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Latin America and Caribbean Environment Unit
World Bank

IMPACT EVALUATION REPORT

Evaluating the Impacts of the Formalization of Water Right for Agriculture Use: Water Rights in Peru

February 2012

1. INTRODUCTION

1.1 Water Management and Development

Water is essential for human survival and is indispensible as a commodity that serves various social, developmental, and commercial purposes. However, as a commodity that is scare and essential for human survival, the manner in which communities and nations manage water resources is crucial in order to preserve societal cohesion; management of water resources is also a recognized priority for development and poverty reduction. According to the United Nations, 2.7 billion people will face severe water shortages by 2025. In this context, the coordination of water use becomes complex as well as crucial for the mitigation of conflicts. Furthermore, the recent episodes of the rise in food prices reinforces the need to promote and assure an efficient allocation of water resources that are able to enhance agriculture productivity and prevent sub nutrition in developing countries.

Water has unique features as a resource and a commodity that distinguish it from other natural resources: mobility, uncertainty in supply, bulkiness, indivisibility, social and environmental uses, sequential and multiple uses, and interdependency among uses, and other. These characteristics of water can give rise to multiple market failures such as a vulnerability to monopolization and natural monopolies, externalities, public goods, and asymmetric information. These must be addressed by institutions in order to ensure efficient resource allocation. The implementation of water rights reforms is a frequent approach undertaken by governments and communities alike in order to promote secure and sustainable access to water. The theoretical aspects of water rights implementations and their outcomes have been vastly studied. However, to date there are few or no rigorous scientific impact evaluations showing the *effectiveness* of water rights reform in delivering the desired outcomes of water (-resource-) allocation. Most authors do agree that by reducing conflicts and uncertainties about water supply, water rights for irrigation are expected to promote investments in new and more efficient production technologies as well as shift the pattern of production to higher value crops. As a consequence, well-implemented water rights are expected to improve income generation and living conditions of agricultural producers in developing countries.

1.2 Peru: Country Context

The Republic of Peru is a developing country situated in western South America with a population of approximately 30 million people. The Peruvian Highlands (the *Sierras*) represent 30 percent of the country's surface and about 35 percent of its population. Currently more than 10 million people live in the Sierras. The region is characterized by high poverty rates[1]. While the rural Sierra has less than 25 percent of Peru's population, it accounts for 54 percent of the extreme poor. In recent years, the Sierra region has witnessed a growing number of water-related conflicts and disputes. The region experienced rapid growth in demand for water due to population growth, urbanization, and the development of industrial and in particular, mining activities in past decades. Meanwhile, climate change has begun to affect the supply of regional glacial water. Combined, these changes have reduced the availability - and increased the cost of - water used for irrigation. Agriculture is the main economic activity in the Sierras; it accounts for one-quarter of the local GDP and the main source of income for 70 percent of the households in the region. For this reason, scarcity and inefficient allocation of water resources have huge impacts on the already poor living conditions of the Sierra inhabitants.

1.3 Modernization Measures

[1] According to the National Institute of Statistics (INEI) in Peru, in 2002, 80 percent of the population was classified 'poor' and almost 60 percent lived below the extreme poverty line - 20 percent more than the national average.

In order to address the critical issues in water management and increase agriculture production in the Sierras, the Government of Peru, in partnership with the World Bank, is currently implementing the Peru Irrigation Sub-sector in the Sierra and Water Resources Management Modernization Project (US$ 49 million)[2]. The project has the objective of strengthening the technical, financial, and management capacity of farmers and water users' organizations in targeted irrigated areas of the Sierra.

Within this irrigation modernization project, there is a component on the 'Formalization of Water Rights and Extension to the National Water Registry' (- in Spanish, PROFODUA - Program de Formalización de Derechos de Uso de Agua) which today is Peru's national program of formalization of water rights for irrigation. The program was requested by the national board of water users as a way to implement the General Water Law (enacted in 1969) and give legal security to individual and communal water users. PROFODUA allocates water rights[3] based on the available water resources, fostering efficient, equitable, and sustainable water use. It includes an innovative approach for water rights formalization in the Peruvian Andean (Sierras) region. This process in Peru is free of cost to the water user. The innovative character also lies in the following aspects:

i) Extensive use of the prior land titling actions available;
ii) Analysis of water availability to ensure that issued water rights do not exceed supply; and,
iii) In-field verification of the land and water use (using modern technology such as digital aerial photography, high resolution satellite images, geographical information systems, satellite positioning systems, among others).

Nothing comparable has been undertaken so far in the highlands of Peru, or in neighboring countries. It is expected that PROFODUA's intervention in the Peruvian Sierra will have a high potential for replication in these areas.

PROFODUA also relies on intensive participation of local communities. Community participation is ensured through information and awareness raising campaigns, discussion platforms, and technical assistance. Members of the communities fill required documents that state their individual use of irrigation water and their local leaders (e.g. mayors in *municipios* - municipalities, local leaders, or *presidentes de comunidades* in local communities) accompany the process and promote wide-spread participation. Previous experiences implementing the program in Peru's Costa region have proven that such participation is essential for the success of the project. PROFODUA's main objective is to improve the livelihood of poor farmers by promoting equitability and reducing uncertainty about water supply for irrigation. The formalization of water rights is also expected to impact the accountability and transparency of the water users' organizations, their organizational roles and responsibilities regarding system maintenance, and the services they provide to the producers. Indeed, a water right is also a social relationship and an expression of power. The formalization of water rights may result in greater equity in its distribution and strengthen the position of less powerful stakeholders. These hypotheses on the inclusiveness and equity of the program, however, will also need to be tested by the evaluation study.

When fully implemented, the project will deliver two direct outputs: Formal right and issue water licenses or so-called licencias de agua (i.e. permanent water use rights), and, an information system of all users for irrigation water as well as the mapping of all water and land resources in the Sierra

[2] 40 percent of this project is being currently financed by the World Bank.
[3] These are non-transferable water rights of an indefinite duration by law, linked to the use of a specific land plot.

region. In four years of implementation, PROFODUA issued 200,000 water licenses[4] and it is likely to continue expanding inside and outside Peru. So far however, the impacts of the program have not been formally assessed.

2. PROJECT EVALUATION BACKGROUND

2.1 Rationale and Objectives

In line with the Bank-aided Sierra water resource management modernization project and the PROFODUA, an Impact Evaluation study was proposed by the World Bank and its Peruvian counterparts in order to develop a rigorous evaluation of the impact of the program of formalization of water rights for irrigation use in Peru. The main goal of the impact evaluation study was to properly measure the causality of this *intervention* (i.e., the formalization of water rights) on a set of development outcomes[5]. Given the scale of PROFODUA – it will operate in 21 valleys and finance the formalization of about 200,000 Agricultural Water Rights (Licencias con Fines Agrarios) and their integration in the existing National Water Rights Registry when completed– it was deemed crucial to understand how exactly this component of the broader modernization will impact stakeholders for the better.

The purpose of developing a formal impact evaluation of PROFODUA is three-fold:

i) Measuring and documenting the impacts of the program;
ii) Helping to improve the design and efficiency of the program in future implementations; and,
iii) Adding to the scarce empirical literature on evaluation of Water Rights Reforms.

The study will also contribute to the capacity development of the PROFODUA in-country team by strengthening their capacity to conduct and use impact evaluation for results-based management, and promoting country ownership of the information generated through this process.

2.2 Team and Timeline

The impact evaluation team is led by Luis Andres and Darwin Marcelo, and comprised of Word Bank staff, Peruvian academics and local implementing partners with local supervision and consultants where necessary. The evaluation team also counted with the full collaboration of the World Bank project team consisting of Marie-Laure Laujanie and Erwin de Nys, who guided the evaluation in its different states The impact evaluation exercise will have joint supervision from the World Bank team and PROFODUA. The primary source of funding for this study was the Spanish Impact Evaluation Trust Fund (SIEF) and the World Bank project will commit budget for cost-sharing this evaluation for the follow up surveys and activities.

The timeline for the impact evaluation work is as follows:

Apr to Sep 2010: Formalization of the evaluation design, questionnaire, simple design and implementation of the pilot for the data collection;

[4] This amounts to forty times the number of licenses issued *in total* over the previous 35 years.
[5] Table A for the potential impacts of PROFODUA

June 2011: Field work: base-line data collection;

Dec 2011 to Mar 2012: Development of the evaluation analysis and dissemination of these results;

November 2014: Field work for the follow-up survey;

Dec 2014 to Mar 2015: Development of the evaluation analysis and dissemination of the results.

2.3 Research Questions

The team will seek to evaluate the effect of the granting of water rights/permits and a number of perceived outcomes including:

- **Does the intervention promote the adoption of new techniques?**
- **Does it increase production of food products?**
- **Does this system establish equitable access to water?**
- **Is there an increase in the investment of farmers and an improvement in their access to credit due to the program?**

The study seeks above all to understand if the implementation of PROFODUA, through the distribution of water licenses and creation of an information system, actually leads to the outputs and outcomes presented, and to measure the size of these effects on the participant communities.

3. METHODOLOGY: DESIGN AND APPROACH

3.1 Evaluation Design

The survey will measure the responses by the groups that were treated (i.e. given water rights/permits) and compare with those that were not as the 'control groups' under PROFODUA. The evaluation will present and compare statistics for relevant variables for the treatment group and the control group (- which will in fact eventually receive the treatment through a phase-in randomized design). Individuals under the Treatment Group and the Control Group (ITG and ICG, 'I' signifying Internal) who will eventually get the treatment are located in the valleys of Andahuaylas, Huamachuco, and Tarma. These locations were selected due to their propensity to suffer from droughts, thus making the access to water more important.

Randomization

The team proposed a robust identification strategy by randomizing at Irrigation Board (block)b level. Instead of intentionally preventing farmers from accessing the program, the identification strategy works within the natural timing and logistic limitations of the project implementation to construct a *counterfactual.* A group of three representative valleys (mentioned above) were selected for the evaluation. We focus on valleys with a critical mass of blocks and that have not received PROFODUA yet. Assuming that there are 80 blocks in a given valley, physical and human capacity constraints limit the implementation of the program to at most 20 blocks per year. Inevitably, it will take four years to serve all the properties in the valley. The identification strategy consists of using a lottery to randomly distribute the blocks into four different groups. Each group will receive the intervention in a different year where the individuals intervened in the fourth year will serve as a control group for those reached in the first year.

The randomization over a critical number of blocks assures that on average individuals in the treatment and control groups are similar with respect to observable and unobservable characteristics that could influence the results of the program. Choosing from the pool of pre-selected producers helps the internal validity of the evaluation. These producers are likely to have similar levels of organization, motivation, income, and geographic conditions. Finally, randomization across blocks has the advantage of being a fair and transparent method for determining the order in which the benefit will be received and it is likely to be accepted for all involved parts.

The 'External Group' (EG)

To obtain preliminary results on the potential effects of the program, an "external" group was selected to be part of the baseline. This external group was comprised by a valley, Huaraz, that was partially intervened. A sample of those blocks that already benefited from the program will be matched to those blocks that were not exposed to the intervention. These intermediate results will serve as a first approximate reference of the "potential" impact of the intervention.

Moreover, a similar analysis is presented to establish any significant differences between those two groups and the 'external group', in this case, the valley of Huaraz, where the program has already been implemented, thus establishing the individuals' right to using their water.

In attempting to prepare a preliminary evaluation result, the impact evaluation in Peru is pursuing two strategies that result in essentially two comparisons:

- **For the short-term and for immediate comparison to evaluate the intervention**, comparing the average EG farmers development indicators (as reflected in Table A) post-intervention to the average household development indicators of ICG and ITG; and eventually,
- **Over the medium to long-term**, comparing the household development indicators between the ICG and ITG that will be indicative of the benefits from the Irrigation Boards/permits (the 'intervention').

The premise in the approaches above is that a) the internal treatment group and internal control groups , based in the valleys of Andahuaylas, Huamachuco and Tarma, have the same socio-economic conditions at present, and b) the external group, in Huaraz, which already has connection to the sewerage system, had the same *initial* conditions as what the ICG and ITG have at present – before the treatment begins.

This is at present an *ex-post* analysis comparing household groups already part of the Water Board and permit system and household groups that are not. Measuring impacts between the ICG and ITG through the Difference-in-Differences (DiD) methodology (Section 3.3) will be done in the final phase of this impact evaluation study.

3.2 Indicators

It is expected that the intervention will have positive impacts on human development outcomes, including health and nutrition. Water security provided by formalized water rights is likely to yield efficiency benefits, as it protects water users from uncompensated extractions by others, reduces uncertainty for production planning, and facilitates optimum allocation of water for crops. Equity benefits are also expected as small downstream producers benefit specifically from the distributional impact of equal access to water by block. These benefits are likely to encourage producers to invest more in their farming system, for example, through improved on-farm irrigation technologies and changes in crop mix. As such, the pathways linking the formalization of water rights to food

consumption and nutrition along the food supply chain are mainly related to (i) an increase in the direct consumption from increased food production; and (ii) an increase in income from the sale of agricultural commodities. Other major benefits include increase in agricultural investments (tools and techniques, as water supply is more predictable, and presumably, adequate); increased diversity in crops by the farmers; increased productivity; increased farming incomes; and, over the longer-term, improvement in health conditions for the farmer and his/her family as higher incomes increase nutrition and other standards of living.

The formalization of water rights is also expected to impact the accountability and transparency of the water users' organizations, their organizational roles and responsibilities regarding system maintenance, and the services they provide to the producers. Indeed, a water right is also a social relationship and an expression of power. The formalization of water rights may result in greater equity in its distribution and strengthen the position of less powerful stakeholders. These hypotheses on the inclusiveness and equity of the program, however, will also need to be tested by the evaluation study.

Major immediate, short and long-term benefits, which in turn translate into indicators for the team, are listed in *Table A* below.

Table A: Potential impacts of PROFODUA with the Intervention: Water Licenses and Registration/Information System of water users

Immediate Impacts	Short-term Impacts	Long-term
Individual/farmer-level	**Individual level**	**General outcomes**
- Increase legal security -Increase user's satisfaction about quality and frequency of irrigation -Reduce uncertainties -Improve access to credit -Increase in investments -Adoption of new technologies -Increase diversity of crops	-Increase production -Increase productivity -Improve access to exporters -Intensify investment planning (future contracts) -Increase property values -Increase income -Increase consumption	-Improve nutrition -Reduce emigration -Improve education for the kids -Improve health conditions
Collective level	**Collective level**	
-Improve internal organization of the committee -Increase information about the users -Promote formation of associations (cooperatives, exporting association, credit association, etc.) -Reduce the number of conflicts -Promote equitable access to the water -Promote collection and administration of water tariffs	-Increase in the irrigated area (new properties) -Improve quality and management of the irrigation infrastructure	

3.3 Measuring Impacts: The Methodology of Analysis

In addition to the identification of the research questions, the sample structure, treatment and control groups, a systematic impact evaluation requires the definition of a framework of analysis: the study will implement a Difference-in-difference (DiD) approach.

A DiD methodology consists of measuring the average changes in a given indicator between the periods before and after the intervention for both treatment and control groups, and then comparing the changes for the two groups. The differences between two groups reflect the isolated effect of the program. This approach requires the existence of a base-line and post-intervention information for both groups. For this reason, this project will start with the implementation of a base-line survey collecting information about individual, household, and community characteristics of the beneficiaries. The survey will then be re-applied to the same sample just before the beginning of the last round of the program. A difference-in-difference econometric analysis will allow verification of the effectiveness of the randomization strategy creating comparable groups and to correct some potential "contamination" of the data. The *before* and *after* difference for each group corrects for any remaining fixed difference between treatment and control, while the between groups deals with external factors that affect the target population during the interval of analysis. Assuming that those factors reach treatment and control equally, the second difference successfully isolates the true causal effect of the intervention.

4. DATA ANALYSIS, EVALUATION AND FINDINGS

4.1 Household Data Summary

The survey was divided into two stages: Initially, the interviews were conducted for the Treatment Group regions in Andahuaylas, Huamachuco, and Tarma, and the program designers sought to interview 1,607 households. As for the Control Group of Huaraz, 401 households were interviewed. The survey includes information for 2,008 households that include 7,325 individuals.

Descriptive Statistics – Structure of the Survey

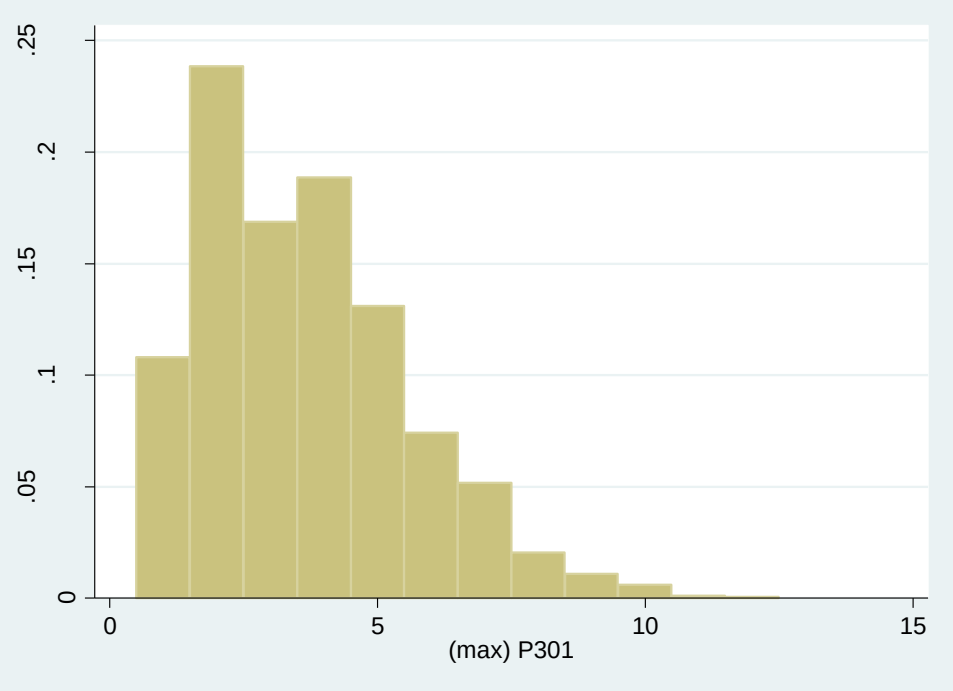
Variable	Obs.	Mean	Std. Dev.	Min	Max
Male (binary)	7325	0.479	0.499	0	1
Age	7274	35.39	23.26	0	98
Younger than 13 (binary)	7325	0.196	0.413	0	1
Age of the household head	2008	56.28	15.23	20	98

Source: Survey Data, Impact Evaluation Team, 2011.

The results show that 47.95% of surveyed individuals are male, while 52.05% are female. The average age for the individuals is close to 35 years old, and 19.58% of them are 13 or younger. The oldest person in the sample is 98 years old.

The figure below introduces the distribution of the number of people within the households. This information is relevant given that the analysis will cover on the program's impacts in children, and therefore the need to focus on the households that have at least two members.

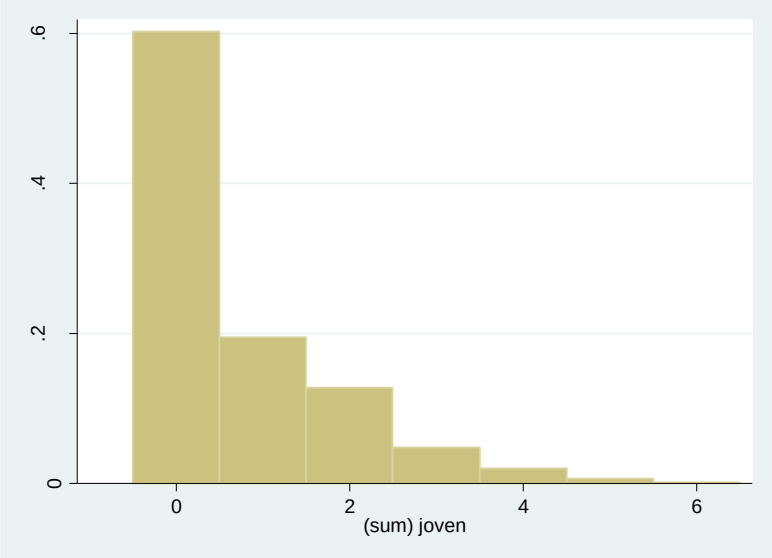
Number of individuals living in the household



Source: Survey Data, Impact Evaluation Team, 2011.

We see that most households have two, three, and four members, and that the mean of people within the households is 3.65 (members). In order to further determine the household structure, the analysis looks at the number of children within the household. Any household member younger than thirteen years old is considered a child for the purposes of this study. The figure below presents the distribution of children within the households.

Number of children younger than 13 by household



Source: Survey Data, Impact Evaluation Team, 2011.

We see that 60.21% of households do not have any children, while 19.47% report having one child, and 12.75% have two children. The number of households with more than two kids is just 7.57 %, which amounts to just 162 households.

We are also interested in the variables which show the economic characteristics of the surveyed individuals. The table below presents the descriptive statistics that show the number of hours worked and the monthly income for the participants. The survey indicates that 78.39% of the heads of the household held a job last week. The average monthly income for the household is $506 *Peruvian Soles* with a standard deviation of $635. Finally, the survey shows that just 28.94% of the surveyed adults had completed a high school degree, while just 140 individuals had finished a college education. Most of the individuals in this subgroup (26.61%) had not completed primary school.

Descriptive Statistics – Socioeconomic Characteristics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Head of household – worked (binary)	2008	0.784	0.419	0	1
Monthly household income	1607	506	635	0	9000
Completed HS degree or more (for those 21 or older)	4633	0.289	0.459	0	1

Source: Survey Data, Impact Evaluation Team, 2011.

Health indicators are nother crucial element emerging from the baseline; the table below contains information about the relevant health indicators in the survey. A majority of respondents said that they had been sick for at least one day in the past month (99.02%), and the average days of sickness was 9.28 during the month. Moreover, just 38.66% of those who had been sick answered that they had fully solved the health problem; while a majority answered that they had partially dealt with the issue (42.71%). Only 4.01% had been unable to solve their problem due to a lack of financial means. Moreover, given the respondents' answers, health coverage does not seem to be an issue in the three survey regions. For instance, 58.26% of those who had been sick were treated wither in a hospital, a small rural clinic. Just 14.14% had not relied on someone else for help, and about 17.97% of them solved the issue by talking to the local pharmacist (this was most likely the case with small illnesses).

Descriptive Statistics – Health Statistics

Variable	Obs.	Mean	Min	Max
Sick in the past 30 days	1838	0.9902	0	1
How many sick days	1838	9.2832	0	30
Fully solved health problem	1838	0.3866	0	1
Visited hospital or rural clinic	1838	0.5826	0	1

Source: Survey Data, Impact Evaluation Team, 2011.

Lastly, the following table presents general information about the households' situation in terms of water usage for their *chacras* (small landholdings). On average, the households were only able to water their chacra for about 5 months in the past year, thus reducing the potential agricultural yields from their plot. Furthermore, even when they did water their plot, they had to do so by relying on gravity (97.61% of them), as opposed to using more productive techniques such as irrigation. In terms of right to water use, only those in the external group (in Huaraz) already had access to them (19.97% of total households in the survey).

Descriptive Statistics – Variables related to water usage

Variable	Obs.	Mean	Min	Max
Months watering chacra	2000	4.71	0	12
Water chacra by gravity	2008	0.9761	0	1
Right to water use	2008	0.1997	0	1

Source: Survey Data, Impact Evaluation Team, 2011.

4.2 Balance Statistics: Internal Control and Treatment Groups

The intervention relies on a randomized experiment with a phase-in design. First, the households in each of the three regions were randomly assigned to either the treatment or the control group. Given that the program designers were interested in providing water rights to the entire target population, they decided to rely on a phase-in design, which results in access for everyone while being able to conduct an evaluation after the first group has received the treatment, but before the second group has been 'treated'. The database contains information for ITC (-treated first) and ICG (those treated in the second phase of the evaluation).

These groups should not be significantly different in any of the relevant measures.The following table presents the number of individuals, households, and children in each of the two groups.

Number of observations by group

Variable	ITG	ICG
Number of households	751	856
Number of individuals	2623	3106
Number of children	571	678

Source: Survey Data, Impact Evaluation Team, 2011.

We find that the groups are evenly divided, with ICG having a slight majority of households within the entire treatment population (53.27%). Furthermore, the percentage of individuals in each group (54.22% for ICG) is similar to the households in each group, which seems to indicate that the households in each group are equal in size. Finally, the percentage of young children in the household (54.28% for ICG) resembles the previously presented indicators. This also seems to indicate a similar household structure for each of the groups, given that they have a similar percentage of kids within them.

The data also presents a comparison between the groups' socioeconomic, health, and housing indicators to understand whether there are any significant differences between them:

Health, housing and socioeconomic indicators for each of the groups

Variable	ITG	ICG	p-value
Head of Household -- worked	0.755	0.791	0.0861
Homeowner	0.866	0.879	0.3952
Brick Walls in Place	0.055	0.068	0.2357
Sick in past 30 days	8.762	8.366	0.7202
Cement floors	0.236	0.257	0.3230
Can read and write	0.822	0.825	0.7251
Programa Juntos	0.049	0.456	0.5348

Source: Survey Data, Impact Evaluation Team, 2011.

The table above shows that there are no significant differences in the relevant variables between the treated group and the control. While some of the numbers are slightly higher for ICG, these

differences are not statistically significant, which confirms the fact that at least in terms of health, housing and socioeconomic indicators, the two groups are not different and are likely to produce reliable estimates during the evaluation.

The table below shows the difference in the relevant water usage variables by each group. It is important to see, in particular, whether there is a difference in the percentage of households that already have a right to water use pre-intervention.

Water usage variables by group

Variable	Group 1	Group 2	p-value
Months watering chacra	5.03	5.59	0.0254
Water chacra by gravity	0.971	0.988	0.0117
Would you like right to water use	0.874	0.943	0.0524
Willingness to pay for irrigation	1.400	1.470	0.2735

Source: Survey Data, Impact Evaluation Team, 2011.

As can be seen in the table, the differences between the groups for a few of the variables are statistically significant at the 5% level for all the relevant water usage variables.

4.3 Internal Groups(IT) and External Group (EG)

In order to show the potential impacts of the program's intervention, the team conducted a survey and presented the data for an external group, located in Huaraz. This group, comprised of 401 households, had already received the intervention, and is therefore expected to show some differences in terms of the water usage indicators when compared to the future treatment – and current, control – groups.

The following table presents the differences between the households that will be treated in the three regions (ITG) and those who have already been treated, in Huaraz (EG).

Comparison of the treatment groups with the external control group

Variable	IG (1)	EG (2)	p-value (3)
Age	35.10	36.40	0.0490
Head of Household -- worked	0.5432	0.4624	0.0000
How many sick days in past 30 days	8.3767	11.54	0.0000
Homeowner (binary)	0.8731	0.8529	0.2840
Brick Walls in Place	0.0622	0.0299	0.0117
Months watering chacra	5.33	3.00	0.0000
Water chacra by gravity	0.9801	0.9127	0.0000
Cement floors	0.2470	0.2319	0.5284
Programa Juntos	0.474	0.001	0.0000
Can read and write	0.823	0.829	0.5814

Source: Survey Data, Impact Evaluation Team, 2011.

The IG is also younger than the EG, although the variable is only significant at the 5% level. The table above shows significant differences between the two groups, given that those in IG seem to be doing better in terms of health, housing, and income than those in the external group. While this may seem contradictory, given that the external group *has already received the treatment*, the differences may be due to the fact that Huaraz could be a poorer region than the three to-be-treated, thus making the comparison unfair. However, the table shows that the intervention was correctly applied in Huaraz given that 99.25% of households in the survey have the right to water use and the vast majority of

them (94.47%) have the right through legal and certified means, as opposed to the low percentage in the IG. Finally, the table also shows that a smaller percentage of households in the secnd group had to water their plots by relying on gravity, thus increasing the usage of more advanced techniques (like irrigation).

In order to better understand the potential effects of the intervention, the survey presents the respondents' answers for a few variables pre- and post-intervention. Although the answers could be helpful for understanding the impacts of the intervention, it is important to note that there is room for potential respondent error, given that they may not correctly remember the answer to some questions (such as the worth of their chacra). The results are presented below:

Pre- and post-treatment effects on the external control group

Variable	Pre-	Post-
Conflicts due to water usage	0.1809	0.1106
Access to credit	0.0603	0.1658
Worth of chacra	7667	8039

Source: Survey Data, Impact Evaluation Team, 2011.

The variables presented in the table above show some improvement for the respondents in Huaraz after the intervention. For example, the results show a significant decrease in water conflicts, which may be driven by the better allocation of the rights of water usage, caused by the intervention. Furthermore, the access to credit showed a vast improvement, which is consistent with what households had answered about expecting to have better access once they were granted these rights.

Finally, there is a small improvement in the self-assessed worth of the chacra, although the difference is not statistically significant.

5. Conclutions

As the different tables and figures show, there are no significant differences between the treatment and control groups, which makes it likely that the evaluation will yield unbiased results. On the other hand, it is important to note that a significant percentage of the households in these two groups already had some sort of right to water usage, although not formally established. If the households do not view these two types of rights as significantly different, they may not have an incentive or the certainty to change their behavior about their water usage.

While the external group allows for examining the potential impacts of the intervention, it seems that the region of Huaraz is significantly poorer than the other three regions, which may be the reason behind the lower values for the relevant variables where comparing the IG with the EG (Age;sick days; work by Head of Household; literacy). The evaluation has to account for the differences in the economic status of each region before conducting any significant comparisons. On the other hand, as shown in the table above, there are improvements in a few of the relevant variables for the households in Huaraz, which indicates that the PROFODUA may have a significant role to play for the future treatment groups.

The variables presented in the table above show some improvement for the respondents in Huaraz after the intervention. In particular, the preliminary results show a significant decrease in water conflicts, which may be driven by the better allocation of the rights of water usage, caused by the intervention. Furthermore, the access to credit showed a vast improvement, which is consistent with what households had answered about expecting to have better access once they were granted these rights.

ANNEX 1: The Process of Formalization for of Water Rights

The process of formalization of water rights is comprised of the following five main activities:

(1) Preliminary actions – PROFODUA's team arranges a meeting with the chosen local irrigation committee for the preliminary identification of the irrigation network, current allocation and standards of water use. The team also organizes an informative meeting to clarify the objectives of the program and prepare the members of the community for the following stages.

(2) Field work – During the field visits, PROFODUA's team collects information about plot sizes, ownership and production characteristics. Producers must present their national ID and land title in order to be included in the program.

(3) Office work – The information collected during fieldwork is verified, compiled and integrated into PROFODUA's information system. Combining satellite information of the area to the field data, the technician validates the dimensions and characteristics of the irrigation block and plans the allocation of the water resources across land plots.

(4) Proposition of water allocation and public consultation – The compiled information and proposed allocation is made publicly available. The information is posted for 15 days in strategic places previously defined by the irrigation committee. During this period, the local community, farmers and individuals can study the process and allocations and propose modifications.

(5) Issuing and distribution of the water rights – After the period of public consultation and modifications, individual and communal water rights are distributed as a public act. The irrigation committee also receives a document from PROFODUA that contains information of all the formalized users in the block.