The Impact of Agricultural Extension Services: The Case of Grape Production in Argentina

Pedro Cerdán-Infantes, Alessandro Maffioli, and Diego Ubfal*

ABSTRACT

In this paper we evaluate the impact of the provision of agricultural extension services to grape producers in Mendoza, Argentina, on yield and grape quality. Using fixed effects and matching techniques, we show that despite presenting non-significant average treatment effects on yield, the program has large positive effects on productivity for producers who were in the bottom of the productivity distribution before the launching of the program. There is also evidence of increased grape's quality, especially for large producers and those in the middle of the yield distribution. However, large groups of producers did not see any impact on yields or quality. Consistent with a previous qualitative evaluation of the program, these results point to the need to balance flexibility of the program with effective targeting mechanisms. Producers with different characteristics, such as land size, productivity or structure of production seek different objectives and have different needs, so that targeting these types of programs effectively to the different needs of producers would increase their effectiveness.

JEL Codes: Q12, Q16, H43

KEYWORDS: Technology Adoption, Productivity, Agriculture Sector, Policy Evaluation

* Pedro Cerdan-Infantes, Office of Evaluation and Oversight, Inter-American Development Bank, pedroce@iadb. org; Alessandro Maffioli, Office of Evaluation and Oversight, Inter-American Development Bank, alessandrom@iadb. org; Diego Ubfal, Department of Economics, University of California at Los Angeles, dubfal@ucla. edu

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INTRODUCTION

Assisting farmers to become more productive has been common practice in development assistance for a long time, as well as the objective of ministries of agriculture and sub-national governments around the world. Agriculture is still the main economic activity for the majority of the world's population and it is generally correlated with low socioeconomic indicators, such as education, health and poverty. In fact, as noted by the World Development Report 2008[1], three out of four poor people in developing countries live in rural areas, and most of them depend on agriculture for their livelihoods. In addition, agricultural products, whether in bulk or processed form, are common exports in developing countries, and many people depend on their production as their main economic activity. However, while the objective of improving farmers' productivity and agricultural workers livelihood is common to numerous types of agriculture or rural development programs, the approaches vary significantly by type of program. The most common interventions include infrastructure development, market access, provision of fertilizer and other inputs, or provision of extension services to producers.

In this paper, we focus on extension services, and particularly on a program in Mendoza, Argentina that provides extension services to grape producers. Extension services generally aim at transferring specific knowledge to producers, the transfer of technology, the improvement of management practices or the development of capacities[2]. The provision of these services take a wide range of forms (Purcell and Anderson, 1997), including availability of occasional assistance by specialists when demanded by producers, formal training on specific topics for groups of producers, or specialists working directly with farmers. In addition, there are variations in the type of financing and service provision, sometimes including co-payments or fees, and provision of the services by public officials or private companies.

This study focuses on the PROSAP (Programa de Servicios Agricolas Provinciales), which has as an objective "to increase the value of agricultural exports by improving quality and increasing production volumes[3] by financing extension services on key topics in grape producing". The services were free, publicly financed and provided by consultants hired by the program. These services were offered to all grape producers[4], who had to choose whether or not

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[1] *Agriculture for Development*, World Development Report 2008, World Bank.
[2] Similar definitions are found for example in Birkhaeuser et al. (1991), Evenson (2001), and Owens et al. (2001).
[3] From IDB AR-0061 Loan Document, page 10.
[4] There were very few restrictions on eligibility, as we discuss in Section 3.

to receive them. Since the stated objectives of the program were to improve quality and to increase production, we focus our evaluation of its impact on these two outcomes, yield (our measure of productivity) and sugar content of the grapes (a measure of quality).

The results indicate that the program was effective at increasing yields for those with low yields before participation, and increased the average quality of grapes produced by beneficiaries. Our approach uses a combination of fixed effects and different matching methods to isolate program effects and provide evidence that the program did have a positive and significant impact on productivity and quality, though the effects differ widely by pre-program characteristics of the producers. There is, however, no evidence of significant differences in introduction of new varieties or switch in the production structure of beneficiaries.

The paper begins in Section 2 by reviewing some theoretical justifications for the provision and/or financing of extension services and the existing evidence on the impact of such program. Section 3 describes the extension services program (PROSAP) in Mendoza, the results of a previous qualitative evaluation and the characteristics of the beneficiaries at the baseline. Section 4 and 5 analyze the data and the identification strategy including the different matching methods used in the evaluation. In Section 6 the main results of the paper are presented. Finally, Section 7 concludes and provides some policy recommendations arising from the analysis.

AGRICULTURAL EXTENSION SERVICES, THEORY AND EVIDENCE

The provision of agricultural extension services has been justified in the literature on both equity and efficiency grounds. In the presence of market failures, for example externalities, limited access to credit or non-competitive market structures, producers will not face the correct incentives to produce certain varieties, use new production techniques or adopt new technologies, resulting in production levels that are not socially optimal[5]. In addition, if less advantaged farmers are more exposed to these failures because of their limited resources (lack of market power in an oligopsony, limited access to credit, low capacity to pay for extension services[6]), the justification for solving these market failures

[5] See, for example, Hanson and Just (2001) and Feder et al. (2003).
[6] See the World Development Report 2006, for examples on how inequality might create poverty through limitations in market access.

through public intervention gains relevance under both equity and efficiency arguments.

Agricultural extension confront some of these inefficiencies, through training and provision of technology for beneficiaries. The question is why if producers are inefficient and extension services are effective, a private market for extension services is not rampant in rural areas. The literature identifies three main reasons for the absence of such markets. First, services provided by these programs are non-rival, such that their use by one farmer does not preclude other farmers from using it. In addition, they are non-excludable, given the difficulty to limit the transfer of knowledge or technology. Finally, if services are non-rival and non-excludable, the appropriability of the benefits of such programs is low, since a successful technology would be immediately adopted (copied) by competitors, eliminating the profits for the first adopter. Thus, the incentives to demand these services for a positive price are low, limiting the development of these markets[7].

Under these circumstances, public intervention could generate large positive externalities if it directly targets these inefficiencies. However, even if public intervention is advisable, the question still remains of whether the government should provide the services itself or instead set the institutional structure to create a market and finance private providers for the services. In addition, despite the existence of appropriability issues and externalities, the services provided are expected to increase the value of production, and as such these services have a monetary value that could be charged to the beneficiaries. However, the incentives to set or accept market prices are complex, due to asymmetric knowledge of the value of the service between government (principal) and private provider (agent), the heterogeneity of beneficiaries and the uncertainty of agricultural activities, and, as a consequence, the difficulty to design outcome-based payments that create the right set of incentives between the government and the provider. Together with the high cost of monitoring private providers (remoteness & sparseness of services), the availability of information for effective targeting by the public sector, might justify public financing and provision of services in some settings.

Finally, if governments are generally concerned with equity considerations, even in the absence of coordination failures or other market imperfections, public intervention might be appropriate on equity grounds if targeted to low-income farmers. In addition, and since poor farmers tend to be, among other things, less educated, which combined with their lower capacity to pay for extension services would result in large productivity differences based on socioeconomic status, the

[7] See Hanson and Just (2001).

efficiency and equity arguments would both hold for support of low income farmers with the provision of extension services.

Evidence

Notwithstanding the theoretical considerations for public intervention through the financing and/or provision of extension services, the existing evidence of their effectiveness is scarce and inconclusive, partly due to the few rigorous impact evaluations undertaken until now. In addition, these evaluations fail to address questions on the effectiveness of new modalities of extension programs around the world (e.g. , privatization, fee-for-service, decentralization, etc.). As Alex and Rivera (2005) point out after reviewing 44 case studies, reforms in extension services include decentralization, privatization, demand-driven approaches, new approaches for public services and national strategies. In addition, Hanson and Just (2001) delimit five categories of extension under which those reforms can be understood, including: i) public extension with public funding and traditional delivery, ii) paid public extension with public provision, with a fee-for-service funding, iii) partially public-funded private extension, delivered by private firms and financed in part by public budgets and in part by user fees, iv) policy-supported private extension, provided by firms and financed by users, but with government subsidies or taxes for specific production techniques, and v) private extension, provided by private firms that charge fees for their services. In this section we review the evolution of the reforms and analyze their logic on the basis of the arguments developed in the previous section. Unfortunately, the evidence on the comparable effectiveness of these five models is non-existent.

The main body of research on the effect of extension services on producers is based on production functions using the extension variable as one of the inputs, showing large positive rates of return to extension services (Birkhaeuser et al., 1991). However, in the absence of random assignment to treatment and control groups, this methodology is likely to provide biased estimates of causal effects, due to endogeneity of program participation and the presence of unobservable characteristics that might determine participation and be correlated with the outcome variable. In addition, as pointed out in Dinar et al. (2007), this approach assumes that farms operate at technically efficient levels, an assumption that is disputed by evidence of inefficiencies in production that serve as a justification for the provision of public extension services. This led to a more sophisticated method, based on stochastic frontier models, which relax the efficiency assumption by defining a "best practice" frontier production function and measuring the distance from this frontier for each producer[8]. However, stochastic frontier models suffer from the same identification problems if treatment is not random and includes unobservable characteristics.

In demand driven programs, as is the case of PROSAP, when farmers initiate the contact with extension agents on the basis of their own personal characteristics and necessities, the treatment coefficient in production function estimations will include unobservable characteristics that determine both participation and the outcome of interest. The sign and importance of the bias will depend on these unobservable characteristics. For example, if farmers who demand extension services were more motivated, we would expect the production function regression to overestimate the returns to extension services. Other examples of selection bias might come from program implementation, such as when extension agents are more prone to contact more educated productive farmers, or if the programs are devoted to regions where there is more responsiveness to extension services.

The few pseudo-experimental evaluations generally show positive results, though not uniform. Duflo & Kremer (2003)[9] in the only randomized experiment to date show that farmers do not use the optimal amount of fertilizer due to risk aversion (hyperbolic discounters). Godtland et al. (2004) estimate the effect of a farmer field school program and a traditional extension program on farmers' knowledge of integrated pest management practices, using both a regression with controls and matching techniques, and show significant positive effect of both programs, but of higher value for the farmer field school program.

With regards to the farmer field school approach, Feder et al. (2003) use a modified differences-in-differences model and find no impact on yields or on the reduction of pesticide use for Indonesia. Their modified model accounts for the fact that the program was introduced at different times across villages, taking into account that the diffusion of innovation would reduce the impact of extension with the years. On the other hand, Praneetvatakul and Waibel (2006) claim that two time-point observations are not enough to estimate the impact of this kind of programs. They use a panel of four years that comprises eight rice-growing seasons in Thailand and find a positive impact on knowledge and pest management practices both on the short and long run. Nevertheless, in a companion paper they do not find any impact of the program on rice production yield.

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[8] See Aigner et al. (1977) for the seminal paper on the literature. Coelli et al. (1998), Kumbhakar and Lovell (2003) can also be consulted for a theoretical discussion of its options. For empirical applications see, among others, Bravo-Ureta and Evenson (1994) and O'Neill et al. (1999).

[9] See also Duflo et al. (2004)

Several works using panel data have been carried out since then, but the number is limited when compared to other areas of development economics. With fixed effect or difference-in-difference models, they control for farms' and farmers' time-invariant unobservable characteristics. Owens et al. (2003) and Romani (2003) estimate the impact of traditional extension services using panels of farmers for Zimbabwe and Ivory Coast respectively[10]. Both studies find a positive impact of extension services on productivity and yields. However, they note that this impact is neither present for all the years nor for all the crops studied.

Another body of literature has used instrumental variables to identify program effects, finding generally positive though small and heterogeneous program effects. However, the instruments and assumptions are at least questionable. As Romani (2003) and Feder et al. (2003) point out, finding a variable correlated with the participation in extension programs but not with the studied outcome is not an easy task since by program design the criteria used to select farmers for extension services are usually correlated with the outcome. They argue that the only option is to rely on strong distributional assumptions such as the joint normal distribution of errors[11]. Akobundu et al. (2004), using as instruments the distance from the extension office, whether an individual was rejected a loan, total farm debt, and the previous visit of an extension agent (not of the program) find a positive impact on farm income only for individuals with a high number of visits. The heterogeneity of results is also significant: farmers with better education, more skills and wealthier are more likely to adopt certain kind of innovations that are dependent on knowledge. Wealth and size of the farm can have similar effects on extension through the adoption rate. This is in accordance to the results of Godtland et al. (2004) who find that the farmer field school approach is effective for wealthier farmers.

In summary, the evidence on the impact of extension services on farmers' productivity and technological adoption is generally positive, though it tends to suffer from biases resulting from endogenous placement and omitted variable bias. The results of pseudo-experimental studies highlight the heterogeneity of program impacts based on farmer's characteristics, such as education, experience and wealth. Alston et al. (2000) review an important number of evaluations, with the majority dedicated to agricultural research, and find a median rate of return of 58%. Evenson (2001) describes rates of return between 5 and 50% for developing countries, but also notes that impacts vary widely. These results point

[10] Owens et al. (2003) also control for time effects, use clustered standard errors at the village level and count with a measure of farmers' skills.

[11] With several periods of data a dynamic panel data estimator could be used, and further differences or the moments of the distribution could act as appropriate instruments.

to the specificity of impacts depending on the particular design of the program, especially as it relates to the methodology for selecting beneficiaries.

THE PROSAP PROGRAM

The program object of this evaluation consists of the provision of free services[12] to grape producers in the province of Mendoza, Argentina. The program was part of a larger national program approved in 1995, designed to support agricultural services, PROSAP (Programa de Servicios Agricolas Provinciales), seeking "to increase the value of agricultural exports by improving quality and increasing production volumes[13]." This broad objective was to be achieved through a combination of interventions, including, for example, better administration of water resources, providing basic agricultural infrastructure or monitoring and ensuring both animal and plant health. Among them was the program evaluated in this paper, the provision of "extension services" to encourage the adoption of better technologies and methods of production, providing integrated agricultural information services and strengthening the programming capacity of the beneficiary provinces.

Extension Services Program Description

The program targeted one of the factors which, according to the IDB's loan document, were contributing to the inefficiency of grape production in Mendoza: the lack of adequate technical services for grape producers[14]. The services were publicly financed but provided by private agricultural specialists, contracted by the program. There was no fee for service, though up-to-date payments on water for irrigation fees were required for participation. The program provided farmers with technical advise on production processes, especially on the use of variable inputs (including water), with the stated objectives of increasing the efficiency of production and improving the quality of the grapes produced[15]. The services were promoted by inspectors of the irrigation system and consisted of periodic meetings on different topics related to grape production. The menu of topics from which groups of participants could choose included 8 topics, among others, the

[12] According to a previous evaluation, the project originally planned for co-payments from beneficiaries in some departments that would increase in time till reaching 100% by the 4th year. However, this co-payment was never materialized in practice, and the services were considered free.
[13] From IDB (1995), page 10.
[14] IDB (1995), Chapter 1, starting page 6.
[15] From IDB's loan document.

use of fertilizers, irrigation, and pruning, use of different machinery or phytosanitary plans.

Selection of Beneficiaries

A previous qualitative evaluation of the program, commissioned by PROSAP and conducted in 2006[16], noted that the selection of beneficiaries had no clear targeting mechanism and both the objectives of beneficiaries upon joining and their perception of the impact of the program after participation varied widely depending on the characteristics of the beneficiaries. Program promotion was done for all producers, who were instructed to create groups of 12-14 producers who would receive the services together. The result of the lack of clear targeting mechanisms was a large heterogeneity among these groups, both in terms of the characteristics of the producers and their objectives upon entering the program.

The lack of clear targeting rules makes the program difficult to evaluate for two reasons. On the one hand, the objectives of the participants varied widely. The main needs for producers outlined in the qualitative evaluation, which were gathered from conversations with different beneficiaries, included increasing the productivity of their vineyards, improving the quality of their grapes, introducing new varieties, improving market access and increasing efficiency of production by reducing costs (better water management being a key objective). The evaluation pointed out that producers within groups were largely homogenous, which allowed them to broadly categorized the groups in "established producers seeking access to markets and industrialization", "experienced producers with limited resources seeking to improve production methods" and "less experienced producers seeking basic advice on production methods"[17]. However, the beneficiaries note that the menu of options often did not serve their needs, especially regarding access to markets.

Since the program was not targeted to specific types of producers and offered a wide arrange of topics for services, we cannot identify the specific goals of each beneficiary upon entering the program. Since according to the qualitative evaluation the objectives of these groups varied widely, to the extent that the impact of the program was small or not significant on objectives not sought by participants the estimated average treatment effects are likely to understate the true program impacts by including producers in the beneficiary group that did not seek that particular objective. Though, as we will see, our methodology considers these issues by dividing producers into different categories according to their pre-

[16] Evaluación del Programa de Servicios Agrícolas Provinciales, Martinez and Posada (2006).
[17] Note that we do not have individual information for producers categorized in these groups, so we cannot use individual information on these categories in our empirical analysis.

program observable characteristics, we cannot explicitly control for the objectives of the participants due to lack of information.

On the other hand, since groups were formed voluntarily, we would expect the characteristics of beneficiaries and non-beneficiaries to be different. Since these include both observable and unobservable characteristics that are likely to be correlated with the outcomes of interest, simple OLS estimations are likely to produce biased estimates of the program impact. The bias from these characteristics is unclear, and it will be our goal to eliminate most of this bias using fixed effects and matching techniques, as we discuss in the methodology section.

DATA

Since the program did not collect information on outcome variables, this evaluation relies on secondary data sources, which were difficult to gather[18]. We gained access to restricted administrative datasets that allowed us to evaluate the program[19]. The main source of information is the National Institute of Vitiviniculture (INV for its name in Spanish), which compiles yearly information on production and basic input use for all grape producers in the region of Mendoza. We have access to annual data for every producer (8,873 in total) in the region starting in 2002, before the inception of the program, and ending in 2006. These data include production for each variety of grape[20], total land size and productive land, and some data on input use (type of irrigation system, for example). Although most of the grapes from farmers in INV's dataset have as final destination the production of wine, about 25 percent of the production is of table grapes for direct consumption. However, producing more than one variety of different quality levels is the usual practice, and only 10 percent of the farmers have their entire production in table grapes. Thus, most of the producers have grapes used for wine elaboration. Data for beneficiaries were provided by the coordination unit of the program, and included a unique producer identifier number which allowed the identification of beneficiaries in the INV dataset. The

[18] Note that the Loan Document listed no specific outcome indicators for the project other than "production" and non-measurable indicators such as "producers show knowledge of the appropriate techniques of production" (IDB (1995), page 9, Annex III-1). The Project Performance Monitoring Report largely reports on the completion of activities and program outputs (people trained), but not on the proposed outcome variables (IDB (2006) PPMR).

[19] These data were managed under strict confidentiality by an institutional agreement between the INV and the IDB, under the guidance of OVE.

[20] There are a total of 107 varieties in the dataset, but 14 varieties concentrate 90 percent of production. We categorize them into highest quality, high quality and low quality following INV's classifications.

result is a rich panel dataset of all producers that allows us to identify beneficiaries.

There are, however, some limitations to the data provided. First, there is no demographic information about the producer, such as age, level of education or experience in grape production. Although we can control for all time-invariant characteristics[21] by including producer fixed-effects, this lack of information on the producer does not allow us to explore differential effects of the program by demographic characteristics, which, as we saw in the literature review, have been shown to be determinant in other programs (for example, more educated vs. less educated producers). In addition, the dataset does not have information on specific fertilizer or water use, two of the main inputs for production, which makes it impossible to observe short-term changes in production practices that might lead to lower costs, a potential objective of the program. Lastly, we do not have information on the specific menu of topics provided by the program to each beneficiary.

Furthermore, we lack information on prices received by the producer, but instead we were able to obtain yearly average prices for varieties that are traded in the Mendoza centralized market, which are higher quality varieties. Not traded varieties are those of less quality. Thus, as a proxy, we make the assumption that lower quality varieties have a lower price than the higher quality varieties with the lowest price, and thus assign the same price to all low quality grapes, the minimum price of higher quality varieties. Since we lack price information for about 50 percent of the production, we are forced to make this conservative assumption in order to evaluate the impact of the program in monetary value. In practice, we are probably overestimating the price for these grapes and thus assigning a higher value than the one low quality producers are likely to get. We use these prices to monetarize the production as a means to homogenize the measure of production (since better quality grapes with higher prices might have different yields, money is a better measure than weight to compare different producers) to consider program impacts on the value of production driven by quality.

[21] Besides controlling for time-invariant characteristics such as gender or location, fixed-effects control for characteristics such as age and experience, to the extent that they vary uniformly with time for all producers. In addition, assuming that most producers did not increase their stock of education in the studied period, fixed-effects also controls for education level.

Baseline Characteristics

The program benefited 372 producers in the 2003-2006 period, though we only have complete information for 311 of them. As we can see in Table 1, the program take-up was slow at the launching of the program in 2003, but the number of beneficiaries increased notably in 2005 and 2006. According to the previous evaluation of the program, this increase was a result of a greater emphasis on program promotion. Geographically, the program targeted beneficiaries in three departments within Mendoza, Junin, Rivadavia and San Martin.

Table 1. Number of Beneficiaries and Non-Beneficiaries by Department, 2002-2004

	2002		2003		2004		2005		2006	
Department	Benef	No Benef	Benef	No Benef	Benef	No Benef	Benef	No Benef	Benef	No Benef
Junin	0	1695	3	1620	40	1583	110	1547	114	1560
La Paz	0	54	0	51	0	52	0	54	0	54
Lavalle	0	1256	0	1152	2	1170	2	1206	2	1231
Rivadavia	0	1678	0	1594	27	1569	103	1520	112	1542
San Martin	0	3190	35	3034	51	3028	108	3010	141	3014
Santa Rosa	0	697	0	673	0	668	1	676	1	690
Total	0	8570	38	8124	120	8070	324	8013	370	8091

Note: "Beneficiaries" are those that participated in the program at any point since inception, so the number of beneficiaries should be thought of as cumulative. Source: Own calculations using INV dataset.

As we noted in the previous section, arising from the previous evaluation and the discussion on the selection of beneficiaries we expect that i) beneficiaries differ significantly from non-beneficiaries, and ii) there is a large heterogeneity in the characteristics of beneficiaries.

The differences between beneficiaries and non-beneficiaries are evident in Table 2, which presents summary statistics of key variables in 2002 for producers that would later benefit from the program and those that never participated. Beneficiaries have less land (12.4 ha vs 17.7 ha of non-beneficiaries), but have levels of production that are not significantly different from non-beneficiaries. As a result, they are about 30 percent more productive before participation than producers that never received the services, as measured by yield (total production/land size).

There are, however, no significant differences in the broad types of grapes produced. The percentages of production in the highest quality varieties ("fina") and the high quality varieties ("especial") are the same. In addition, grape quality, as measured by sugar content, was not significantly different between participants and non-participants. On input use, we see some differences in the percentage of land covered by the different types of irrigation systems, with beneficiaries having a slightly larger extension of their land covered by irrigation systems (31 vs 26 percent covered by reservoir, for example). There are no significant differences, ex-ante, on the use of drop irrigation, considered to be the most sophisticated system and rarely used by grape producers in Mendoza in 2002.

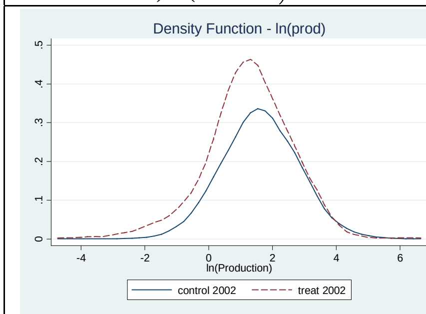
Table 2. Baseline Characteristics of Beneficiaries and Non-Beneficiaries

	PROSAP			*Full Sample, Non-Beneficiaries*				
	N	Mean	Std	N	Mean	Std	Dif-Means	*t-stat*
Outcome variables								
Total Land Size (ha)	344	12.4	(26.52)	7229	17.7	(47.64)	**-5.31**	**3.46**
Productive Land (ha)	344	8.1	(11.70)	7229	10.0	(17.24)	**-1.88**	**2.84**
Production (kg)	344	100,019.7	(156229.1)	7229	102,311.3	(226948.6)	-2291.60	0.26
Yield (kg/ha)	344	13,033.7	(19063.8)	7207	10,401.3	(16768.84)	**2632.33**	**-2.51**
Yield ($/ha)	344	10,293.5	(14029.8)	7207	8,264.0	(12995.6)	**2029.46**	**-2.63**
% production in highest quality varieties	300	0.2	(0.35)	5839	0.2	(0.31)	0.03	-1.54
% production in high quality varieties	300	0.3	(0.36)	5839	0.3	(0.36)	0.00	-0.15
% production in wine varieties	300	0.6	(0.37)	5839	0.6	(0.38)	0.00	0.22
% production in table wine varieties	300	0.4	(0.37)	5839	0.4	(0.38)	0.00	-0.05
Sugar content	300	222.0	(9.80)	5839	222.5	(10.88)	-0.43	0.73
Input variables								
% of land with reservoir irrigation	344	0.31	(0.39)	7229	0.26	(0.38)	**0.05**	**-2.39**
% of land with aspersion irrigation	344	0.00	(0.00)	7229	0.00	(0.01)	**0.00**	**2.26**
% of land with superior irrigation	344	0.79	(0.26)	7229	0.76	(0.30)	**0.03**	**-1.95**
% of land with irrigation turno	344	0.65	(0.36)	7229	0.62	(0.38)	0.03	-1.39
% of land with drop irrigation	344	0.00	(0.05)	7229	0.01	(0.07)	1.05	0.00
% of plantation with anti-hail	344	0.01	(0.09)	7229	0.01	(0.07)	0.00	-0.95
Number of Reservoir	344	0.07	(0.25)	7229	0.09	(0.35)	**-0.03**	**1.84**
Reservoir Capacity	344	6,119.0	(107836.4)	7229	37,992.7	(567360.4)	**-31873.74**	**3.60**
Harverst machine, own	344	0.00	(0.00)	7229	0.00	(0.03)	2.24	0.00
Harvest machine, rents	344	0.00	(0.05)	7229	0.00	(0.04)	-0.33	0.00
Harvest machine, doesn't use	344	0.99	(0.08)	7229	0.97	(0.16)	-4.79	0.00
Number of tractors	344	0.71	(0.60)	7229	0.66	(0.79)	0.05	-1.50

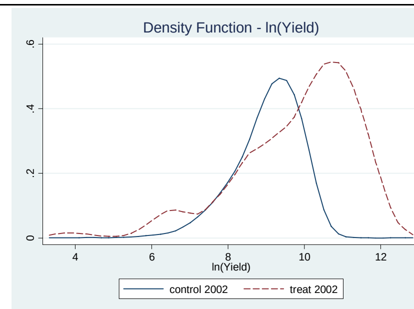
In order to explore the heterogeneity of producers who become beneficiaries of the program, we present in Figure 1 the density function for key variables (production, area, yield and sugar content) at baseline, for producers who became beneficiaries in later years and for those who did not. As it is evident from the figures, the variability in the characteristics of beneficiaries is at least as large as that of non-beneficiaries in all 4 variables, as shown by distributions of the density functions. In fact, beneficiaries seem to have a wider distribution in yield, both in quantity and monetary value, and sugar content (a proxy of grape quality). It is important to note that yield and quality, the two stated objectives of the program at inception, vary significantly among participants. Among beneficiaries we find producers both at the top of the yield distribution and at the bottom. Similarly, we find producers at the highest levels of sugar content, pointing to potentially different objectives of producers upon joining the program.

Figure 1. Density function of production, yield and sugar content, 2002

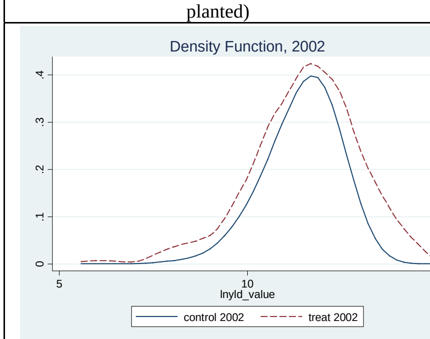
a) Ln(Production)



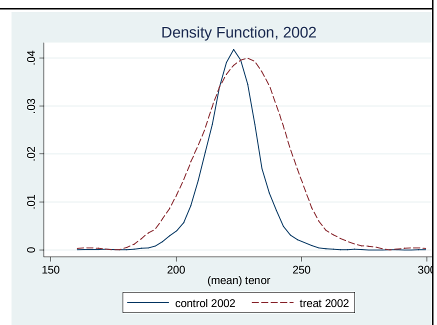
b) Ln(Yield)



c) yield in value (value production/extension planted)



d) Sugar Content



Given the disparity in the characteristics of beneficiaries in outcome variables ex-ante, we will divide the sample of producers in different categories to explore differential effects of the program for different types of producers. The categories, presented in Table 3, divide our sample first by pre-program yield, then by land size and finally by the percentage of the total production in highest quality varieties. Unfortunately, the overlap of these categories and the small number of beneficiaries do not allow us to combine theses categories into sub-groups of producers (i.e. combinations of land size and quality, for example), so we look at the three break-downs separately. These divisions seek to address the likely differences in objectives, and resemble the groups identified in the qualitative evaluation. First, we divide producers by their productivity ex-ante. A priori, we expect that groups of low yield producers are likely to seek an increase in yields. However, for those at the top of the distribution, the expected objective is unclear: while their high yields might imply objectives other than productivity, these producers might have a tendency to seek higher yields, which had them at the top of the distribution before the program and which might drive their participation in the program. While there is no way of verifying this empirically, the qualitative evaluation noted that producers within groups were largely homogenous both in objectives and skills. Second, the qualitative evaluation noted differences in objectives for producers of different sizes, dividing them into i) less than 1 ha, ii) 1 ha to 6 ha, iii) 6 ha to 12 ha and iv) more than 12 ha of land. We use these categories in our analysis. Finally, highest quality varieties require a different set of production techniques and respond to a different market structure than less quality varieties[22], so we divide producers in categories by the percentage of production in the highest quality varieties.

Table 3. Baseline Characteristics of Beneficiaries and Non- Beneficiaries

	Range			# Producers	
	Min	Max	Mean Value	Benef	Non-Benef
Yield Quntiles					
Quintile 1	34	4,369	2,524	52	1243
Quintile 2	4,369	7,826	6,118	50	1244
Quintile 3	7,833	11,871	9,797	47	1247
Quintile 4	11,877	17,853	14,600	72	1222
Quintile 5	17,864	308,257	24,944	90	1204
Land Size Categories					
<1 ha.	0.0	1.0	0.6	17	607
1ha -6 ha	1.0	6.0	3.1	185	3931
6ha - 12 ha	6.0	12.0	8.5	101	1660
12 ha or more	12.0	573.0	30.0	69	2040
% production in highest quality varieties					
0 % highest quality varieities	0.0%	0.0%	0.0%	196	4310
0-25%	0.3%	25.0%	12.3%	43	674
25-50%	25.0%	50.0%	36.6%	18	450
50-75%	50.0%	74.7%	60.7%	11	278
75-100%	75.1%	100.0%	97.3%	43	616

Two things are worth noticing in Table 3, which shows descriptive statistics for our groupings. First, the number of beneficiaries in each category reflects the heterogeneity of beneficiaries, since the distribution of beneficiaries among categories is similar to that of non-beneficiaries, which will allow us to estimate differential effects for each category. Second, the variability in the values of yield, land size and production of highest quality varieties is substantial, as judging by the difference between the lowest and the highest category.

[22] Azpiazu and Basualdo (2003).

In summary, we have seen that the conditions for participation in the program were few, and, as a consequence, the characteristics of beneficiaries and non-beneficiaries prior to participation were significantly different. On average, beneficiaries of the program were smaller and more productive, though the heterogeneity of the beneficiaries is notable, as it is evident from the density distributions of the outcome variables of interest, yield and sugar content. Given the diversity in objectives and characteristics, we categorize the producers by pre-program yield, land size and quality of the grapes produced. In the next section, we present our identification strategy, and show how we will use these categories to explore differential effects of the program depending on the characteristics of the beneficiaries.

IDENTIFICATION STRATEGY

The identification of a proper counterfactual scenario, that is what would have happened to the beneficiaries in the absence of the program, is the main challenge of the evaluation of the impact of any program, such as PROSAP. Beneficiaries self-selected into the program, since there were few restrictions on participation. We already saw in the previous section that the observable characteristics differ significantly, especially regarding productivity and land size. However, we expect that unobservable characteristics differ as well. If motivation, intelligence, networking abilities or other unobservables are determinants of both participation and, presumably, the outcomes of interest (yields, quality of the grapes), the results of OLS estimations on the production function will produce biased estimates. This selection-bias problem has been widely analyzed by the literature on policy evaluation and the same analysis can be easily adapted to the evaluation of PROSAP.

Let's define Y_{it}^{T} as the productivity of producer i in year t if he/she participates in PROSAP and Y_{it}^{C} the productivity of the same producer at the same time if it does not participate in the program. The objective of any program evaluation is the identification of the difference between the outcome of an individual when participating in the program and the outcome of the same individual at the same time, when not participating in the program. We are, thus, interested in the difference $Y_{it}^{T} - Y_{it}^{C}$. However, this difference is impossible to identify, as we cannot observe the same individual at the same time with and without the program. As a result, we have to resort to estimating the counterfactual Y_{it}^{C}, that best resembles what would have happened with the treatment group in the absence of treatment.

In practice, we cannot compute the program impact for any individual producer but we can estimate an average effect of program participation, $E[Y_{it}^T - Y_{it}^C]$ by comparing data on participating and non-participating producers. Defining D as the dummy variable for program participation, the average treatment effect will be given by:

$$\delta = E[Y_{it}^T \mid D=1] - E[Y_{it}^C \mid D=0] \qquad (1)$$

Subtracting and adding $E[Y_{it}^C \mid D=1]$, we obtain:

$$\delta = E[Y_{it}^T \mid D=1] - E[Y_{it}^C \mid D=0] = E[Y_{it}^T \mid D=1] - E[Y_{it}^C \mid D=1] - E[Y_{it}^C \mid D=0] + E[Y_{it}^C \mid D=1] =$$

$$= E[Y_{it}^T - Y_{it}^C \mid D=1] + E[Y_{it}^C \mid D=1] - E[Y_{it}^C \mid D=0] \qquad (2)$$

The term $E[Y_{it}^T - Y_{it}^C \mid D=1]$ in (2) is the average effect of the treatment on the treated that we want to isolate. The difference $E[Y_{it}^C \mid D=1] - E[Y_{it}^C \mid D=0]$ is the selection bias: in addition to the effect of the program, there may be systematic differences between participating and non-participating producers that may affect the impact of the program.

A simple estimator of δ using the sample analogue $E[Y_{it}^T \mid D=1] - E[Y_{it}^C \mid D=0]$ will give an unbiased estimate of the program impact only if there is no selection bias, that is only if $E[Y_{it}^C \mid D=1] - E[Y_{it}^C \mid D=0] = 0$. However, as seen in section 2, participating and non-participating producers differ in a number of dimensions (e. g. yield, size) that are likely to affect both their productivity and the probability being supported by PROSAP. Therefore, the simple difference in mean outcomes between participants and non-participants is capturing the effect of program participation together with the impact of other factors affecting both the capability of increasing the productivity and the probability of participating in the program.

In the presence of a panel data set, as in the case of PROSAP, we can impose some restrictions on the data generation process and use over time and between producers' variation to deal with the selection on unobservables problem and identify the impact of the program. A first restriction is to assume linearity of the conditional expectation function, $E[Y \mid x, D]$ with respect to the set of observable covariates x. A second restriction is to assume that the unobservable characteristics are constant over time.

Using a log linear specification, we can write:

$$\log(y)_{it} = \beta_1 * \log(x)_{it} + \beta_2 * D_{it-1} + \beta_3 * \vartheta_t + \gamma_i + \eta_{it} \tag{3}$$

where y_{it} is the *producer i* productivity in year *t*, x_{it} is a vector of observable covariates, D_{it-1} is a dummy variable for program participation (1 year lagged), ϑ_t denotes year dummies controlling for time effects affecting the farm performances; γ_i is a producer-specific component common to all producers and η_{it} is an i.i.d. zero mean random variable assumed to be independent of x_{it} and D_{it-1}.

Under the assumption of no-correlation between η_{it} and D_{it-1}, β_2 can be consistently identified using a fixed effects estimator that exploits within group time variation, that is, changes in producers participation over time. The fixed effects model is a direct extension of the difference-in-difference (diff-in-diff) estimator where there are only two groups and two periods. As in the simple diff-in-diff model, under the assumption of time-invariant unobservable factors, fixed effects relax the assumption of no correlation between unobservable factors and program participation accounting for self-selection into the program on the basis of producer-specific characteristics that affect both the outcome variable (yield, sugar content) and program participation.

The correction for individual fixed effects rests on the assumption that self-selection operates through farm characteristics that remain constant over time leaving out three potential sources of variation that could bias the estimated program impact. First, we cannot control for time varying unobservables that could drive program's participation (for example, increased demand that results in systematic participation of producers in exceptionally good or bad years will produce biased results even with a fixed-effects estimation). Second, we cannot reduce the bias induced by the potential correlation between the program's modifications and the outcome of interest when policy interventions respond to changes in the outcome variable. In the case of PROSAP, according to program documents, there were no major policy changes during implementation[23]. Finally, individual fixed effects estimations rest on the assumption that in the absence of the program, trends are common to treatment and comparison groups and equal to the pre-treatment trend, with common differences controlled for by time dummies. However, if treatment and comparison groups comprise a wide variety of producers, it is hard to argue that the trends would have been the same in the absence of the program (for example, between large and small producers, or producers of high quality and low quality varieties). In order to capture heterogeneous effects, commonly found in the literature as we saw in section 2, we will use interactions between program participation and yield, land size and percentage of highest quality variety quintiles.

In practice, we run the following regression:

$$\log(y)_{it} = \beta_1 * \log(x)_{it} + \beta_{21} * D_{it-1} * Q_{i1} + \beta_{22} * D_{it-1} * Q_{i2} + .. + \beta_{2q} * D_{it-1} * Q_{iq} + \beta_3 * \vartheta_t + \gamma_i + \eta_{it} \quad (4)$$

where Q denotes a dummy for the category in which the producer falls. In concrete, we divide the β_2 coefficient in q coefficients by using interactions of the participation dummy with the category dummies.

Matching Techniques

In addition to fixed effects, we use matching techniques to identify a comparison group that is more likely to meet the conditions of equal trend in the absence of the program. We use propensity score matching to identify producers that are similar to beneficiaries of the program in observable characteristics, which combined with individual and time fixed effects minimize the bias in our estimates. Given the heterogeneity in the characteristics of beneficiaries, which resemble those of the population as a whole, and the absence of a rich set of demographic variables, we would expect a low capacity to predict participation from our model. However, while our methodology relies more on the long panel of producers than in the matching for identification purposes, the propensity score allows us to limit the sample by excluding producers outside the common support, as defined by positive probability of participation in our sample[24][25].

[23] Evaluación del Programa de Servicios Agrícolas Provinciales, Martinez and Posada, February 2006.

[24] Note that common support restricts the control group to those with the same range of probabilities as the treatment group, excluding those with 0 probability of participating.

[25] We also run weighted regressions, which use the distribution of propensity scores to weight observations. Concretely, we use a weight that is equal to p/(1-p) (where p is the propensity score). This methodology effectively puts less weight on observations at the end of the distribution of propensity scores for both treatment and control groups and more weight to those in the middle of

In order to complement the propensity score matching and provide robustness analysis on our results, we use a non-parametric approach, single variable matching methods on the two most important variables that determined participation, both in our model and the qualitative evaluation: yield and land size. We use two samples, single variable matching on land size and matching on both yield and land size[26]. In order to construct these comparison groups, for each treated producer we find a comparison producer from the universe of non-beneficiaries that has the closest value to the treated producer. We do this exercise for yield and land size. In practice, in most cases we are able to find a producer that has the same value. We consider these samples as our most restrictive, since we limit the samples to those with the same value of the variables of interest. We will first explore the propensity score matching, to then show a comparison of sample balance from the different methods.

Propensity Score Matching

Propensity score matching implies the estimation of the probability of participating in the program given the set of observable characteristics available. This probability is then used to match treated producers to untreated producers with similar estimated probability of participation. If targeting rules imply quantitative measures that determine participation, propensity score matching would eliminate the bias arising from differences at baseline. In the absence of quantitative rules for selection of beneficiaries that allow us to estimate precisely the participation function, we rely on the full set of outcome and input variables at our disposal to predict participation at baseline, and use the predicted probability for participation to choose the comparison group. The results of the probit estimation of participation are presented in Table 4.

The strongest determinants of participation in our probit regression are yield, land size, production of high quality varieties and the use of aspersion irrigation. This is consistent with the categorizations of the qualitative evaluation, so in alternative matching samples we will use only these variables to select comparison groups. As we saw in the previous section, participants tend to be more productive ex-ante. However, in the simple summary statistics we saw that they tend to have a larger proportion of the land covered by irrigation, the differences disappear in the probit regression, once we control for other factors.

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the distribution, but did not change the results. Regressions are available from the authors upon request.

[26] Single variable matching on yield only did not vary the results from yield and land size. Regressions are available upon request from the authors.

Controlling for yield, land size is also positively correlated with participation, as is the percentage of land planted with the highest quality varieties.

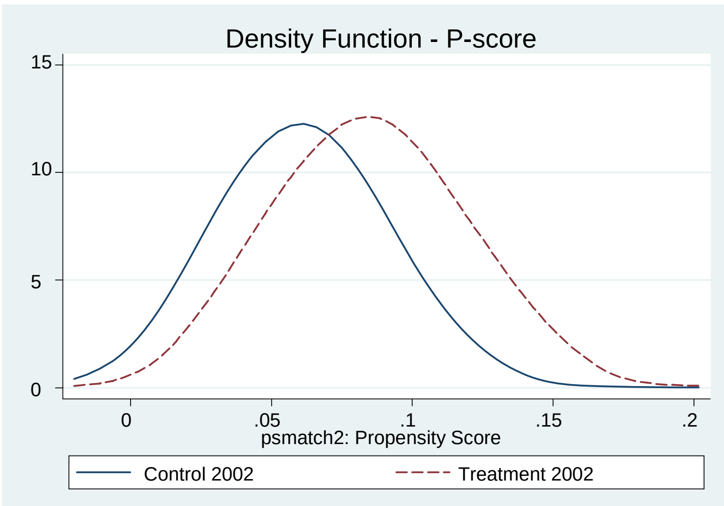
Table 4. Matching, Probit Results

Pr (participating)	Probit Coefficient
Ln (Yield)	0.136***
	(0.03)
Land, total planted	0.092**
	(0.04)
Land, total planted of highest quality variety	-0.009
	(0.01)
% of production in highest quality varieties	0.165
	(0.10)
Land size of high quality variety	-0.027***
	(0.01)
% of production in high quality varieties (special)	0.245***
	(0.09)
% of land with anti-hail	0.166
	(0.33)
% of land with irrigation (superior)	0.131
	(0.09)
% of land with irrigation (aspersion)	-0.249
	(0.15)
% of land with irrigation (turn)	0.112
	(0.11)
# of tractors	0.063
	(0.05)
Capacity of the reservoirs	0.00
	0.00
Departamento 3	-1.261***
	(0.23)
Departamento 4	0.214***
	(0.07)
Departamento 5	-0.032
	(0.07)
Constant	-2.980***
	(0.33)
Observations	6471

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

It is important to note that, as expected, the limitation in the number of variables on the producer's characteristics in our dataset results in low capacity of the model to predict participation. As we can see in Figure 2, which shows the histogram of the propensity scores for treatment and control, the largest predicted probabilities are 0.20 for both groups. This means that given the information we have at baseline the beneficiary most likely to participate would have an estimated probability of 20 percent. This low predictive capacity of the model reflects both the large heterogeneity of participants and the lack of specific information about the producers that might have helped disentangle the determinants of participation.

Figure 2. Propensity Score Distribution, Treatment and Control Groups, 2002



Since the objective of this exercise is to create comparison groups that are similar to the treatment group, we present summary statistics for all the samples used in Table 5. The "full- sample" of comparison producers is self-explanatory, including all non-beneficiaries in our sample. Columns 2, 3 and 4 show summary statistics of the common support of the propensity score matching, the single variable matching on pre-program yield and the matching on yield and land size, respectively. As we can see, columns 3 and 4 are more similar to the PROSAP sample, especially on outcome variables of interest. The differences in yields and land size are significantly reduced with these matching methods, resulting in more similar samples. Though we do not show density functions of these variables, the distributions of treatment and control groups are significantly more similar.

Table 5. Baseline Characteristics, Matched Sample

		PROSAP	Full Sample	Propensity Score	Match Yield	Land size and yield
Outcome variables						
Total Land Size (ha)	Mean	12.4	17.7	16.8	15.9	12.2
	St. Dev	(26.52)	(47.64)	(40.37)	(47.76)	(25.07)
Productive land (ha)	Mean	8.1	10.0	10.6	9.8	8.3
	St. Dev	(11.70)	(17.24)	(16.83)	(15.64)	(11.42)
Production (kg)	Mean	100,019.7	102,311.3	122,623.9	125,905.0	106,041.1
	St. Dev	(156229.10)	(226948.63)	(231610.31)	(218947.56)	(147497.00)
Yield (kg/ha)	Mean	11,659.5	9,241.7	11,898.5	13,258.4	13,297.1
	St. Dev	(9377.58)	(8678.20)	(8500.14)	(8741.49)	(8665.55)
Yield (kg/ha)	Mean	13033.7	10401.3	13017.1	15335.7	14733.9
	St. Dev	(19063.79)	(16768.84)	(18259.42)	(21975.53)	(18626.93)
Yield (kg/ha)	Mean	10293.5	8264.0	10339.6	11910.2	11490.6
	St. Dev	(14029.79)	(12995.60)	(13713.36)	(15146.60)	(13567.98)
Yield ($/ha)	Mean	154,214.5	115,402.9	150,368.4	174,593.3	176,823.7
	St. Dev	(168142.70)	(135867.80)	(143352.30)	(173153.10)	(170135.70)
% production in highest quality	Mean	0.2	0.2	0.2	0.2	0.2
	St. Dev	(0.35)	(0.31)	(0.32)	(0.35)	(0.34)
% production in high quality	Mean	0.3	0.3	0.3	0.3	0.3
	St. Dev	(0.36)	(0.36)	(0.35)	(0.36)	(0.36)
% production in wine varieties	Mean	0.6	0.6	0.6	0.6	0.6
	St. Dev	(0.37)	(0.38)	(0.39)	(0.38)	(0.37)
% production in table wine varieties	Mean	0.4	0.4	0.4	0.4	0.4
	St. Dev	(0.37)	(0.38)	(0.39)	(0.38)	(0.37)
	Mean	252.4	2063.1	2851.7	632.7	233.2
	St. Dev	(4366.51)	(32930.68)	(40246.15)	(7914.26)	(4087.90)
Sugar content	Mean	222.0	222.5	222.6	222.3	222.2
	St. Dev	(9.80)	(10.88)	(10.91)	(10.61)	(10.03)
Input variables						
% of land with reservoir irrigation	Mean	0.3	0.3	0.3	0.3	0.3
	St. Dev	(0.39)	(0.38)	(0.40)	(0.40)	(0.40)
% of land with aspersion irrigation	Mean	0.0	0.0	0.0	0.0	0.0
	St. Dev	(0.00)	(0.01)	(0.01)	(0.03)	(0.04)
% of land with superior irrigation	Mean	0.8	0.8	0.8	0.8	0.8
	St. Dev	(0.26)	(0.30)	(0.24)	(0.24)	(0.25)
% of land with irrigation turno	Mean	0.6	0.6	0.7	0.7	0.6
	St. Dev	(0.36)	(0.38)	(0.38)	(0.36)	(0.36)
% of land with drop irrigation	Mean	0.0	0.0	0.0	0.0	0.0
	St. Dev	(0.05)	(0.07)	(0.05)	(0.04)	(0.05)
% of plantation with anti-hail	Mean	0.0	0.0	0.0	0.0	0.0
	St. Dev	(0.09)	(0.07)	(0.08)	(0.09)	(0.09)
Number of Reservoirs	Mean	0.5	0.5	0.6	0.6	0.6
	St. Dev	(0.62)	(0.82)	(0.86)	(0.81)	(0.70)
	Mean	0.1	0.1	0.1	0.1	0.1
	St. Dev	(0.25)	(0.35)	(0.37)	(0.33)	(0.28)
Reservoir Capacity	Mean	6119.0	37992.7	43213.9	15018.3	5486.8
	St. Dev	(107836.37)	(567360.40)	(519881.33)	(170377.54)	(100894.36)
Harverst machine, own	Mean	0.0	0.0	0.0	0.0	0.0
	St. Dev	(0.00)	(0.03)	(0.03)	(0.04)	(0.00)
Harvest machine, rents	Mean	0.0	0.0	0.0	0.0	0.0
	St. Dev	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)
Harvest machine, doesn't use	Mean	1.0	1.0	1.0	1.0	1.0
	St. Dev	(0.08)	(0.16)	(0.05)	(0.06)	(0.05)
Number of tractors	Mean	0.7	0.7	0.7	0.8	0.7
	St. Dev	(0.60)	(0.79)	(0.78)	(0.74)	(0.62)
Number of Observations		344	7229	4745	579	393

Before presenting the results from these methodologies, it is worth discussing briefly the interpretation of the decomposition of the average treatment effect into heterogeneous impacts for different groups, and how this fits with the different matching methods. As we pointed out in the methodological section, in order to identify differential program effects we use interactions of the participation dummy and categories of yield quintile, land size and percentage of highest quality varieties produced on 4 samples: full sample, propensity score matching, single variable matching on yield and single variable matching on land size. Since there is no excluded category in the interaction terms, the coefficients measure the average treatment effect for each specific group, when compared to the average non-participant, who is different in each matched sample. We use this comparison group because the program was, in principle, open to all participants. Had the program been targeted to specific groups of producers, the reference comparison group would have been restricted to those targeted. Instead we rely on different comparison groups using matching techniques and fixed-effects to control for pre-program conditions. In other words, the estimated coefficient of each interaction measures the program effect when compared to the same comparison group, controlling for time-invariant characteristics and pre-program conditions.

Note that we divide the producers in categories using the full sample and run the propensity score matching for the entire sample, controlling for the variables used to create the categories. We do not run matching models separately for each category. We assume that given our limited capacity to replicate the participation model which results in our use of all indicators available to estimate our common support, the determinants of participation that are correlated with our outcomes of interest do not vary by category. Though unreported, we ran regressions separately for each category, providing qualitatively similar results to the ones presented in the next section[27].

In the following section we focus our analysis on two outcome variables: yield (both measured in quantity per ha and value per ha using proxy prices) and grape quality, as measured by the sugar content of the grapes. In addition to these outcomes, which were originally included in the objectives of the program, we performed complementary analyses to understand other potential impacts, to the extent allowed by data availability. Particularly, we explore impacts on the percentage of production coming from higher quality varieties and introducing new varieties.

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[27] The coefficients tend to be smaller and less precisely estimated for yield regressions, and larger for sugar content regressions. In addition, impact on sugar content for those in the lowest yield quintile becomes significant at 10% confidence. However, since predictive power of our propensity score matching is limited, we prefer to present matching results for the full sample instead of separate regressions for each category. Alternative results are available upon request.

RESULTS

The results of our evaluation show no significant average treatment effect on yields, both in quantity and value, except when matching only on both yield and land size (not using propensity score) where the impact is positive. However, the program did increase the average sugar content of the grapes produced by beneficiaries, though there is no evidence of introduction of new varieties or increased production of highest quality varieties, except for some specific groups of producers (those that did not produce any highest quality varieties increased their production slightly). Finally, the program, had no significant impact on switching or introducing new varieties, and limited impact on increasing the production of highest quality varieties in the time frame of this evaluation.

The heterogeneity of the impact is large, both on yield and quality. Compared to non-participants, producers at the bottom of the yield distribution before participation in the program saw large increases in yield and small increases in the production of high quality varieties, while those at the top of the distribution saw their yields reduced and no evidence of change in the mix of varieties produced. Quality follows a different pattern, though the heterogeneities are equally notable. Importantly, for some groups of producers there is no evidence of improvements in any of the outcome indicators (medium size producers, for example). The main results point to the need to balance the flexibility of the program and effective targeting to the needs of potential beneficiaries to guarantee that each producer can receive a program that is useful for his/her particular needs.

The results are presented separately for yield and quality. In all tables we present a summary of the results for each outcome of interest, which include the 4 methodologies described in the previous section in 4 columns (full sample (1), propensity score matching (2), single variable matching on pre-program land size (3), and on both land size and yield (4). For each methodology, we present separate regressions for the average treatment effect, and differential effects by pre-program yields, land size category and the percentage of production in the highest quality grapes. Full results are presented in the Appendix.

Results: Yield

The results of the impact of the program on yield as measured by kilograms per hectare (kg/ha) show a non-significant average treatment effect except when using the matched sample on both yield and land size (Table 6). However, the non-significant effect is due to large differences in impact by pre-program characteristics. The relationship between pre-program yield and program impact on yield is clear and consistent across methodologies, with a significant inverse relation between pre-program yield and increase in yield. For the least productive grape producers before participation, yields increased by between 46 and 58 percent (depending on the sample used). The coefficients of the interaction terms are all negative, getting larger (and more significant) for higher quintiles, pointing to significantly smaller impacts for those at the top. The size of this negative effect is large, with yields being reduced by between 25 and 11 percent. The results become more positive in the single variable matching, columns 3, 4 and 5, indicating that the estimate of the program effect is larger when we compare beneficiaries to non-beneficiaries with the most similar land size and pre-program yield, i.e. the two most important determinants of participation in our model and the previous qualitative evaluation.

There are also significant differences in program effects by land size, once we restrict our sample to comparison producers with similar yields and land sizes ex-ante. Smaller producers saw their yields increase by about 30 percent, while larger producers (more than 6 ha) experienced smaller increases in yield. Medium size producers, between 1 and 6 ha, however, did not benefit from the program in terms of increased yields. By percentage of highest quality production, the results vary with the sample used. We see a large increase for beneficiaries producing lower quality varieties in the most restrictive sample (column 4), while we estimate negative effects for those with a mix of quality in their production (with 25-50 percent in highest quality varieties) in the full sample and propensity score estimates (Columns 1 and 2). These contradictory results might be due to differences in the structure of production between producers of different yields and land sizes, which disappear once we restrict the comparison sample by yields and extension.

Table 6. Regression Results, Yield

Ln (Yield)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Average Treatment Effect	-0.003	-0.014	0.011	0.094*
	(0.04)	(0.04)	(0.04)	(0.05)
Yield Quintile Interactions				
q1	0.473***	0.462***	0.496***	0.583***
	(0.11)	(0.12)	(0.12)	(0.12)
q2	0.231***	0.238***	0.265***	0.352***
	(0.07)	(0.07)	(0.07)	(0.07)
q3	(0.09)	(0.07)	(0.05)	0.03
	(0.07)	(0.08)	(0.08)	(0.09)
q4	-0.163***	-0.143**	-0.108*	(0.02)
	(0.05)	(0.06)	(0.06)	(0.07)
q5	-0.246***	-0.228***	-0.201***	-0.114*
	(0.05)	(0.06)	(0.06)	(0.07)
Land Size Category Interactions				
<1 ha.	0.16	0.19	0.21	0.295**
	(0.17)	(0.15)	(0.20)	(0.13)
1ha -6 ha	-0.03	-0.085*	-0.06	0.02
	(0.05)	(0.05)	(0.05)	(0.07)
6ha - 12 ha	0.00	0.04	0.07	0.154**
	(0.06)	(0.06)	(0.07)	(0.08)
12 ha or more	0.05	0.08	0.10	0.181**
	(0.09)	(0.09)	(0.08)	(0.08)
% of production in highest quality varieties category				
0 % in highest quality	0.01	0.01	0.04	0.123**
	(0.04)	(0.04)	(0.05)	(0.06)
0-25%	-0.08	-0.07	-0.06	0.03
	(0.10)	(0.10)	(0.11)	(0.14)
25-50%	-0.238**	-0.224*	-0.20	-0.12
	(0.12)	(0.13)	(0.13)	(0.13)
50-75%	-0.10	-0.09	-0.07	0.02
	(0.12)	(0.12)	(0.14)	(0.10)
75-100%	0.00	0.02	0.05	0.13
	(0.08)	(0.09)	(0.08)	(0.10)
No of Observations	28,582	19,954	2,488	1,706
Number of Producers	6,275	4,157	510	350
Fixed Effects	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Matching Technique	No	PS	Single Variable Yield	Single Variable Yield & Land

Note: Number of observations and producers refers to average treatment effect regression. The number of observations varies in each regression in order to maximize the number of observations used, though the results are not sensitive to variations of sample used.

These results point to a strong relationship between pre-program conditions and the increase in yields caused by the program. While this may be partly due to the objectives of the participants upon entering the program, these differential effects also indicate that the heterogeneity of participants might have limited the effectiveness of the program by providing specific services to beneficiaries who did not need them. For example, the reduction in yields for those at the top of the yield distribution might reflect a greater emphasis on quality or cost savings by these producers. However, it is hard to argue that medium size beneficiaries have particular objectives systematically unrelated to increasing yields, so the non-significant coefficient is likely to reflect no impact of the program on these beneficiaries.

Finally, while not reported in the main body of the text[28], except for year and department dummies, the rest of the coefficients in the different regressions are systematically non-significant, which may indicate that most of the variation in our sample is explained by producers' characteristics that are time-invariant.

Since production of different types of varieties of grapes tend to have different yields and different varieties have different prices, we also explore the impact of the program in monetary terms, using the proxy prices described in the methodological section. The results for the value of production are similar to those of yield quantities, even in the size of the coefficients (see Table 7), except the impact on very small producers. Using the same categories as in Table 6 we show that those with low yield before the program saw the value of their yields increase by about the same amount as the increase in quantity. The results show significant impact on value of yield by land size categories only for producers with more than 6 ha of land, similarly to what we saw when measured in quantity. The impact on yield, thus, seems consistent with an insignificant change in production structure that might reflect substantial price differentials among grapes.

[28] See Appendix for full results.

Table 7. Regression Results, Value of the Yield

Ln (Yield Value)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Average Treatment Effect	0.012	0	0.027	0.106*
	(0.03)	(0.04)	(0.04)	(0.06)
Yield Quintile Interactions				
q1	0.472***	0.464***	0.495***	0.576***
	(0.11)	(0.12)	(0.12)	(0.13)
q2	0.257***	0.265***	0.292***	0.376***
	(0.07)	(0.08)	(0.08)	(0.08)
q3	-0.06	-0.04	-0.01	0.06
	(0.09)	(0.10)	(0.08)	(0.08)
q4	-0.139**	-0.118*	-0.08	0.00
	(0.06)	(0.06)	(0.06)	(0.07)
q5	-0.247***	-0.229***	-0.198***	-0.116*
	(0.06)	(0.05)	(0.06)	(0.07)
Land Size Category Interactions				
<1 ha.	0.10	0.15	0.17	0.25
	(0.20)	(0.21)	(0.23)	(0.17)
1ha -6 ha	0.00	-0.06	-0.03	0.05
	(0.05)	(0.05)	(0.06)	(0.06)
6ha - 12 ha	0.01	0.05	0.08	0.161**
	(0.06)	(0.06)	(0.07)	(0.08)
12 ha or more	0.05	0.08	0.10	0.177**
	(0.08)	(0.10)	(0.09)	(0.08)
% of production in highest quality varieties category				
0 % in highest quality	0.01	0.02	0.05	0.130**
	(0.04)	(0.05)	(0.05)	(0.06)
0-25%	-0.02	-0.01	0.01	0.09
	(0.10)	(0.10)	(0.09)	(0.10)
25-50%	-0.228*	-0.22	-0.20	-0.13
	(0.13)	(0.13)	(0.13)	(0.12)
50-75%	-0.13	-0.12	-0.10	-0.02
	(0.16)	(0.12)	(0.15)	(0.12)
75-100%	0.01	0.03	0.06	0.14
	(0.08)	(0.08)	(0.10)	(0.09)
No of Observations	28,582	19,954	2,488	1,706
Number of Controls	6,275	4,157	510	350
Fixed Effects	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Matching Technique	No	PS	Single Variable Yield	Single Variable Yield & Land

Note: Number of observations and producers refers to average treatment effect regression. The number of observations varies in each regression in order to maximize the number of observations used, though the results are not sensitive to variations of the sample used.

Results: Grape Quality

The program increased the average sugar concentration of grapes produced by beneficiaries, by an average of 1 to 1.5 grams per liter (g/l) (see Table 8). Since the average sugar concentration at baseline was 221 g/l, this represents an average increase of 0.6 percent in the sugar content for beneficiaries or 0.125 of a standard deviation, a significant increase by production standards. Higher sugar contents might be due to improvements in production practices (such as optimal ripening of the grapes before collection, or better water usage) or switching to different varieties (higher quality varieties tend to have higher sugar content). Thus, while it is not a perfect measure of quality, it is correlated with higher quality of production.

In addition to the positive average treatment effect, we observe significant differences in program impact on sugar content by pre-program yield, extension of land and the percentage of highest quality varieties. The results are consistent with different objectives being pursued by different producers who decided to participate. Producers in the middle of the yield distribution saw the largest increases in sugar content, an increase of close to 0.25 standard deviations. Producers at the bottom of the distribution, which saw a sizeable increase in yield, did not improve their sugar content significantly. There is some evidence, however, that those at the top of the distribution improved the quality of their grapes, when we restrict the sample to the common support of the propensity score matching and single variable matching on yield.

The impact on grape sugar content varies also notably by land size. Producers with areas larger than 12 ha (considered large producers), saw important increases in the sugar content of their production (about 0.25 standard deviations in the full sample estimation). Consistently with the qualitative evaluation, where these producers were depicted as seeking mainly improved quality and access to markets, the quality of the grapes seems to have increased as a result of the program. In addition, small producers (1 ha to 6 ha) also experienced increases in grape quality. Finally, the increase in sugar content seems to have occurred more for those producers that previous to program participation, did not produce highest quality varieties.

Table 8. Regression Results, Sugar Concentration

Sugar Content	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Average Treatment Effect	1.019*	1.274**	1.687**	1.32
	(0.58)	(0.61)	(0.74)	(0.97)
Yield Quintile Interactions				
q1	1.15	1.33	1.75	1.30
	(1.34)	(1.38)	(1.57)	(1.45)
q2	-0.17	-0.10	0.33	0.00
	(1.69)	(1.50)	(1.79)	(2.06)
q3	2.559*	2.761*	3.224**	2.949*
	(1.36)	(1.42)	(1.52)	(1.51)
q4	0.57	0.81	1.24	0.72
	(1.17)	(1.19)	(1.56)	(1.24)
q5	1.53	1.699**	2.049*	1.78
	(1.02)	(0.86)	(1.15)	(1.33)
Land Size Category Interactions				
<1 ha.	2.00	2.35	2.77	2.41
	(5.45)	(4.27)	(4.35)	(3.37)
1ha -6 ha	1.21	1.620**	2.037**	1.60
	(0.85)	(0.80)	(1.03)	(1.23)
6ha - 12 ha	-0.17	-0.17	0.17	-0.16
	(1.22)	(0.94)	(1.04)	(1.20)
12 ha or more	2.401*	2.571*	3.085**	2.857**
	(1.27)	(1.41)	(1.38)	(1.25)
% of production in highest quality varieties category				
0 % in highest quality	1.874**	2.060***	2.476***	2.013**
	(0.83)	(0.69)	(0.93)	(0.92)
0-25%	0.52	0.64	0.97	0.61
	(1.51)	(1.88)	(2.04)	(1.51)
25-50%	1.86	2.02	2.52	2.00
	(1.54)	(1.49)	(1.77)	(1.62)
50-75%	1.88	2.08	2.84	2.05
	(2.34)	(2.00)	(2.35)	(2.43)
75-100%	-1.68	-1.46	-1.07	-1.51
	(1.41)	(1.27)	(1.52)	(1.74)
No of Observations	28,582	19,954	2,488	1,706
Number of Controls	6,275	4,157	510	350
Fixed Effects	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Matching Technique	No	PS	Single Variable Yield	Single Variable Yield & Land

Note: Number of observations and producers refers to average treatment effect regression. The number of observations varies in each regression in order to maximize the number of observations used, though the results are not sensitive to variations of sample used.

Since increases in quality might, in addition to better production practices, come from increases in production of highest quality grapes or introduction of new varieties, we also explored the impact of the program on these variables. The results for the production of new varieties not produced before (unreported) show no evidence of switching production to new varieties as a result of the program, both overall or for any of the categories. While switching categories might require more time of participation in the program and, as a consequence, we might not be able to observe it in our sample, lagged regressions did not estimate any significant changes in this variable. The increase in quality, thus, does not seem to come from switching varieties.

In addition to introducing new varieties, and given that the average number of varieties produced is slightly higher than 3, a potential effect of the program related to the increase in quality of the grapes might have been the shift in the share of production of the different varieties without the need to introduce new ones. That is, achieving a better quality might also be possible by counting with a larger share of the production in highest quality varieties, enhancing production of certain varieties already in place before the program and without the need to introduce new varieties. As evidence of increased production, Table 9 shows some positive impact for very low-yield producers and those with 6-12 ha. However, the size of the coefficients is small (between 2 and 5 percent). This small estimated effect may be due to the short time span of the intervention and increasing production might require longer periods of time since participation. A longer time frame of analysis may have shown larger effects on the structure of production. Interestingly, those producers with a majority of their production in highest quality varieties seemed to have diversified slightly from these varieties. However, the size of the change is also small.

Table 9. Regression Results, % Production in Highest Quality Varieties

% of production in fina varieties	(1) Full Sample	(2) Matched Sample 1	(3) Matched Sample 2	(4) Matched Sample 3
Average Treatment Effect	0.009	0.01	0.012	0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Yield Quintile Interactions				
q1	0.052**	0.056*	0.053*	0.052*
	(0.03)	(0.03)	(0.03)	(0.03)
q2	-0.01	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
q3	0.03	0.03	0.03	0.03
	(0.03)	(0.02)	(0.03)	(0.03)
q4	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.02)
q5	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Land Size Category Interactions				
<1 ha.	-0.01	-0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
1ha -6 ha	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
6ha - 12 ha	0.025*	0.026*	0.029*	0.027*
	(0.01)	(0.02)	(0.02)	(0.02)
12 ha or more	0.03	0.03	0.03	0.03
	(0.02)	(0.02)	(0.02)	(0.02)
% of production in highest quality varieties category				
0 % in highest quality	0.015*	0.017*	0.019**	0.02
	(0.01)	(0.01)	(0.01)	(0.01)
0-25%	0.04	0.04	0.04	0.04
	(0.03)	(0.03)	(0.03)	(0.03)
25-50%	0.06	0.06	0.05	0.05
	(0.04)	(0.04)	(0.04)	(0.04)
50-75%	0.00	0.00	0.00	0.00
	(0.03)	(0.03)	(0.03)	(0.03)
75-100%	-0.045**	-0.044***	-0.041**	-0.042**
	(0.02)	(0.01)	(0.02)	(0.02)
No of Observations	28,582	19,954	2,488	1,706
Number of Controls	6,275	4,157	510	350
Fixed Effects	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Matching Technique	No	PS	Single Variable Yield	Single Variable Yield & Land

Note: Number of observations and producers refers to average treatment effect regression. The number of observations varies in each regression in order to maximize the number of observations used, though the results are not sensitive to variations of sample used.

As a summary, Table 10 shows the results obtained in our different estimations for different groups of producers. First, the beneficiaries with low productivity ex-ante were the most benefited from the program, seeing their yields increased and switching their production towards higher quality varieties. Second, those producers with more than 6 ha of productive land also saw their yields increase and in addition, the largest producers (12 ha or more) experienced an improvement of the quality of their grapes. Small producers (1ha or less) did not experience any improvements in yields or grape quality. Interestingly, those producers with no production in highest quality varieties experienced improvements in yields and grape quality, while differences in the production structure above 0 (measured by the % of production in highest quality varieties) does not seem to result in differential impacts on any variables. Thus, the results confirm the importance of pre-program yield and land size on the impact of the program, and point to those producing no highest quality varieties as a potential group that would benefit from these services.

Table 10. Summary Ttable of Main Results

	Yield	Value of yield	Sugar content	% production in highest quality varieties	new varieties
ATE	0	0	+	0	0
Yield Quintile Interactions					
q1	**+**	**+**	0	+	0
q2	**+**	**+**	0	0	0
q3	**0**	**0**	+	0	0
q4	**-**	**-**	0	0	0
q5	**-**	**-**	0/+	0	0
Land Size Category Interactions					
<1 ha.	0/+	0	0	0	0
1ha -6 ha	0	0	0/+	0	0
6ha - 12 ha	0/+	0/+	0	+	0
12 ha or more	0/+	0/+	+	0	0
					0
% of production in highest quality varieties category					
0 % in highest quality	0/+	0/+	+	+	0
0-25%	0	0	0	0	0
25-50%	-/0	0	0	0	0
50-75%	0	0	0	0	0
75-100%	0	0	0	-	0

Note: The signs reflect significant coefficients in the matching regressions. The 0 denotes non-significant coefficients. In addition, when the result is consistent across methodologies, only one sign will be used, whereas two signs (including 0) denote that the result only holds for some methodologies.

However, many groups of beneficiaries, mainly those in the middle of the yield distribution and the small producers, did not increase their yields or saw the quality of their grapes improve. Finally, while there is some evidence of greater emphasis on production of high quality varieties, there is no evidence of switching production to these varieties. Both of these changes might require a longer time-frame than covered by this evaluation. However, informal conversations with some beneficiaries let us know that many of these significant changes were not introduced due to lack of confidence in the profitability of the introduction of the new varieties. Expected prices were apparently not high enough to compensate for the risky investment. Moreover, many smaller producers argued that their better quality grapes would not been recognized due to the existence of an oligopsony. All of these should be topics for future research.

CONCLUSION

This paper has evaluated the impact of the provision of agricultural extension services for grape producers in Mendoza on the stated objectives of the program: to increase quality and production. With regards to yields, our results show that the impact depends greatly on the ex-ante productivity of the farms. It was a demand-driven program, since producers organized in groups that then received training on issues of their choice within a menu of alternatives. There were few restrictions on participation, and as a result there was a large heterogeneity in the participants. Using fixed effects and matching methods, we showed that producers at the bottom of the productivity distribution benefited greatly from participation in the program, seeing their yields increase by around 40%. Participants at the top of the distribution saw a reduction in their yields, which could be linked to some evidence of improved quality in their grapes.

These results point to a trade-off between effective targeting and flexibility of the programs. The program was effective at increasing yields for those with low yields before participation, and for large producers. In addition, the average quality of the grapes was improved, especially for those at the top of the yield distribution. However, there is no evidence that the program served the needs of other beneficiaries who did not see their yields or the quality of their grapes increase. A plausible explanation, outlined by a previous qualitative evaluation of the program, might be that these producers received extension services in a menu of topics that did not match their needs. These include producers who could be transitioning from the need to increase yields to focusing on grape quality (i.e those in the middle of the yield distribution). This would point to the need to better target the program to the requirements of the beneficiaries. If a program were specifically designed for those producers with low productivity, we have shown it can have a large impact on increasing yields. Likewise, targeting those in search of increased quality would increase the effectiveness of such a program. We have shown that there are data available for such targeting from administrative sources, so that effective targeting could be undertaken in similar programs. In addition, clear objectives and targeting rules would ease the evaluation of the impact of the program, by reducing the unobservable characteristics that determine participation in flexible programs such as PROSAP.

The alternative explanation, common in evaluations of programs, is that there existed unintended impacts on those producers for whom we do not observe impact on the outcomes stated in the program objectives. In the case of PROSAP, the main candidates are cost structure and market access. On the one hand, while the former is feasible, the latter is unlikely since market access was not one of the activities supported by the extension services. On the other hand, the impact on cost structure merits some consideration as more efficiency in production might have been translated into lower costs for the same production, instead of increased production. However, since there is no data available on the cost structure of producers, it falls out of the scope of this evaluation. The impact on cost should be, however, object of future research, considering the effects of the oligopsonic market structure[29] for grapes, which might limit incentives to increase production. The data could be collected at a low marginal cost since a census of grapes produced is carried out every year.

[29] Aciar (2005) argues that the market in Mendoza is only oligopsonic for low quality grapes.

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APPENDIX – RESULTS

A) Yield Regressions

Ln (Yield)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary	**-0.003**	**-0.014**	**0.011**	**0.094***
	(0.04)	**(0.04)**	**(0.04)**	**(0.05)**
Land	0.005	-0.001	-0.202	-0.666
	(0.01)	(0.02)	(0.42)	(1.36)
Land squared	0.0	0.00	0.00	0.046
	(0.00)	(0.00)	(0.01)	(0.12)
% of land with anti-hail	0.814	0.933	0	0
	(0.62)	(0.84)	(0.00)	(0.00)
% land with reservoir	-0.002	0.105	0.472*	0.209
	(0.13)	(0.13)	(0.28)	(0.38)
% of land with irrigation (superior)	-0.265	0.04	-0.351	-0.768
	(0.19)	(0.20)	(0.51)	(0.69)
% of land with irrigation (aspersion)	-0.641	-0.236	-1.166	0.00
	(17.41)	(21.05)	(28.71)	0.00
% of land with irrigation (turn)	0.157	-0.129	-0.231	0.22
	(0.21)	(0.19)	(0.50)	(0.70)
Number of reservoirs	-0.017	0.028	-0.248	-0.156
	(0.06)	(0.08)	(0.29)	(0.25)
# of tractors	0.036	0.045	0.08	0.126
	(0.06)	(0.07)	(0.18)	(0.14)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(0.51)	(0.00)
Year 2003	0.509***	0.600***	0.552***	0.537***
	(0.01)	(0.01)	(0.04)	(0.04)
Year 2004	0.491***	0.505***	0.469***	0.477***
	(0.01)	(0.01)	(0.04)	(0.04)
Year 2005	0.413***	0.349***	0.240***	0.170***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2006	0.539***	0.537***	0.486***	0.382***
	(0.01)	(0.01)	(0.04)	(0.06)
Number of Observations	28582	19954	2488	1706
Number unique id	6275	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Ln (Yield)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*Yield Q1	**0.473*** **	**0.462*** **	**0.496*** **	**0.583*** **
	(0.11)	**(0.12)**	**(0.12)**	**(0.12)**
Beneficiary*Yield Q2	**0.231*** **	**0.238*** **	**0.265*** **	**0.352*** **
	(0.07)	**(0.07)**	**(0.07)**	**(0.07)**
Beneficiary*Yield Q3	**-0.091**	**-0.072**	**-0.052**	**0.03**
	(0.07)	**(0.08)**	**(0.08)**	**(0.09)**
Beneficiary*Yield Q4	**-0.163*** **	**-0.143** **	**-0.108* **	**-0.021**
	(0.05)	**(0.06)**	**(0.06)**	**(0.07)**
Beneficiary*Yield Q5	**-0.246*** **	**-0.228*** **	**-0.201*** **	**-0.114* **
	(0.05)	**(0.00)**	**(0.06)**	**(0.07)**
Land	0.006	-0.002	-0.223	-0.65
	(0.01)	(0.02)	(0.28)	(1.58)
Land squared	0	0.00	0.00	0.043
	0.00	0.00	(0.01)	(0.12)
% of land with anti-hail	0.904	0.935	0	0
	(0.66)	(0.88)	0.00	0.00
% land with reservoir	0.028	0.114	0.554*	0.319
	(0.11)	(0.13)	(0.31)	(0.33)
% of land with irrigatio	-0.24	0.043	-0.376	-0.794**
	(0.23)	(0.20)	(0.47)	(0.32)
% of land with irrigatio	-0.651	-0.239	-1.259	0
	(21.90)	(21.13)	(26.13)	0.00
% of land with irrigatio	0.163	-0.141	-0.255	0.167
	(0.20)	(0.22)	(0.52)	(0.42)
Number of reservoirs	-0.048	0.015	-0.339	-0.243
	(0.06)	(0.09)	(0.34)	(1.07)
# of tractors	0.043	0.044	0.076	0.098
	(0.04)	(0.07)	(0.18)	(1.03)
Capacity of the reservoi	0.00	0.00	0.00	0.00
	0.00	0.00	(1.79)	(0.01)
Year 2003	0.528***	0.600***	0.552***	0.536***
	(0.01)	(0.01)	(0.04)	(0.04)
Year 2004	0.501***	0.505***	0.469***	0.478***
	(0.01)	(0.01)	(0.04)	(0.04)
Year 2005	0.402***	0.351***	0.249***	0.182***
	(0.01)	(0.01)	(0.04)	(0.06)
Year 2006	0.522***	0.537***	0.480***	0.371***
	(0.01)	(0.01)	(0.04)	(0.06)
Number of Observation	25794	19954	2488	1706
Number unique id	5388	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Ln (Yield)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*<1 ha	**0.159**	**0.188**	**0.213**	**0.295******
	(0.17)	**(0.15)**	**(0.20)**	**(0.13)**
Beneficiary*1 ha - 6 ha	**-0.031**	**-0.085***	**-0.059**	**0.024**
	(0.05)	**(0.05)**	**(0.05)**	**(0.07)**
Beneficiary*6 ha-12 ha	**0.003**	**0.042**	**0.07**	**0.154******
	(0.06)	**(0.06)**	**(0.07)**	**(0.08)**
Beneficiary*>12 ha	**0.051**	**0.083**	**0.101**	**0.181******
	(0.09)	**(0.09)**	**(0.08)**	**(0.08)**
Land	0.005	-0.001	-0.209	-0.663
	(0.01)	(0.02)	(0.34)	(1.55)
Land squared	0	0.00	0.00	0.045
	0.00	0.00	(0.02)	(0.12)
% of land with anti-hail	0.814	0.933	0.00	0.00
	(0.83)	(0.85)	0.00	0.00
% land with reservoir	-0.002	0.104	0.473	0.196
	(0.11)	(0.18)	(0.33)	(0.41)
% of land with irrigation (superior)	-0.265	0.038	-0.361	-0.782
	(0.20)	(0.21)	(0.42)	(1.23)
% of land with irrigation (aspersion)	-0.642	-0.238	-1.186	0
	(10.52)	(21.88)	(18.52)	0.00
% of land with irrigation (turn)	0.158	-0.128	-0.228	0.24
	(0.18)	(0.21)	(0.41)	(1.45)
Number of reservoirs	-0.017	0.026	-0.261	-0.201
	(0.06)	(0.08)	(0.31)	(0.29)
# of tractors	0.036	0.047	0.095	0.173
	(0.05)	(0.06)	(0.17)	(0.14)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(0.67)	(0.00)
Year 2003	0.509***	0.600***	0.552***	0.537***
	(0.01)	(0.01)	(0.04)	(0.04)
Year 2004	0.491***	0.505***	0.467***	0.475***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2005	0.413***	0.349***	0.240***	0.170***
	(0.01)	(0.01)	(0.05)	(0.05)
Year 2006	0.539***	0.537***	0.486***	0.382***
	(0.01)	(0.01)	(0.04)	(0.06)
Number of Observations	28582	19954	2488	1706
Number unique id	6275	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Ln (Yield)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*% fina=0	**0.006**	**0.012**	**0.039**	**0.123****
	(0.04)	**(0.04)**	**(0.05)**	**(0.06)**
Beneficiary*% fina (0,25%]	**-0.078**	**-0.066**	**-0.055**	**0.026**
	(0.10)	**(0.10)**	**(0.11)**	**(0.14)**
Beneficiary*% fina (25,50%]	**-0.238****	**-0.224***	**-0.197**	**-0.12**
	(0.12)	**(0.13)**	**(0.13)**	**(0.13)**
Beneficiary*% fina (50,75%]	**-0.103**	**-0.094**	**-0.072**	**0.022**
	(0.12)	**(0.12)**	**(0.14)**	**(0.10)**
Beneficiary*% fina (75,100%]	**-0.004**	**0.017**	**0.047**	**0.129**
	(0.08)	**(0.09)**	**(0.08)**	**(0.10)**
Land	0.006	-0.001	-0.212	-0.694
	(0.01)	(0.02)	(0.25)	(1.11)
Land squared	0	0.00	0.00	0.048
	0.00	0.00	(0.01)	(0.09)
% of land with anti-hail	0.902	0.933	0	0
	(0.82)	(0.90)	0.00	0.00
% land with reservoir	0.023	0.103	0.457	0.187
	(0.14)	(0.16)	(0.31)	(0.33)
% of land with irrigation (superior)	-0.243	0.04	-0.335	-0.747*
	(0.19)	(0.20)	(0.48)	(0.44)
% of land with irrigation (aspersion)	-0.648	-0.234	-1.147	0
	(22.15)	(18.99)	(13.98)	0.00
% of land with irrigation (turn)	0.172	-0.127	-0.249	0.204
	(0.21)	(0.19)	(0.50)	(0.52)
Number of reservoirs	-0.041	0.031	-0.231	-0.143
	(0.06)	(0.07)	(0.34)	(0.23)
# of tractors	0.044	0.045	0.091	0.148
	(0.06)	(0.06)	(0.22)	(0.11)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(0.24)	(0.00)
Year 2003	0.528***	0.600***	0.552***	0.536***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2004	0.501***	0.505***	0.468***	0.477***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2005	0.401***	0.349***	0.239***	0.169**
	(0.01)	(0.02)	(0.04)	(0.07)
Year 2006	0.522***	0.537***	0.485***	0.381***
	(0.01)	(0.02)	(0.04)	(0.07)
Number of Observations	25830	19954	2488	1706
Number unique id	5400	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

B) Yield Regressions – Value

Ln (Yield Value)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary	**0.012**	**0.00**	**0.027**	**0.106***
	(0.03)	**(0.04)**	**(0.04)**	**(0.06)**
Land	0.006	0.001	-0.185	-0.517
	(0.01)	(0.02)	(0.23)	(1.00)
Land squared	0	0.00	0.00	0.033
	0.00	0.00	(0.01)	(0.08)
% of land with anti-hail	0.952	1.051	0	0
	(0.86)	(0.83)	0.00	0.00
% land with reservoir	-0.003	0.121	0.297	0.035
	(0.13)	(0.16)	(0.34)	(0.39)
% of land with irrigation (superior)	-0.215	0.083	-0.174	-0.441
	(0.20)	(0.21)	(0.78)	(0.57)
% of land with irrigation (aspersion)	-0.656	-0.265	-0.872	0
	(25.76)	(19.17)	(18.08)	0.00
% of land with irrigation (turn)	0.159	-0.13	-0.147	0.094
	(0.16)	(0.20)	(0.89)	(0.80)
Number of reservoirs	-0.036	0.031	-0.165	-0.096
	(0.07)	(0.08)	(0.30)	(0.29)
# of tractors	0.04	0.045	0.152	0.174
	(0.06)	(0.06)	(0.20)	(0.13)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(1.44)	(0.00)
Year 2003	1.160***	1.247***	1.182***	1.159***
	(0.01)	(0.02)	(0.04)	(0.05)
Year 2004	1.932***	1.937***	1.891***	1.891***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2005	1.860***	1.792***	1.676***	1.602***
	(0.01)	(0.02)	(0.05)	(0.06)
Year 2006	1.712***	1.706***	1.642***	1.538***
	(0.01)	(0.01)	(0.05)	(0.06)
Number of Observations	28582	19954	2488	1706
Number unique id	6275	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Ln (Yield Value)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*Yield Q1	**0.472*** **	**0.464*** **	**0.495*** **	**0.576*** **
	(0.11)	**(0.12)**	**(0.12)**	**(0.13)**
Beneficiary*Yield Q2	**0.257*** **	**0.265*** **	**0.292*** **	**0.376*** **
	(0.07)	**(0.08)**	**(0.08)**	**(0.08)**
Beneficiary*Yield Q3	**-0.061**	**-0.04**	**-0.014**	**0.064**
	(0.09)	**(0.10)**	**(0.08)**	**(0.08)**
Beneficiary*Yield Q4	**-0.139** **	**-0.118* **	**-0.083**	**0**
	(0.06)	**(0.06)**	**(0.06)**	**(0.07)**
Beneficiary*Yield Q5	**-0.247*** **	**-0.229*** **	**-0.198*** **	**-0.116* **
	(0.06)	**(0.00)**	**(0.06)**	**(0.07)**
Land	0.007	0.001	-0.207	-0.504
	(0.01)	(0.02)	(0.42)	(2.03)
Land squared	0	0.00	0.00	0.03
	0.00	0.00	(0.02)	(0.16)
% of land with anti-hail	1.028	1.053	0	0
	(0.85)	(0.82)	0.00	0.00
% land with reservoir	0.029	0.129	0.371	0.135
	(0.15)	(0.13)	(0.40)	(0.50)
% of land with irrigation (superior)	-0.179	0.086	-0.197	-0.465
	(0.25)	(0.24)	(0.56)	(0.63)
% of land with irrigation (aspersion)	-0.651	-0.268	-0.958	0
	(22.57)	(28.25)	(27.76)	0.00
% of land with irrigation (turn)	0.148	-0.141	-0.168	0.045
	(0.26)	(0.25)	(0.75)	(0.77)
Number of reservoirs	-0.064	0.019	-0.249	-0.171
	(0.06)	(0.08)	(0.35)	(0.34)
# of tractors	0.044	0.044	0.145	0.139
	(0.06)	(0.08)	(0.22)	(0.12)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(0.53)	(0.00)
Year 2003	1.178***	1.247***	1.182***	1.159***
	(0.01)	(0.02)	(0.04)	(0.05)
Year 2004	1.941***	1.937***	1.891***	1.891***
	(0.01)	(0.02)	(0.05)	(0.05)
Year 2005	1.850***	1.793***	1.685***	1.615***
	(0.02)	(0.02)	(0.06)	(0.06)
Year 2006	1.694***	1.705***	1.637***	1.528***
	(0.01)	(0.02)	(0.04)	(0.06)
Number of Observations	25794	19954	2488	1706
Number unique id	5388	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Ln (Yield Value)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*<1 ha	**0.098**	**0.145**	**0.173**	**0.251**
	(0.20)	**(0.21)**	**(0.23)**	**(0.17)**
Beneficiary*1 ha - 6 ha	**-0.002**	**-0.058**	**-0.032**	**0.047**
	(0.05)	**(0.05)**	**(0.06)**	**(0.06)**
Beneficiary*6 ha-12 ha	**0.01**	**0.05**	**0.08**	**0.161****
	(0.06)	**(0.06)**	**(0.07)**	**(0.08)**
Beneficiary*>12 ha	**0.05**	**0.082**	**0.104**	**0.177****
	(0.08)	**(0.10)**	**(0.09)**	**(0.08)**
Land	0.006	0.001	-0.19	-0.513
	(0.01)	(0.02)	(0.34)	(0.99)
Land squared	0	0.00	0.00	0.032
	0.00	0.00	(0.02)	(0.07)
% of land with anti-hail	0.952	1.051	0.00	0.00
	(0.81)	(0.83)	0.00	0.00
% land with reservoir	-0.004	0.12	0.298	0.024
	(0.15)	(0.12)	(0.34)	(0.61)
% of land with irrigation (superior)	-0.216	0.081	-0.183	-0.453
	(0.23)	(0.26)	(0.49)	(0.58)
% of land with irrigation (aspersion)	-0.657	-0.267	-0.889	0
	(23.98)	(18.42)	(21.99)	0.00
% of land with irrigation (turn)	0.159	-0.129	-0.144	0.11
	(0.22)	(0.24)	(0.66)	(0.90)
Number of reservoirs	-0.036	0.03	-0.176	-0.133
	(0.07)	(0.08)	(0.36)	(0.29)
# of tractors	0.04	0.047	0.166	0.213
	(0.05)	(0.07)	(0.22)	(0.14)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(0.00)	(0.00)
Year 2003	1.160***	1.247***	1.182***	1.159***
	(0.01)	(0.02)	(0.04)	(0.04)
Year 2004	1.931***	1.937***	1.890***	1.890***
	(0.01)	(0.01)	(0.04)	(0.04)
Year 2005	1.860***	1.792***	1.676***	1.603***
	(0.01)	(0.02)	(0.05)	(0.05)
Year 2006	1.712***	1.706***	1.642***	1.538***
	(0.02)	(0.02)	(0.04)	(0.06)
Number of Observations	28582	19954	2488	1706
Number unique id	6275	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Ln (Yield Value)	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*% fina=0	**0.014**	**0.021**	**0.05**	**0.130****
	(0.04)	**(0.05)**	**(0.05)**	**(0.06)**
Beneficiary*% fina (0,25%]	**-0.02**	**-0.007**	**0.006**	**0.085**
	(0.10)	**(0.10)**	**(0.09)**	**(0.10)**
Beneficiary*% fina (25,50%]	**-0.228***	**-0.215**	**-0.195**	**-0.126**
	(0.13)	**(0.13)**	**(0.13)**	**(0.12)**
Beneficiary*% fina (50,75%]	**-0.129**	**-0.12**	**-0.104**	**-0.015**
	(0.16)	**(0.12)**	**(0.15)**	**(0.12)**
Beneficiary*% fina (75,100%]	**0.009**	**0.031**	**0.064**	**0.143**
	(0.08)	**(0.08)**	**(0.10)**	**(0.09)**
Land	0.007	0.001	-0.191	-0.543
	(0.01)	(0.02)	(0.56)	(9.28)
Land squared	0	0.00	0.00	0.035
	0.00	0.00	(0.03)	(1.21)
% of land with anti-hail	1.027	1.051	0	0
	(0.86)	(0.85)	0.00	0.00
% land with reservoir	0.024	0.119	0.283	0.012
	(0.15)	(0.15)	(0.30)	(0.39)
% of land with irrigation (superior)	-0.179	0.085	-0.144	-0.396
	(0.20)	(0.26)	(0.58)	(0.69)
% of land with irrigation (aspersion)	-0.646	-0.26	-0.835	0
	(21.01)	(18.16)	(32.50)	0.00
% of land with irrigation (turn)	0.155	-0.131	-0.183	0.052
	(0.19)	(0.23)	(0.73)	(0.84)
Number of reservoirs	-0.056	0.035	-0.15	-0.092
	(0.08)	(0.10)	(0.32)	(0.34)
# of tractors	0.045	0.046	0.167	0.206
	(0.05)	(0.06)	(0.24)	(0.13)
Capacity of the reservoirs	0.00	0.00	0.00	0.00
	0.00	0.00	(0.92)	(0.00)
Year 2003	1.178***	1.247***	1.182***	1.159***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2004	1.941***	1.937***	1.891***	1.891***
	(0.01)	(0.01)	(0.04)	(0.05)
Year 2005	1.849***	1.792***	1.676***	1.602***
	(0.01)	(0.02)	(0.04)	(0.06)
Year 2006	1.695***	1.706***	1.642***	1.537***
	(0.01)	(0.02)	(0.06)	(0.05)
Number of Observations	25830	19954	2488	1706
Number unique id	5400	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

C) Sugar Content

Sugar Content	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary	**1.019***	**1.274****	**1.687****	**1.32**
	(0.58)	**(0.61)**	**(0.74)**	**(0.97)**
Land	-0.025	-0.038	0.291	-1.493
	(0.05)	(0.13)	(6.16)	(19.28)
Land squared	0	0.00	-0.01	0.193
	0.00	0.00	(0.23)	(1.67)
% of land with anti-hail	-3.083	-2.506	0	0
	(7.30)	(6.77)	0.00	0.00
% land with reservoir	-1.776	-1.64	-2.618	-6.753
	(2.06)	(2.10)	(6.61)	(8.58)
% of land with irrigation (superior)	2.226	2.572	-3.886	4.494
	(2.57)	(4.20)	(10.17)	(10.57)
% of land with irrigation (aspersion)	12.932	13.688	6.226	0
	(181.69)	(210.04)	(173.56)	0.00
% of land with irrigation (turn)	0.67	0.436	11.714	6.469
	(2.94)	(3.87)	(12.01)	(12.19)
Number of reservoirs	0.933	1.514	1.574	-1.889
	(1.05)	(1.26)	(6.74)	(8.10)
# of tractors	0.234	-0.014	-1.539	2.694
	(0.70)	(0.80)	(3.96)	(3.39)
Capacity of the reservoirs	0.00	0.00	-0.02	0.02
	0.00	(0.00)	(0.08)	(0.08)
Year 2003	-2.484***	-3.670***	-3.286***	-2.271***
	(0.20)	(0.23)	(0.56)	(0.59)
Year 2004	0.529***	-0.482**	-0.568	-0.123
	(0.19)	(0.24)	(0.53)	(0.71)
Year 2005	-7.062***	-8.556***	-8.457***	-7.645***
	(0.21)	(0.29)	(0.58)	(0.89)
Year 2006	2.408***	1.536***	1.121*	2.056**
	(0.21)	(0.26)	(0.65)	(0.95)
Number of Observations	28582	19954	2488	1706
Number unique id	6275	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

	(1)	(2)	(3)	(4)
Sugar Content	Full Sample	PS Matching	Single Variable Match:Yield	Single Variable Match: Yield & Land
Beneficiary*Yield Q1	**1.152**	**1.327**	**1.745**	**1.299**
	(1.34)	**(1.38)**	**(1.57)**	**(1.45)**
Beneficiary*Yield Q2	**-0.165**	**-0.095**	**0.334**	**0**
	(1.69)	**(1.50)**	**(1.79)**	**(2.06)**
Beneficiary*Yield Q3	**2.559***	**2.761***	**3.224****	**2.949***
	(1.36)	**(1.42)**	**(1.52)**	**(1.51)**
Beneficiary*Yield Q4	**0.569**	**0.81**	**1.24**	**0.724**
	(1.17)	**(1.19)**	**(1.56)**	**(1.24)**
Beneficiary*Yield Q5	**1.534**	**1.699****	**2.049***	**1.779**
	(1.02)	**(0.00)**	**(1.15)**	**(1.33)**
Land	-0.018	-0.038	0.362	-1.357
	(0.04)	(0.23)	(3.10)	(12.23)
Land squared	0	0.00	-0.01	0.188
	0.00	(0.00)	(0.15)	(1.20)
% of land with anti-hail	-3.116	-2.512	0	0
	(6.98)	(6.35)	0.00	0.00
% land with reservoir	-1.664	-1.644	-2.7	-6.897
	(1.79)	(2.87)	(5.35)	(9.02)
% of land with irrigation (superior)	2.722	2.597	-3.795	4.687
	(2.79)	(3.61)	(8.39)	(19.52)
% of land with irrigation (aspersion)	13.751	13.744	6.508	0
	(202.78)	(298.23)	(256.06)	0.00
% of land with irrigation (turn)	0.588	0.437	11.782	6.614
	(2.79)	(3.30)	(9.10)	(20.25)
Number of reservoirs	1.076	1.522	1.645	-2.05
	(1.00)	(1.49)	(5.80)	(7.86)
# of tractors	0.228	-0.003	-1.496	2.986
	(0.77)	(0.97)	(3.02)	(3.03)
Capacity of the reservoirs	0.00	0.00	-0.02	0.02
	(0.00)	0.00	(15.85)	(0.08)
Year 2003	-2.480***	-3.670***	-3.286***	-2.269***
	(0.22)	(0.20)	(0.49)	(0.73)
Year 2004	0.538**	-0.483**	-0.573	-0.129
	(0.21)	(0.21)	(0.64)	(0.79)
Year 2005	-7.038***	-8.557***	-8.470***	-7.662***
	(0.22)	(0.21)	(0.64)	(0.86)
Year 2006	2.362***	1.537***	1.129	2.069**
	(0.21)	(0.22)	(0.76)	(0.86)
Number of Observations	25794	19954	2488	1706
Number unique id	5388	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Sugar Content	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*<1 ha	**2.004**	**2.346**	**2.765**	**2.413**
	(5.45)	**(4.27)**	**(4.35)**	**(3.37)**
Beneficiary*1 ha - 6 ha	**1.207**	**1.620****	**2.037****	**1.603**
	(0.85)	**(0.80)**	**(1.03)**	**(1.23)**
Beneficiary*6 ha-12 ha	**-0.165**	**-0.171**	**0.17**	**-0.158**
	(1.22)	**(0.94)**	**(1.04)**	**(1.20)**
Beneficiary*>12 ha	**2.401***	**2.571***	**3.085****	**2.857****
	(1.27)	**(1.41)**	**(1.38)**	**(1.25)**
Land	-0.025	-0.038	0.352	-1.273
	(0.06)	(0.18)	(5.40)	(17.17)
Land squared	0	0.00	-0.01	0.178
	0.00	(0.00)	(0.14)	(1.79)
% of land with anti-hail	-3.085	-2.508	0.00	0.00
	(5.64)	(8.24)	0.00	0.00
% land with reservoir	-1.783	-1.646	-2.617	-6.827
	(1.61)	(2.34)	(5.56)	(7.65)
% of land with irrigation (superior)	2.219	2.554	-4.124	4.089
	(3.06)	(3.22)	(9.09)	(14.52)
% of land with irrigation (aspersion)	12.931	13.68	6.091	0
	(187.22)	(258.02)	(208.84)	0.00
% of land with irrigation (turn)	0.694	0.477	12.22	7.253
	(2.60)	(3.07)	(9.15)	(15.33)
Number of reservoirs	0.922	1.492	1.508	-2.043
	(1.07)	(1.70)	(5.11)	(6.35)
# of tractors	0.234	-0.017	-1.645	2.655
	(0.67)	(0.81)	(3.37)	(3.27)
Capacity of the reservoirs	0.00	0.00	-0.02	0.01
	0.00	(0.00)	(0.08)	(0.08)
Year 2003	-2.484***	-3.670***	-3.286***	-2.269***
	(0.20)	(0.22)	(0.59)	(0.59)
Year 2004	0.528***	-0.485*	-0.586	-0.15
	(0.19)	(0.28)	(0.62)	(0.71)
Year 2005	-7.061***	-8.555***	-8.454***	-7.637***
	(0.24)	(0.25)	(0.68)	(0.73)
Year 2006	2.408***	1.536***	1.122	2.064**
	(0.20)	(0.23)	(0.70)	(0.91)
Number of Observations	28582	19954	2488	1706
Number unique id	6275	4157	510	350

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Sugar Content	(1) Full Sample	(2) PS Matching	(3) Single Variable Match:Yield	(4) Single Variable Match: Yield & Land
Beneficiary*% fina=0	**1.874****	**2.060*****	**2.476*****	**2.013****
	(0.83)	**(0.69)**	**(0.93)**	**(0.92)**
Beneficiary*% fina (0,25%]	**0.521**	**0.636**	**0.965**	**0.609**
	(1.51)	**(1.88)**	**(2.04)**	**(1.51)**
Beneficiary*% fina (25,50%]	**1.861**	**2.021**	**2.516**	**1.998**
	(1.54)	**(1.49)**	**(1.77)**	**(1.62)**
Beneficiary*% fina (50,75%]	**1.878**	**2.076**	**2.844**	**2.048**
	(2.34)	**(2.00)**	**(2.35)**	**(2.43)**
Beneficiary*% fina (75,100%]	**-1.684**	**-1.456**	**-1.069**	**-1.51**
	(1.41)	**(1.27)**	**(1.52)**	**(1.74)**
Land	-0.019	-0.039	0.212	2.158
	(0.06)	(0.16)	(5.78)	(1.54)
Land squared	0	0.00	-0.01	-0.083
	0.00	(0.00)	(0.29)	(0.06)
% of land with anti-hail	-3.113	-2.501	0	-4.709
	(6.38)	(7.41)	0.00	(10.54)
% land with reservoir	-1.67	-1.644	-2.529	0.513
	(1.81)	(2.00)	(6.65)	(4.02)
% of land with irrigation (superior)	2.641	2.477	-4.452	-0.47
	(2.19)	(2.61)	(7.10)	(5.67)
% of land with irrigation (aspersion)	13.605	13.534	5.307	0
	(158.54)	(269.42)	(321.79)	0.00
% of land with irrigation (turn)	0.631	0.508	12.192	6.793
	(2.31)	(2.84)	(8.95)	(6.42)
Number of reservoirs	1.066	1.495	1.451	0.456
	(1.03)	(1.56)	(7.01)	(4.12)
# of tractors	0.219	-0.011	-1.549	-0.287
	(0.73)	(0.75)	(3.00)	(1.70)
Capacity of the reservoirs	0.00	0.00	-0.02	0.00
	0.00	(0.00)	(0.08)	(0.02)
Year 2003	-2.490***	-3.669***	-3.286***	-3.545***
	(0.21)	(0.24)	(0.59)	(0.45)
Year 2004	0.542***	-0.483**	-0.571	-0.899**
	(0.16)	(0.23)	(0.61)	(0.40)
Year 2005	-7.029***	-8.553***	-8.438***	-8.465***
	(0.19)	(0.26)	(0.69)	(0.41)
Year 2006	2.361***	1.535***	1.110*	1.516***
	(0.19)	(0.27)	(0.64)	(0.39)
Number of Observations	25830	19954	2488	7935
Number unique id	5400	4157	510	1654

Note: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%