IMPACT ASSESSMENT OF THE CSICAP INITIATIVE

Results and Recommendations

Executive Summary

Due to its geographical characteristics, Colombia is a country particularly vulnerable to climate change. Simultaneously, the country's agricultural sector is a receiver of negative externalities due to the phenomena that derive from climate change and a contributor to these externalities. In this context, to face these multidimensional challenges of the agricultural sector, the Alliance of Bioversity International and CIAT, with the Ministry of Agriculture and Rural Development of Colombia (MADR for its acronym in Spanish), developed and began to implement, since 2013, an agreement for Technical and Scientific Cooperation. The agreement had four basic topics to mitigate climate change effects on Colombian farmers: 1) Development and validation of climate predictions for different Colombian agricultural sectors' regions to improve crop management. 2) Identify problems that limit agricultural sector growth, collect information at the farm level, and propose technological solutions adapted to the producer's needs. 3) Define agricultural innovations and best agricultural management practices that contribute to reducing greenhouse gas (GHG) emissions and offer alternatives for adapting to climate change. 4) Identify sustainable production systems adapted to the national context and train interested partners in using new tools and technologies to mitigate climate change effects.

Based on that experience, the MADR, the Alliance, and the Andean Development Corporation-Development Bank of Latin America (CAF for its acronym in Spanish) began the formulation of the initiative “Climate-smart initiatives for climate change adaptation and sustainability in prioritized agricultural production systems in Colombia (CSICAP)” attending the proposal of the National Planning Department (DNP for its acronym in Spanish). It was required an two types of studies, an *ex-post* impact evaluation of the 2013 cooperation agreement and an *ex-ante* evaluation of the strategies and activities planned for the CSICAP initiative. In this document, the main results of those evaluations are presented. The studies were carried out by the temporary partnership between the consulting firm INSUCO and Universidad del Rosario, with the support of the Alliance Biovertisy - CIAT.

Through the *ex-post* impact evaluation, we sought to quantify and understand the effects of the activities carried out within the technical agreement framework since 2013. These activities focused mainly on rice and maize, in collaboration with the producers' associations of FEDEARROZ and FENALCE and specific regions of the country. The *ex-ante* economic evaluation simulates the potential effects of implementing the initiative CSICAP in Colombia. For both, the evaluations follow a mixed-methods approach, by which quantitative and qualitative techniques are used to approximate the effects of interest.

The quantitative *ex-post* impact analysis is based, fundamentally, on primary information collected in the field using face-to-face surveys made to producers of the two crops of interest during the second half of 2020. For rice production, 616 surveys in 39 municipalities of six departments of the country (Córdoba, Meta, Sucre, Tolima, Casanare, and Valle del Cauca) were collected. For corn, 406 surveys were carried out in 41 municipalities of 6 departments (Córdoba, Meta, Tolima, Quindío, Risaralda and Valle del Cauca).

The survey instruments used allows us to describe different dimensions of the producers, like household composition, production decision-making, characterization of the production unit, production of other crops, characterization of the crop of interest, agronomic management, information-technical assistance, exposure to adverse weather events, adoption of resilient practices, living conditions, among others.

Due to the project's initial design, it was not possible to specifically identify the producers who were directly exposed to the activities of the agreement advanced since 2013. Nevertheless, the survey allows us to approximate a definition of useful treatment for the evaluation. It was feasible to identify producers exposed to technical assistance and received knowledge related to the a. Therefore, the impact of this type of activities on different outcomes of interest for the producers was evaluated (i.e., yield, water footprint reduction or water use efficiency, crops losses due to climate change, use of agroclimatic predictions in production decisions, the adoption of improved varieties developed within the framework of the technical agreement, among others). Also, in the report's appendix (in Spanish), the analysis is carried out using an alternative definition of the treatment. The producers that lived in any of the municipalities that were part of the agreement are considered treated. This definition, of a more macro nature, allows capturing potential spillover (or snowball) effects between producers.

Usually, an *ex-post* impact evaluation's main challenge is to find a valid counterfactual, which allows inferring what would have happened to the treated units if the intervention had not occurred. To overcome this challenge, this evaluation uses matching techniques, which essentially consist of selecting the control group units that are more similar to those of the treatment in the observable characteristics that are possible to measure. In particular, two types of algorithms are used for this purpose: genetic matching and propensity score matching (PSM) models. In each case, after processing the data and matching the treated producers with the most appropriate control units, and evaluate the impact of the intervention on the outcomes of interest. This is done using mean difference tests in the case of genetic matching and multiple regressions weighting each observation by the inverse of its participation probability in PSM (Inverse Probability Weighting regression - IPW).

The results of the *ex-post* impact evaluation show that there are heterogeneous effects by type of crop. In the case of rice, the project has a positive and significant impact on crop yields. A producer who has participated in agreement (2013) technical assistance activities presents an expected yield 0.6 ton/ha higher than one that has not. Additionally, the agreement's activities have a large, positive, and significant impact on the use of agroclimatic forecasts to make production decisions. The effect is substantial: a treated producer is 23% more likely to use this type of forecast. The mechanism throughout yield changes seems to be the adoption of agroclimatic predictions.

In contrast, there is no impact on other outcomes of interest, like reducing the water footprint or reducing the loss of crops due to climate change. Finally, on the subject of the agreement's varieties (Fedearroz 67 and 68), there is no attributable impact to the mechanisms used to change adoption rates. However, it is noted that approximately 41% of the producers, both treated and controls, plant these varieties. Indeed, there were other interventions by the rice producer association to promote its adoption.

However, the results further reveal that the potential effect of reduced crop losses on yield cannot be underestimated. The correlation between both variables is negative and significant. The producers who report not having crop losses due to climate change have an expected higher yield of more than 0.8 ton/ha. Therefore, the agreement interventions has reduced crop losses due to climate change that results in significant yield gains. This result is also evident in the case of maize.

Nevertheless, the rest of the results in this crop are different. The evidence does not show an impact on any of the variables of interest, unlike what happens in rice. One of the fundamental findings of the qualitative analysis probably explains this discrepancy in the results. There are significant institutional differences between the associations of each crop, which have an impact on the relationship between them and the Alliance and the subsequent dissemination of the knowledge for producers.

The qualitative analysis of the *ex-post* evaluation, reported in Section 3 of the report, also focused on the design of the agreement and its implementation. It began by recognizing that these activities had two central moments. In the first place, the one corresponding to the interaction between the Alliance and the producer's associations (FEDEARROZ and FENALCE) aims to generate information related to agroclimatic conditions, identifying soil characteristics and selecting improved varieties with higher capacity to adapt into particular geographic regions of interest. Besides, this interaction focused on the associations incorporating the techniques and technologies developed within the technical agreement framework into their daily tasks continuously and sustainably. A fundamental part of the Alliance-Associations interaction was the design and development of platforms for data systematization. In the second place, the intervention involved the interaction between the associations and the producers. This stage consisted of those activities carried out by the producer's associations to disseminate the knowledge and innovations generated in the technical agreement to the producers. The final objective of this set of institutional interactions and the intervention was to ensure that the producers participate in the program, using the information regarding the two components (agroclimatic information and site-specific agriculture) to transform some of their production practices and to increase productivity.

For this qualitative analysis, a total of 18 interviews were carried out, distributed as follows: FEDEARROZ, three interviews; FENALCE 5 interviews; CIAT, four interviews; MADR, two interviews; and producers four interviews. Additionally, one of the meetings between INSUCO's team and a FENALCE representative was transcribed, and it is part of the qualitative information. The information analysis process consisted of transcribing the interviews and coding them using Atlas.Ti, software for qualitative analysis. This analysis serves two primary goals: first, it enables the agreement's (2013) institutional impact to be assessed, something difficult to achieve with quantitative analysis. Second, the qualitative analysis helps to elucidate the underlying mechanisms associated with the impacts, or lack of those, identified in the quantitative assessment.

In this order of ideas, the qualitative *ex-post* evaluation's main results can be grouped into four large sections. First, although the agreement (2013) has a high potential to positively impact producers by increasing their productivity and helping them mitigate the effects of climate change, some bottlenecks must be overcome to meet this objective. In particular, although the interaction between the Alliance and the producer's associations was fluid and satisfactory, the subsequent transmission of knowledge to the producers was not always as expected. The interviews show that knowledge and good practices did not reach the final beneficiaries at all times, perhaps because this stage of the project was more concerned with research and experimental activities than rather dissemination. This would explain, to some extent, why the quantitative analysis still does not find impacts on some of the outcomes of interest.

Second, the interviews with the producers, and even the associations, show that the agreement (2013) has a significant recognition problem. Some of the actors could not associate the activities they were participating in with the agreement in question. Sometimes even the actions carried out within the agreement's framework are confused with other programs in which the associations participate actively.

This explains, largely, why it was difficult for the evaluation to identify the beneficiaries of the activities carried out within the framework of the agreement. This, without a doubt, is an aspect to improve when scaling the initiative. Third, an essential part of the work between the Alliance, the producer's associations, and some producers consisted of research and experimental trials regarding improved varieties, both in rice and maize, which would have higher yields and reach optimal production levels. However, higher crop production does not necessarily translate into higher profitability or higher profits for producers. It is important to consider other factors, such as the commercialization of the promoted varieties, which largely also respond to consumer preferences in each market. It is of little use to find varieties that reach higher yields if the product buyers in question do not feel comfortable with some characteristics of that variety.

Finally, the fourth finding has to do with the evident heterogeneity between the two producer's associations in question and the consequences of those differences. Although the intervention fulfilled its task of training technicians of the organizations, the fact that there are differentiated impacts according to crop was evident in the evaluation's quantitative component. The differences in the degree of incorporation and continuity in the use of the transferred knowledge rely upon the capacity of the associations and do not exclusively in the activities carried during the agreement. In other words, the institutional conditions in which the project is implemented will be crucial for understanding its impacts. In the particular case of rice and maize, qualitative evidence shows that the capacities in the case of FEDEARROZ were greater than those of FENALCE. However, this does not imply that the interaction with the latter was not smooth or fruitful. The dynamics were different, and there was a very good disposition by the association in many cases. It simply means that the interaction had to be different, among other things, because the human talent loss was more significant for the maize association, making it difficult to continue and consolidate what was transmitted. Therefore, the finding's lesson is that the implementation of the initiative in the future cannot and should not be homogeneous but must be adapted to the particularities of each sector.

Section 4 of the report deals with the *ex-ante* economic evaluation of the CSICAP initiative in Colombia. This analysis aims to simulate and forecast the potential impacts of initiative implementation in the country. For this, standard methodologies of economic assessment of projects are used. In particular, the economic surplus method is used, which consists of calculating, for different markets and moments in time, the changes in consumers and producers' surpluses due to technological changes resulting from interventions associated with the initiative CISCAP. The analysis focuses on eight key products for Colombian agriculture, which have the potential to be impacted by the initiative, specifically: livestock (milk and meat), potatoes, panela cane, rice, sugar cane, corn, coffee, and bananas. The simulation exercises depend on the assumptions established about the markets of interest and on relevant parameters, such as the price elasticities of supply and demand, the initial average prices of the products, the initial annual production, the technological effects of the intervention on the yield changes or costs of production, technology adoption curves, among others. For the parameterization of the models, surveys and interviews with experts from the Alliance and each sector were used and specialized literature on the subject. At the end of the simulation exercise, it is possible to calculate key indicators for the economic evaluation, such as the Internal Rate of Return (IRR), the modified internal rate of return (MIRR), the Net Present Value (NPV), and the Benefit-Cost Ratio (RBC).

The simulations show that the project's consolidation would be highly profitable for all the crops and products analyzed, regardless of whether an optimistic or conservative scenario is assumed in terms of

adoption curves and technological effects. The estimates show that the benefits would far outweigh the costs, which is valid for the components of the program of "agro climatic risk management and digital agriculture", "genetic improvement," and "use of water resources and gas emissions". Therefore, this component's policy recommendation is quite clear: an agile and timely implementation of the initiative would be highly beneficial for the agricultural sector, benefiting consumers and producers.

The report concludes with some recommendations based on these findings, specifically:

1. The qualitative evidence shows that the interaction between the Alliance and the associations was good, but the producers' vertical dissemination was not always satisfactory. It is key to incorporate spaces and strategies that allow farmers to be massively involved.

2. There are important heterogeneities between the producer's associations, as confirmed by the qualitative analysis in FEDEARROZ and FENALCE. These differences in capacity interfere with the final impact these types of projects have on final producers, as shown by the quantitative evaluation. Therefore, the design of a more ambitious and comprehensive program, covering more sectors, must consider these differences in the associations' initial capacities.

3. The research and experimental trials in improved varieties should not only seek to optimize their yield performance. To maximize the profitability of producers and to increase the adoption rate, it is important to take into account other dimensions, such as market acceptance and the consumer preferences for these varieties.

4. Qualitatively, it is clear that disseminating good practices is more expeditious when it occurs horizontally among farmers in the same region. However, the quantitative impact assessment shows that it was not always possible to generate this snowball effect. It is essential to work on strategies to generate this type of network externalities (spillovers), as they would greatly enhance the intervention's effects.

5. It is essential to structure and consolidate the information systems associated with the initiative. For the consulting team, it was not trivial to identify the places, times, and beneficiaries of the agreement's (2013) different activities. This is key to being able to monitor, follow up and evaluate the intervention and to be able to determine its impact in the future.

6. The agreement (2013), to a large extent, depended on the transmission of knowledge from entities with a scientific vocation, such as the Alliance, to producer associations and producers. However, the human capital flight and staff turnover was a challenge that threatens the durability of the effects over time. It is key to implement strategies that ensure that knowledge is preserved despite personnel turnover within organizations.

7. As the ex-ante evaluation shows, it is important to start the transfer activities in the shortest possible time, considering the adoption curves and how maximum yield/cost differences are reached for each market.

8. It is essential to identify, in the field, the factors that could restrict the adoption of the knowledge and practices promoted by the CSICAP initiative since the results (surpluses) depend substantially on the adoption rate.

9. In line with the previous recommendation, it is suggested to use scientific tools based on behavioral economics and impact evaluation, which serves to encourage as much as possible the adoption of the practices and knowledge promoted by the CSICAP initiative.

In summary, the CSICAP initiative is key for the agricultural sector to adapt the country to climate change. The activities carried out so far have generated considerable impacts on some variables and can potentially impact many others. Furthermore, the simulations show that scaling up the initiative would be highly profitable in different dimensions. It is important to speed up the process.