Evaluating the long-term impacts of rural infrastructure investments in Argentina

Technical Cooperation

I. Basic Information for TC

▪ Country/Region:	ARGENTINA
▪ TC Name:	Evaluating the long-term impacts of rural infrastructure investments in Argentina
▪ TC Number:	AR-T1392
▪ Team Leader/Members:	Schling, Maja (CSD/RND) Team Leader; De Salvo, Carmine Paolo (CSD/RND) Alternate Team Leader; Otero Maria De Los Angeles (CSC/CAR); Buchter Edgar Juan (CSD/RND); Natalia Magrino (CSC/CAR); Jacquet, Bruno (CSD/RND); Diaz Gill Virginia Maria (LEG/SGO); Saldarriaga Jimenez, Andrea (SCL/GDI); Cataldi Marianela (CSC/CAR)
▪ Taxonomy:	Operational Support
▪ Operation Supported by the TC:	AR-L1198AR-L1198-
▪ Date of TC Abstract authorization:	23 Aug 2024.
▪ Beneficiary:	Secretary of Agriculture, Livestock and Fisheries
▪ Executing Agency and contact name:	Inter-American Development Bank
▪ Donors providing funding:	OC SDP Window 2 - Sustainability(W2A)
▪ IDB Funding Requested:	US$300,000.00
▪ Local counterpart funding, if any:	US$0
▪ Disbursement period (which includes Execution period):	30 months
▪ Required start date:	December 1, 2024
▪ Types of consultants:	Firms, Individual Consultants
▪ Prepared by Unit:	CSD/RND-Env, Rural Dev & Disaster Risk
▪ Unit of Disbursement Responsibility:	CSC/CAR-Country Office Argentina
▪ TC included in Country Strategy (y/n):	No
▪ TC included in CPD (y/n):	No
▪ Alignment to the Update to the Institutional Strategy 2024-2030	Diversity; Environmental sustainability; Indigenous People; Social inclusion and equality

Description of the Associated Loan

2.1 The requested Technical Cooperation (TC) is primarily associated with the sovereign guaranteed loan “Provincial Agricultural Services Program (PROSAP) – Phase IV” (AR-L1198), which is the phase of PROSAP currently in execution. PROSAP has been the main policy instrument since 1996 to support rural development in Argentina, with financial and technical support from IDB since its inception. The Bank approved four investment loans totalling US$855 million to finance successive phases of the PROSAP program through 2016. The first three operations were completed in 2012, 2014 and 2017, respectively (AR-0061, AR-L1030, and AR-L1120), and the fourth is still in execution, while a fifth operation with an investment amount of US$325 was approved in 2023 (AR-L1335). Among other

products, PROSAP financed the construction of more than 1,200 km of irrigation and drainage systems, over 1,000 km of rural roads, and more than 7,100 km of power lines for rural electrification. Through these investments in rural infrastructure, the loans have aimed to improve productivity, increase sales and create value added for small and medium-sized agricultural producers, with a focus on strengthening their resilience to climate change (CC).

2.2 The current executing agency is the Ministry of Economy, through the Executing Unit of the General Directorate of Sectoral and Special Programs and Projects (DIPROSE). PROSAP IV is expected to finalize its execution in May 2024 and reach operational closure by the end of this year.

III. Objectives and Justification of the TC

3.1 **Objective.** The objective of this TC is to assess the long-term term impact of rural infrastructure projects from the historical PROSAP portfolio in Argentina, using econometric impact evaluation methods (difference-in-differences and propensity scores) along with panel data from farmer household surveys.

3.2 **Theory of change.** In Latin America and the Caribbean (LAC), a significant portion of farms and rural households lack access to transportation, energy, and other types of infrastructure. For example, 64% lack access to sanitation, 16% to drinking water and 12% to electricity (OECD, 2018; World Bank, 2019). These infrastructure deficiencies in turn, hinder access to markets for agricultural inputs, products, and credit, and contribute to a continuous cycle of low productivity, rural poverty, and food insecurity (IDB, 2019). In addition, the inefficient and unsustainable use of agricultural inputs contributes to the degradation of natural resources, jeopardizing the sustainability of agricultural production. Rural infrastructure development is therefore an essential condition for boosting productivity, equity, and sustainability in the region.

3.3 Empirical research has established that the provision of rural public goods in the form of rural infrastructure (i.e. electrification, irrigation, rural roads) provides essential conditions for the development of markets and private production activities (see, for instance, Dercon et al., 2009; Fan, 2009; Jacoby, 2000; Jouanjean, 2013; Khandker et al., 2009). Investment in rural infrastructure has also been found to be both more effective and efficient than financing of private goods in boosting agricultural productivity, reducing rural poverty, and diminishing adverse effects in the management of natural resources (Fan et al., 2002; López & Galinato, 2007; Sills et al., 2015).

3.4 Even though this empirical evidence shows that rural infrastructure boosts agricultural production and productivity, there are relatively few studies from Latin America and particularly from Argentina. Most studies of PROSAP have relied on methods that do not support causal inference. Only a handful of studies have examined interventions financed by PROSAP using quasi-experimental methods. Using difference-in-differences (DID) methods, Gibbons et al. (2016) evaluated the impact of an irrigation infrastructure project implemented in the second phase of

PROSAP and found significant positive impacts on production (16%) and yields (14%). Two additional studies carried out by the PROSAP executing unit that also used DID and that also focused on irrigation detected consistent positive productive impacts (Rossi, 2013; Rossi, 2016). While these studies represent important contributions, they are limited to one kind of intervention, namely irrigation.

3.5 **Contribution of this study.** Given the financial scale of investments, and the continued implementation of rural infrastructure projects through the PROSAP program, more rigorous empirical evidence is needed to improve project design by, among other things, identifying the most efficient rural infrastructure investments from a portfolio of possible future projects. To that end, this TC proposes to fill this important knowledge gap by assessing the long-term productive impact and cost-effectiveness of rural infrastructure projects in Argentina that have been financed through PROSAP.

3.6 Additionally, to better understand the impact of rural infrastructure improvements on smallholder production systems and rural development in the region, both policy makers and researchers highlight the need for innovative data to rigorously monitor and evaluate the performance of these interventions. While the conventional strategy is to conduct field surveys, remote sensing using satellite imagery is an innovative and increasingly cost-effective tool for evaluating rural development projects. Although satellite imagery presents a low-cost option for measuring changes in land use, crop health, and economic activity at high spatial and temporal resolution, the literature that draws on this data source in the context of impact evaluations remains limited (Kubitza et al., 2020).

3.7 In order to ensure that the program's impact on agricultural productivity and economic activity can be measured, particularly for those projects which were implemented in the first three phases of PROSAP between 2006 and 2017, a complementary and innovative line of work using geospatial data is also proposed. Specifically, measuring and assessing the health and change of crops, soils and yields using satellite imagery is becoming more widely used. Such images can, for example, show variations in organic matter and drainage patterns. Vegetation imagery can show crop growth from planting to harvest, and changes as the seasons and years progress. Additionally, changes in economic activity in the intervention zones can be captured using remotely sensed nighttime lights (NTL) data. A key advantage over most socio-economic indicators which typically rely on census data or similar administrative data, is that light emission can be measured instantaneously, objectively, and systematically at considerably high resolution (Cauwels et al., 2014; Levin et al., 2020). Considering the dearth of reliable socioeconomic data, particularly in the developing world, multiple studies have relied on nighttime light intensity data as a proxy for economic growth to carry out empirical analysis at low levels of spatial disaggregation (Agnew et al., 2008; Alesina et al., 2016; Corral et al., 2018; Corral & Schling, 2017; Schling et al., 2022; Storeygard, 2016).

3.8 This TC then aims to contribute to the generation of evidence of the long-term impact of rural infrastructure investments in Argentina in two ways: First, we propose to use robust econometric impact evaluation methods (difference-in-differences and propensity scores) along with panel data from farmer household surveys to evaluate five rural infrastructure projects (irrigation, rural roads, electrification), financed through PROSAP. Secondly, we propose to complement the analysis based on traditional household survey data with a longitudinal panel of satellite data to measure agricultural yield using the Normalized Difference Vegetation Index (NDVI) or similar indices, and economic activity using Nighttime Lights (NTL). To our knowledge, this analysis would be one of the first to use remote sensing data to estimate the impact of an agricultural project on productive yields and rural development, complementing the work of Ortiz-Monasterio and Lobell (2007), Bellora et al. (2017), Salazar et al. (2021), and Schling and Pazos (2022).

3.9 **Research questions.** Taken together, the proposed research activities aim to address the following specific research questions:

What is the effect of the construction of rural roads, irrigation channels, and rural electrification infrastructure on agricultural yields and production income?
What is the effect of the construction of rural roads, irrigation channels, and rural electrification infrastructure on economic activity in rural areas?
Are these types of rural infrastructure projects cost-effective in the Argentinian context?

3.10 **Identification strategy.** To evaluate the impact of the different types of rural infrastructure interventions characteristic of the PROSAP program, the following five rural infrastructure interventions financed by the program have been selected for evaluation , including two rural roads interventions financed in Entre Ríos and Mendoza Provinces, two rural electrification interventions financed in Formosa and Neuquén Provinces, and one irrigation system financed in San Juan Province. Note that these interventions were implemented in different phases of the PROSAP programmatic series. Additionally, the rural electrification intervention in Neuquén Province benefitted about 6,000 people belonging to two Mapuche indigenous communities, so that a qualitative evaluation of this project will provide additional insight on the heterogeneous impact on this vulnerable population. More information on each intervention can be found in Appendix 1.

3.11 **Data.** We will use data from two surveys conducted separately for each infrastructure project: (i) a baseline survey already administered to a sample of treated and untreated farmers prior to the implementation of each project, as described above, and (ii) a follow-up survey to be administered in 2025/6 to the same farmer households. It should be noted that due to budgetary shortages toward the end of the PROSAP program in both Phase 3 and 4, follow-up data was not collected for these evaluations, though they would render important insights into the effectiveness of these rural development investments. No baseline survey is

available for the PROSAP I and II interventions, so their evaluation will rely on the endline survey and longitudinal satellite data. The agricultural household surveys will measure the outcomes of interest – principally annual agricultural yield, production and income – and additional variables including socio-economic, demographic and productive characteristics of the farmers and their farms.

3.12 Additionally, farmer plots will be georeferenced during the survey to obtain remote sensing imagery that can be used to measure changes in crop yields, land use, and economic activity for a period of several years ranging back to 2000. To understand the temporal dynamics between improvements in rural infrastructure and productivity changes, remote sensing data make it possible to detect pattern variations in crop organic matter, thus capturing their growth from the time of planting to harvest, as well as any other changes that occur over the years and seasons. The accuracy of estimates of agricultural yields and other agronomic and environmental indicators, and their consistency with field measurement, have been confirmed by several studies (see Bégué et al. (2018) and Chivasa et al. (2017) for systematic reviews of this literature). Other studies have established a strong correlation between grass growth and cattle stocking rates that make it possible to approximate livestock productivity with NDVI data (Alves Veloso et al., 2020; Green et al., 2016). A common measurement indicator in this context is the Normalized Difference Vegetation Index (NDVI). The NDVI is a remote sensing index that measures the level of vegetation in a given area. To construct the NDVI, we will use NASA satellite images (Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced, Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI)) for the period between January 2000 (or depending on when each intervention began) and December 2023. Using the georeferenced information from treated and untreated plots, we will calculate the average monthly NDVI for each one using pixel data, following a methodology similar to Huang et al. (2019).

3.13 Lastly, the same georeferenced plot data will be used to construct panel data of NTL to capture changes in economic activity at the farm level. Since NOAA made Earth-based lights captured by satellites publicly available in the early 1990s, an increasing number of papers have relied on NTL as a proxy for income and GDP growth. Numerous studies, including those by Elvidge et al. (1997), Sutton and Costanza (2002), Doll et al. (2006), Ghosh et al. (2010), and Henderson et al. (2012) have attempted to assess the viability of night light intensity as a proxy for traditional measures of economic activity, particularly in contexts where administrative data may not be available, for instance due to low levels of spatial disaggregation. Using the georeferenced information from treated and untreated plots, we will calculate the average monthly NTL for each one using pixel data for the period of January 2000 (or depending on when each intervention began) to December 2023.

3.13 **Methodology.** To identify the causal impact of the rural public goods provided under the Program and to address any remaining concerns about the validity of the control group, the impact evaluation design will employ a difference-in-differences (DID)

method. Under this strategy, two surveys inform the analysis, conducted separately for each of the three infrastructure projects: (i) where available, a baseline survey administered in 2015 or 2019 to a sample of treated and untreated farmers prior to the implementation of the project, (ii) a follow-up survey to be administered in 2025 and 2026 to the same farmer households.

The basic intuition behind the DID strategy is that program impact can be measured by comparing the change in the mean of the outcome variable(s) between the treatment and control households. In this manner, the strategy controls for bias from two sources: (i) systematic differences in time-invariant characteristics between households in treatment and control group, and (ii) general time trends over the period of the Program.

The primary outcome (impact) of interest will be (i) annual agricultural yield, production volume and income (based on survey data); and (ii) monthly logged NDVI and NTL (based on satellite data).

In the case of the longitudinal data collected through remote sensing, our study will apply the DID strategy incorporating an additional fixed effects term at the farm level which allows to control for time-invariant unobservable differences across farms. An additional advantage of this econometric approach is that the longitudinal data will allow us to verify the underlying assumption of parallel trends using the NDVI and NTL data in the years pre-treatment.

3.15 **Strategic Alignment.** The TC is consistent with the IDB Group Institutional Strategy: Transforming for Scale and Impact (CA-631) and is aligned with the objectives of: (i) reduce poverty and inequality; and (ii) address climate change by generating empirical evidence to guide policy makers in the design of rural infrastructure projects that contribute to increasing agricultural productivity and income of vulnerable smallholder farmers, as well as improving their adaptation to the effects of climate change. The Program is also aligned with the operational focus areas of: (i) biodiversity, natural capital and climate action; (ii) social protection and human capital development; and (iii) productive development and innovation through the private sector. This TC will contribute to the IDB Group Impact Framework 2024-2030 (GN-3195-8). The Results Matrix indicators (impact evaluation study, training and dissemination workshops) will help to advance the CRF Country Development results level 1 indicators of government effectiveness (15), voice and accountability (18); and the level 3 indicators of projects supporting institutional capacity and rule of law (9), and average downloads of IDBG publications (22). In addition, this TC is consistent with the Agriculture Sector Framework Document (GN-2709-16), by contributing to the knowledge agenda of the Bank to increase knowledge on the effectiveness of the programs and policies it supports. Additionally, this operation is aligned with the objectives and pillars of the Ordinary Capital Strategic Development Program for Sustainability (OC-SDP for Sustainability) (GN-2819-14), in particular with the objectives of promoting opportunities for LAC productive sectors that directly depend on healthy, functioning

ecosystems (especially agriculture, nature-based tourism and associated segments) to improve the transition towards sustainable production techniques and development. Finally, the TC is aligned with the Bank's Strategy with Argentina (2021-25) (GN-3051; GN-3051-2), by generating knowledge and best practices and making them available to the country with a view to better targeting IDB Group interventions and achieving greater effectiveness, supporting two of the Strategy's strategic pillars which focus on (i) economic recovery and productive development; and (ii) macroeconomic stability and public policy effectiveness. In this sense, the TC will contribute to strengthening policies in this sector with empirical evidence relevant to the national context.

3.16 Beneficiaries. The direct beneficiary of this TC will be the Executing Unit of the PROSAP programmatic series, the Secretary of Agriculture, Livestock and Fisheries. Additional beneficiaries include policy makers and sector stakeholders, both in Argentina as well as in other countries in the regions, who rely on rigorous empirical evidence on the effectiveness of rural infrastructure projects to improve agricultural productivity and welfare of smallholder farmers.

IV. Description of activities/components and budget

4.1 The TC is structured in three components:

4.2 **Component I: Collection of follow-up field surveys.** This component aims to obtain the necessary agricultural household survey data for the impact evaluation of the four PROSAP interventions in Entre Ríos (rural roads), Mendoza (rural roads), Formosa (rural electrification), Neuquén (rural electrification) and San Juan (irrigation). To that end, the component will finance firm consultancies to carry out the implementation of five follow-up surveys to be collected among a random sample of beneficiary and non-beneficiary producers, based on the quasi-experimental and qualitative designs described in the previous section. These surveys will collect information on the productive and socio-demographic characteristics of selected farmers. The consulting firm(s) selected to collect these four surveys will prepare a summary report of the survey results.

4.4 **Component II: Geospatial data collection and processing.** This component aims to obtain and process remote-sensing data to estimate PROSAP's impact on agricultural yields and economic activity using satellite images of vegetation and nighttime lights for a random sample of beneficiary and non-beneficiary farms. To that end, the component will finance firm consultancies to carry out two activities: (i) data collection, processing and cleaning of satellite imagery to measure agricultural yields and economic activity, ensuring calibration and validation with regards to collected plot polygons; (ii) data analysis using remote sensing data to estimate the NDVI (or similar indices) and NTL.

4.5 **Component III: Supervision, evaluation, and dissemination.** This component aims to support evaluation activities and generate knowledge products based on the

data collected. In order to do so, the component will finance individual consultancies and workshops to carry out the following activities: (i) field technical supervision, to ensure surveys are implemented according to highest technical standards on the ground and coordinated closely with implementing units in each province and with regards to geospatial data collection activities; (ii) research assistance for data analysis and impact evaluation report preparation, to provide the needed technical resources to carry out a rigorous econometric analysis; (iii) dissemination events of evaluation results, including the organization of an in-person seminar with relevant policy stakeholders in Argentina, as well as a virtual seminar to facilitate the participation of a wider audience, as well as printing and distributing of dissemination materials, such as infographics and policy briefs; and (iv) a workshop to provide capacity building on evaluation methodologies, including the use of remote sensing technologies for monitoring and evaluation, among project executing partners in Argentina (DIPROSE and stakeholders in the provinces and at universities).

4.6 **Expected results.** The expected result of this TC is to generate robust empirical evidence about the long-term impact of rural infrastructure provision in Argentina, thereby contributing to evidence-based policy making in Argentina and elsewhere in the region.

4.7 The estimated total cost of this operation is US$300,000 to be financed with resources from Window 2 (W2A – Sustainability) of the Ordinary Capital Strategic Development Program (OC SDP). The operation will not receive counterpart funding. The execution period for the operation will be 30 months. The Inter-American Development Bank will execute and supervise the fulfillment of the responsibilities derived from this TC.

Indicative Budget (in US$)

Activity/Component	IDB Funding	Counterpart Funding	Total Funding
Component 1	**160,000.00**	**0.00**	**160,000.00**
Product 1: Follow-up survey collected in Entre Ríos	35,000.00	0.00	35,000.00
Product 2: Follow-up survey collected in Mendoza	35,000.00	0.00	35,000.00
Product 3: Follow-up survey collected in Formosa	35,000.00	0.00	35,000.00
Product 4: Follow-up survey collected in San Juan	35,000.00	0.00	35,000.00
Product 5: Qualitative evaluation conducted in Neuquén	20,000.00	0.00	20,000.00
Component 2	**30,000.00**	**0.00**	**30,000.00**

Product 1: Remote-sensing data collected, processed and validated	20,000.00	0.00	20,000.00
Product 2: Remote-sensing data analyzed to calculate NDVI and NTL	10.000,00	0.00	10.000,00
Component 3	**110,000.00**	**0.00**	**110,000.00**
Product 1: Field work technical supervision report finalized	20,000.00	0.00	20,000.00
Product 2: Statistical and econometric analysis finalized for impact evaluation	70,000.00	0.00	70,000.00
Product 3: Dissemination activities (seminar, materials) completed	10,000.00	0.00	10,000.00
Product 4: Evaluation training workshop completed	10,000.00	0.00	10,000.00
Total	**300,000.00**	**0.00**	**300,000.00**

4.7 **Supervision.** The IDB, through the project team leader, will have the responsibility for the implementation and overall supervision of the project. Supervision will be closely coordinated with the Secretary of Agriculture, Livestock and Fisheries through DIPROSE's monitoring and evaluation team, as well as PROSAP's executing units in the five provinces (Entre Ríos, Formosa, Mendoza, Neuquén and San Juan) to facilitate field work.

4.8 **Monitoring and evaluation.** Monitoring of the TC will be carried out by the project team, comprised of CSD/RND members at HQ and at the Argentina country office. On an annual basis, the team will produce progress reports on each of the components and expected results of the TC. The final evaluation report will be the key deliverable of this TC and will be available by the end of TC execution.

V. Executing agency and execution structure

5.1 The Inter-American Development Bank will execute and supervise the fulfillment of the responsibilities derived from this TC in light of synergies and complementarities with Bank operations and research, as requested by the Secretary of Agriculture, Livestock and Fisheries. The Bank and the Secretary of Agriculture, Livestock and Fisheries will coordinate the contracting and focus of the studies to be contracted with the resources of this TC. Execution by the Bank will ensure the timely contracting of TC consultancies contracted by the Bank. The principal reason for this execution structure is that the IDB, and the research team in particular, have the technical expertise to conduct the research described above. They have considerable experience conducting rigorous impact evaluations, including experimental ones, to evaluate the efficacy of agricultural interventions. In addition, the IDB and the project team have considerable experience implementing and analyzing IDB rural infrastructure interventions. A second reason is that the Bank has the capacity to identify and fill knowledge gaps at the regional scale. A final

reason has to do with dissemination: the policy implications from the proposed studies will be informative for other countries.

In coordination with the Secretary of Agriculture, Livestock and Fisheries, the IDB, as executor of this TC, will be responsible for: (i) identifying the necessary studies and technical work; (ii) selecting and contracting consultants to provide the necessary services; and (iii) managing the execution and delivery of the consultancy services. The Climate Change and Sustainable Development Sector (CSD) will act as the Basic Responsibility Unit for these procurements.

5.3 The activities to be executed under this operation will be included in the Procurement Plan and will be executed in accordance with the Bank's established procurement methods, namely: (i) hiring of individual consultants, as established in the Complementary Workforce Document (AM-650); and (ii) contracting of services in accordance with the Institutional Procurement Policy (GN-2303-33) and its associated guidelines.

5.4 The knowledge products generated within this technical cooperation will be the property of the Bank and may be made available to the public under a creative commons license. However, at the request of a beneficiary, in accordance with the provisions of AM-331, the intellectual property of said products may also be licensed to one or more beneficiaries through specific contractual commitments that shall be prepared with the advice of the Legal Department. In case this operation will receive, manage or use information that may contain personal data or sensitive information through the collection of survey information, compliance with the Bank's Personal Data Privacy Policy (GN-3030) will be assured, for instance through the submission of a Data Privacy Impact Assessment.

VI. Major issues

6.1 The main risk associated with the implementation of this TC is the delay in identifying and contracting the consulting firms that will carry out the work, which could affect the timing of the completion of the PROSAP program's impact evaluation (which, in the case of PROSAP IV, is a key input to the operation's PCR). A delay in the implementation of the field survey for the impact evaluation has also been identified as a potential risk that would not allow the work of Components 1 and 2 to be synchronized. To mitigate these risks, the project team has prepared Terms of Reference (TOR) and has initiated the contracting process. In addition, the process of identifying the information needed to identify the samples for each production chain (Component 1) and to obtain georeferenced plot information (Component 2) has already begun, all in close coordination with DIPROSE.

VII. Exceptions to Bank policy

7.1 There are no exceptions to Bank policy.

VIII. Environmental and Social Aspects

8.1 This Technical Cooperation is not intended to finance pre-feasibility or feasibility studies of specific investment projects or environmental and social studies associated with them; therefore, this TC does not have applicable requirements of the Bank's Environmental and Social Policy Framework (ESPF).

Required Annexes:

Request from the Client_79833.pdf

Results Matrix_7028.pdf

Terms of Reference_38902.pdf

Procurement Plan_46024.pdf