Technology Transfer to Small Farmers Program in Haiti (PTTA)

IMPLEMENTATION, EVALUATION AND LESSONS LEARNED

MAY 2018

IDB

Inter-American Development Bank
Published May 2018
www.iadb.org

Authors
Karen Macours, Dan Stein, Lina Salazar, Sébastien Gachot, Bruno Jacquet, Jossie Fahsbender, Jery Rambao, Jérémie Gignoux and Kelsey Wright

Editors
Elettra Legovini and Carmine Paolo De Salvo

Photo credits
Carmine Paolo De Salvo

Design and Layout
Elena Sampedro | elena@lacasagrafica.com

Technology Transfer to Small Farmers Program in Haiti (PTTA)

IMPLEMENTATION, EVALUATION AND LESSONS LEARNED

MAY 2018

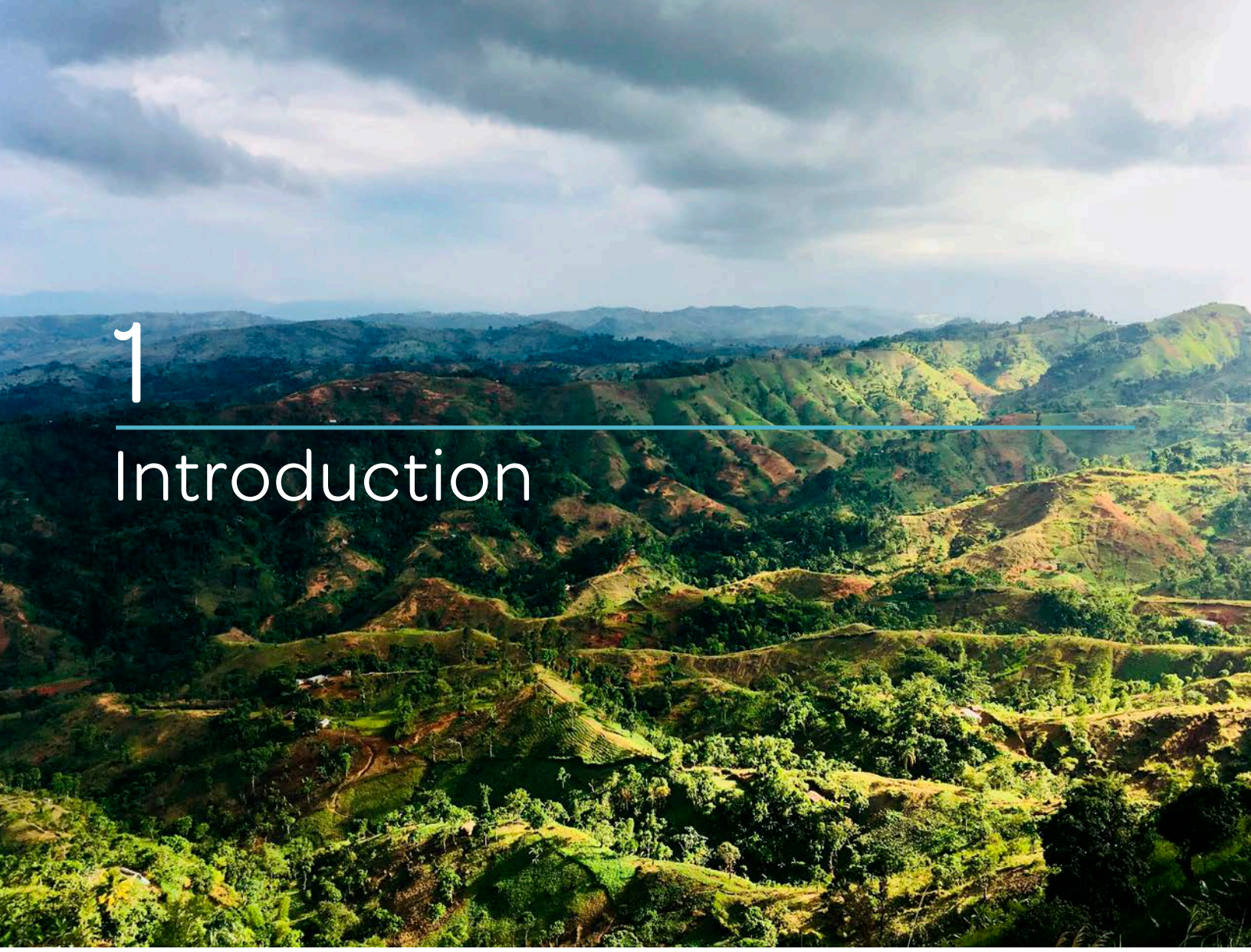
AUTHORS OF THE EVALUATIONS:
Karen Macours
Dan Stein
Lina Salazar
Sébastien Gachot
Bruno Jacquet
Jossie Fahsbender
Jery Rambao
Jérémie Gignoux
Kelsey Wright

EDITORS OF THE SUMMARY DOCUMENT:
Elettra Legovini and Carmine Paolo De Salvo

ABSTRACT

Smart subsidy programs have been advocated in many developing countries to encourage the adoption of modern inputs and increase agricultural productivity. Evidence from Sub-Saharan Africa has shown that one-time targeted subsidies can be effective at increasing adoption of fertilizer and boosting agricultural productivity. Similarly, the Technology Transfer to Small Farmers Program (PTTA) in Haiti, implemented by the Ministry of Agriculture, Natural Resources and Rural Development, provided vouchers to subsidize agricultural inputs, such as certain labor tasks, seedlings, fertilizer, pesticides, and other inputs. A series of evaluations deploying a variety of methods were conducted to test the program's effectiveness on a series of agricultural and socio-economic variables. Agroforestry incentives attracted around two-thirds of the program's budget, whereas the remaining third was devoted to annual crops. Main findings show that PTTA agroforestry subsidies were effective at increasing the total value of production of crops and at increasing agricultural income derived from the sales of these crops. These findings provide a strong justification for further iterations of similar programs geared towards agroforestry.

CONTENTS



1 Introduction

Agriculture plays a dominant role in the Haitian economy, contributing to over 20% of GDP and accounting for around 38% of overall employment (CIA World Factbook, 2017). The majority of Haitians depend on the agricultural sector, mainly small-scale subsistence farming, with an average farm size of less than one hectare. Main agricultural crops include maize, tubers, mangoes, coffee, avocados, citrus, rice, sorghum, beans, and cocoa. Of these, mangoes, coffee, cocoa, together with essential oils, are the key Haitian exports. Milk production for domestic consumption is limited, but on the rise, whereas eggs and poultry are the main sources of animal protein for the population.

While most Haitians live below the poverty line (close to 60% of the population are poor), the impact of poverty is far more severe in rural areas, where 75.2% of individuals live below the poverty level, compared to 40.8% in urban areas (UNDP, 2014). Haitian agriculture has a high potential for growth and income generation, with an increasing demand for agricultural products in the local market and clear opportunities for export.

“ The majority of Haitians depend on the agricultural sector, mainly small-scale subsistence farming, with an average farm size of less than one hectare”

However, lack of competitiveness in the international market is preventing economic benefits from occurring. Faltering competitiveness is due to low levels of productivity at the farm level, mainly caused by the dual predicament of scarce access to finance and information. As a result, rural households have little access to modern technologies and sustainable agricultural practices. Farmers resort to inefficient and intensive agricultural practices that over time imperil land fertility and yields.

“Rural households have little access to modern technologies and sustainable agricultural practices. Farmers resort to inefficient and intensive agricultural practices that over time imperil land fertility and yields”

Smart subsidies have been advocated in several developing countries to increase the adoption of modern inputs and agricultural productivity. Evidence from Sub-Saharan Africa shows that one-time targeted subsidies can be effective at increasing fertilizer adoption and productivity (Carter et al., 2014). Smart subsidies were introduced in Haiti in 2009, as the Ministry of Agriculture, Natural Resources and Rural Development (MARNDR) partially reversed from its earlier supply-side approach to input distribution. While supply-side subsidies supported the use of certain inputs, they also generated several undesirable effects, such as market distortions, parallel markets, stock shortages, and clientelism. Conversely, demand-side subsidies are more market-friendly, allow to target beneficiaries, and to offer farmers agricultural advice and technical packages at subsidized prices. Before turning demand-side subsidies into a full-fledged policy, the MARNDR decided to introduce and evaluate a series of pilot projects.

Between 2010 and 2013, the MARNDR introduced smart subsidies through a gradual programmatic approach. It implemented and evaluated a set of four large-scale subsidy-based projects.[1] Among these, the Technology Transfer to Small Farmers Program (hereafter referred to as “PTTA” or “the Program”) was implemented by the MARNDR between 2011 and 2017.[2] The Program aimed to achieve **three objectives**:

1. Increasing agricultural production.
2. Increasing farmers’ revenues.
3. Preserving natural resources.

[1] The Technology Transfer to Small Farmers Program is one of four demand-side incentive-based projects pursued by the MARNDR, and the largest by budget. The other three are, respectively: Programme de renforcement des services publics agricoles I (RESEPAG I), Programme de mitigation des désastres naturels (PMDN), and Projet de sécurité alimentaire en Haïti (SECAL).

[2] The Program was co-funded by the Global Agriculture and Food Security Program (GAFSP) and the Inter-American Development Bank (IADB), contributing USD 25M and USD 15M, respectively.

The Program aimed to accomplish the above through two components:

- Promoting improved and sustainable agricultural technology adoption through non-reimbursable financial support for eligible farmers in the form of vouchers for agricultural goods and services.
- Strengthening the National Seeds Service by assisting the MARNDR to build capacity to control and regulate seeds.

The present report aims to summarize the implementation and evaluation of PTTA. Its goal is to provide a clear, yet concise overview of this multi-year Program, illustrating the lessons that can be learned from its design and execution. The main takeaway is that PTTA was particularly effective at boosting agroforestry systems, thus providing a strong conceptual justification for its follow-on program, the Agriculture and Agroforestry Technological Innovation Program (PITAG). This document is structured as follows: the next section gives background information on the program structure and implementation; the following section delves into the evaluation of the Program and details both the quantitative and qualitative studies carried out to assess its effectiveness; to conclude with, a selection of lessons learned, divided into policy and operational ones, presents possible improvements for future replications of programs similar to PTTA and, more generally, of agricultural subsidy schemes in Haiti.

“The Technology Transfer to Small Farmers Program (PTTA) aimed to achieve 3 objectives: 1) increasing agricultural production; 2) increasing farmers’ revenues; and 3) preserving natural resources”

2 Program Structure and Implementation

While PTTA consisted of two components, the bulk of its activities and resources (94%) concentrated on the first, i.e. the demand-side subsidy scheme. For this reason, the report will concentrate on the lessons learned from the implementation of Component 1. This component will be described in this report in greater depth than the second component, which supported the National Seeds Service.

TABLE 1. **PTTA Program Details**

PROGRAM	DONORS	PERIOD	LOCATIONS	BUDGET	ACTIVITIES
Technology Transfer to Small Farmers Program (PTTA)	Global Agriculture and Food Security Program (GAFSP) and the Inter-American Development Bank (IADB)	2011-2017	• North • North-East Departments (22 communes) • Artibonite (1 commune)	**Component 1** USD 33M (subsidies)	"Smart subsidies" to give farmers vouchers for various agricultural inputs (seeds, seedlings, fertilizer, various labor tasks), with the objective of increasing input use and obtaining higher yields.
				Component 2 USD 2M (institutional strengthening for the National Seeds Service)	Construction of a seed quality control laboratory, support for developing draft legislation on the status of farmers, and for developing a seed sub-sector policy.

COMPONENT 1: PROMOTING IMPROVED AND SUSTAINABLE AGRICULTURE TECHNOLOGY ADOPTION

Component 1 provided direct financial support to farmers to buy goods and services and to adopt climate-smart agricultural practices. The incentives were given in the form of vouchers to acquire bundles of inputs and support for given labor tasks from pre-approved suppliers. Suppliers were individuals or private enterprises with a track record of providing the inputs and services needed. The value of the program-financed support represented 80% of the total cost of production for up to 0.5 ha per farmer. The bundles, called 'technological packages' (TPs), 27 in number, supported various crops and crop systems, and over time they increasingly targeted agroforestry systems over annual crops, following beneficiaries' demand (the breakdown of investment by TP and by location is presented in Table 2 below). Overall, agroforestry subsidies absorbed around two-thirds of the total program financing. They supported the implementation of agroforestry systems by introducing perennial crops, often in combination with annual crops; in what follows, they will be referred to as the "agroforestry" TPs. By the end of the Program, most of the intervention areas were in mountainous regions and concentrated on perennial crops. Agroforestry TPs appeared particularly adapted to tackle all three of the Program's paramount objectives, and particularly the third (preserving natural resources). In fact, unlike annual crops, which prevail in intensive farming, agroforestry TPs contribute significantly to environmental conservation (Kiefe et al., 1992; Young, 1989; Young, 1993).

Technical packages included paid labor for given agricultural tasks (e.g. land preparation), seeds, fertilizer, and pesticides, among others. The TPs were adapted to some location-specific characteristics, such as soil conditions, rainfall, and market access. Following meetings with farmers, individual packages were identified and customized. Farmers selected the TPs they wanted, and vouchers were then delivered to them by local implementation partners (hereafter referred to as "the operators"). Farmers used vouchers to pay suppliers when purchasing goods or services. In turn, the suppliers cashed the vouchers at the Program's partner financial institution (Banque Nationale de Crédit).

A key element of the PTTA design is that it provided TPs to farmers only for one season. Through a one-time intervention, PTTA aimed to simultaneously remove the main constraints to technology adoption: lack of access to credit, incomplete agronomic information, and risk aversion. In line with "big push" and "poverty trap" theories (Rosenstein-Rodan, 1943; Murphy et al., 1988), PTTA did not provide farmers with continued support over multiple years. Instead, it tested the hypothesis that, the first time they were received, the subsidies would provide such a strong

" Through a one-time intervention, PTTA aimed to simultaneously remove the main constraints to technology adoption: lack of access to credit, incomplete agronomic information, and risk aversion"

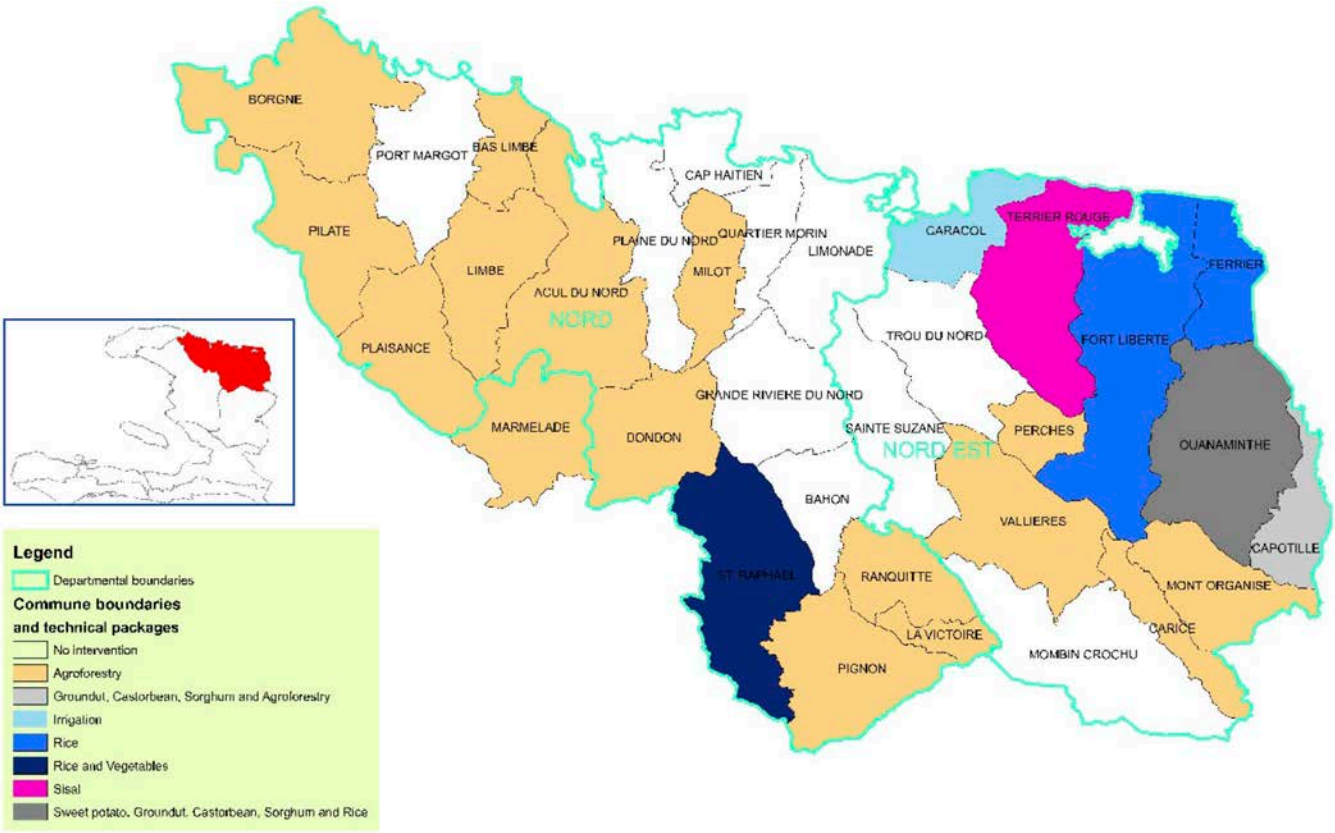
productivity boost that farmers would continue to cultivate profitably for years to come. This self-sustaining chain of technology use and profitable reinvestment would be unlocked by their earnings from the first harvest.

Implementation of the PTTA took place between 2011 and 2017 in twenty-two communes in the North and Northeast Departments, and in the Marmelade commune in the Artibonite Department. The Program targeted these departments in recognition of their significant agricultural growth potential. Figure 1 below illustrates the intervention areas.

Selection criteria of participating farmers and suppliers

The Program was administered to smallholder farmers who expressed an interest in participating, according to two sets of criteria. First, PTTA considered farmers who, by several pre-defined socio-economic characteristics, were most likely to capitalize on and benefit from the subsidies. Specifically, to be eligible, farmers had to farm an area equal to or greater than 0.25 ha within the intervention zone. In the case of perennial crops, farmers

FIGURE 1
Illustration of the PTTA Intervention Area



had to own or have the usufruct of the plots for long enough to allow for at least a complete crop cycle. Secondly, farmers needed to have a valid means of identification and signing a contract of engagement with the Program.

Other criteria applied to goods and service suppliers wishing to participate in the Program. Regardless of their exact legal status, the suppliers needed to be registered as a formal business. They also had to have an account at the PTTA partner financial institution. Additionally, they were expected to have had prior experience in agricultural services and inputs delivery, and to be able to supply products in line with pre-defined quality standards. Following a preparatory campaign to raise farmers' awareness about the functioning of the incentive mechanism, the Program established two registries to take stock of all eligible individuals, one for interested farmers and one for suppliers. Signing up in the respective registry was also a selection pre-requirement.

Seventy-thousand farmers registered in the North and Northeast Farmers' Register. On their part, as many as 500 local suppliers signed up in their respective register. Over the Program implementation period, 33,913 farmers in a total area of 15,445 ha (averaging 0.45 ha / farmer) received subsidies.

TABLE 2. **Breakdown of technical packages, investment and geographical coverage of PTTA**

COMMUNE	DEPARTMENT	BENEFICIARIES	TPS	INVESTMENT (USD)	SURFACE (HA)
Acul du Nord	North	1,104	Agroforestry	441,009	455.77
Bas-Limbé	North	902	Agroforestry	577,230	366.32
Borgne	North	1,942	Agroforestry	1,107,659	821.27
Dondon	North	2,497	Agroforestry	1,781,916	1,123.00
La Victoire	North	715	Agroforestry	314,422	366.09
Limbé	North	1,847	Agroforestry	1,051,561	762.07
Milot	North	1,840	Agroforestry	1,031,101	850.00
Pignon	North	654	Agroforestry	541,775	314.80
Pilate	North	1,522	Agroforestry	1,159,749	635.90
Plaisance	North	2,931	Agroforestry	1,969,240	1,257.73
Ranquitte	North	932	Agroforestry	709,469	453.81
Saint Raphaël	North	4,342	Rice, Vegetables	1,447,335	1,790.00
Capotille	Northeast	253	Groundut, Castorbean, Sorghum	42,133	150.90
	Northeast	1,303	Agroforestry	974,572	580.05
Caracol	Northeast	12	Irrigation	13,761	9.20
Carice	Northeast	1,490	Agroforestry	1,225,477	699.80
Ferrier	Northeast	1,243	Rice	284,223	571.05
Fort-Liberté	Northeast	1,493	Rice	318,268	700.30
Mont-Organise	Northeast	856	Agroforestry	1,564,623	822.80
Ouanaminthe	Northeast	599	Sweet potato	267,667	250.50
	Northeast	558	Groundut, Castorbean, Sorghum	51,928	244.80
	Northeast	595	Rice	129,623	251.25
Perches	Northeast	420	Agroforestry	262,659	178.30
Terrier-Rouge	Northeast	100	Sisal	59,583	100.00
Vallières	Northeast	1,257	Agroforestry	974,406	611.50
Marmelade	Artibonite	2,506	Agroforestry	2,051,943	1,078.71

“Over the Program implementation period, 33,913 farmers in a total area of 15,445 ha (averaging 0.45 ha/farmer) received subsidies”

COMPONENT 2: STRENGTHENING OF THE NATIONAL SEEDS SERVICE

Component 2 aimed at strengthening the National Seeds Service by assisting the MARNDR to build capacity to control and regulate seeds. Direct outcomes of this component were the construction of a seed quality control laboratory, and support for developing sector-relevant draft legislation pertaining to the legal status of farmers and to a national seed policy. As mentioned above, this component will not be the main subject of the present report.

3 Program Evaluation

This section focuses on the studies conducted to evaluate the Program's effectiveness with respect to a set of outcomes of interest.[3] These studies concentrated on Component 1 of PTTA and employed four impact evaluations (IE) and mixed-method evaluations. These efforts investigated different policy aspects and implications of PTTA.

[3] Other evaluations of PTTA (such as a process evaluation focusing on financial, managerial and administrative aspects) and other minor reports are not included here.

The IEs were:

- **Two Randomized Controlled Trials** (2014-2015) testing the effectiveness of smart subsidies for rice and horticulture in the Northeast Department and in Saint Raphaël (North Department).
- **Two Propensity Score Matching studies** (2016) testing the effectiveness of smart subsidies on peanut production and agroforestry in the Northeast and Limbé (North Department).

The mixed-method evaluations were:

- **An agroeconomic diagnostic study** (2014-2015) focusing on a small-scale, in-depth case study of farmers dwelling in the Saint Raphaël irrigated area.
- **A qualitative evaluation** (2014-2015) investigating the sustainability of PTTA's effects on supply chain actors.

The following section presents each impact evaluation's key research questions, methodology and results.

A. IMPACT EVALUATIONS

Randomized Controlled Trials (RCTs) allow for the identification of the causal impact of a policy intervention on variables of interest. The two RCTs conducted under the PTTA umbrella (Gignoux et al., 2017) focused on annual crops that were covered early in the Program (rice and horticulture). They were designed to measure three main outcomes: (a) agricultural yields, production values and profits, (b) technology adoption, and (c) food security.

The Propensity Score Matching (PSM) evaluations focused on similar variables. Unlike the RCTs, however, the PSMs allowed for the estimation of the impacts of the Program on the crops in the agroforestry TPs as well. These evaluations are summarized in Table 3.

IMPACT EVALUATIONS	A1. RANDOMIZED CONTROLLED TRIAL OF PTTA SMART SUBSIDIES FOR RICE
	A2. RANDOMIZED CONTROLLED TRIAL OF PTTA SMART SUBSIDIES FOR HORTICULTURE
	A3. PROPENSITY SCORE MATCHING OF PTTA SMART SUBSIDIES FOR PEANUT
	A4. PROPENSITY SCORE MATCHING OF PTTA SMART SUBSIDIES FOR AGROFORESTRY

TABLE 3. **Summary of Impact Evaluations and Results**

TARGET CROP OR SYSTEM	YIELDS	VALUE OF PRODUCTION	PROFITS[4]	INPUTS USE	FOOD SECURITY
Rice IE METHOD: RCT	The Program resulted in a significant decrease in annual[5] rice yields among treatment farmers compared to the control group	The Program resulted in a significant decrease in the treatment farmers' production values compared to the control group	No difference	The Program resulted in a significant decrease in the use of inputs among treated households	No difference
Horticulture IE METHOD: RCT	No difference	Overall, no difference. A significant decrease in the production value for Buenabite	Overall, no difference. Significantly negative impact for Buenabite	Increase in fertilizer use was only significant in Buenabite, while treatment and control farmers in Merlene used similar amounts of fertilizer. Significant decrease in pesticide use	No difference
Peanut IE METHOD: PSM	No difference	No difference	No difference	Inputs use was significantly higher among treated households	No difference
Agroforestry IE METHOD: PSM	N/A	Positive and significant impact. The total value of crop production (including actual and expected crop production) was 38% higher in the treatment group	Positive and significant impact. Treatment farmers' profits (including actual and expected profits) from crops were 63% higher than the control farmers'	No difference	N/A

[4] To calculate profits, the cost of inputs paid for with vouchers was included in total input cost.

[5] As opposed to the seasonal analysis, for which the difference was not significant.

A1. Randomized Controlled Trial of PTTA smart subsidies for rice

METHODOLOGY

This evaluation focused on the provision of smart subsidies for rice. It took place in two communes (Ouanaminthe and Ferrier) in the Northeast Department, where the rice TP was delivered. The location of the two communes (situated in plain areas) and the rice agricultural cycle aligned well with the RCT roll-out. Additionally, the short cycle of rice allowed to measure impacts after 8 to 12 months after the intervention.[6]

The IE methodology deployed was a stratified randomized phase-in at the 'habitation' level.[7] Comparing outcomes in habitations benefitting from PTTA with other habitations that were not yet part pf the Program, allowed isolating the Program's causal impact at the habitation level. Following a census conducted to identify eligible households, 39 habitations (20 in Ferrier and 19 in Ouanaminthe) were identified. Baseline data collection took place in the fall of 2013 and collected data on all the eligible households in habitations with less than or equal to 30 eligible households. In habitations with 31 or more eligible households, a random sample of 30 households was selected for inclusion in the sample.

Baseline data indicated that the two communes have rice as their prevalent culture and one of the main cash crops. The baseline survey also allowed for a better profiling of farmers in the eligible households. Most of the farmers (72%) cultivated rice in the year prior to the survey and also cultivated other annual crops; the main income source was paid work (esp. agricultural labor), while less than 40% of income came from the sale of agricultural products. Education levels were low, with less than one-third reporting they could read and write, and 31% of household heads reporting to never have attended school.

Baseline data also showed that, on average, households owned and/or cultivated 2 ha of land (or 2.8 plots). Households cultivating rice in the year prior to the survey owned approximately 1.5 rice plots and the total rice plot size per household was 0.9 ha. On average, rice was the crop contributing the most to household income, but also the one attracting the largest production spending (in terms of agricultural inputs, seeds, irrigation,

[6] Most of the other intervention areas are mountainous or otherwise difficult to access, with a high concentration of agroforestry systems.

[7] Haiti's administrative divisions descend from *départements* (the largest), down to *communes* and sections *communales* (the smallest). *Habitations* are unofficial yet informally recognized sub-sections of sections *communales*.

and paid labor). Overall, many of the selected farmers bought fertilizer and pesticide already before the subsidies, in part through loans. At baseline, households applied less chemical fertilizer per hectare than recommended in the rice TP (311 kg versus 400 kg). Conversely, they used substantially more seeds per hectare than recommended (203 kg versus 50 kg).

In the fall of 2013, 521 households from 39 habitations were identified as eligible to receive rice vouchers, according to the eligibility criteria described earlier. Of these habitations, 18 were randomly assigned to an early-treatment group and eligible farmers received vouchers in 2014. The randomization was stratified by commune, access to water, and demand (i.e. the number of farmers registered in the habitation). Eligible farmers

in the control habitations would receive vouchers after the final follow-up survey, scheduled for August 2015. Three household surveys were conducted: a baseline (late 2013), a first follow-up (February 2015), and a final follow-up (August 2015). Attrition was kept to a minimum through repeated visits in case of absence, and the final sample included 515 households, 240 in the treatment habitations and 275 in the control.

IMPLEMENTATION

Program participants received vouchers for a variety of labor tasks and inputs, including plowing and transplanting, seeds and fertilizer. Compliance with implementation protocols was high, as bank records of the Program's partner financial institution (Banque Nationale de Crédit) and respondents' reports indicate, with voucher delivery standing at over 75% across all voucher categories. However, there were reports of some delays (only 71% reported that seeds and fertilizer arrived on time). Furthermore, implementation was heavily affected by drought. The vouchers were initially planned to be distributed for use in the first season of 2014 (January-May). However, that season experienced a severe drought, and many farmers with no access to irrigation could not sow. The PTTA therefore allowed the farmers to use the vouchers in the second season (July-November). Finally, although originally the vouchers were meant to correspond to the recommended amount of fertilizer at an agreed retail price, in 2014 the wholesale price of fertilizer in Haiti increased. The price increase meant that vouchers were worth less than the recommended quantities. Specifically, while the recommended quantity of fertilizer for half a hectare was 200 kg, following the price increase the voucher could only buy 135 kg. This quantity was comparable to fertilizer use among the control farmers.

The first follow-up survey was conducted in February 2015, to measure the short-term effects shortly after the two seasons in which vouchers could have been used. The second follow-up survey was conducted in August 2015 to capture the medium-term effects of the Program in the first season in which no vouchers were distributed.

RESULTS

Following the intervention and RCT roll-out, several significant results emerged. Treatment farmers' rice yields and production values decreased compared to the control group. This negative effect occurred in the year in which the vouchers were distributed (2014), but also in the following year (2015). The negative productivity effects were likely due to the significant decline in input use (about 1/3), particularly urea and sulfate. Probably as a direct result of the lower production values, treatment

farmers sold less rice in 2015. Interestingly, however, there was no negative impact on agricultural profits for rice. Decreased input use in 2014 may be due to a few factors. Farmers in the treatment areas were regular users of many of the subsidized inputs already prior to the intervention. An investigation of their spending suggests that farmers used the vouchers as substitutes rather than as complements to their own spending. Following the 2014 price increase, vouchers could only buy inputs in smaller quantities than farmers previously used. Also, there were no vouchers for sulfate, one of the most popular fertilizers. Finally, lower input use may also be attributed to the late delivery of seed vouchers, affecting farmers' chances to sow at the right time.

"An investigation of their spending suggests that farmers used the vouchers as substitutes rather than as complements to their own spending"

On the other hand, decreased input usage in 2015 may be due to either or a combination of the following factors. First, vouchers may have caused households to take fewer loans. This might be because they expected new vouchers, and in that expectation decided to invest less in the following season. Indeed, a complementary RCT tested outcomes of reminding or not reminding farmers that vouchers were a one-time event and thus would not be delivered in the following season. The experiment showed that farmers in the voucher treatment who did not receive the reminder had lower input use in the following season. This would suggest that uninformed farmers expected to receive vouchers again, and therefore withheld part of their investment.

Secondly, it is possible that farmers decided to invest less due to adverse weather conditions in both years. As investment returns are lower in the case of drought, a recurring phenomenon in the area, this strategy may have been optimal. In that season, just like in 2014, treatment farmers borrowed less money. It is possible that the liquidity unlocked for not having to pay for inputs in the voucher season enabled them to pay off their earlier loans. In 2015, with bad weather looming large, they did not feel compelled to take on new loans. Also, because they did not have any outstanding debt, it is possible that they felt they could disengage from high-intensity agriculture. Incidentally, there is no indication that farmers used their liquidity to purchase assets or increase their food security, as no impact emerges from welfare indicators.

A2. Randomized Controlled Trial of PTTA smart subsidies for horticulture

METHODOLOGY

This evaluation focused on the provision of smart subsidies for horticulture in the commune of Saint Raphaël, in Haiti's North Department. The IE methodology was a randomized phase-in at the individual level. It compared households who were randomly assigned to receive vouchers in 2014 with control households who were only to receive vouchers after the follow-up data collection in 2015. Two habitations in particular (Merlene and Buenabite) were chosen for the impact evaluation due to their good water access. In the two habitations, 413 farmers registered and were eligible for the vouchers. In some cases, there was more than one eligible farmer per household. Therefore, households were classified according to the treatment assignment of the main farmer in the household. Thus, 160 farmers were randomly assigned to the treatment group and 169 to the control group.

The treatment farmers were to receive vouchers in the fall of 2014, while the control farmers would only receive the vouchers in June 2015. The randomization was stratified first by habitation, and within each habitation it was stratified again on a water access binary variable, qualifying access to water for the target plots as 'good' or 'average'. Due to time constraints, no baseline data was collected prior to voucher distribution, but a short registration form was filled for all treatment and control farmers prior to the randomized assignment. The variables collected in the registration form confirm that randomization led to balance on baseline characteristics. As was the case in the parallel evaluation in the Northeast, many of the selected farmers already used fertilizer and pesticide prior to the subsidies.

Follow-up data was collected in May 2015 on treatment and control farmers in Saint Raphaël. This timeline coincided with approximately eight months after the treatment group received vouchers and little after the last harvest of the season for which vouchers were used. Meanwhile, the control group had not yet been phased-in to receive the vouchers. Almost all farmers were interviewed during the follow-up. Given the randomized assignment of the intervention, differences between treatment and control farmers after voucher distribution point to a causal impact of being assigned to treatment, barring important spillovers between treatment and control.

IMPLEMENTATION

The program design included vouchers for soil preparation, inputs (i.e. seeds, fertilizers and agrochemicals), and technical assistance. For each individual, a specific plot was selected for the use of vouchers. The total value of the vouchers was substantial, averaging USD 414. The vouchers were distributed for use during the season from September 2014 to April 2015 (accounting for cases with multiple harvests). In contrast with the implementation of the rice package in the Northeast, where compliance was overall high, the same cannot be said about implementation in Saint Raphaël. The Program was implemented by a private company contracted by the government to coordinate voucher distribution in the area. Implementation problems were highlighted by a comparison between household survey data about the vouchers received and the implementer's administrative records. Problems appeared for all vouchers, but failures seem particularly important for vouchers meant to facilitate access to services, compared to those for inputs, although select inputs were also seriously affected. Overall, more than half of the treatment farmers received less than the entire package, and some received no subsidy at all. On the other hand, one-fourth of the control farmers received at least one voucher. Lastly, among the recipient households, many were not able to exchange the vouchers for the earmarked goods or services. In particular, this was the case for pesticide and technical assistance vouchers.

RESULTS

In the context of the impact evaluation, these implementation issues imply sub-optimal compliance. Despite these implementation problems, conclusions can be drawn considering intention-to-treat impacts using the initial randomized assignment. Thus, the IE compared outcomes of all treatment farmers, regardless of whether or how many vouchers they received, to those assigned to the control. The difference-in-means provides an internally valid intent-to-treat estimate. While this approach underestimates impacts that may have been obtained with full compliance, it is still highly relevant from a policy perspective because it provides estimates that in part reflect the imperfect, but real-world conditions of the implementation. Conclusions presented below refer particularly to farm area, inputs use, agricultural production value, and profits.

Treatment farmers replaced some of the crops they used to cultivate with those offered in the TPs. Conversely, no difference was detected in the total area cultivated with project crops (around 0.75 ha). This shows that, while the intervention led to some reallocation of crops, it did not induce farmers to expand their horticulture cultivation. While the probability of using fertilizer was high for all farmers, treatment farmers were more likely to use fertilizer (increasing from 79% to 90%). The quantity of fertilizer per hectare planted also significantly increased (with 45 kg per ha). The total reflects increases in both urea and NPK fertilizer. However, the increases were only significant in Buenabite, while treatment and control farmers in Merlene appeared to use very similar amounts of fertilizer.

“While the intervention led to some reallocation of crops, it did not induce farmers to expand their horticulture cultivation”

The use of fertilizer for treatment and control combined was higher in Merlene than in Buenabite. This could indicate that there was less room for impact on fertilizer use in Merlene. Alternatively, it is possible that the results for Merlene reflect spillovers to the control farmers, assuming some of the fertilizers intended for the treatment farmers were channeled to the control.[8] On the other hand, the difference in Buenabite was relatively large, amounting to a 55% increase in the quantity of fertilizer used per hectare. In contrast, there was a de facto decrease in pesticide use for treatment farmers in both habitations. This is consistent with the hypothesis that farmers may have been reluctant to invest money to buy pesticides in the expectation to receive them from PTTA. However, as described above, many of them eventually did not receive them, due to operational loopholes.

[8] As explained in the Implementation section above, a number of control farmers were reported to have received vouchers.

No positive effects on yield or production were found. This is possibly due to the implementation problems listed above (concerning the distribution of both inputs and technical assistance), as many farmers reported not receiving vouchers, or less than expected, or not being able to redeem them. Considering the total production value for the PTTA crops, there were no significant impacts when considering all crops together, nor for any of the PTTA crops taken separately. Notably, however, there was a significant and large decrease in the production value for Buenabite. Inclusion in the Program resulted in an increase in the probability of growing hot peppers in Buenabite, from 32% to 49%. Concurrently, the Program led to an increase of fertilizer available to farmers, but not of pesticides. Because hot pepper is particularly sensitive to pests and diseases, farmers in Buenabite, where PTTA shifted cultivations to hot pepper, experienced a significant decrease in output, in the absence of an adequate pesticide supply. In contrast, there were no significant differences in Merlene, where differences between treatment and control farmers in input use were smaller.

“The Program led to an increase of fertilizer available to farmers, but not of pesticides”

The findings above also apply to impacts on profits. For the two regions combined, there was no significant difference in returns, but the impact was significantly negative for Buenabite. This computation included the cost of inputs purchased through the vouchers in the total input cost. Therefore, this finding does not imply that the farmers in Buenabite were necessarily worse off as a result of the Program, as they did not pay themselves for most of the inputs used. However, the results do suggest that the return on investment from the Program’s perspective were negative in Buenabite. In Merlene, differences were not significant. Finally, in the short time window considered for this evaluation, no clear-cut impacts could be observed on other welfare indicators, including food security.

A3. Propensity Score Matching of PTTA smart subsidies for peanut

METHODOLOGY

This IE (Fahsbender et al., 2017a) evaluated the effectiveness of the peanut technological package distributed as part of PTTA in the Northeast Department between March and April 2016. The peanut TP provided new varieties of peanut seeds as well as technical assistance for soil preparation and harvesting. Also, as part of the Program, a private firm (ACCESO) committed to buy the beneficiary farmers’ peanut harvest at a fixed price. Farmers were surveyed between November and December 2016. The survey questionnaire centered on the agricultural cycle between November 2015 and October 2016. The dataset corresponds to 373 households, 97 treated and 276 in the control group.

To measure the Program's causal effect, it was necessary to identify a comparable counterfactual. However, since participation in the Program had not been randomized, there was a risk of selection bias. In this context, the methodology selected was the PSM. This technique enables to identify non-treated farmers comparable to the treated, eliminating the possible sampling bias due to observable characteristics.

It should be noted that, even though the final sample only included members of the two groups with an equal probability of being assigned to the Program given their pre-treatment characteristics (the Propensity Score), this does not totally rule out possible attribution problems. In the absence of a baseline survey, it is possible that the two groups differed at baseline by some unobservable characteristics. In that case, impact may not be entirely attributed to the Program alone. Therefore, the study results are best read in the perspective of studying trends and dynamics, as opposed to placing all emphasis on individual results. The caveat holds for both PSMs conducted under PTTA.

RESULTS

The treatment and control groups were very similar with respect to the socio-economic variables used to estimate the Propensity Score.[9] The only significant difference was on the number of households dedicated to agricultural work: 97% of the treatment households engaged in agricultural work, while only 86% of the control households did. Once Propensity Scores were estimated, the matching of treated and control households was conducted to show the impact of the peanut TP on the various variables of interest.

The results show that there were no significant effects of the Program on the area planted by the households or on the number of plots planted. Regarding annual crops, the Program had a negative impact on the number of annual crops cultivated, which is an index of crop diversification. Also, the TP had no significant effects on the total value of production or the value of production per hectare. The Program seems to have increased the percentage of annual crops sold by 12%. The results also show that PTTA decreased the probability of selling crops in the local market by about 15%. The fact that treatment farmers had ACCESO as an alternative sale outlet for their harvest helps to interpret this result. There were

[9] These variables included average household and head of household's characteristics, and economic situation. Differences in means of all these socio-demographic and economic characteristics between the treated and the non-treated households were not significant.

no significant effects of the Program on agricultural income, even when the latter is disaggregated between annual and permanent crops. Similarly, there was no significant impact on total agricultural profits, even when disaggregated between annual and perennial crops.

Results were mixed as far as livestock variables are concerned. There was no significant impact on livestock holdings and income from livestock sales, but participation in the Program is positively associated with the number of livestock units sold. Treated and control farmers did not differ with regard to food security indicators, transportation costs, use of post-harvest technology and use of labor. However, use of inputs such as fertilizers and pesticides increased (14%), as did the expenditure for this kind of inputs (USD 1.83).

A4. Propensity Score Matching of PTTA smart subsidies for agroforestry

METHODOLOGY

This IE (Fahsbender et al., 2017b) evaluated the impact of PTTA agroforestry TPs delivered between January and June 2015 in the Limbé commune, a mountainous and humid area located in the North Department. The TPs consisted of banana and pineapple seedlings, fruit trees, forest trees, cocoa trees, yam seeds and beans, as well as services such as pruning and grafting. The analysis is based on data collected from a random sample of households, 100 treated and 190 in the control group.

The controls were farmers who had enrolled in the Program but who eventually, due to budgetary constraints, had not received the vouchers. Additional non-participants were farmers identified ex-post, whose observable characteristics of interest were highly comparable to the treated. A PSM methodology was used in this case as well. The data was collected between September and November 2016, one to two years after the distribution of the vouchers in Limbé. The survey questionnaire asked about the last agricultural cycle (i.e. the year preceding the survey). No baseline data was collected.

Considering that agroforestry TPs claimed the lion's share of the Program, having absorbed 72% of the total program funds, it is important to consider the findings below with extreme care. Although the interval between implementation and data collection was relatively short, some important positive impacts came to light already at the end of the controlled experiment. This suggests that there is room for even greater impact if this intervention is brought to scale, and it provides a practical justification for similar interventions.

RESULTS

Differences in means with respect to the socio-economic variables used to estimate the Propensity Score between the two groups were small and statistically insignificant. This indicates that the socio-demographic and economic characteristics of the two groups were comparable.[10] The analysis of the data collected highlights positive impacts of the Program on the number of cultivated plots, total value of production, agricultural income and profits, labor use and investment in perennial crops.

[10] As in the parallel PSM in the Northeast, the questionnaire collected information on socio-demographic characteristics including average household and head of household's characteristics, and economic situation.

Results indicate that program beneficiaries planted a higher number of plots, especially those farmed with annual crops. There was no clear impact on the diversification of annual crops, the use of intercropping systems, or the proportion of harvest sold. However, the amount of money spent on the annual crops was USD 6.4 greater for treatment farmers (although this difference was not strongly significant). When factoring in the expected revenue from sales of PTTA crops once mature, the Program's impact on the value of production is considerable (around 38%). The impact of PTTA on agricultural income and profits from crops (counting in sales from expected harvest) was positive and significant, amounting to a 58% and 63% increase, respectively.

The Program's impact on livestock ownership and sales was not statistically significant. However, income from livestock sales decreased. The trend observed may be desirable from the farmer's perspective, as livestock is a source of capital. It is possible that the subsidies allowed beneficiaries to hold on to their livestock, unlike their control counterparts who, lacking capital for agricultural purchases, may have felt compelled to sell it in greater quantities. The impact of the Program on transportation expenditure and on the use of post-harvest technologies was not significant. Finally, PTTA had no significant effect on labor use.

Overall, positive results emerged for some of the most relevant variables of interest in this experiment, specifically value of production and profits (both actual and expected). These results are all the more telling considering that data collection happened only one to two years after voucher distribution. This length of time is insufficient for the impact of the agroforestry TP intervention to fully materialize. It is estimated that this would take three to four years, and the results above should be considered as conservative estimates of the total impact estimate.

“The Program's impact on livestock ownership and sales was not statistically significant. However, income from livestock sales decreased”

B. AGROECONOMIC DIAGNOSTIC STUDIES

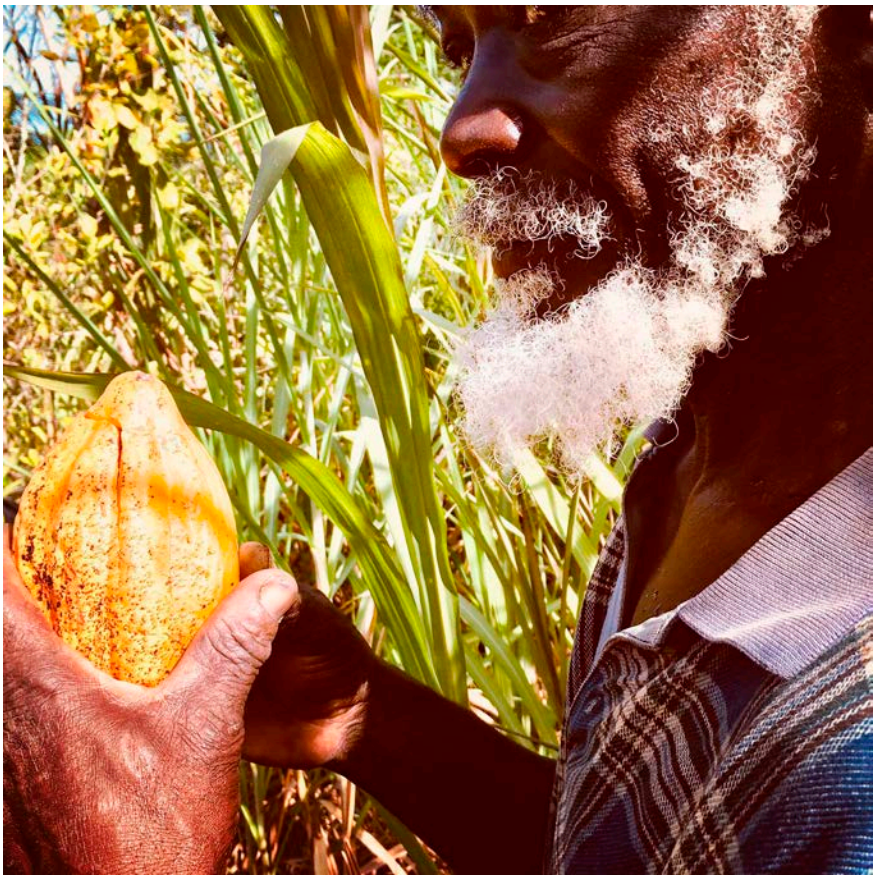
While the IEs quantify PTTA's impacts according to a given set of economic parameters, the two agroeconomic diagnostic studies presented in this section take a qualitative stance on the level of adaptation of the TPs with respect to the target areas and actors in the agricultural value chains in Haiti. They converge on calling for corrective measures in order to adapt the TPs and the demand-side subsidy management system to the Haitian context.

METHODOLOGY

Although the two studies were methodologically different, they both adopted a multi-disciplinary and diachronic approach, borrowing from different disciplines, from agronomy, to sociology and economics. They aimed to draw conclusions after studying the PTTA target area, identifying local development trends, and understanding the strategies and operations of the actors involved (farmers and suppliers, respectively). Both studies were conducted in-depth and on a small number of participants.

In particular, the former (Ruffy, 2015) was conducted on 28 beneficiaries living in or around an irrigated area in the Saint Raphaël commune. In Saint Raphaël, the Program delivered annual crop TPs of two types: one for rice cultivation and three for horticulture (combining onion and hot pepper, leek and hot pepper, or carrot and tomato). Farmers in the irrigated area differed by size of land owned prior to the Program and quality of access to irrigated land (rated from above average to poor), given that the irrigation infrastructure varies across the irrigated area. Irrigation characteristics, in turn, determine what crops farmers cultivated at baseline: farmers with reliable water access practiced high-intensity agriculture, using agricultural inputs and high-yield crop varieties before the subsidies. Their main cultivations were rice and horticulture, and had two productive seasons per year (rice in the rainy season and vegetables in the dry season). In contrast, the remaining farmers practiced rainfed and highly diversified agriculture (especially horticultural), and had stopped cultivating rice, given the associated water requirements.

The second study (Pech, 2015) is an analysis of sustainability prospects of the goods and service supply system as it operated under PTTA. The analysis reflects on the building blocks needed for the development of a network of commercially viable suppliers capable to cater sustainably to the needs of farmers. The core of the research consisted of qualitative surveys with 90 suppliers and 50 farmers. Both studies are essentially qualitative. As such, and given the size of their samples, conclusions drawn from them should be nuanced, considering that their data is limited in terms of generalizability and scope. That said, a few valuable takeaways are presented below.



“The two studies suggest that some aspects of PTTA should be reconsidered, while others should be amplified”

FINDINGS

The two studies suggest that some aspects of PTTA should be reconsidered, while others should be amplified. In line with the quantitative evaluations described above, the first study highlights how recipients of annual crop TPs did not benefit as much from the intervention as the recipients of agroforestry TPs.

It is possible that by adapting them further to farmers’ needs, the annual crop TPs yield positive results. In particular, the study suggests tailoring the TPs around pre-existing farmers’ characteristics. Such differences ultimately determine the extent to which farmers benefit from the TPs. For example, a substantial share of farmers in San Raphaël were offered to choose rice TPs, even if they farmed in an area characterized by poor water access (especially the plots downstream of the irrigated area). Poor water access meant that, for a long time, these farmers had not cultivated rice. It seems that the rice TP was not well adapted to their needs and their land potential. As a result, some of these farmers either did not use the rice package, or, in an effort to follow through with it, faced adverse effects. To make up for stunted growth in the rice nurseries, the local PTTA implementer had farmers switch to the horticulture TPs. For both rice and

horticulture, PTTA only partly covers the cost of the farming operations. The farmers had to foot the rest of the costs. Furthermore, chemical application had suboptimal effects even in the case of the vegetables, as the water requirement for best results was higher than availed by the local irrigation infrastructure.

The study also echoes some of the implementation concerns voiced by the rice RCT described above. A substantial proportion of participants received less goods and services than expected in return for their vouchers. This affected the provision of both inputs and technical assistance (TA). Regarding the TA, in the absence of clear specifications for their role, the service suppliers put in an erratic performance. Reportedly, many of them failed to deliver technical advice systematically, mainly for two reasons. First, they considered that beneficiary farmers already followed the practices built into the TPs. Indeed, many of the practices were not novel to the local farmer population. Rice and horticulture farmers with good water access already farmed in ways almost identical to the TPs, with very few exceptions (such as seed quantities, input doses and transplanting methods). On the other hand, there was no knowledge impartation for other practices (such as transplanting rice in lines) because service suppliers believed these had not been adequately tested yet. Only in a minority of cases was TA on par with expectation. Thus, the level of TA support to farmers was highly heterogenous, ranging from a simple stride through the farmer's plot to complete support to all the agricultural operations, while some reported not receiving any TA at all.

The analysis of the suppliers' end (Pech, 2015) indicates that through a one-time boost to suppliers, PTTA contributed to build up suppliers' capacity, but future interventions need to set the conditions to sustain this growth. On the one hand, PTTA has created opportunities for private suppliers in some areas —for example, in the agroforestry zones, where a market for agricultural goods and services did not exist prior to the Program. In such cases, the subsidy system is seen to have created a market, though temporary in nature, and several suppliers have seized this opportunity to expand and develop their operations. However, others were not able to durably capitalize on the higher profits generated through PTTA to strengthen and diversify supply.

Finally, other challenges concern the bureaucratic burden and legal constraints of providing certain services. From an administrative perspective, a global evaluation of the relative role of the public sector in the Haitian market for agricultural inputs (Germain et al., 2013) suggests that demand-side subsidy systems have the disadvantage of being particularly cumbersome. This has implications for compliance with the proposed TPs if vouchers are delivered later than agreed. When seed

"A global evaluation of the relative role of the public sector in the Haitian market for agricultural inputs suggests that demand-side subsidy systems have the disadvantage of being particularly cumbersome"

vouchers, among others, are delivered late, there is a risk that farmers will use their own seeds for fear of missing the planting window. Similarly, because of this administrative constraint, suppliers are paid much later (up to a month) after selling inputs to farmers. At a structural level, the study (Pech, 2015) observes that even if the supply of goods and services is adequate, in the absence of a corresponding increase in demand, the effects on the supply cannot be long-lasting. Demand for goods and services will only increase if, in parallel, farmers change cultivation practices, and this is matched by higher productivity.

4

Lessons Learned

This report summarized the results from several evaluations of **PTTA, a large-scale demand-side agricultural subsidy scheme targeting Haitian smallholders**. This approach was adopted by the MARNDR to pilot and test demand-based subsidies in a partial reversal of the earlier supply-side policy.

Researchers conducted quantitative and qualitative evaluations of the Program in two Departments (North and Northeast). The evaluations tested different versions of the agricultural incentives. Results shed new light on some important questions. Can a one-time, demand-side subsidy intervention targeting smallholders sustainably transition them to a profitable cycle of heightened production and reinvestment? Do impacts of such interventions vary according to farmers' pre-intervention characteristics, and in what ways? And do impacts homogeneously or heterogeneously affect the different actors in the agricultural value chain, specifically farmers and suppliers?

As preparations for the follow-on of PTTA are under way, it is important to reflect upon these questions in order to apply and strengthen an evidence-based approach to policy making. Lessons learned are presented below and are divided into policy and operational lessons.

A. Policy Lessons

RE-TARGETING INVESTMENT

The return on investment for the crops grown under agroforestry systems is significant already in the medium term. The full economic benefits are not immediate, but materialize over several years. It has to be noted as well that environmental positive externalities were not measured but are very likely to exist. Future schemes, paired with rigorous research, can shed light on the crops and production systems for which the intervention is most effective and at which conditions. At the same time, the evaluation results suggest that there are no obvious first-order gains in productivity from providing subsidies for annual crops. Over the course of the Program, farmers cultivating annual crops used the subsidies as cash substitutes and did not re-invest in ways that increased productivity.

ADAPTATION OF SUBSIDIES TO FARMERS' NEEDS AND CHARACTERISTICS

The evaluations of PTTA indicate that a one-size-fits-all technical package is not adapted to the diversity of cropping and production systems in the target areas. The TPs should acknowledge this diversity and support it. As was seen, even farmers that are geographically close experience highly diverse sets of challenges. Future projects should therefore acknowledge the plethora of different agroeconomic needs and situations stemming from farmers' locations, land and capital endowments. In recognition of this diversity, new projects should be re-oriented and the TPs offered in a more granular way by carefully reviewing beneficiaries' water management needs and input requirements. In yet another set of cases, the TPs offered nothing novel to the farmers, thus turning into cash substitutes instead of being launchpads to innovate farming practices. The evaluations suggest that TPs should target inputs and practices that are not already in use.

LEVERAGING TECHNICAL ASSISTANCE

Smart subsidy programs in Sub-Saharan Africa have a track record of allowing farmers to learn and adopt new technologies. In contrast, the PTTA subsidies evaluated in Saint Raphaël, as well as in the Northeast, were for inputs and practices that were already widely used. The policy recommendation is for future schemes to be designed to ease actual technological gaps. Furthermore, the combination of adaptive research and technical assistance is the main tool for popularizing technical packages, but implementation shortcomings have, in the past, undercut its potential. The recommendation is thus two-fold: (a) future programs should invest in and oversee more closely the TA pillar by making sure that the assistance is delivered as planned; and (b) TA should be iterative and not limited to one time only. Recurrent knowledge transfer over several seasons is necessary to allow suppliers and farmers to learn, exchange and evaluate the merits of the technologies proposed.

RISK MITIGATION

Among the major obstacles to increased profitability amongst subsistence farmers are not just scarce input availability and lack of knowledge, but also excessive weather-induced risk. Smallholders are found to chronically underinvest in farm technologies, including fertilizer, high-yield seeds and farming equipment, because they face the risk of weather shocks. Because underinvestment is driven by a combination of cash constraints and risk aversion, these challenges could be addressed in tandem. Subsidies may take care of the former constraint; one way to

mitigate the latter would be to create a market for microinsurance, and specifically for weather index insurance. In a context of insured risk, farmers may cease to use subsidies as mere cash substitutes, and instead start complementing them with productive investment, thus driving up agricultural profitability.

RIGOROUS EVALUATION

All the four quantitative impact evaluations described above had a clear impact evaluation plan, and the RCTs effectively used a difference-in-differences approach thanks to the availability of baseline data. Generally, randomized controlled trials seem particularly appropriate to measure the impact of large-scale agricultural subsidy schemes. As widely discussed in the literature, the main strength of this technique is its internal validity. Internal validity refers to the ability to assert (with a certain degree of confidence) that a program is not just associated with, but has actually caused the measured results. Other methods falling short of the same amount of rigor should be used sparingly. At the same time, qualitative tools should be adopted to complement and enrich findings from quantitative analyses.

B. Operational Lessons

IMPLEMENTATION PROTOCOLS

The design, implementation and monitoring of voucher delivery should ensure that the value of vouchers is not eroded by delays, inflation or supply chain distortions. The evaluations conducted brought to light some implementation loopholes. While the studies above are valuable because they underscore the impact of the Program in real-world conditions, they also suggest that there are ways to redress imperfect implementation and bring about a more performant mechanism. It will be important to strengthen supervision of the actors involved (in the case of PTTA, providers and operators), to drive up the overall quality of the operations.

IMPERFECT INFORMATION

Farmers should be clearly informed of the benefits they are entitled to and for how long, so that they can hold suppliers accountable, and determine the size of personal investment to complement the amounts received in the form of subsidies. As shown by the horticulture RCT, imperfect program implementation has made access to inputs unpredictable for farmers and limited the extent to which they could effectively restructure their investment decisions.

ADMINISTRATIVE PROCEDURES

The incentive system, from the development of the farmers' register to the financial oversight of the incentives, is described by most actors as bureaucratic and cumbersome. Administrators spend a great deal of time managing the voucher system and taking care of the bureaucratic procedures for voucher delivery. Administrative time spent on red tape generates significant costs. All in all, only about 70% of the total project budget reaches the end beneficiaries (Bérut et al., 2016). This ratio should improve, and similar future programs should engage in constantly improving administrative procedures, including the quality of automation and digitization of information flows.

REGISTERS' FRAGILITY

The registers of farmers and suppliers currently exist only through the subsidy projects supported by the MARNDR. As a result, register updates and functioning are also project-dependent, while the aspiration is for them to be ever-expanding and permanent resources eventually covering the entire national territory. The recommendation is that these registers become independent of fixed-term projects and that the MARNDR truly considers these as permanent tools to support its policies and operations.

REFERENCES

Bérut, C. and Jenn-Treyer, O. (2016) / *Evaluation de la performance technico-économique et institutionnelle du système d'incitations mis en œuvre dans les premières communes pilotes dans le cadre des programmes PTTA, PMDN, RESEPAG et SECAL*. IRAM.

Carter, M. R., Laajaj, R. and Yang, D. (2014) / *Subsidies and the persistence of technology adoption: Field experimental evidence from Mozambique.* No. w20465. National Bureau of Economic Research.

Central Intelligence Agency, CIA (2017) / *The World Factbook: Haiti.* https://www.cia.gov/library/publications/the-world-factbook/geos/ha.html

Fahsbender, J., Gachot, S., Jacquet, B., Rambao, J. and Salazar, L. (2017a) / *Evaluating the Impact of the Agricultural Technology Transfer Program on Peanut Production in Haiti.*

Fahsbender, J., Gachot, S., Jacquet, B., Rambao, J. and Salazar, L. (2017b) / *Evaluation de l'Impact du Programme de Transfert de Technologie Agricole sur les Systèmes d'Agroforesterie en Haïti.*

Germain, J. and Jenn-Treyer, O. (2013) / *Evaluation du rôle du secteur public sur le marché des intrants agricoles en Haïti*. IRAM.

Gignoux, J., Macours, K., Stein, D. and Wright, K. (2017) / *Haiti Project of Technology Transfer to Small Farmers. Impact Evaluation Report.*

Kiefe, P. and Young, A. (1992) / *Soil conservation through agroforestry: experience from four years of demonstrations at Machakos, Kenya*. In: Hurni, H. and Tato, K. (eds) / *Erosion, Conservation and Small-scale Farming*. Geographica Bernensia, Berne, pp. 303-312.

Murphy, K. M., Shleifer, A. and Vishny, R. W. (1988) / *Industrialization and the Big Push*. NBER Working Papers 2708, National Bureau of Economic Research, Inc.

Pech, B. (2015) / *Quels sont les effets du Programme de Transfert de Technologie aux Agriculteurs sur les fournisseurs de biens et services agricoles et leur offre dans des communes du Nord et du Nord Est d'Haïti?*. Stage Agro Campus Ouest, IRC PTTA.

Rosenstein-Rodan, P. (1943) / *The problem of industrialization of eastern and south-eastern Europe.* Economic Journal, 53, 202-211.

Ruffy, M. (2015) / *Comprendre les conditions de succès du Programme de Transfert de Technologies Agricoles (PTTA) pour améliorer durablement les revenus des agriculteurs. Diagnostic des systèmes de production au sein du périmètre irrigué de Saint Raphaël en Haïti.* Mémoire de fin d'études, Montpellier SupAgro.

United Nations Development Program, UNDP (2014) / *Millennium Development Goals Haiti Country Report.*

Young, A. (1989) / *Agroforestry for Soil Conservation.* CAB INTERNATIONAL and ICRAF, Wallingford.

Young, A. (1993) / *Agroforestry as a viable alternative for soil conservation.* Entwicklung und Landlicher Raum 27, 3-7.

WWW.IADB.ORG