA) was completed as part of the preparation of the proposed Project and a Gender Action Plan is expected to be completed by PSI with measures to promoting the meaningful engagement of female beneficiaries. Both previous Sierra projects showed that there is still potential for improvement in promoting gender equity in the sector despite progress made. As part of the Sierra Irrigation Subsector Project (P104760) efforts were made to empower poor rural women to participate in decision making within water user boards, which resulted in significant level of women's participation.[63] The Sierra Rural Development Project (P079165) also showed that efforts to include female beneficiaries[64] and encouraging their participation leads to positive outcomes. Over the 9 years of implementation, 39 percent of the project's beneficiaries were women (34,053 of a total 87,723 beneficiaries). The share of women taking the lead in implementing subprojects was also significant, with the steering committees of 36 percent of subprojects having female members. Moreover, evaluation processes played an important role in improving inclusiveness.[65]

[63] Gender-disaggregated data were collected throughout the implementation of the Sierra Irrigation Subsector Project (P104760). The data show that a total of 2,117 women received training through the Project, accounting for 22.3 percent of the total population of beneficiaries. Of these, 914 were from indigenous communities. Moreover, women benefiting from training and technical assistance accounted for 34 percent of the total.

[64] Female beneficiaries were defined as households formally represented by women in the subprojects.

[65] A beneficiary survey under the Sierra Rural Development Project (P079165) determined that to improve female participation found that providing women with special training to be the most popular recommendation (made by 58 percent of interviewees); the second most popular recommendation (45 percent of beneficiaries) was to educate husbands about the importance of women's economic contribution.

60. **The proposed Project incorporates strengthened training plans in cultivation processes of crops, such as good agricultural practices and integrated management of pests and diseases**. 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.

61. **Based on the experience from the Sierra Irrigation Subsector Project, the Project will adopt a watershed management perspective wherever possible.**[66] 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. A reduction in water return flow, previously lost via leaks in irrigation schemes (e.g., through percolation into the soil and surface runoff), may negatively impact downstream water users since, on a net-basis, inflows to their systems are reduced. 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. Especially in water stressed and drought-prone areas, this can cause downstream communities to be worse off due to a Project intervention upstream.

62. **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.** The results of this analysis, carried out for a sample of eight subprojects, show a high variation in potential water savings from increased water use efficiency, ranging between 7 and 58 percent. 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)[67] to identify pilot subprojects to carry out further analysis on the impact of increased water use efficiency.

III. IMPLEMENTATION ARRANGEMENTS

A. Institutional and Implementation Arrangements

63. **The PSI will be responsible for the overall implementation of the Project**. 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.

[66] The Sierra Irrigation Subsector Project determined that from a water scarcity risk management perspective, it is important to consider activities to conserve water sources in the upper parts of the micro watersheds.
[67] Local water administration units (*Administración Local del Agua* [ALA]) are the local offices of ANA.

64. **The PSI currently works nationwide through its seven regional offices[68] 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. Annex 3 includes the PSI organizational chart. 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.

65. **The PSI has successfully implemented investment projects with development institutions for many years.** These engagements include the World Bank Sierra Project, which closed in 2017. The Implementation Completion and Results Report (ICR) rated the Project's overall outcome, the Project's implementation, and the implementation agency performance as satisfactory. The PSI also holds extensive experience implementing projects supported by Peru's national investment program (*Sistema Nacional de Programación Multianual y Gestión de Inversiones - InviertePE*), the Inter-American Development Bank (IADB), the Agency for Japan International Cooperation (JICA), and the Global Environment Facility (GEF).

66. **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. Given the geographic scope and overall scale of the Project, it is likely that additional resources will be needed to support the PSI during implementation.

67. **The Project design calls for interaction and coordination among different agencies.** The Project will require the active participation of FGs, WUOs, local and regional governments, and ANA. 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.

68. **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**. Governance and institutional related activities under Component B will require strong collaboration between several of MIDAGRI's offices and ANA. 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). The Steering Committee does not participate in the functions or activities that correspond to the execution of the Project, which are the responsibility of the PSI.

B. Results Monitoring and Evaluation Arrangements

69. **Project monitoring will be carried out regularly, and will include physical and financial progress, intermediate outcomes and development results, compliance with safeguards policies and fiduciary regulations**. The results framework (RF) will be used to monitor and evaluate achievement of the PDO and outcomes.

70. **The PSI, as the Project's implementation Unit (PIU), will be responsible for organizing and merging the data coming from different areas of the Project to track the advancement of the work against the indictors detailed in the RF**. The PIU will have a supervision specialist who will carry out the supervision, follow-up, and M&E of progress. The specialist will evaluate progress based on technical reports from the field as well as field supervision visits. The supervision specialist will make recommendations to ensure achievement of the objective, goals and expected results. The specialist will prepare periodic progress and results reports that will be sent to key stakeholders.

71. **At the regional level, for Component B, specialists hired to carry out training and TA to the FGs and WUOs will submit technical reports and verification, such as lists and records of the events carried out, of the implementation of**

[68] The seven regional implementation offices cover the following Project regions: (i) Piura and Tumbes, (ii) Lambayeque, Amazona, and Cajamarca, (iii) La Libertad and San Martin, (iv) Junin, Huancavelica, Huanuco, Ayacucho, and Pasco, (v) Arequipa, Moquegua, Tacna, and Puno, (vi) Cusco and Apurimac, and (vii) Ancash. The Lima and Ica regions do not have a PSI office and are they served from the PSI headquarters. The regions of Tumbes and Pasco are not part of the Project areas.

activities. The reports will be uploaded to an evaluation and monitoring system that will allow for the follow-up, control and systematization of training and TA events. For Component A, periodic progress evaluation meetings (quarterly, semi-annual, and annual) will be carried out with all the entities involved in these activities, including GORES, local governments, FGs, and WUOs, among others. When it comes to infrastructure works, the contractors engaged will be responsible for generating the data on various civil works-specific intermediate indicators, while the supervision firm will be responsible for the analysis of the data provided.

72. **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.

73. **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.

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

75. **To establish an approximate baseline for the results indicators, a beneficiary satisfaction survey was carried out in February 2023**, generating responses from 325 out of 7,767 beneficiary families (representing 4 percent of all beneficiaries), across 93 out of 130 subproject locations (72 percent of all participating FG). While this survey will not replace the rigorous data collection that will be carried out for each subproject, the sample size can be considered representative, offering results to determine a valid baseline for the targets established in the results framework.

C. Sustainability

76. **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.

77. **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.

78. **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.

IV. PROJECT APPRAISAL SUMMARY

A. Technical, Economic and Financial Analysis

Technical Analysis

79. **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. The portfolio distribution places 73 percent of subprojects in the Sierra, 22 percent in the Costa, and 5 percent in the Selva regions.

80. **The subprojects' level of readiness was rated based on whether preliminary studies, feasibility studies, and detailed engineering designs are available**. 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. Out of the first 18 subprojects with detailed designs, a representative sample group of 5 subproject proposals was reviewed during preparation and deemed acceptable from a technical point of view. These 5 subprojects comprise different regions and different on-farm irrigation technologies. 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.

Feasibility studies (*Ficha Técnica*)

81. 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.

82. **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).

Economic and Financial Analysis[69]

83. **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).

84. **Methodology used for the financial and economic (EFA) analysis.** For the purposes of the analysis, eight sub-projects that are considered representative of all sub-projects under the Project were analyzed. 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.

85. **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. For each crop, a productive on-farm

[69] For additional details on the economic and financial analysis, please see the corresponding Annex.
[70] A cost-benefit analysis will be carried out for each subproject as part of the feasibility studies as per national investment guidelines.
[71] Crops included potato, purple maize, peas (vetch), rye grass, oats, clover, oregano, and grapes.

model was developed based on the information provided by the PSI to represent the 'with' and 'without project' scenarios. The model calculates incremental net benefits over a period of 20 years, holding constant the input and output prices to capture the effect of the change in production.

86. **Existing crop production techniques were assumed to be replaced by the introduction of sustainable and sustainable on-farm agricultural practices[72] in the Project areas.** In the 'with project' scenario, it is assumed that the investment will enhance the efficient use of natural resources through the introduction of technologies and agronomic practices that reduce or improve 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.

Economic Analysis

87. **The economic analysis shows positive profitability indicators, with economic internal rates of return (EIRR)[73] between 13.2 percent to 21.6 percent**. 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.

88. **For the general economic analysis of the Project, economic flows were extrapolated.** Benefits across the total Project area were extrapolated from the cropping composition and relative size of each of the eight subprojects.[76] The total cost of the Project is estimated at US$126.0 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.

89. **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. This points to the robustness of the Project.

90. **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. The analysis considers an evaluation horizon of

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[72] Including agricultural practices that enable the sustainable use and safeguarding of natural resources needed for improved water use efficiency and productivity.

[73] The economic internal rate of return (EIRR) produced by a 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 *InviertePE*.

[75] Shadow prices are utilized to quantify non-market costs and benefits. Shadow prices assume that all resources in the economy were optimally allocated and 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. The subprojects cover a total of 5.19 percent of the total Project area (8,014.38 has), and the scaling factor is therefore 19.27.

[77] After concluding the EFA, the total project cost changed from US$130.7 million to US$126.0 million. This does not have a significant impact on the EFA and does not change the results at the level of precision (one tenth of one percent) presented.

[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.

10 years and a social discount rate of 8 percent; it applies factors to convert financial prices to social prices of the inputs and outputs. The analysis results in a NPV at social prices of US$13.8 million and a social IRR of 11.35 percent for the entire Project.

91. **Moreover, incremental economic benefits from the reduction of emissions and carbon sequestration over a 20-year period were included in the analysis**. A constant shadow price of US$7.17 per ton of CO2.[79] Over the Project duration of 20 years, the Project is expected to lead to a net carbon reduction of 111,258 tons of CO2-eqivalent (tCO2-eq). The Project is also expected to provide a reduction of 5,562 tCO2-eq per year (see Annex 6 and 7 on Climate Change Co-benefits and alignment with the Paris Agreement).

Financial Analysis

92. **Financial viability was determined as positive for the eight subprojects, with financial internal rate of return (FIRR)[80] 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),[81] holding constant the input and output prices to capture the effect of the change in production.

93. **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.[82]

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**. According to a diagnostic of the WUOs,[83] 62.5 percent of WUOs has an operating cost recovery ratio lower than 50 percent, and 12.5 percent lower than 75 percent. On top of this, the revenue collection rate is between 70 to 90 percent (Costa shows better rates of 80 to 90 percent, while Sierra and Selva show rates of 70 to 80 percent).

Implementation approach

95. **The Project's implementation approach is informed by lessons learned from the Sierra Project, reflects good practices and is logically sound.** The success of the Project's investments hinges on having a strategic implementation approach given the large number of subprojects and wide territorial expanse.

96. **The 130 subprojects under Component A extend across Peru's territory.** The subprojects are in 19 of the Project's 24 departments and distributed across Peru's geographical zones as indicated in Annex 2. The regions with the highest quantity of subprojects are Cusco, Cajamarca, Lima, Arequipa, Ayacucho, Huancavelica, and Piura.

97. **Given the broad territorial reach, the experience executing similar projects, and the level of Project readiness, the PSI will implement the Project in four phases over a period of 5 years.** To group the subprojects into phases, the PSI considered two aspects: (i) the level of readiness of the subprojects and (ii) the priority level. The subprojects' level of readiness was determined based on whether preliminary studies, feasibility studies, and detailed engineering designs had been developed. The subprojects' priority level (high, medium, and low) was evaluated based on a batching methodology

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[79] This method follows the requirement of the *InviertePE*.

[80] 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.

[81] This rate includes different risks (for example macroeconomic and agricultural) and inflation.

[82] 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.

[83] PSI. Arrese, Ricardo León. *Diagnóstico del Estado Situacional de las Organizaciones de Usuarios de Agua (OUAs). Estudio Socio Económico de los miembros (productores agrarios y/o usuarios) de las OUAs y Criterios de Priorización de las JUs.* Enero 2018

developed for the Project that considers poverty levels, climate vulnerability, geographical location, and number of farmers in the area covered by the subproject.

98. **During the first year of implementation, the Project will launch Phase 1, which will consist of the 18 subprojects with detailed designs and six with advanced feasibility studies**. The five subprojects with advanced feasibility studies will be procured under a design-build contract model. The total amount projected to be contracted under the first year is US$16 million. Table 1 below shows the organization of the phases.

Table 1: Organization of subprojects in implementation phases.

Phase	# of Subprojects	Level of readiness	Priority level	# of works contracts
Phase 1A	18	Detailed design	High	3-4
Phase 1B	5	Advance feasibility study	High	1-2
Phase 2	32	Feasibility study	Medium	6
Phase 3	37	Feasibility study and preliminary design	Medium	5
Phase 4	38	Preliminary design	Low	5

Paris Alignment

99. **The proposed Project is aligned with the goals of the Paris Agreement on both mitigation and adaptation. Assessment and reduction of mitigation risks.** 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. In addition, these activities (which include gravity-based irrigation systems, technical assistance and water and energy efficiency) are considered universally aligned. Moreover, the capacity building and technical assistance activities contemplated in the Project are considered universally aligned. In sum, the Project is not expected to have a negative impact on Peru's low GHG-emissions development pathways and as such it is considered aligned for mitigation.

100. **Assessment and reduction of adaptation risks:** While climate risks are expected to affect Peru, these are not expected to pose a material risk in achieving the Project development objectives. The main climate-related risks identified in the project area are droughts, floods, and frost: (i) Drought's frequency and intensity may be increased by climate change, possibly threatening to water supply services; (ii) Climate change might also reduce water generated by glacier melts, which act as a buffer to provide water during droughts; and (iii) Climate change can also lead to more intense El Niño events, which in turn leads to flood and mudslide[84] risks. 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. Similarly, there could be delays in the provision of technical assistance and capacity building activities. However, given the nationwide coverage and the phased approach contemplated in the implementation of these activities, this is not expected to pose a risk to achieving the project objectives. 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. As such, the project can be considered aligned on adaptation.

[84] Mudslides typically result during occasional very intense rains, affecting the surrounding hills in Project areas.

B. Fiduciary

101. **Financial Management.** 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.

102. **Main FM-related risks and associated mitigation measures are as follows.**

- <u>Potential delays in budget allocation at the beginning of Project implementation and low budgetary execution.</u> This is a common issue for projects in Peru, as evidenced by frequent low levels of execution of central government budget in the project portfolio financed by the Bank. 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. Adequate budget management procedures will be included in the POM.
- <u>Timely recruitment of a sound FM specialist (Project Administrator) that will support Project implementation</u>. To manage this risk, terms of reference will be prepared in a timely manner; additionally, a dated covenant has been included in the loan agreement requiring the FM specialist to be hired within four months after the declaration of effectiveness.
- <u>The lack of a tool to support the preparation of reliable financial reports and the monitoring of implementation at subproject level.</u> As mitigating measure, setting up a new monitoring system is included as a dated covenant.

103. **Procurement activities will be carried out by the PSI according to the World Bank's "Procurement Regulations for IPF Borrowers,"** dated September 2023, for the supply of works, goods, non-consulting, and consultant services under the Project. While the PSI has satisfactory experience working with World Bank-financed projects, for implementation, the PSI will have to strengthen its procurement capacity by hiring at least one procurement specialist fully dedicated to the Project. With the specialist onboard, the procurement risk is rated Low. See Annex 1 for details on procurement risks.

104. **A Project Procurement Strategy for Development (PPSD) has been developed by PSI.** The PPSD establishes the best procurement arrangements to ensure value for money while efficiently achieving the PDOs. 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. A Procurement Plan for the first 18 months of implementation of the Project was developed based on the results of the PPSD.

C. Legal Operational Policies

Legal Operational Policies	**Triggered?**
Projects on International Waterways OP 7.50	Yes
Projects in Disputed Area OP 7.60	No

105. **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. For this reason, an exemption to the notification requirement was

requested for this Policy and authorized on March 15, 2023.

D. Environmental and Social

106. **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.

107. **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.

108. **From the social perspective, the proposed Project is expected to generate important positive impacts and opportunities for small and medium-sized farmers and their families, considering the outcomes of similar past projects in Peru**. Nonetheless, possible social risks could include: (i) exclusion of vulnerable populations from taking full advantage of the Project's different benefits and opportunities, including how to access modernized infrastructure and water services, how to participate in offered training and TA, and how to benefit from labor opportunities, among others; (ii) possible complaints from local farmers not considered in the Project scheme; (iii) minor labor influx risks; and (iv) health challenges to workers and communities posed by the ongoing COVID-19 health context.

109. **A cross-cutting risk that might impact beneficiaries and stakeholders is related to weak/deficient levels of coordination among the multiple entities involved in the preparation and implementation of the Project.** Considering the risks above, as well as the measures that will be put in place to mitigate them, the task team has determined the Social Risk Rating to be moderate.

110. **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. Additionally, a Social and Gender Assessment (SGA), an Indigenous Peoples Planning Framework (IPPF), and Labor Management Procedures (LMP) have also been prepared by the Borrower as part of the ESMF and according to the environmental and social standards of the ESF. Comments received from stakeholders will be incorporated into the ESMF. A draft ESMF, including the SGA, LMP, and IPPF, was disclosed on the Bank's website on January 26, 2023 and will be finalized and disclosed within 30 days of the effective date of the Project. In addition, an Environmental and Social Commitment Plan and Stakeholder Engagement Plan were disclosed on the Bank's website on January 31, 2023 and April 6, 2023, respectively.

111. **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. Additionally, each of the contractors and supervision firms for the various subprojects will take on a dedicated professional with expertise in E&S management.

Gender

112. **PSI aims to promote the closing of gender gaps and measures to reduce barriers to the opportunities and benefits offered by the Project.** In accordance with the current General Government Policy (2021-2026) that promotes female autonomy and access to productive, economic, and financial resources of enterprises led by women, PSI conducted a Social and Gender Assessment (SGA) of the population in the Project's targeted areas to identify relevant gender gaps and barriers (as part of the ESMF) that the Project may be able to address. Two main gaps were identified for this Project, (i) the lack of representation of women in relevant associations, specifically in leadership positions, and (ii) the of lack of technical training women receive.

113. **A Gender Action Plan (GAP) is being developed by PSI** to promote opportunities for women, including better access to training, technical jobs, improving the position of women in WUOs and strengthening their status as agricultural producers. The GAP will be based on Peru's existing policies and relevant experiences on integrating gender in water, agriculture, and rural development projects.[85] The following activities will be included: (i) developing gender-sensitive proposals and methodologies to institutionalize gender in the proposed investments; (ii) providing technical trainings for female farmers on irrigation management, roles and responsibilities of WUOs, and water regulations; (iii) hosting "soft-skills" workshops for women to improve their leadership and communication skills to counteract the common perception of men as being better leaders; (iv) providing workshops for male leaders and users to raise awareness on the importance of a gender focus in WUOs and on water policies with an emphasis on gender equity; and (v) carrying out workshops with the joint participation of women to raise awareness on the contribution and value of the work of female users.

114. **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. Accordingly, during the development of subcomponent A.2 (Technical Assistance and Training to the GGRT), PSI will ensure that female farmers are aware of the opportunities offered by the Project and promote the training of groups of interested women. Under Component B, actions will be designed to increase representation and participation of women in decision-making roles on irrigation water management through WUOs.

115. **To ensure the participation of both men and women in Farmer Groups (GGRTs), PSI will conduct wide-ranging and tailored information dissemination about the benefits and opportunities offered by the Project in the most inclusive way possible**. This will be achieved using various communication channels[86] and consultation meetings, focus groups, among others. Participation mechanisms (dissemination and consultation) will be identified in the Stakeholder Engagement Plan (SEP).

116. **The Project will monitor the implementation of gender actions and their outcomes through gender indicators included in the results framework.** The results chain will include a focus on increased participation and leadership. The indicator will monitor the increase in female representation in management positions (presidency, vice-presidency, and treasury) in decision making bodies of WUOs (water user boards, -commissions and -committees). Currently, the baselines for women's representation in management positions for water user boards (JU) and water user commissions is approximately 6 percent and 10 percent, respectively, which the Project aims to double. A second indicator will monitor the share of female farmers benefitting from TA and training with the target of 35 percent.

Citizen Engagement

117. **Community participation and beneficiary engagement is critical to achieving the development objectives of the Project.** During Project preparation, potential impacts on beneficiaries, especially on socially excluded groups, were

[85] The PSI will continue consultations in separate groups for women and men to better understand the barriers they face.

[86] These include written materials, phone calls, emails, WhatsApp messages, in-person meetings, workshops, focus groups, and more.

examined and several citizen engagement mechanisms were explored. 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. Stakeholders and vulnerable individuals will have access to participation mechanisms identified in the SEP. The SEP also outlines the process flow of the Complaints and Grievances System.

118. **The Project will also ensure that a citizen engagement strategy, gender approaches, and climate change aspects are included in the design and implementation strategy.** To that end, the PSI has identified FGs, and investment subprojects based on the PSI guidelines for efficient irrigation investments. These guidelines include socio-economic, technical, and institutional criteria following a demand-driven, participatory, and gender-sensitive approaches. 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.

119. **A beneficiary satisfaction survey that assesses improvements in irrigation service delivery in targeted areas will be conducted at the Project's start, mid-term review and completion.** At the start of Project implementation, Project beneficiaries in targeted areas will be informed on the expected level of irrigation services provided. The survey results will be publicly available, and meetings will be held with beneficiaries to identify improvements and will be used as part of PSI internal management performance evaluation. The results framework will track as a PDO-level indicator the increase in beneficiary satisfaction on the improvements in irrigation service delivery, from a baseline established in year 1, target at completion 85 percent.

V. GRIEVANCE REDRESS SERVICES

120. **Grievance Redress.** 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). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the Bank's independent Accountability Mechanism (AM). The AM houses the Inspection Panel, which determines whether harm occurred, or could occur, as a result of Bank non-compliance with its policies and procedures, and the Dispute Resolution Service, which provides communities and borrowers with the opportunity to address complaints through dispute resolution. Complaints may be submitted to the AM at any time after concerns have been brought directly to the attention of Bank Management and after Management has been given an opportunity to respond. For information on how to submit complaints to the Bank's Grievance Redress Service (GRS), visit http://www.worldbank.org/GRS. For information on how to submit complaints to the Bank's Accountability Mechanism, visit https://accountability.worldbank.org.

VI. KEY RISKS

121. **The overall risk of the Project is assessed as Moderate.** While most risks are considered moderate, the political and governance and institutional capacity risks are substantial.

122. **Political and governance risks are assessed as Substantial.** In recent years, Peru has experienced significant political uncertainty and frequent turnover of high-level government officials at both the executive and ministerial level. This environment may lead to high level changes within the PSI, MEF and MIDAGRI with the potential of slowing down Project implementation and achievement of the PDO. Given Peru's political context, the inherent political and governance risk is rated Substantial. The mitigation measures for the Project will include: (i) reestablishing support for the proposed Project at both MIDAGRI and MEF immediately after high-level changes occur; (ii) having communication and citizen engagement strategies in place; (iii) ensuring an on-going dialogue with the government officials responsible for project implementation at the working level; and (iv) establishing a high-level Project Steering Committee to provide guidance,

coordination and oversight over Project implementation.

123. **Institutional capacity for implementation and sustainability risk is assessed as Substantial.** 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. To mitigate this risk, a comprehensive implementation strategy will be developed, and a thorough capacity assessment will be conducted to identify the resources required to support effective implementation. Furthermore, the phased approach to implementation based on the subproject readiness and priority level will be used. The Project Steering Committee will help facilitate the coordination among relevant sector agencies at different Government levels.

VII. RESULTS FRAMEWORK AND MONITORING

PDO Indicators by PDO Outcomes

Baseline	Closing Period
Sustainability and efficacy of water services for irrigation	
Water User Organizations that increase operational efficiency in their hydraulic blocks by 10%. (Percentage)	
Jan/2023	Dec/2029
0.00	90.00
Regional Governments with at least 500 hectares of 'technified' irrigation projects included in their respective multi-annual investment portfolios. (Number)	
Jan/2023	Dec/2029
8.00	16.00
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/2023	Dec/2029
0.00	20.00
Beneficiaries report an increase in satisfaction with the improvements of irrigation services provided. (Percentage)	
Jan/2023	Dec/2029
0.00	80.00
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/2023	Dec/2029
0.00	50.00
Increase in efficiency of application of irrigation water on-farm in areas with improved/'technified' irrigation. (Percentage)	
Jan/2023	Dec/2029
0.00	100.00

Intermediate Indicators by Components

Baseline	Period 1	Period 2	Closing Period
Component A: Irrigation Investments for Climate Resilient Agriculture			

'Technified' irrigation projects implemented. (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) CRI			
Jan/2023			Dec/2029
0.00			24117.00
➢Farmers reached with agricultural assets or services - Female (Number) CRI			
0.00			12058.00
Area provided with new/improved irrigation or drainage services (Hectare(Ha)) CRI			
Jan/2023			Dec/2029
0.00			8000.00
➢Area provided with improved irrigation or drainage services (Hectare(Ha)) CRI			
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. (Percentage)			

Jan/2023			Dec/2029
0.00			90.00
Percent of the Regional 'Technified' Irrigation Plans have a portfolio of projects of 'technified' irrigation projects of at least 500 hectares each. (Percentage)			
Jan/2023			Dec/2029
0.00			80.00
Female participation in management positions in WUO decision making bodies (Percentage)			
Jan/2023			Dec/2029
0.00			100.00
Female farmers benefitting from TA and training (Percentage)			
Jan/2023			Dec/2029
0.00			35.00
Component C: Project Management and Interagency Coordination			

Monitoring & Evaluation Plan: PDO Indicators by PDO Outcomes

Sustainability and efficacy of water services for irrigation	
Number of Regional Governments that have a solid portfolio of efficient irrigation projects that contribute to closing the gap of agricultural land without efficient irrigation systems.	
Description	Measures the number of participating Regional Governments that have a solid portfolio (defined as an investment portfolio of "technified" irrigation projects included in their respective Multi-annual Investment Portfolios), of a total of at least 500 hectares per each Regional Government.
Frequency	Annually
Data source	GORE
Methodology for Data Collection	
Responsibility for Data Collection	PSI
Water User Organizations that increase operational efficiency in their hydraulic blocks by 10%. (Percentage)	
Description	Measures the percentage of FG and/or WUOs that increase their operational efficiency (defined by the relationship between the water volume distributed at the level of the users' properties or plots divided by the volume extracted or derived from a given water source) by 5-10% or more in their respective blocks.
Frequency	Annually
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	
Beneficiaries report an increase in satisfaction with the efficacy of water services for irrigation provided.	
Description	To measure the efficacy of irrigation services, this indicator measures the increase in satisfaction with farmers to receive the appropriate volume of irrigation water at the appropriate opportunity as per the irrigation plan.
Frequency	Baseline, MTR and closing
Data source	Surveys carried out by PSI
Methodology for Data Collection	Representative beneficiary survey
Responsibility for Data Collection	PSI
Productivity of water on family farms in selected areas that are vulnerable to climate change.	
Increase in agricultural water productivity (Percentage)	
Description	Measured in kg crop yield per cubic meter water used. (kg/m3).
Frequency	Annually
Data source	PSI, FG data
Methodology for Data Collection	
Responsibility for Data Collection	PSI
Increase in efficiency of application of irrigation water on-farm in areas with improved/'technified' irrigation. (Percentage)	
Description	At the end of the Project, the agricultural area with "technified" irrigation more than doubles (increase of 100%) the efficiency of irrigation water application at the farmer plot level.
Frequency	Annually
Data source	FG/PSI data
Methodology for Data	

Collection	
Responsibility for Data Collection	PSI
Direct beneficiaries receiving improved water services for irrigation in climate-vulnerable areas. (Number)	
Description	Climate Indicator to count the number of beneficiaries who receive improved water services for irrigation in climate-vulnerable areas, as defined as areas vulnerable to drought and or frost. "Prone to low water levels and low precipitation or frost" is one selection criteria for the subprojects. The number of beneficiaries is estimated as those identified in 120 subprojects that tagged this selection criteria.
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. (Percentage)	
Description	This indicator measures the average increase in water use efficiency at subproject level, including the off-farm infrastructure as well as on-farm efficiency gains. Water use efficiency is defined as volume of water applied on each plot in relation to the volume of water extracted from the intake source at subproject level. The target is an increase of at least double (100%) compared to the baseline.
Frequency	
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	
Farmers reached with agricultural assets or services (Number) [CRI]	
Description	This indicator measures the number of farmers who were provided with agricultural assets or services as a result of World Bank project support. "Agriculture" or "Agricultural" includes: crops, livestock, capture fisheries, aquaculture, agroforestry, timber, and non-timber forest products. Assets include property, biological assets, and farm and processing equipment. Biological assets may include animal agriculture breeds (e.g., livestock, fisheries) and genetic material of livestock, crops, trees, and shrubs (including fiber and fuel crops). Services include research, extension, training, education, ICTs, inputs (e.g., fertilizers, pesticides, labor), production-related services (e.g., soil testing, animal health/veterinary services), phyto-sanitary and food safety services, agricultural marketing support services (e.g., price monitoring, export promotion), access to farm and post-harvest machinery and storage facilities, employment, irrigation and drainage, and finance. Farmers are people engaged in agricultural activities or members of an agriculture-related business (disaggregated by men and women) targeted by the project.
Frequency	
Data source	
Methodology for Data	

Collection	
Responsibility for Data Collection	
Farmers reached with agricultural assets or services - Female (Number) CRI	
Description	
Frequency	
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	
Area provided with new/improved irrigation or drainage services (Hectare(Ha)) CRI	
Description	This indicator measures the total area of land provided with irrigation and drainage services under the project, including in (i) the area provided with new irrigation and drainage services, and (ii) the area provided with improved irrigation and drainage services, expressed in hectare (ha).
Frequency	Bi-annually
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	
Area provided with improved irrigation or drainage services (Hectare(Ha)) CRI	
Description	Measures in hectares the total area of land provided with new or improved irrigation or drainage services in operations supported by the World Bank.
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.
Frequency	Baseline, MTR, Closing
Data source	
Methodology for Data Collection	
Responsibility for Data Collection	
Component B: Institutional Strengthening for Effective and Sustainable Irrigation Services in response to Climate Change–Exacerbated Vulnerabilities	
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)	
Description	Measures the financial and managerial effectiveness of Farmer Groups.
Frequency	Annually
Data source	FG
Methodology for Data Collection	
Responsibility for Data Collection	PSI
Percent of Water Distribution Programs (PDA) that are implemented in the WUOs in which the 130 'Technified' Irrigation Projects arelocated.	

(Percentage)	
Description	Measures the level of collaboration between FG and WUOs and the results of the TA provided.
Frequency	Bi-annually
Data source	FG, WUOs, ANA, ALA
Methodology for Data Collection	
Responsibility for Data Collection	PSI, ANA
Percent of the Water User Boards (Junta de Usuarios), with which the Farmer Groups interact in the territory, implement TA servicesreceived. (Percentage)	
Description	Measures success of collaboration between the Project, FG and corresponding Water User Boards (Junta de Usuarios / JU) with regard to the implementation of TA support provided by the Project.
Frequency	Annually
Data source	WUO, ANA, FG
Methodology for Data Collection	
Responsibility for Data Collection	PSI, ANA
Percent of the Demonstration Plots that show favorable indicators for production, profitability and efficiency in the use and application of water. (Percentage)	
Description	Measures the progress achieved in Demonstration Plots with regards to production, profitability and efficiency of water applied and crop yield.
Frequency	Annually
Data source	FG
Methodology for Data Collection	
Responsibility for Data Collection	PSI
Percent of the Water User Boards, with which FG interact, implement their Strategic Management Plan, incorporating new investment proposals. (Percentage)	
Description	Percent of the Water User Boards with which the 130 Farmer Groups interact in their respective subproject areas, implement their Strategic Management Plan, generating investment proposals from FGs to be incorporated into investment portfolios of Regional and Local Governments.
Frequency	Annually
Data source	WUO, FG
Methodology for Data Collection	
Responsibility for Data Collection	PSI, ANA
Percent of the Regional 'Technified' Irrigation Plans have a portfolio of projects of 'technified' irrigation projects of at least 500 hectares each. (Percentage)	
Description	"Solid Portfolio" is defined as at least 500ha of 'technified' irrigation projects. Including these projects in Regional 'Technified' Irrigation Plan is a prerequisite to later incorporate these projects in regional multi-annual investment portfolios. Measured cumulatively during project implementation period.
Frequency	Annually
Data source	GORE, GOLO, FG
Methodology for Data Collection	
Responsibility for Data Collection	PSI
Female participation in management positions in WUO decision making bodies (Percentage)	

Description	Female participation in management positions (presidency, vice-precidency and treasury) in WUO decision making bodies. In Juntas is currently (period 2021-2024) at 6% (baseline) and the target for the 6 year duration of the project will be 12%. In the case of the committees is 10% and the target will be 20%. Targets are representing a 100% increase.
Frequency	At MTR and at Project end
Data source	WUOs, ANA,
Methodology for Data Collection	
Responsibility for Data Collection	PSI, ANA
Female farmers benefitting from TA and training (Percentage)	
Description	Measures the percentage of female farmers as part of the beneficiaries of the Project who benefit from the TA and training provided.
Frequency	At Mid-term and at Closing
Data source	Beneficiary survey.
Methodology for Data Collection	
Responsibility for Data Collection	PSI
Component C: Project Management and Interagency Coordination	

ANNEX 1: Implementation Arrangements and Support Plan

COUNTRY: Republic of Peru
Irrigation for Climate Resilient Agriculture

Project Institutional and Implementation Arrangements

1. **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.** It relies on: (i) a Project Steering Committee (SC) with strategic and consultative functions; (ii) the PSI, responsible for overall Project coordination and implementation; (iii) the ANA, responsible for TA support under Component B; and (iv) various subnational Government and beneficiary entities.

2. **Borrower.** 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. PSI will be the implementing agency, responsible for the implementation of all Project activities, internal and external communications, FM, procurement, and compliance with ESF.

3. **The Project Steering Committee.** MIDAGRI will establish the Steering Committee (SC). The SC will be the highest governing body of the Project. 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. These members will include one representative from the MEF, the Executive Director of the PSI, one representative of the ANA. The SC operates at a strategic, consultative level, and ensures the Project's alignment with government policy and directives.

4. **The SC will hold biannual meetings to fulfil its responsibilities**, including: tracking Project's activities; monitoring and assessing progress to ensure that targets, disbursements and expected results are reached as agreed; providing institutional support to the PSI, including to ensure that appropriate human resources are in place; monitoring compliance with World Bank policies and guidelines; reviewing and approving key Project documents, such as the POM and annual budget; recommending strategies to resolve bottlenecks during Project implementation; documenting decisions made; and referring issues, as necessary, for deliberation by higher instances. In fulfilling its functions, the SC will be supported by an Executive Secretariat led by PSI, whose responsibilities will include coordinating and undertaking tasks assigned to the SC. 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.

5. **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.

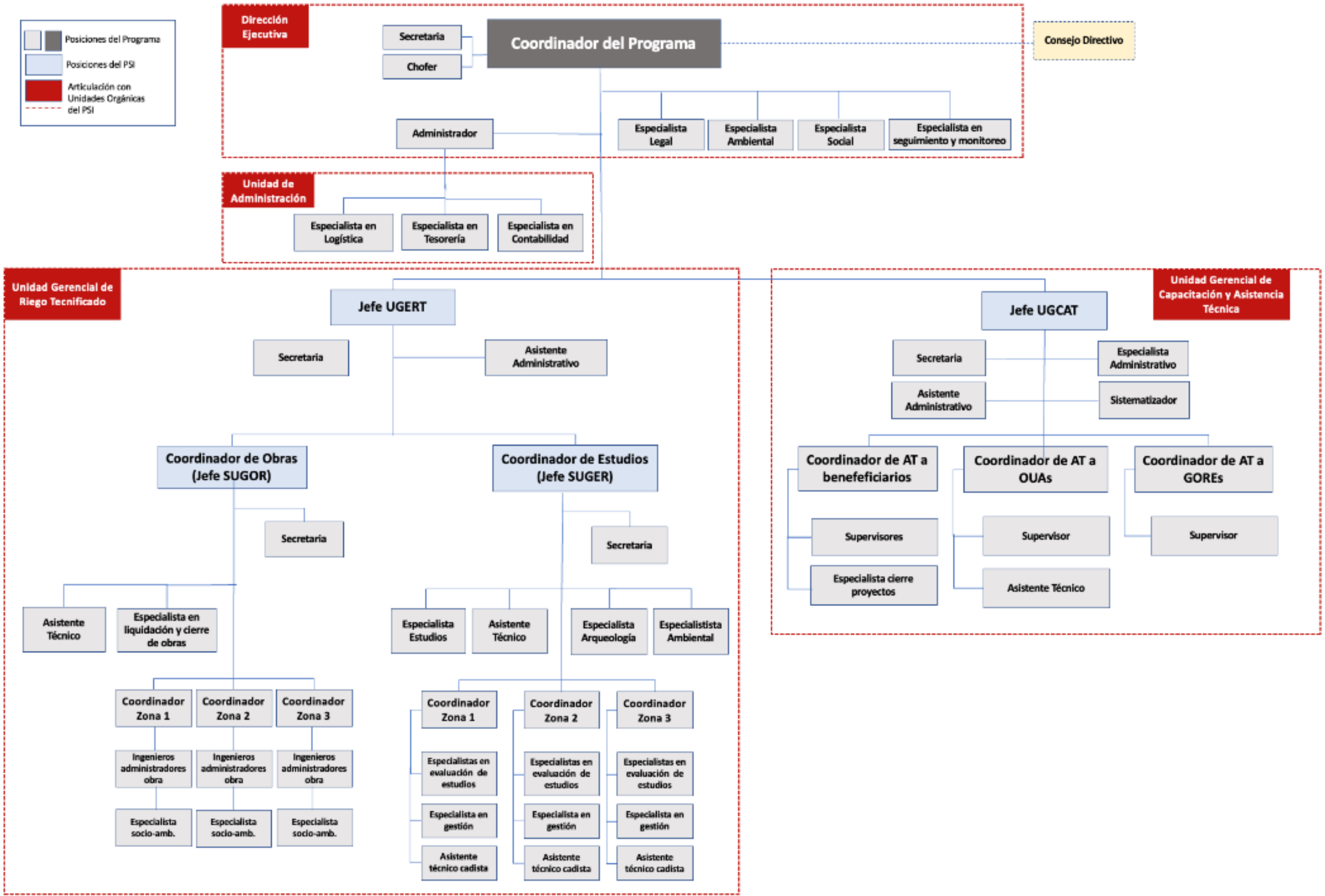

Figure A 1: PIU Organigram of PSI.

6. **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).

[87] These engagements include the recently closed World Bank Sierra Irrigation Subsector Project (P104760). The Implementation Completion and Results Report, which was finalized in June 2017, rated the Project's overall outcome, the Project's implementation, and the implementation agency performance as satisfactory.

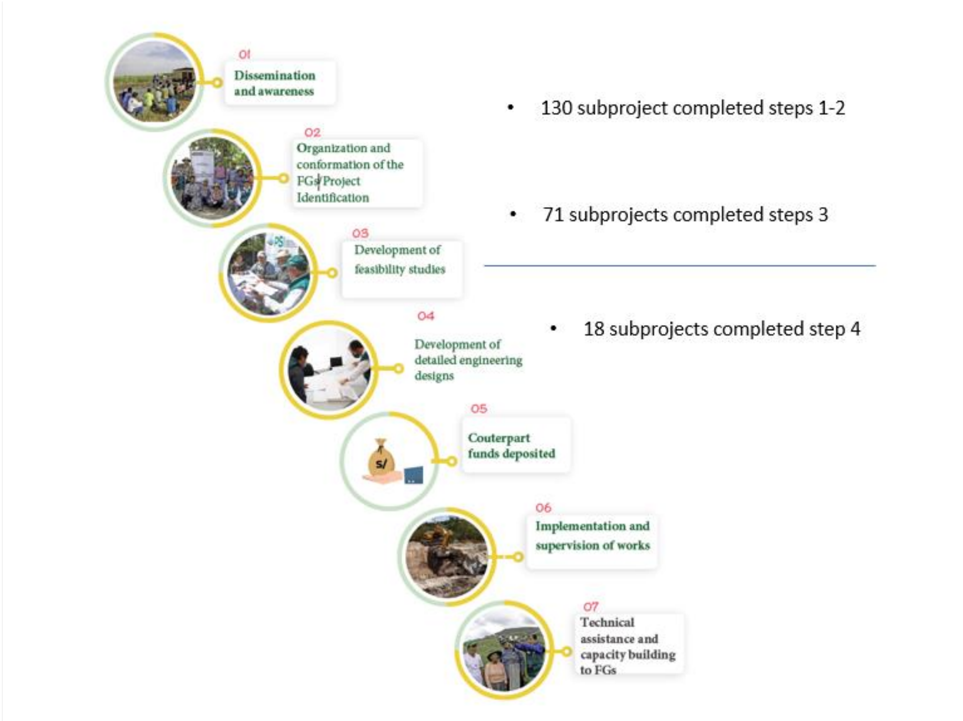

Figure A 2: PSI Implementation Process (as Regulated by its NTIP Regulation).

Table A 1: Distribution of the 130 subprojects by departments and regions.

DEPARTMENT	AREA (HA)	NUMBER OF PROJECTS	REGION
AMAZONAS	170.51	2	Selva
ANCASH	279.27	5	Costa/Sierra
APURIMAC	271.91	3	Sierra
AREQUIPA	647.3	10	Costa/Sierra
AYACUCHO	744.27	10	Sierra
CAJAMARCA	714.32	11	Sierra/Selva
CUSCO	781.2	14	Sierra
HUANCAVELICA	636.69	9	Sierra
HUÁNUCO	217.26	4	Sierra
ICA	329.96	7	Costa/Sierra
JUNÍN	555.34	8	Sierra/Selva
LA LIBERTAD	494.55	7	Costa/Sierra
LAMBAYEQUE	131.27	3	Costa/Sierra
LIMA	666.83	12	Costa/Sierra
MOQUEGUA	346.15	7	Sierra
PIURA	523.55	10	Costa/Sierra
PUNO	335.16	4	Sierra
SAN MARTIN	100.19	2	Selva
TACNA	68.65	2	Sierra
TOTAL	**8014.38**	**130**	

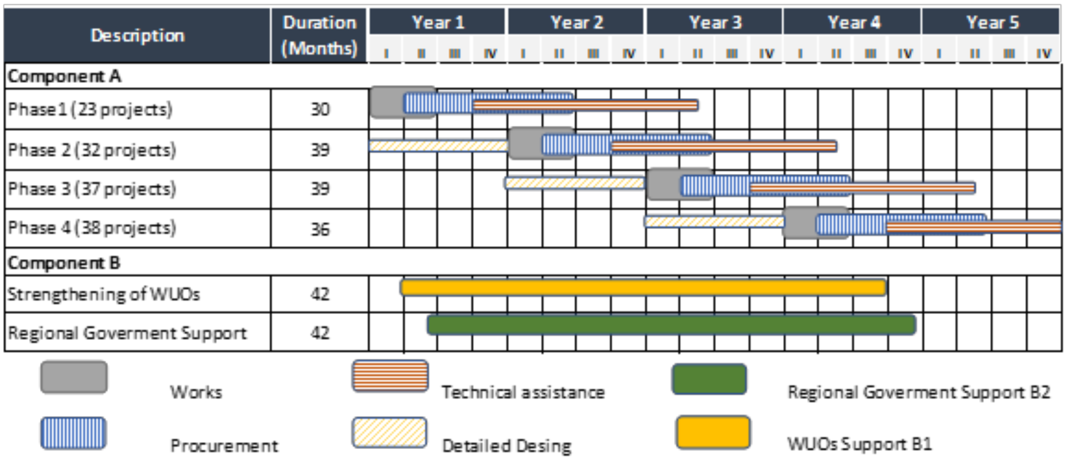

Figure A 3: Simplified implementation Schedule for Components A and B of the project.

7. **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. Given the geographic scope and overall scale of the Project, it is likely that additional resources will be needed to support the PSI during implementation.

8. **The Project design calls for interaction and coordination among different agencies.** The Project will require the active participation of farmer groups (GGRTs), WUOs (encompassing Water User Boards with their commissions and committees), local and regional governments, and ANA. 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.

9. **In addition, the Project will require coordination with MIDAGRI's ongoing rural programs (AGROIDEAS, AGRORURAL, and Sierra-Selva Exportadora) and the INIA**.[88] 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 AGROIDEAS).

10. **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.

Implementation Support Plan and Resource Requirements

11. **The Implementation Support Plan** is based on the Project's risk profile, the lessons learned of previous operations

[88] Partnerships with MIDAGRI's rural programs are envisioned to support improvements to the supply chain of strategic crops and to apply research results and extension services to farmers benefiting from on-farm irrigation improvements. 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.

with MIDAGRI and the PSI, and water sector projects of similar scope.

12. **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. Implementation Status and Results Reports (ISR) will be filed after every mission. The World Bank will continue to provide fiduciary, ESF and other Project-related training as needed.

13. **The Implementation Support Plan will be reviewed annually to ensure that it continues to meet the implementation support needs of the Project.** 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. The World Bank task team will work with the PMU and designated officials to clarify the requirements necessary to effect any changes. 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.

14. **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**. These estimates will be reviewed and revised as needed throughout implementation.

Table A 2: Resource Requirements

Focus	Skills Needed
Project management and Project implementation support coordination	Team Leaders
Compliance with E&S standards and management of E&S risks	Environmental and Social Development Specialists
Technical, oversight of civil works, and quality review of Terms of Reference, technical reports and bidding documents	Task Team Leaders, Technical Specialists (Irrigation, Water Resources Management, Disaster Risk Management (Droughts), Gender, Climate Change), Externally hired consultants (as needed)
Procurement review of bidding documents/implementation support	Procurement Specialist
FM supervision / implementation support	FM Specialist

Table A 3: Implementation Support Plan.

Skills Needed	Number of Staff Weeks per Year	Number of Trips per Year
Task Team Leaders	20	2
Irrigation Specialist	6	2
Disaster Risk Management	6	1
Gender Specialist	1	0
Climate Change Specialist	1	0
FM Specialist	3	2
Procurement Specialist	3	2
Environmental Specialist	3	3
Social Specialist	6	3
Operations support	3	2
STC Consultants (support to project management; oversight of civil works; technical expertise on DRM, drought risk reduction, reforestation; support to procurement and contract management)	6	0

Financial Management

15. **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.

16. **The PSI will be responsible for the overall implementation of the 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 Implementation Completion and Results Report, finalized in June 2017, rated the Project's overall outcome, the Project's implementation, and the implementation agency performance as satisfactory. 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).

17. **The FM risk without considering the agreed mitigating measures described in the following paragraphs is rated Substantial**. **Residual FM risk (after mitigation) is considered moderate.** 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.

18. Main FM-related risks and associated mitigation measures are as follows.

(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 will explore options to process a budget reallocation within its institutional budget to support the beginning of the Project. Adequate budget management procedures should be included in the OM.

(ii) Timely recruitment of a sound FM specialist (Project Administrator) that will support Project implementation. To manage this risk, the Bank will approve the terms of reference. Additionally, a dated covenant has been included in the loan agreement requiring the FM specialist to be hired within four months after the declaration of effectiveness. 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.

19. **The FM Action Plan** is provided in the table below:

Table A 4: Financial Management Action Plan.

Action to be completed	Responsible	Target Date
Timely recruitment of a sound FM specialist (Project Administrator)	PSI	4 months after the declaration of effectiveness. (Dated Covenant)
Recruitment of the Treasury Specialist, and an Accounting Specialist	PSI	6 months after the declaration of effectiveness
PSI shall implement a financial information system in a manner satisfactory to the Bank, including, inter alia, the required functionality to allow preparation of financial reports and control and monitoring of Subprojects.	PSI	6 months after the declaration of effectiveness. (Dated Covenant)

20. 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.

21. **Organization and Staffing:** The PSI's Administration Unit is responsible for accounting, administrative and financial transactions, internal control, preparation of financial statements, procurement and contracting, human resources, treasury and will undertake overall responsibility for the Project's financial management tasks, in close coordination with the Planning, Budgeting and Monitoring Unit. To this end, a Project Administrator, a Treasury Specialist, and an Accounting Specialist will be hired, as part of the Project team, to support Project implementation. This FM staff will work in close coordination with the Administration Unit and the Planning, Budgeting and Monitoring Unit. The FM staff, with required qualifications and practical experience, will be key to ensuring adequate FM arrangements throughout the life of the Project. The Project Administrator considered the FM specialist shall be considered key staff and shall be hired no later than four months after the Project Effectiveness date.

22. **Programming and Budget:** The preparation of the annual budget will be in line with general government procedures regulated by the Annual Budget Law established by the Ministry of Finance through the *Dirección Nacional de Presupuesto Público* (DNPP) and related guidance. The budget is operated under the *Sistema Integrado de Adminsitración Financiera* (SIAF). PSI will have the responsibility to formulate the budget to the (DNPP) for Loan and counterpart funds of the Project. 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. To mitigate the risk, PSI will seek options within the country and institutional arrangements.

23. **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. Once the system is designed and implemented, the Bank will review its operation to ensure transactions processed in SIAF are consistently reflected in the SISGA system. 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.

24. **Procedures and Internal Control:** PSI has developed expertise and has put in place processes, procedures, and internal control mechanisms for the implementation of the former Project. PSI's payment procedures including internal controls for the approval, processing, and authorization of payments under civil works are adequate and according to the

information provided by PSI, payments are made on a timely basis. The CY2021 audited financial statements of PSI, specifically the internal control report, did not raise any observation about these procedures. PSI will prepare a draft version of the POM including the FM chapter. 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.

25. **Internal Audit:** PSI is under the scope of the Organic Law of the National System of Control and the General Comptroller of the Republic (*Ley Orgánica del Sistema Nacional de Control y de la Contraloría General de la República*), and as such, their organizational structure includes an Internal Control Office (*Órgano de Control Institucional,* OCI), dependent of the *Contraloría General de la República* (CGR), and responsible for the oversight of all operations. Currently, the OCI has ten auditors, four professionals hired by the CGR and assigned to PSI, and six professionals hired by PSI. Additionally, to carry on concurrent audits to subprojects, PSI, per OCI Chief request, hire temporally other technical professionals to be part of the audit team (i.e., environmental engineer, hydraulic engineer, etc.). This staff is considered sufficient to comply with the annual plan which is coordinated and approved by the CGR. The OCI may include under their annual program a review of the Project activities and proposed recommendations if needed. If such audits occur, PSI will provide the Bank with copies of internal audit reports covering Project activities and financial transactions. Additionally, OCI's reports are publicly available on the CGR Web page.

26. **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 reports should be prepared in local currency and in US dollars. The IFRs would be submitted on a semi-annual basis, within 45 days after the end of each calendar semester. Once the new system and additional modules are in place, the Bank will assess whether PSI has acceptable arrangements to prepare reliable IFRs.

27. **Auditing arrangements:** Project financial statements will be audited following International Standards on Auditing (ISA), by an independent firm and in accordance with terms of reference, both acceptable to the Bank. An audit firm will be hired by PSI, through the General Comptroller Office of Peru, which will perform the audit of the Project and provide the audit report. PSI will submit the audit report to the Bank no later than 6 months after the end of each fiscal year or any other period agreed with the Bank. Audit cost would be financed out of loan proceeds. 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.

28. **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 Bank will disburse loan proceeds using one of following three methods: (i) advance method: under the STA with a fixed ceiling; (ii) direct payment; and (iii) reimbursement. The Project's flow of funds is presented in the following chart:

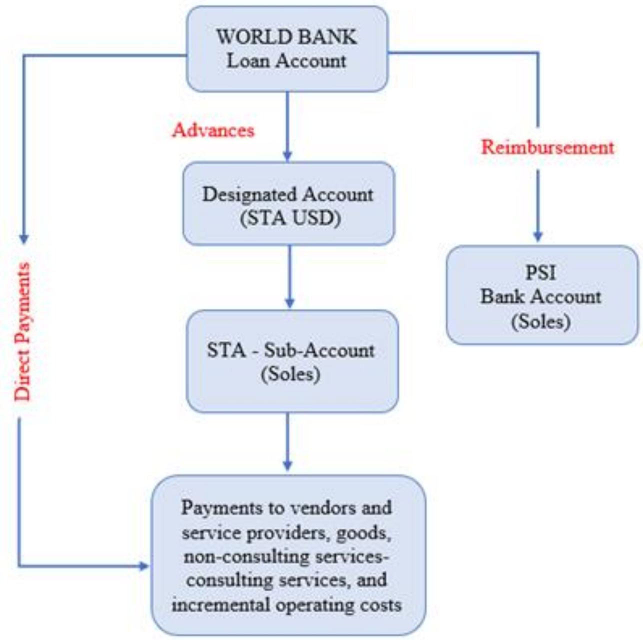

Figure A 4: Diagram of Flow of Funds.

29. **PSI will be responsible for presenting disbursement applications to the Bank as well as presenting their justifications for expenditures** (through statements of expenditures - SOEs). The specific protocols and applicable internal control arrangements for the payment processes and procedures will be reflected in the POM.

30. Loan proceeds will be disbursed against the following expenditure categories:

Table A 5: Expenditure categories.

Category	**Amount of the Loan Allocated (expressed in USD)**	**Percentage of Expenditures to be Financed (Inclusive of taxes)**
(1) Goods, works, non-consulting services, consulting services, Operating Costs, and external audits for the Project	100,000,000	100
TOTAL AMOUNT	**100,000,000**	

31. **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.

32. **As part of the program management team, an administrative specialist will prepare monthly reports and financial reports on the implementation of the intervention as part of the overall program coordination.** For Component A, an administrative assistant will prepare monthly reports and financial reports on the implementation of this intervention. 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.

Table A 6: Annual Financial Schedule of the Project

Description	Total cost	Financial Schedule				
		Year 1	Year 2	Year 3	Year 4	Year 5
I. Portfolio of 130 projects	**106,732,269.15**	**12,524,223**	**24,347,227**	**34,182,243**	**31,532,421**	**4,146,155**
1.1 Studies and works	90,187,515	12,025,632	21,860,602	29,586,719	26,714,562	-
1.2 Technical assistance	16,544,754	498,591	2,486,626	4,595,524	4,817,859	4,146,155
II. Other program interventions	**6,724,081**	**815,011**	**1,367,371**	**1,765,848**	**1,806,076**	**969,774**
2.1 Activity 1	5,182,802	405,083	1,020,919	1,459,866	1,524,392	772,542
2.2 Activity 2	1,541,280	409,928	346,453	305,981	281,684	197,233
III. Program management	**12,593,685**	**2,242,714**	**2,864,773**	**3,989,363**	**1,957,777**	**1,539,060**
Total	**126,050,036**	**15,581,948**	**28,579,372**	**39,937,453**	**35,296,274**	**6,654,989**

Procurement

33. **Procurement activities will be carried out by PSI according to the World Bank's "Procurement Regulations for IPF Borrowers", dated September 2023, for the supply of works, goods, and non-consulting and consultant services under the Project.** The World Bank's Standard Procurement Documents will govern the procurement of World Bank-financed Open International Competitive Procurement. For procurement involving National Open Competitive Procurement, and other methods, the documents will be agreed on with the World Bank.

34. **An advanced draft of the PPSD has been carried out by PSI.** The PPSD describes how procurement in this operation will support the PDO and deliver value for the money invested under a risk-based approach. The PPSD focuses on the most important contracts related to the execution of the subprojects to be financed under Component A of the Project. As explained in previous sections, the 130 subprojects are expected to be carried out in a sequential way along the implementation of the Project.

35. **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. During the preparation, PSI has carried out market research. 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.

36. **The rest of the subprojects are at level of feasibility study and/or preliminary design**. 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).

37. **Procurement for works, goods, consulting services and non-consulting services will be implemented based on Mandatory Procurement Prior Review Thresholds detailed in Annex I of the WB's Procurement Procedures.** All procurement procedures, including the roles and responsibilities of different participating entities and units, will be defined in the POM.

38. **PSI prepared a Procurement Plan, which provides adequate supporting market analysis for the selection methods detailed in the Plan, based on the PPSD.** In accordance with Paragraph 5.9 of the Procurement Regulations, the World Bank's Systematic Tracking and Exchanges in Procurement system will be used to prepare, clear, and update procurement plans and conduct all procurement transactions for the Project.

39. **Civil works: Component A** will finance civil works under Component A for: (i) the construction and improvement of off-farm irrigation systems under Subcomponent A.1., which include: construction of new and improvement of existing

water intake structures and loading chambers or small reservoirs, grit removal works, and construction of water main and distribution networks from the intake structure up to the farm gates; and (ii) construction of efficient on-farm irrigation systems under Subcomponent A.2., which involve the construction and provision of resource water-efficient field application systems (e.g. drip irrigation, sprinklers, micro sprinklers).

40. **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).

41. **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. Besides that, the Project will finance goods and non-consulting services required for the Project Management such as: computers, equipment, office furniture, publicity services etc.

42. **A procurement capacity assessment deemed PSI's procurement arrangements as adequate, subject to a hiring a dedicated procurement specialist and additional training.** PSI has a history of satisfactory management of procurement for World Bank-financed Projects. However, for the implementation of the Project, PSI will need to hire a procurement specialist who is fully dedicated to the Project and has experience with the WB's procurement procedures. Additionally, the Bank will provide periodic training over the course of the Project to ensure that the procurement regulations are adequately applied.

43. **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.

ANNEX 2: Supplementary Project Details

Irrigated Agriculture in Peru

1. **Irrigated agriculture plays a fundamental role in Peru's development and has become increasingly important.** 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. Irrigation, and agriculture in general, plays an important role in the region in relation to food security and the provision of a certain level of employment for the mostly poor rural population. 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.

Topographic Distinctions

3. **Water resources and irrigation infrastructure vary throughout the country.** Irrigation is well established in the *Costa* region but less so in the *Sierra* and *Selva* regions since. 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.

4. **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. However, the inhabitants of the *Costa* suffer the full effects of ENSO; they are also affected by recurring droughts, periods without rain, and, to a lesser extent, high and extreme temperatures, forest fires, and strong winds.

5. **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. In contrast, the Sierra and Selva regions are difficult to traverse, with isolated, remote communities (away from the Costa), thereby resulting in large development gaps. Moreover, lower population densities and inadequate infrastructure in many regions of the Sierra and Selva, hamper the distribution of food and access to markets. Higher transportation costs also raise prices of agricultural products.[94]

6. **The *Sierra* and *Selva* regions have abundant water resources contrasted by rudimentary irrigation systems**. In the *Sierra* and high-altitude areas of the *Selva,* where half of the rural population lives in poverty, only around 20 percent of the cultivated land is under irrigation, exposing agricultural production to shifts in rainfall patterns linked to climate change and variability.[95]

7. **In the mountains of the *Sierra* as well as the high-altitude zones of the *Selva* (*Ceja de Selva*), irrigation, when**

[89] The Bank's Sierra Irrigation Subsector Project reported yield increases of 30 to 70 percent and net household income per hectare increases of 25 to 500 percent because of improvements in water availability and irrigation.
[90] INEI. 2012. "Resultados definitivos. IV Censo Nacional Agropecuario 2012." Instituto Nacional de Estadística e Informática. Ministerio de Agricultura y Riego. Lima, Peru. (Available at: http://proyectos.inei.gob.pe/web/DocumentosPublicos/ResultadosFinalesIVCENAGRO.pdf).
[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.
[92] For example, yields of irrigated crops are double those of rainfed (dryland) yields in Peru (FAO 2022).
[93] IV Censo Nacional Agropecuario 2012. INEI https://proyectos.inei.gob.pe/web/DocumentosPublicos/ResultadosFinalesIVCENAGRO.pdf
[94] Bergmann et al, 2021.
[95] Lines in the Water: A Roadmap to Sustainable Development in an Uncertain Water Future, Peru Water Security Diagnostic, 2022).

used, complements rainfall during the dry months. There are rainfall distribution challenges in most areas of the Sierra region and parts of the Selva.[96] *Sierra* and *Ceja de Selva* also face a climate with more extreme temperatures, high levels of soil erosion and fragmentation of farmland, difficult market access, and limited availability of water resources, among other factors. 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. In the Sierra, only about 20-30 percent of systems run on electricity, with the rest requiring high-cost diesel-powered pumps.

8. **Inequitable distribution of land ownership also impacts agricultural productivity.** In Peru, around 87 percent of land is owned by 5.5 percent of the population, mostly large-scale farmers owning more than 20 hectares[97] while seventy-nine percent (79 percent) of producers own less than 5 hectares of land (mostly concentrated in mountainous areas), and 15 percent own between 5–20 hectares.[98] These small- and medium-size producers practice traditional agriculture (extensive or subsistence) and make up 91 percent of the national Gross Value of Production (GVP).[99]

Project Description Details

9. **At the heart of the Project is the implementation of 130 investment subprojects**. These are expected to transform the current off-farm surface irrigation schemes used by small-scale family farmers into 'technified'[100] 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).

10. **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.

11. **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. Considering that the crop categories vary among Peru's regions, the type of 'technified' irrigation system to be implemented in each of the 130 projects was determined based on the crop category and its profitability.

[96] Most precipitation occurs between November and March, resulting in a large dry period with water deficits.

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

[98] INEI. 2012. "Resultados definitivos. IV Censo Nacional Agropecuario 2012." Instituto Nacional de Estadística e Informática. Ministerio de Agricultura y Riego. Lima, Peru. (Available at: http://proyectos.inei. gob.pe/web/DocumentosPublicos/ResultadosFinalesIVCENAGRO.pdf).

[99] PNUD; MINAM. 2009. Las Implicancias del Cambio Climático en la Pobreza y la Consecución de los Objetivos del Milenio. Autor: Del Carpio, O. Informe preparado en el marco del Proyecto Segunda Comunicación Nacional del Perú a la Convención Marco de las Naciones Unidas sobre Cambio Climático. Lima: PNUD y MINAM. Programa de las Naciones Unidas para el Desarrollo – PNUD y Ministerio del Ambiente – MINAM.

[100] 'Technification' entails conversion of open surface canals of the off-farm conveyance and distribution systems to (mostly) gravity-fed pressurized piped systems to prevent losses of water through seepage and evaporation, while removing the need for the use of energy through pumps (in areas where the altitude allows for gravity-fed systems).

12. **'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.[101] 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.

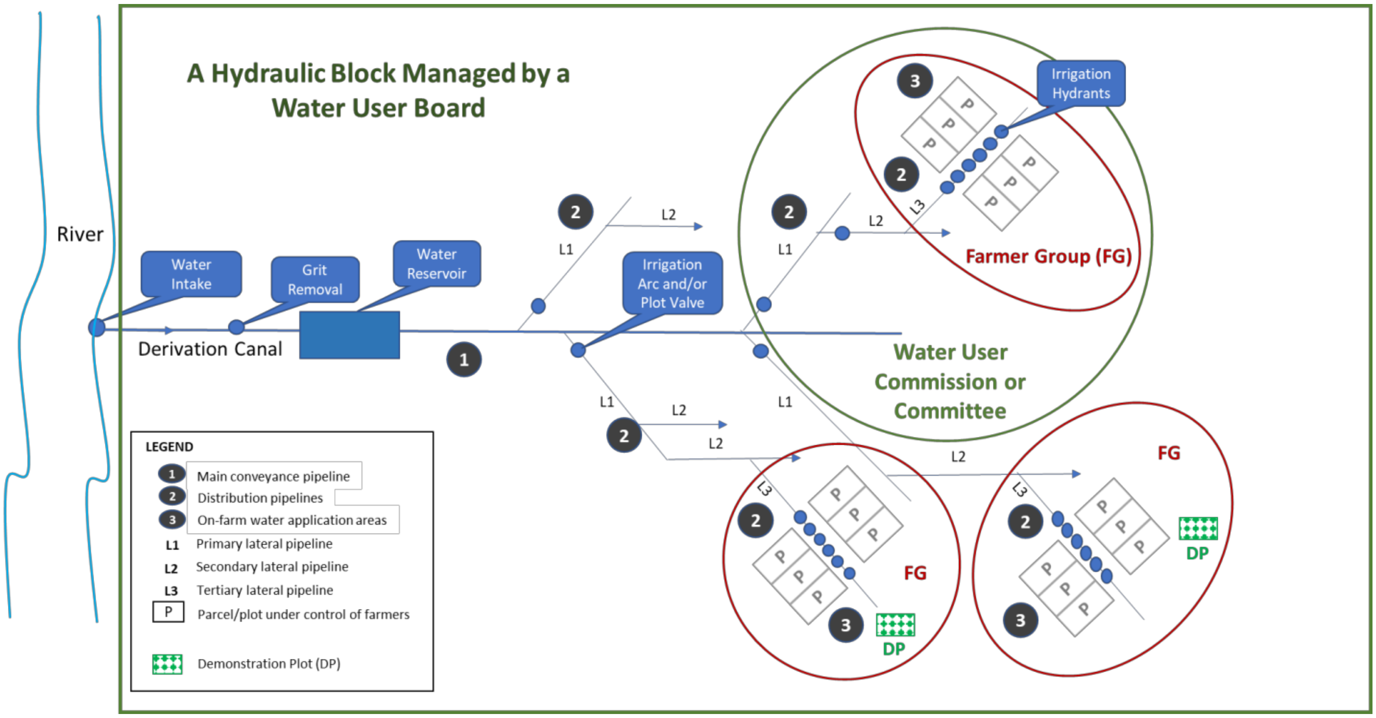

Figure A 5: – Diagram of a Sub-Project (Hydraulic Unit)

[101] 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.

Sample of 8 Subprojects Used for Overall Project Analysis

13. To conduct the calculations for GHG emissions, soil degradation, and the economic and financial assessments, the PSI team selected a sample of 8 sub-projects from different regions to be analyzed as a representative sample of all 130 sub-projects. 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). The following two tables provide requisite details on the sample of 8 sub-projects as per the following tables.

Table A 7: Profile of selected subprojects.

#	**Sub-Projects** [representing Farmer Groups (GGRT)]	**Terrain**	**Climate**	**Average Altitude** (MASL)	**Main Soil Type**	**Irrigation System**	**Crops** (evaluated)	**Cultivated Area** (ha)	**Number of Beneficiaries**
1	Aprocondor	Sierra	Warm temperate dry	3,574	Lo	Sprinkler	Potatoes and Forage Oats (50% each)	84.00	49
2	Atunmayo	Sierra/Selva	Warm temperate dry	2,925	Lo	Sprinkler	Rye Grass, Clover, and Purple Corn (33% each)	78.03	167
3	Qoto Pucyo Piscacucho	Sierra	Cool temperate dry	2,846	Lo	Drip irrigation	Avocado (100%)	38.52	46
4	Hyillaparac San Rafael	Sierra	Warm temperate dry	3,352	Lo	Sprinkler	Peas, Corn, and Potatoes (33% each)	37.26	43
5	Lateral 7	Costa/Sierra	Tropical dry	202.89	SaClLo	Drip irrigation	Grapes (100%)	52.84	18
6	La Merced de Chaute	Sierra/Costa	Cool temperate dry	2,400	Lo	Drip Irrigation	Grapes (100%)	40.20	63
7	Comunidad Campesina de Llocllapampa	Sierra/Selva	Warm temperate dry	3,511	Lo	Sprinkler	Rye Grass and Trebol (50% each)	50.00	50
8	Achahueco	Sierra	Cool temperate dry	3,051	SaClLo	Micro-Sprinkler	Oregano (100%)	34.14	66

ANNEX 3: Project Map

Figure A 6: Map of Project locations

ANNEX 4: Economic and Financial Analysis

1. 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.

Identification of Costs and Benefits

2. 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).

Table A 8: Cost and benefit identification.

Total costs	Financial Benefits	Economic Benefits
Component A: US$107.3 million **Component B: US$9.8 million** **Component C: US$13.6 million** **Total: US$130.7 million**	**Quantified** ▪ Productivity increases per hectare (pea, peach, oat, rye grass, clover, oregano, and grape) ▪ Potential increment of cultivated area	**Quantified** ▪ Productivity increases per hectare (pea, peach, oat, rye grass, clover, oregano, and grape) ▪ Potential increment of cultivated area ▪ Environmental benefits due to the implementation of mitigation activities (fertilizers and pesticides use, associated with a decrease in equivalent carbon emissions).
	Non quantified ▪ The multiplier effect over the value chain of selected crops (maize, coffee, cotton, sugarcane) due to forward and backward production linkages. ▪ The multiplier effect over other related sectors of the economy (transport, services)	**Non quantified** ▪ The multiplier effect over the value chain of selected crops (maize, coffee, cotton, sugarcane) due to forward and backward production linkages. ▪ The multiplier effect over other related sectors of the economy (transport, services) ▪ Other environmental benefits, such as reduction of soil erosion

Source: FAO elaboration, 2022.

Financial Analysis

3. 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). Selection of sub-projects incorporated the following parameters:

- The location in 3 project regions (2 located in the north, 3 in the center, and 3 in the south).
- Different types of crops (potato, forage oats, purple corn, avocado, peas, corn, grapes, fruit trees, associated grasses, oregano).
- Various types of advanced irrigation systems (drip, sprinkler, micro sprinkler).

4. Each sub-project considered different crops representative of dominant production schemes, including potato, purple maize, peas (vetch), rye grass, oats, clover, oregano, and grape. 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.

5. 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.

6. The table below presents yields and output-price assumptions for the financial analysis. To calculate these values, the 'without project' scenario was compared against the 'with project' scenario. 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.

7. 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.

Table A 9: Yields and output price assumptions

Crop	Without Project		With Project		
	Yield (t/ha)	Harvest cycles per year	Yield (t/ha)	Harvest cycles per year	Output price (USD/t)
Potato	20	1	40	2	66
Purple Maize	7.5	1	10	2	105
Peas	6.5	1	9.5	2	189
Rye Grass	60	1	70	3	18
Oats	90	1	140	2	7
Clover	12	1	18	3	38
Oregano	2.5	1	3.5	2	558
Grape*	20	1	28	1	395

*Yields when at full production

Source: FAO elaboration, based on data from PSI, 2022.

8. 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 input and output prices to capture the effect of the change in production. 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.

Table A 10: Financial indicators at sub-project level

Subproject General Description			Net income (US$/year)			Financal Internal Rate of Return (FIRR)	Net Present Value (US$/year) 12% 20 years
Sup-Project Name	**Composition of Production**	**Cultivated Area (ha)**	**Without Project**	**With Project**	**Incremental**		
1. Aprocondor	50% potato 50% oats	84	32,022	202,460	170,437	16.0%	224,202
2. Atunmayo	33% rye	78.03	26,845	166,084	139,239	17.5%	237,306

	33% clover 33% maize						
3. Qoto Pucyo Piscacucho	100% avocado	38.52	202,312	293,816	91,504	12.7%	26,776
4. Huillaparac San Rafael	33% peas 33% maize 33% potato	37.26	15,086	84,480	90,435	21.0%	220,603
5. Lateral 7	50% grape* 50% avocado*	52.84	294,895	424,995	130,100	19.1%	315,068
6. La Merced de Chaute	100% grape*	40.20	237,569	340,032	102,462	19.9%	274,375
7. Llocllapampa	50% rye 50% clover	50	24,612	143,500	118,888	25.2%	366,817
8. Achahueco	100% oregano	34.14	34,065	106,255	72,190	14.9%	74,098

Economic Analysis

9. 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. The table below presents the conversion factors considered in this analysis.

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.

10. 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.

Table A 12: Economic Indicators

Agricultural Model			**Net income (US$/year)**			**Economic Internal Rate of Return (EIRR)**	**Net Present Value (US$/year) 12% 20 years**
Sup-Project Name	***Composition of Production***	***Cultivated Area (ha.)***	***Without Project***	***With Project***	***Incremental***		
1 Aprocondor	50% potato 50% oats	84	38,682	204,430	165,747	13.7%	419,071
2 Atunmayo	33% rye 33% clover 33% maize	78.03	30,622	152,858	122,236	14.5%	372,264

3 Qoto Pucyo Piscacucho	100% avocado	38.52	199,703	285,514	85,810	9.9%	99,059
4 Huillaparac San Rafael	33% peas 33% maize 33% potato	37.26	19,575	89,004	99,833	21.6%	435,833
5 Lateral 7	50% grape* 50% avocado	52.84	290,526	413,957	123,431	15.8%	441,066
6 La Merced de Chaute	100% grape*	40.20	437,473	620,401	182,927	16.7%	384,096
7 Llocllapampa	50% rye 50% clover	50	24,207	136,471	112,264	21.1%	480,064
8 Achahueco	100% oregano	34.14	36,745	108,490	71,745	13.2%	169,872

11. For the general economic analysis of the Project, economic flows were extrapolated. Benefits across the total Project area were extrapolated from the cropping composition and relative size of each of the eight subprojects. 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. In this case, the subprojects cover a total of 5.19 percent of the total Project area (8,014.38 ha), with a scaling factor of 19.27.

12. 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).

13. 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.

14. 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.[102] 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. This points to the robustness of the Project.

[102] For the Sensitivity Analysis it has been simulated the economic profitability indicators considering the shadow price of carbon proposed by the World Bank, 2017. 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". http://documents.worldbank.org/curated/en/621721519940107694/pdf/2017-Shadow-Price-of-Carbon-Guidance-Note.pdf

Table A 13: Sensitivity Analysis. Source: FAO elaboration, 2022.

Variable	Variation	Economic indicators	
		Net Present Value (million US$)	Internal Rate of Return
Reduction in expected yield	-5%	$49.60	15.56%
	-10%	$38.59	13.93%
	-15%	$27.59	12.28%
Delays in benefit generation	1 year	$44.3	13.9%
	2 years	$29.3	11.6%
	3 years	$15.3	9.8%
Cost overruns	10%	$50.3	15.0%
	20%	$40.0	13.1%
	30%	$29.7	11.6%
Shadow price of carbon	US$80 t/CO2eq, annual incremental rate of 2.25%	$84.7	21.3%
	US$40 t/CO2eq, annual incremental rate of 2.25%	$71.7	19.0%
	US$0 t/CO2eq	$58.6	16.8%

15. 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 CO2eq, and a delay in the implementation of the Project that would permit the generation of one-year benefits. Under these conditions, the Project continues to present positive economic-profitability indicators, with an incremental net-present value of US$12.4 million and an internal rate of return of 9.6 percent. These results represent a robust performance in economic terms and, considering the productive and climatic impacts, create societal economic value.

Table A 14: Scenario Analysis

Variable	Pessimistic Scenario	Neutral Scenario	Optimistic Scenario
Expected yields of crops	Reduction of 10% of the expected yield	Expected yields are achieved in with project scenario	Expected yields are increased in 10% in with project scenario
Benefit generation	Delay in 1 year in benefit generation	No delays in benefit generation	No delays in benefit generation
Investment costs	10% cost overruns	No cost overruns	No cost overruns
Shadow price of carbon	US$ 0 tCO2eq	US$ 7.17 tCO2eq annual incremental rate of 0.0%	US$ 80 tCO2eq annual incremental rate of 2.25%
Economic Indicators			
Net Present Value (million US$)	US$14.2 million	US$60.6 million	US$106.7
Internal Rate of Return	9.8%	17.2%	24.7%

Source: FAO elaboration, 2022.

16. **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. The charge varies among the subprojects from S/190 in Atunmayo to S/1,230 per ha per year in Llocllapampa. This charge

will be in addition to the tariff charged by the WUOs. 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.

Subproject Name	# Farmers	Area (ha)	O&M/year (PEN)	O&M/ha/year PEN/ha/yr
1 Aprocondor	49	84	19,981	238
2 Atunmayo	167	78	14,826	190
3 Qoto Pucyo Piscacucho	46	39	26,180	680
4 Huillaparac San Rafael	43	37	44,000	1,181
5 Lateral 7	18	53	39,366	745
6 La Merced de Chaute	63	40	10,191	254
7 Llocllapampa	50	50	61,500	1,230
8 Achahueco	66	34	21,200	621
Total	**502**	**415**	**237,243**	**572**

17. **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[103], 62.5 percent of the WUO has an operating cost recovery ratio lower than 50 percent, and 12.5 percent lower than 75 percent. On top of this, the revenue collection rate is between 70 to 90 percent (La Costa shows better rates of 80 to 90 percent, while la Sierra and la Selva show rates of 70 to 80 percent).

18. **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.

Estimation of water saved from efficiency measures and usable for productive purposes

14. **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.

15. **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.

16. 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. Increasing irrigation efficiency delivers the presumed expected benefits of increased

[103] PSI. Arrese, Ricardo León. *Diagnóstico del Estado Situacional de las Organizaciones de Usuarios de Agua (OUAs). Estudio Socio Económico de los miembros (productores agrarios y/o usuarios) de las OUAs y Criterios de Priorización de las JUs.* Enero 2018

water availability overall. 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.

17. 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. The above-mentioned water balance analysis clearly reflects that reducing water deficits in the projects will enhance the systems' resilience. 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).

18. 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.

19. 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.

ANNEX 5: Building Resilience through Combination of Irrigation and Agronomic Measures

1. **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.

2. **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.

4. **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).

5. **Attention to soils, to which irrigation water is applied, represent a vital aspect in efficient water management and crop production**. While climatic factors ultimately control plant-water relationships, soil moisture plays a decisive role in determining the yield potential of crops. 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. **Soil is the plant's water reservoir**.[106] Soil water dynamics play a critical role in deciding how much water is needed for irrigation. Globally, about two-thirds of all fresh water is held in soil (known as 'green water'[107]), representing the largest terrestrial water reservoir (accessible to plants).[108] In contrast, approximately one-third of the fresh water is stored in rivers, lakes, aquifers ('blue water') and can be directly abstracted for human use, including irrigation (the largest freshwater consumer). Combining soil moisture conservation with irrigation allows for greater overall on-farm water use efficiency.

7. **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. For example, irrigation is typically triggered when soil moisture content is depleted to a point where plants experience water stress and potential growth (and yield) reduction.

[106] Soils regulate water by acting as a sponge to hold water in plant available form. Soil moisture plays a decisive role in determining the yield potential of crops by regulating the moisture levels in the plant.

[107] Green water is the precipitation that is stored as soil moisture and eventually returning to the atmosphere via transpiration and evaporation.

[108] Conceptually, the freshwater cycle can be partitioned into two parts – 'green' and 'blue' water – in accordance with the hydrological processes. Both 'types' of water are involved in food production.

the demands placed on them to grow food. Crops can also better withstand climatic stresses of insufficient or excessive water availability (and extremes such as droughts and floods) and help mitigate these stresses. Moreover, safeguarding soil health is also one of the best ways to cultivate plants that are more resistant to pests and diseases, while being robust in adverse conditions (such as drought, heavy rain, or frost).

8. **On-farm agronomic practices directly impact soil health**. Practices that are part of climate-smart, regenerative, and conservation agriculture are important for keeping the soil water moisture[109] in an optimal state for plant growth. These practices affect the soil structure and porosity, the water infiltration rate and moisture holding capacity of soils, the diversity and biological activity of soil organisms, and plant nutrient availability – all of which sum up to efficient water use and long-term farm productivity. Such agricultural techniques are interrelated and include (a) planting cover crops, leaving crop residue and mulching, and (b) minimum or zero tillage; (ii) increasing diversity of crops and soil microorganisms by (a) crop rotations, intercropping, and managed grazing, and (b) adding organic soil amendments.[110]

9. **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. The suite of agronomic techniques (described above) aids in sustainable soil and farm management in the long run by keeping the soil healthy and improving yields, respectively. They allow for a decrease in water supply to irrigation, thereby maximizing the impact of the water used. In summary, strategies to reduce crop water use include (i) maintaining healthy, water-absorbent soils and (ii) utilizing low-volume irrigation systems (e.g., drip irrigation, sprinklers, and micro sprinklers).

10. **The above-listed agronomic practices also benefit the wider catchment by improving land-water dynamics, such as rainfall runoff, infiltration, water consumption, and water quality and improving resilience to climate variability and change**. To that end, water management at a smaller scale must be embedded in the larger frame of catchment resource management. Building resilience is inextricably linked to the condition of ecosystems in which irrigated agriculture is conducted. Healthy, well-functioning ecosystems enhance natural resilience to adverse impacts of climate change and reduce the vulnerability of people.

11. **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 global food crisis. Ultimately, the time and effort invested in regenerative agronomic practices at the outset will pay off long-term. 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. After the oceans, soils are the greatest carbon sink.[115]

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[109] Soil moisture is the amount of water in the in the unsaturated part of the soil subsurface (within the active layer, typically the top 1–2 meters) and is the main source of water for agriculture and natural vegetation.

[110] This entails protection of soil from disturbance by tillage, as wind and water erosion, and compaction. By maintaining soil structure, these practices reduce soil erosion as well as its compaction.

[111] Resilience can be considered across multiple scales, from individual fields to agricultural landscapes and beyond, encompassing environmental, economic, and social dimensions (Walker & Salt, 2006).

[112] Soil is comprised of 4 components: (i) water (as a solution of salts), (ii) air and other gases, (iii) organic matter (residue from plants, animals, bacteria, etc.), and (iv) minerals and nutrients.

[113] A key goal in this regard is addressing *vulnerability of agro-ecological systems,* as determined by exposure (degree of stress), sensitivity (e.g., crop responsiveness to climate change), and adaptive capacity of producers (Webb et al, 2017).

[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.

[115] Lal, R. 2011. Sequestering carbon in soils of agro-ecosystems. Food Policy, 36: S33-S39. https://doi.org/10.1016/j.foodpol.2010.12.001.

ANNEX 6: Climate Change Adaptation and Mitigation Efforts of the Project

1. **Peru is susceptible to natural disasters including droughts, floods, frost, and landslides, which are expected to be exacerbated by climate change**. This becomes particularly challenging during more pronounced dry seasons when water is needed for the irrigation of crops. 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 identified risks included droughts, whose frequency and intensity may be increased by climate change, possibly threatening to water supply services. Climate change might also reduce water generated by glacier melts, which act as a buffer to provide water during droughts. Climate change can also lead to more intense El Niño events, which in turn leads to flood and mudslide[116] risks. As the agriculture sector in Peru is entering a more turbulent phase of increased risk and uncertainty, production systems, if not adapted,[117] may suffer from more frequent and substantial crop yield losses due to climate change impacts.

2. **The Project includes measures to mitigate and adapt to climate change**. Appropriate interventions are to be selected carefully to match specific conditions in each sub-project. 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. The paragraphs below summarize the Project's activities aimed at addressing these issues.

3. **The Project's emphasis on implementing energy- and water-efficient irrigation systems, increasing water storage, and strengthening water resources management is fully aligned with Peru's NDC and NAP priority actions**. All activities under the program are on the Universally (Paris) Aligned list.[118] 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).

Adaptation measures

2. **The main climate-related risks identified in the project area are droughts, floods, and frost.** 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. Some measures are elaborated below.

3. **Most of the project areas are based in the Sierra, which experiences significant climate variability – ranging from exposure to high temperatures (and extreme heat) to extremely cold and freezing temperatures (known as heladas)**. It is estimated that nearly 70 percent of the 130 subprojects financed by the Project are located over 2,000 msl.[119] Between June and August, these areas are exposed to temperatures near or below freezing. Irrigation systems can be used to protect crops from frost injury.[120] 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. However, use of irrigation for frost protection must be carried out in a specific way to avoid further damage to crops.

4. **The Project also ensures provision of adequate water storage to attenuate climate change impacts**. Reservoirs that supply pressurized water to farm irrigation networks (within each sub-project) capture water from a micro-watershed or

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[117] 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.

[118] After the ratification of the Paris Agreement, Peru validated six action objectives and targets for reducing vulnerability in agriculture.

[119] In the sample of 8 subprojects, maximum altitude ranges between 2,533 and 3,574 MASL and minimum altitude ranges 2195 and 3463 MASL.

[120] The heat released by irrigation water prevents ice from forming inside the plant tissue. In contrast, when soils are dry, more air spaces are created that inhibit heat transfer and storage.

a canal from a river. 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.

5. **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 risk of intense low-duration precipitation in some subproject areas – causing floods – is to be protected with adequate vegetation the immediate area of water recharge and the surrounding reservoirs.

Mitigation measures

6. **Taking advantage of topographic elevation for off-farm irrigation investments allows the introduction of gravity-based, pressurized water conveyance and distribution—thereby eliminating the need for electricity or diesel to run the water pumps**. 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).

7. **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. Approximately 1 to 2 percent of the land in the immediate surrounding area of the 130 reservoirs[124] is expected to be reforested. Tree crops sequester carbon in their main body and transfer it to the soil through their roots. 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.

8. **In addition to reducing the need for irrigation water, the adoption of beneficial agronomic practices (that improve soil health) typically also leads to reductions in the application of inputs such as fertilizers and pesticides, resulting in reductions of GHG emissions**. Soils of good quality are key to a resilient agro-ecologic systems. Long-term sustainability of agricultural systems requires ensuring that soils stay productive. Healthy soils function as sponges by being better able to absorb rainfall and hold onto moisture in times of insufficient rain. This can improve the resilience of crop yields to variable rainfall and lower the need for irrigation. Soils and their management can also affect the incidence of meteorological droughts[126] and floods.

9. **It is estimated that, in Peru, the efficiency of application of granulated fertilizers is approximately 30 percent**. Annual and perennial crops are inefficiently fertilized with nitrogen compounds, which emit nitrogenous gases, due to prevalent application methods. Inadequate application of fertilizers also causes loss of applied nutrients. Emissions of nitrogenous

[121] Sound agronomic practices include context-appropriate in-field soil and water management techniques and crop choices.

[122] Pasture areas, particularly those with brachiaria and alfalfa, have deep root systems and sequester carbon. Brachiaria (Brachiaria brizantha L.) is a perennial grass (also known as bread grass) mostly used for pastures under continuous or rotational grazing. Bread grass is also valuable for cut-and-carry feeding, hay, and silage. Alfalfa (Medicago sativa L.) is a perennial herbaceous legume with high nutritional quality, yields, and adaptability. It represents a major source of protein for livestock.

[123] The net effect will also depend on crop mix in each subproject.

[124] Each of the 130 reservoirs is on an area of approximately 500 to 1,000 square meters.

[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.

[126] For example, addition of organic matter to increase soil water holding capacity reduces drought risk.

gases are expected to diminish substantially with adopted usage of drip irrigation (e.g., fertigation).[127] Drip irrigation is expected to provide a triple benefit of a better uptake of nutrients by plants, lower fertilizer usage, and reduced emissions of GHGs, thereby contributing to increased crop yields and potentially higher incomes.

Alignment of the Project with the Paris Agreement and Impacts on GHG Emissions

10. **Within the framework of the intended nationally determined contributions (iNDCs) proposed by Peru in 2015, six action objectives and targets for reducing vulnerability in agriculture were preliminarily projected**. 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.

11. **The implementation of the mitigation measures proposed in the NDCs is expected to reduce a total of 69.4 MtCO2eq, representing 23.3 percent**. In that sense, although there is a gap of 6.7 percent to reach the national goal of 30 percent, it is planned to define in the short term the necessary measures to cover it. On the contribution of mitigation measures to the reduction of GHG emissions in 2030, proposed in both the iNDCs and NDCs, the greatest potential comes from the USCUSS and Energy sectors. It is observed that of the total of 69.4 MtCO2eq (23.3 percent), the agriculture sector corresponds to only 6.5 MtCO2eq => (2.2 percent of the total).

12. **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 iNDCs proposed to reduce 89.4 MtCO2eq, which represents 30 percent of the projected emissions in 2030 (298.3 MtCO2eq).

13. **The Project's GHG accounting analysis estimates a net mitigation potential of the Project is -5,562 Ton CO2eq per year**. This adds up to -33,372 Ton CO2eq after 6 years of execution and -111,258 Ton CO2eq over a period of 20 years. The gross mitigation potential of the Project is -8,795 Ton CO2eq per year after 20 years of project execution.[128] 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.

14. **Out of the total of 130 sub-project, 51 are vulnerable to precipitation lower than 400mm/year (in Sierra and Costa) and all 95 sub-projects in Sierra are exposed to frost** (as shown in tables below). Subprojects bridging vulnerability to both low precipitation and frosts stand at 120 (92 percent of the total area).

Precipitation less than 400 mm/year			
Geographic Region	*Number of Sub-Projects*	*Total Area of Vulnerable Sub-Projects (ha)*	*Beneficiaries*
Costa	25	1,431.17	594
Sierra	26	1,360.95	1,309
Totals	**51**	**2,792.12**	**1903**

Frost Impacts			
Geographic Region	*Number of Sub-Projects*	*Total Area of Vulnerable Sub-Projects (ha)*	*Beneficiaries*
Sierra	95	5,932.95	6,728

Climate Vulnerability - Low Precipitation and/or Frosts			
Geographic Region	*number of sub-projects*	*total area*	*beneficiaries*
Costa	25	1,431.17	594
Sierra	95	5,932.95	6,728
Total	**120**	**7,364.12**	**7,322.00**

[127] Fertigation is the practice of applying water-soluble fertilizer with irrigation water (commonly through a micro sprinkler or drip on-farm irrigation systems), thereby combining fertilization and irrigation.

[128] 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.