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Désiré Kanga, Richard Moussa,
Vassiki Sanogo

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Désiré Kanga
Ecole Nationale Supérieure de Statistique et d'Economie Appliquée, Abidjan, Côte d'Ivoire
Corresponding author.
kanga.desire@gmail.com

Richard Moussa
Ecole Nationale Supérieure de Statistique et d'Economie Appliquée, Abidjan, Côte d'Ivoire
moussakr@gmail.com

Vassiki Sanogo
Department of Pharmaceutical Outcomes and Policy, University of Florida,
United States of America
vassikisanogo@gmail.com

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Abstract

The aim of this paper is to assess the impact of Vision for Change (V4C) – a private initiative implemented in coordination with the public sector – on the productivity of cocoa producers in Côte d'Ivoire. This paper shows that the program increases cocoa yields by up to 115 kilograms per hectare, income by up to 48% and the price of cocoa by up to 42 XOF (0.06 euros) per kg. The success of the project is based on a number of factors. Firstly, the novel approach used to provide high-yield and swollen-shoot tolerant technology. Secondly, through background investigations, training activities (using innovation platforms) and external support provided by extension agents (cocoa village center operators), the available technologies are able to meet the demands of cocoa producers. Thirdly, the public-private coordination platform provides an effective mechanism for coordinating interventions as well as generating learning among stakeholders, thereby reducing the research and development costs. The agreements between institutions involved in the platform lead to economies of scale, helping to make the new technologies affordable to producers. In addition, policy coordination at the macro level – with the public sector and a wide range of private companies (with varied interests) – helps manage the tension between coordination and capture.

Keywords Impact evaluation • Adoption • Extension services • Productivity (yield) • Public-private platform

JEL Classification Q13 • Q16 • D24

Introduction

The cocoa sector is the backbone of the Ivorian economy. It contributes to 40 percent of export revenue and about 800,000 farmers make their living directly from cocoa production. Most of these domestic producers own small-size farms, estimated to vary between 1.5 and 5 hectares. Collectively, these smallholders represent more than 80 percent of the country's total production per year. They are generally poor, without formal education, credit-constrained, disorganized and scattered across the country. Faced with these challenges, these farmers are often not well equipped to cope with climate shocks, declining soil fertility, unproductive orchards, and the spread of cocoa diseases. These issues have been exacerbated by the shortage of land for cocoa plantations. Moreover, recent public and private investment efforts to curb these issues have generated poor outcomes, due in part to the continuous lowering of the cocoa price, the government's inability to guarantee an acceptable cocoa pricing structure, the poor organization of cooperatives, the lack of supervision and technical assistance for producers, and the lack of a stabilization[1] mechanism. As a result, younger generations of farmers are shifting to alternative crops (rubber trees, palm trees) thought to provide a continuous stream of income, threatening the sustainability of cocoa production.

Yet, the global demand for cocoa products remains high and a recent forecast[2] suggests that cocoa demand will continue to grow significantly over the next decade. An important challenge is in meeting the expectations of consumers, who are increasingly demanding in terms of the quality (physical, chemical, ethical, social and environmental) of market products. The complexity of the problem, characterized by a combination of productivity and social issues, requires a synergy of actions from both public and private stakeholders to mobilize technical expertise (extension, research, etc.) and financial resources to promote a sustainable cocoa economy.

To address some of these challenges, Mars Inc. initiated a cocoa sustainability program[3] called Vision for Change (V4C), in the Nawa region in Côte d'Ivoire, in November 2010. The idea is to address issues of market uncertainty and production volatility by boosting productivity and empowering local communities. Specific interventions to increase productivity include the provision of improved planting material and fertilizer, as well as training in good agricultural practices. As for community empowerment, the program aims at improving, in a sustainable way, the environment in which cocoa farming communities live. This includes women's empowerment, investment in social infrastructure and child labor mitigation efforts. This paper is interested in understanding the productivity effects of the V4C project.

V4C belongs to the family of input policies, applied over the last 60 years throughout the world (see Chang, 2009), that provide research, extension services, information and physical inputs. It acknowledges that organized research is needed for producing better technologies in the cocoa sector such as higher yield and swollen-shoot resilient

1. Cote d'Ivoire used to have a stabilization system, but it had many weaknesses, as highlighted by McIntire and Varangis (1999). The system ensured a fixed price for producers, but this price was far from profitable because it was largely below the price on the international market over the period 1983-1997. Ivorian producers paid more than necessary and the surplus generated was used to finance the government budget instead of improving the welfare of the producers. The stabilization system was dismantled in 1999.
2. An expected supply deficit up to 2025 (see ICCO 2012 Conference)

3. Other multinational firms including Mondelez International and Nestlé have also initiated cocoa sustainability programs.

varieties. Then, the research products need to be passed on to farmers, who need to be taught how to use them via extension services. The project developed two innovation platforms: Cocoa Development Centers (CDCs) and Cocoa Village Centers (CVCs). The role of the CDCs is to test new technologies, to demonstrate their value to farmers and to teach them how to use those technologies. CVCs multiply some of the technologies, assist or coach the farmers to use them and provide other physical inputs (fertilizers, pesticides). In addition, the project uses farmer field schools (joint learning groups) and open days to provide information to farmers.

The implementation of each component of the project takes the form of a collaborative mechanism in which a private firm (Mars Inc.), a private international research institution (The World Agroforestry Institute or ICRAF) and public organizations share resources, knowledge and risks to achieve more efficiency in the production and delivery of products and services. The project is structured as a Public-Private Partnership (PPP), according to Hartwich et al. (2007). The project is typically a resourcing partnership, where public research centers or programs receive funding from philanthropic foundations associated with private firms, and a frontier research partnership, where research centers or programs jointly undertake cutting-edge research activities characterized by some unknown probability of success (Spielman et al., 2010). It is financed by Mars Inc. (a private firm) and managed by ICRAF. Mars Inc. acts as a philanthropic organization and provides the funding. It has committed to providing US$50 million to support the project over a ten-year period, of which (at least) $1.4 million has been allocated to research activities. Through ICRAF, the *Centre National de Recherche Agronomique* (CNRA) undertook research activities related to the project. A public research center, therefore, benefits from this donation. In addition, researchers' salaries and research inputs are jointly provided by the Government and ICRAF. More generally, some of the activities have been co-financed with other international donors, including the cocoa industry and public agencies (CCC or *Conseil Café Cacao*, and FIRCA or *Fonds Interprofessionnel pour la Recherche et le Conseil Agricole*). Because production of knowledge in agriculture requires lumpy investment that cannot be provided by public agencies or smallholders alone, such a collaborative effort helps to foster investment in research designed to address the low productivity problem. The parties engaged in research activities are aware of the potential risks inherent in the project – most notably, the fact that results may be inconclusive (research activities are characterized by an unknown probability of success). For example, the research center, in collaboration with ICRAF, could end up with swollen-shoot tolerant hybrid varieties rather than swollen-shoot resilient varieties (the primary target).

V4C is also aligned with the Ivorian Government's 2QC (*Quantité-Qualité-Croissance*) program, which seeks to rehabilitate 40 percent of the country's cocoa orchards and increase yields to 1.5 tons per hectare by 2023. The 2QC program – initiated in 2009 – aims at improving the productivity or the quantity, the quality and the revenues that will induce growth. To develop and implement, in a participatory manner, interventions that are in line with the 2QC program, a public-private partnership platform (PPPP) was launched on 21 May 2012. The platform is a deliberative forum – another type of PPP according to Poulton and Macartney (2012) – for coordinating all the activities in the cocoa sector. Such a forum brings together stakeholders from public and private sectors for dialog that generates mutual understanding and trust, and thereby leads to joint action to strengthen value chains. Since no agent has a panoramic view of the sector, nor knowledge of the distortions the public sector is supposed to correct (Kuznetsov and Sabel, 2011), such a platform generates a learning society, because markets by themselves may not lead to either a good allocation of resources among sectors or the appropriate choice of techniques (Stiglitz, 2017). That is why the PPPP has been a useful tool for building a comprehensive policy for the cocoa sector. The main objective of the platform is to improve the effectiveness of the public and private stakeholders' interventions through (i) dialogs between public and private stakeholders, (ii) promotion of the coordination of interventions, and (iii) monitoring and evaluation of the interventions. This strategic coordination between the public and private sectors is needed both to assist in the design of appropriate public actions and to provide effective feedback on their implementation (Page and Tarp, 2017).

This paper is interested in understanding the productivity effects of the V4C project and the mechanisms that explain the outcomes of such a program. More specifically, the aim of this paper is to assess how the V4C project works by focusing on its productivity side. The paper attempts to answer the following specific questions: (i) Does the V4C project result in higher cocoa yields and an increase in income? (ii) If so, how does it work? (iii) What policy lessons can be learned from the V4C project?

This paper argues that, while funded and managed by the private sector, the V4C project is a collaborative effort between the public and private sector, in which each sector contributes to the activities needed to accomplish a shared objective. Secondly, the activities of the project are part of the working program of two thematic groups (both part of the PPP platform): (i) input supply and productivity improvement, and (ii) the fight against swollen-shoot. Thirdly, this paper shows that the V4C project has developed new technologies that are available (accessible) to and used (adopted) by producers. The most requested products and services are pesticides (68%), fertilizers (54%), grafting (33%) and replanting (29%). The project's innovation platforms accelerate the adoption of the new technologies. The producers attend training sessions and learn good agricultural practices – pruning, weeding, and fertilizer and pesticide application – and apply them in their fields. Fourthly, participation in the program increases yield by up to 115 kgs per hectare, income by up to 48 percent and cocoa price by up to 42 XOF (0.06 euros) per kg. In addition, participation in training sessions – followed by the application of the techniques learned – and the grafting service provided by the CVCs are associated with higher impact on productivity. Fifthly, we do not find any evidence of spillovers on productivity. This last result suggests that the positive effects on yield did not come at the expense of other farmers. Finally, we show that the CVC business is profitable. The average annual net income is 2,655,038 XOF (4,048 €) per CVC.

The main reason for the success of the project is the innovative approach used to provide high-yield and swollen-shoot tolerant technology. Importantly, the new technologies meet the demands of producers. Through the public-private coordination platform, investments are made where needed (resulting in more effective targeting). The platform has proven to be a useful tool for coordinating the interventions as well as generating learning among agents, thereby reducing the research and development (R&D) costs. The agreements among institutions involved in the platform lead to economies of scale and help to make new technologies affordable for producers. Background investigations at the beginning of the project also helped to design technologies that are adapted to the needs of the producers. In addition, training activities have influenced the behavior of farmers in terms of adoption – by alleviating the information asymmetry that could lead to copying of early adopters by late adopters. The external support provided by the CVC operators also helps to promote the new technologies.

The following section presents a summary of the literature. Section 3 highlights the connections between the V4C project, the 2QC program and the public-private coordination platform. Section 4 provides a presentation of the interventions. Section 5 describes the theory of change and section 6 presents the data, summary statistics and empirical strategy. The results of the program are presented in section 7.

Related Literature

There is growing empirical literature that supports the long-standing idea that agricultural productivity is essential for structural transformation (e.g., Foster and Rosenzweig, 2004; Nunn and Qian, 2011; Bustos et al. 2016).[4] It has been demonstrated, for example, that agricultural productivity can stimulate growth and employment in manufacturing through its positive effects on income and aggregate demand (Murphy, et al., 1989; Gollin et al., 2002).

Yet, the persistence of market and institutional failures in the form of low investment and poor public service delivery has plagued agricultural productivity in many sub-Saharan African countries. To overcome these challenges and design an effective industrial policy, it is important to highlight the fundamental failures that weaken entrepreneurial ability in developing countries, particularly in the agricultural sector. According to Rodrik (2004, 2008a, 2008b), Hausmann et al. (2007), and Sabel (2005, 2016), industrial policy in the developing world has to deal with two critical market failures. One relates to the information spillovers; and the other relates to the coordination of investment activities in scale economies (Rodrik, 2004 and Hausmann et al., 2007).

In the case of the agricultural sector, public-private partnerships (PPPs) are increasingly emerging as an attractive cooperative and risk-sharing policy instrument (Poulton and Macartney, 2012). PPPs in the agricultural sector are

4. Early theoretical treatments of the relationships between agricultural productivity and industrial development include Nurkse (1953), Schultz (1953), and Rostow (1960).

matching funds as opposed to conventional models of PPPs.[5] A PPP in the agricultural sector is a partnership that aims to harmonize public and private sector initiatives to achieve greater efficiency. By design, these mechanisms bring together public and private stakeholders in mutually agreed contractual arrangements that seek to reduce transaction costs and market uncertainties. Ultimately, by aligning private incentives with public policy objectives, agricultural PPPs are expected to enhance agricultural productivity and generate wider economic benefits along the supply chain (FAO, 2016). Given that the research on agriculture PPPs is still in its infancy, the circumstances under which these partnerships emerge and are likely to succeed remain poorly understood. Poulton and Macartney (2012) distinguish four types of PPPs in agriculture: (i) capital investment, (ii) service delivery, (iii) new products and services, and (iv) coordination (deliberative fora). One contribution of this paper is to document how an agricultural PPP project (in this case a deliberative forum) works to enhance research in the cocoa sector in Côte d'Ivoire and overcome productivity issues.

Poulton and Macartney (2012) provide an early examination of the effectiveness of PPPs in stimulating private investment in poorly functioning agricultural value chains. Using pioneering data on PPPs involving international organizations, they find suggestive evidence that these arrangements can be investment enhancing. However, given the presence of asymmetric information (each economic agent has a partial view of the main issues in the sector) inherent to such contractual schemes, institutional capacity is key to successful implementation of agricultural PPPs. Other studies, including Spielman and von Grebmer (2004), Hartwich and Tola (2007), and Ferroni and Castle (2011), also support the idea that the enabling institutional environment is critical for successful agricultural PPPs. In the case of Côte d'Ivoire, the macroeconomic and political environment is conducive to investment: its overall ranking for the World Bank's 'Distance to Frontier' indicator has increased since 2012, which shows that the country is performing well in terms of doing business. Governance is also improving: the Country Policy and Institutional Assessment (CPIA) index increased from 2.8 (in 2011) to 4 (in 2016).

In a recent report, FAO (2016) examined 70 case studies from 15 developing countries involving agricultural PPPs for value chain development, innovation and technology transfer, market infrastructure, and agribusiness services. Overall, the study documents the potential of agricultural PPPs in delivering on their promise to generate inclusive economic benefits. Many of the case studies provide some evidence that PPPs improved the livelihoods of smallholder farmers through increased employment opportunities, market access, high productivity, better product quality and technological know-how. In other cases, the partnerships helped agribusiness firms to improve their access to primary commodities and led to a significant increase in sales and market shares. The authors of the report attempted to characterize the features that most of the successful agricultural PPPs had in common. These include: (i) the alignment of private incentives with public policy goals and priorities, (ii) a clear definition of each party's responsibilities and expected benefits, (iii) the design of fair and transparent risk-

5. While there is no widely accepted definition of public-private partnerships, the PPP Knowledge Lab defines a PPP as "a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance" (http://ppp.worldbank.org/public-private-partnership/overview/what-are-public-private-partnerships).

sharing and management mechanisms, (iv) the involvement of financial institutions in the partnership; and (v) the need to improve the monitoring and evaluation of the partnership. The findings from the report help inform policy debate about the importance of agricultural PPPs in the design and implementation of an industrial strategy in Côte d'Ivoire, and elsewhere.

While providing useful theoretical and empirical discussions on the potential benefits of agricultural PPPs, the literature still lacks a rigorous evaluation of such partnerships. In the present study, we aim to fill this gap by assessing the mechanisms and determinants of success for the Vision for Change (V4C) program for cocoa sustainability in *Côte d'Ivoire* (see Graph 1 in appendix). In doing so, we also contribute to the literature on the impacts of Farmer Field Schools (FFS). In fact, in addition to Cocoa Development Centers (CDCs), the V4C program uses FFSs as a capacity-building system. The goal is to promote best agricultural practices, build capacity, and boost productivity and income (Braun et al. 2006). Measuring the impact of this type of initiative requires a clear definition of the intervention (which might include a number of dimensions), the outcome of interest and potential spillover effects (farmer-to-farmer diffusion). Using a combination of propensity score matching (PSM) and difference-in-differences (DD), Davis et al. (2012) show that participation in FFS improves crop productivity and agricultural income in East Africa. Similar results were found for food security, but the impact of FFS on poverty was inconclusive (Larsen and Lilleor, 2014). Gockowski et al. (2010) show that participation in FFSs has significantly modified production practices in Ghana. However, farmer-to-farmer diffusion tends to scale up the training (David 2007). Thus, the impact evaluation should account for neighboring farmers, to avoid underestimating the impact of the intervention (Braun et al., 2006). However, the technical and productivity efficiencies in the cocoa sector are highly dependent on factors such as the age of the trees, farm size and labor (Binam et al., 2008), which can mitigate the impact of FFS. Finally, Gockowski et al. (2011) employ *ex ante* modeling to show that introducing a hybrid cocoa improves farm profitability and income.

To quantitatively assess the effect of the projects, this paper relies on data collected from producers and CVC operators. The design of the survey enables us to deal with the spillover effects of the program. Our empirical strategy relies on propensity score matching. Before applying the technique, a detailed description of the project helps to define the interventions. This analysis is complemented by a description of the link between the V4C project and 2QC initiatives at macro level, to explore the connections between them. This paper assumes that collaboration can help to overcome coordination failures that plague agricultural reforms in Côte d'Ivoire which result from a partial view of the economy and the limited capacity of government and other economic agents to undertake industrial policy – as suggested by Kuznetsov and Sabel (2011).

Connections Between V4c, 2Qc And PPPP

The objective of the Vision for Change (V4C) project is to revitalize the cocoa sector in Soubré (Côte d'Ivoire). The project adopts a holistic approach in which the economic (increasing productivity), social (boosting rural communities) and environmental (establishing effective environmental management) objectives of interventions are interdependent. The economic goal is to increase cocoa productivity for half of the farmers in the Soubré region by boosting yield from an average of 500 kg per hectare to 1.5 tons per hectare by 2020. This will allow producers to increase their income, reinvest in their farms and improve the management of their businesses. The main objectives of the VC4 are, therefore, aligned with the objectives of the 2QC program. The V4C project also includes community empowerment programs. The purpose of these programs is to empower local people to leverage additional public and private funds for development projects aimed at improving living standards in cocoa-producing communities. The environmental goal is to enable producers to reverse the loss of soil nutrients, use pest control and disease control products according to international standards, and use land currently in production more effectively. This will enable them to manage their resources more efficiently and eventually diversify their crops or activities. In turn, this will help reduce deforestation and ensure that farms do not degrade the environment.

For governance and implementation purposes, ICRAF works with private organizations as well as public agencies.[6] The platform should be made aware of all the activities carried out by the private sector under the 2QC program, to ensure proper coordination and evaluation of the actions carried out in the field. The platform has four governance bodies: the Plenary Assembly, the PPP Platform Bureau, the Technical Secretariat and the working groups. All the activities of the platform are overseen by a Plenary Assembly, which defines the overall activities and validates the topics of the working groups. The PPPP Bureau is composed of one president (*Conseil Café Cacao* - CCC) and two vice-presidents (exporters and cocoa industry) elected for two years. The Technical Secretariat monitors all the activities of the platform and reports to the chair. The main operational mechanisms are the thematic groups, also known as working groups. These working groups contribute to the development of the platform action plans and budgets, and examine the issues facing the sector, to make proposals that will be submitted to the authorities after validation by the Plenary Assembly. To date, there are nine thematic groups: (i) certification, (ii) input supply and productivity improvement, (iii) community development, (iv) combating the worst forms of child labor, (v) coffee revival, (vi) extension activities, (vii) producer income and price issues, (viii) combating deforestation and climate change, and (ix) combating swollen-shoot. Each thematic group is composed of a focal point and a secretariat.

The CCC is the principal State agency responsible for enforcing regulations and implementing existing policies. Its first role is to chair the PPP Platform Bureau. As a public agency, it defends the government interest. Secondly, the CCC validates all the 2QC projects, including those financed by the private sector, before their implementation. Overall, V4C's activities have been approved by the CCC prior to implementation. The Orchard Rehabilitation Pilot Project (ORPP) – a V4C initiative – is an obvious example: an agreement between ICRAF and CCC helped plan activities for the coming years. The CCC and ICRAF also agreed to co-finance micro-projects initiated as part of the community development component of VC4.[7] As such, the CCC also acts a funder.

For the research side, the key actor is the CNRA (*Centre National de Recherche Agronomique*), a public research center that

6. The presentation focuses only on the key stakeholders involved in the implementation of the project and not on the governance side of the project.

7. We focus only on the productivity side of the project and not the community development side.

oversees the research component of the project. Its main role is the implementation of research activities for the development of improved plant material for cocoa farmers that will be distributed through the private sector. Its main duty is to test and select high quality clones, test the quality of the soils and propose new fertilizer formulations. Under the 2QC program, the CNRA provides seeds to the CCC and private stakeholders. By only using one entry for seed supply, it is easier to control the origin and quality of the plant material. This is critical as the main objective of the program is to improve productivity. To help the CNRA produce a sufficient quantity of seeds, the World Cocoa Foundation (WCF) and ICRAF have co-financed seed fields in Divo, Soubré and Abengourou.[8]

CNRA's activities, and therefore V4C's activities, are part of the input supply and productivity improvement thematic group working agenda. The V4C activities are also part of the combating swollen-shoot thematic group working agenda. In fact, one outcome of the research activities is cocoa hybrid clones that are tolerant to swollen-shoot. On this issue, the PPP platform helped to harmonize public and private sector interests[9] by identifying the gaps (technical and financial) between the Ivorian Government's program and private interventions. For this program, the cocoa industry (Mars Inc., Nestlé and WCF) provided financial support for the rehabilitation of an early detection laboratory in Anguéledou (a non-cocoa producing area).

Innovation platforms set up by the project – Cocoa Development Centers (CDCs) and Cocoa Village Centers (CVCs) – are used to demonstrate and disseminate the outputs of research activities to farmers. A CDC is a center for demonstration and training in advanced agronomic practices, particularly for the rehabilitation of old cocoa plots using quality planting material. CVCs are small, independent businesses that are linked to a specific CDC. They sell approved planting material and provide technical and agronomic interventions at the village level, such as rehabilitation, grafting, pruning and other good agricultural practices. While CDCs are fully funded by ICRAF, CVCs are managed by local entrepreneurs. Cocoa companies such as ADM, Cargill, PACTS, OLAM and CONTINAF have committed to support CDCs and their corresponding CVCs, while ZAMACOM, Barry Callebaut and Rainforest Alliance plan to establish new CVCs. Although the initial idea for CDCs and CVCs came from Mars Inc., the technical and financial partners have all agreed to support it. In addition to coordination, the PPP Platform also helps to secure funding from other donors – mostly from the private sector, international donors and FIRCA (*Fonds Interprofessionnel pour la Recherche et le Conseil Agricole*) – and all the information is shared among platform members. Alleviating information asymmetry avoids duplication of activities and helps channel funds.

The CVC operators have benefited from training provided by ANADER, a public agency that provides extension services (training and coaching) to farmers. The role of ANADER is to oversee the extension component of the project and the capacity-building of communities in cocoa growing areas. It trains the CVC operators and farmers through demonstration plots and FFS.
In addition, ANADER helps in identifying community-level projects. It also liaises between donors and communities. ANADER's collaboration with ICRAF has strengthened its capacity to carry out its extension activities. ANADER receives equipment and training

8. In the same vein, Nestlé has a somatic embryogenesis laboratory to increase the number of nurseries.
9. The Ivorian Government has developed a program to fight against swollen shoot disease and, at the same time, the private sector, because of its interests in cocoa farming, also decided to undertake actions to fight against the disease.

support from ICRAF. The purpose of the training is to update the knowledge of ANADER's agents on the best approaches to extension.

What Does V4C Do?

The project has seven components that are listed below:

(i) improvements in plant breeding and access to quality plant material

(ii) sustainable development of cocoa production systems

(iii) revitalization of orchards

(iv) innovation platforms

(v) extension activities

(vi) community development and local governance

(vii) monitoring and evaluation, and governance/partnership and institutional support

Components (i), (iii) and (iv) relate to the economic objectives of the project, while component (ii) addresses the environmental objectives. Component (vi) is linked to the social objectives.

The following section focuses on components (i) to (v) because the main objective of this paper is to analyze the impact of the V4C project on cocoa production. Figure 1 summarizes the duties of each actor and the flow of funds between them.

Improvements in plant breeding and access to quality plant material

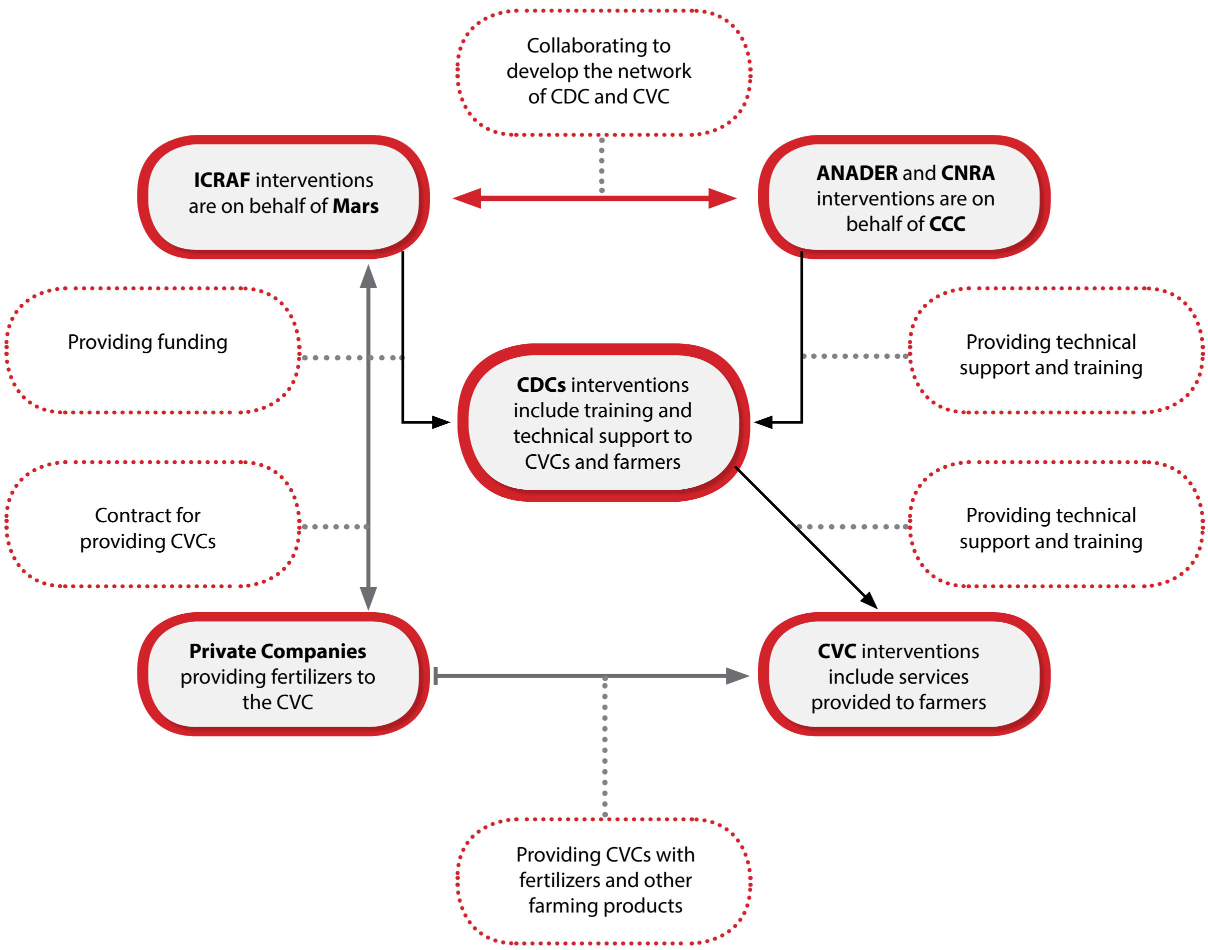
The main activities in plant breeding involve choosing effective cocoa clones and disseminating the improved plants. This task was carried out by the national agricultural research center (CNRA – *Centre National de Recherche Agronomique*). Clones grafted onto mature plants in the field were evaluated in 16 Cocoa Development Centers (CDCs) in Soubré. Results showed that production starts in the first year of grafting. In the fourth year, the yield of the five best clones exceeds two tons per hectare. Note that the project set a target of 1.5 tons per hectare by 2020.

Along with clone selection, the project helped to design a sustainable system to multiply and distribute the plant material to improve accessibility. Firstly, support provided to CNRA enabled the establishment of 18.3 ha of clonal gardens and 5 ha of seed fields. By 2015, CNRA had produced 76,835 grafted seedlings, rootstocks and cocoa cuttings, and 18,062 companion tree seedlings, which were then used for extension activities by the innovation platforms. The clonal gardens have an annual production potential of 4,575,000 grafted plants, which would enable the rehabilitation of 1,500 ha of cocoa plantations per year. Secondly, the project also helped to operationalize a somatic embryogenesis laboratory at the CNRA central laboratory. Somatic embryogenesis is a technique that enables the propagation of genetically uniform plant material. It offers an alternative to conventional methods of vegetative propagation. The laboratory has a productive capacity of 30,000 plants after two years.

Sustainable development of cocoa production systems

Under this component, the project aims to develop a better understanding of the biotic (cocoa diseases and pests) and abiotic (level of soil degradation, vegetation cover, the

Figure 1. Interactions between actors



importance of shade trees, climate change) constraints in Soubré for the sustainable management of cocoa orchards.

The activities began with a survey of diseases and pests, and with research on the state of soil health, plant diversity (companion cocoa trees), diseases and pests – including swollen-shoot.

Studies have shown a low level of soil fertility compared to the standards recommended for cocoa farming. A new formulation of cocoa fertilizer was, therefore, introduced by the project. Producers now have access to this fertilizer through the CVCs.

To help better manage the pressure of swollen-shoot disease, demonstration plots using barrier trees have been installed in the study area. In addition, four long-term trials to evaluate the effectiveness of these barriers were also implemented. Further trials on the systematic use of insecticides for the control of swollen-shoot mealybugs have been initiated.

In addition, nine meteorological stations have been set up to monitor climate data. Studies were conducted to better understand endogenous diversification approaches in cocoa agroforestry and their contribution to the cocoa economy. Another study on the physical and chemical characteristics of cocoa beans was conducted. Finally, CNRA and ESA (the National Agronomy School or *Ecole Supérieure d'Agronomie*) soil analysis laboratories were equipped with infrared spectrometers allowing a fast-spectral analysis of soil and plants at a lower cost.

Innovation platforms

Cocoa Development Centers (CDCs) and Cocoa Village Centers (CVCs) are the main mechanisms for technology diffusion (main innovation of the V4C project). The basic idea is that a physical and visual demonstration of farm rehabilitation and increased yields is a powerful motivator for change. This approach also recognizes that a profitable cocoa sector will create opportunities for the local private sector in the supply chain, particularly in terms of the production of planting material in private nurseries and the provision of grafting services to rehabilitate old cocoa plantations.

Cocoa Development Centers

The project set up 16 CDCs. In each CDC, multidisciplinary teams composed of researchers, extension workers and cocoa producers demonstrate and test efficient regeneration technologies for old cocoa orchards (grafting, total replanting). The CDCs tested 11 clones. Each CDC tests five types of treatment: (i) total replanting, (ii) farming practices, (iii) good practices and grafting of clones, (iv) good practices without fertilization, and (v) good practices with fertilization. The tests found that grafting is faster at rehabilitating old orchards than replanting. Some clones also have good graining rates. In addition, the tests recommended two periods for grafting: May-June and August-September. The CDCs serve as a training center for 80 technicians and 52 CVC operators. CDC technicians provide coaching and planting material for CVC operators, to support rehabilitation actions.

ICRAF staff working in the CDCs live in local villages and interact with the population to facilitate the diffusion of technologies. They work closely with community leaders because trust is an important determinant of technology adoption (see Hunecke et al., 2017). Each CDC is composed of at least one agronomist and one development agent (with a background in sociology). Agronomists and (ICRAF and CNRA) researchers work on demonstration plots to collect data and monitor the process.

CDCs are fully funded by ICRAF and they do not generate income. They will no longer exist at the end of the project, unless additional funding is available.

Cocoa Village Centers (CVCs)

CVCs are both a link in the extension chain and a source of profit (as opposed to CDCs which are not profit generating). The CVC operators are trained in agricultural techniques (good practices, grafting, swollen-shoot disease management and soil fertility), accounting and business management. Master trainer agronomists have been recruited to coach CVC operators, during their first two years of operation, to ensure effective quality control of the services provided to farmers and to strengthen their activities. The project has also helped establish a close and trusting relationship between CVC operators, CDC technicians and ANADER agents.

Two types of activities are conducted in CVCs. Each CVC has demonstration plots to test the technologies (grafting and fertilizers) and practices (pruning with and without fertilizers) recommended by the project. They also multiply some of these technologies (plant material). In addition, CVCs carry out economic activities such as selling fertilizers, pesticides, cocoa plants, banana seedlings and soybeans.

CVC operators also assist producers in implementing good agricultural practices (plant size, product application), replanting plots or grafting.

The CVCs are formal businesses with all the required administrative and legal documentation. By the end of 2015, a total of 52 CVC operators had been trained by Mars Inc./ICRAF (25) and its partners Cargill (15), ECOM (4), HFK (3) and BIOPARTENAIRE (5). Each CVC is under the umbrella of a CDC. A CDC covers one-five CVCs.

CVC operators received training and a starter kit (warehouse, tools, input credit, pesticides and fertilizers). They are privately operating entities and no additional funds are received from ICRAF. Therefore, they rely on their own profits, which come from the sale of products and the provision of agricultural services. ICRAF has established partnerships with pesticide and fertilizers companies (RMG/YARA and FORO CI) who support the CVCs by providing inputs on credit. The operators reimburse the costs after the sale of the products. They also trade in seeds. The partnership with the CCC allows CVCs to secure a supply of hybrid cocoa seeds. In addition, they provide agricultural extension services to farmers (on demand) for a fee. The grafting market is an oligopolistic one – with few suppliers and a large number of consumers. Oligopolies can ensure profits over the long run. High barriers (training and administrative processes) for entry prevent sideline firms from entering the market to capture excess profits. The ORPP, authorized in the Nawa region since 2015 by the CCC, is an illustration of the structure of the grafting market. ORPP (part of the V4C project) aims to scale up grafting activities in order to rehabilitate 300 hectares of cocoa in three years – at an average of 100 hectares per year – for 600 to 700 smallholders (0.25 and 0.5 hectares). This is being implemented by CVC certified agents.

Extension activities

This component aims to broadly adopt and disseminate technology packages from the V4C project through the capacity-building of extension agents, CVC operators and farmers. The main activities carried out under the extension component of the V4C project can be summarized as follows:

(i) training technicians on various topics,

(ii) training producers on good agricultural practices (GAP) through Farmers' Field Schools (FFS),[10] Demonstrations plots (PDs) and exchange visits between producers.

Both ANADER and CDCs monitor the PDs, but FFSs are only organized by ANADER. To raise farmers' awareness of innovative technologies promoted by the project, open days and exchange visits were organized by ANADER and ICRAF; 48 days were organized in 2014 and 32 in 2015. More than 4,000 farmers have been reached through these open days and visits. A communication plan for informing and sensitizing producers – using a variety of tools (radio programs, posters, etc.) – was also developed and implemented.

A summary of the interventions

All the V4C project interventions can be grouped into three categories. The first is training. Through CDCs, CVCs and

10. The Farmers' Field School is a training framework for groups of producers (generally between 25 and 30) – a school 'without walls', which takes place in a field, throughout the growing season. It is a place to exchange experiences and knowledge, where producers who share the same interests, can discuss and make decisions about the management of a field based on its condition.

ANADER, farmers have been trained on good agriculture practices. The second and third categories of interventions relate to the *provision of technologies*. They involve the *provision of inputs* such as fertilizers, pesticides and cocoa plants; and the *provision of services*, where CVC operators assist producers in implementing good agricultural practices, replanting or grafting.

Theory of Change

The agricultural dimension of the project is based on the theory that providing new farming techniques based on research and best agricultural practices will improve cocoa yields while mitigating the negative effects of declining fertility, tree aging, and the spread of diseases. In practice, cocoa farmers can learn innovative techniques and adopt new technologies developed by the program to boost their productivity. In addition to potential changes in productivity, these call for many wider changes in the interactions between stakeholders, access to inputs like seeds and fertilizers, access to insurance, access to processing and value addition and access to end markets (Adekunle and Fatunbi, 2014). The V4C project theory of change is summarized in Graph 1 (in the Appendix).

The strategic coordination between public and private stakeholders through the PPP platform avoids duplications of activities. The PPP dimension of the V4C is a deliberative forum that brings together stakeholders from public and private sectors for dialog that generates mutual understanding and trust and thereby leads to joint action to strengthen value chains (Poulton and Macartney, 2012). Apart from ensuring proper coordination of the activities, it also allows us to identify and remove constraints and to design and implement strategies to transform the sector, as well as evaluate the actions (accountability). For example, producers associate swollen-shoot with the HIV/AIDS virus. To overcome this issue, ICRAF and WCF have invested in the search for a high-yield and swollen-shoot resilient technology. To date, research has developed high-yield and swollen-shoot tolerant hybrid varieties – the available technologies are not yet fully resilient. In addition, the V4C project has added, in its training package, approaches to better managing the swollen-shoot disease. Overall, because of the partial view of the economy and the power of vested interests, as well as the limited capacity of government and other economic agents to undertake industrial policy (Kuznetsov and Sabel, 2011), closer links between the government and the private sector are needed. The PPP platform plays this role. To be effective, this collaboration between the public and private sector should be based on embeddedness, discipline and accountability (Rodrik, 2013).

Combining input supply and productivity with combating swollen-shoot is one of the key reasons for the success of the interventions. Firstly, producers' perceptions of the disease (swollen-shoot is associated with the AIDS virus) means that some of them are reluctant to try any variety that is not resistant to the disease. Secondly, the information sharing within the platform mitigates the effects of knowledge spillovers and allows the coordination of investment (Hausmann et al., 2007; Rodrik, 2004). Sharing information accelerates the identification of new opportunities for investment by discovering new technologies or adapting existing technologies to the local context. This process of discovery is too costly for one firm to undertake on its own. A particular example is the new fertilizer formula developed by the project. This process involves soil testing (conducted by CNRA and ESA), the formulation of a new fertilizer, manufacturing and dissemination. ICRAF signed a MoU with IDH (the Sustainable Trade Initiative) for large-scale production of the new fertilizer, which allows for economies of scale – these products are more affordable for producers compared to the fertilizer that existed on the market before. CVCs provide the connection to farmers. Without the MoU and the guarantee that farmers would use the fertilizers, manufacturing costs would be high (low volume production and no economies of scale) and unaffordable for end-users.

The governance of the platform – which involves both the public (CCC) and private (cocoa exporters and the chocolate industry) sector – helps to foster *embeddedness* by managing the tension between coordination and *capture* – corruption and rent-seeking (Evans, 1995; Kim, 2017; Vu-Thanh, 2017). Nevertheless, close relationships between public and private organizations could potentially serve as a mechanism for transferring rents to corrupt businessmen or bureaucrats (Page and Tarp, 2017). However, the gap between the private sector interests and the expectations of the public sector discourage collaborations that could encourage rent-seeking.

The new technologies used for production are a result of research activities. These activities are undertaken mainly by CNRA and ESA. The tests conducted through the CDCs showed that (i) good agricultural practices and grafting can yield up to 2,000 kg per hectare, and (ii) good agricultural practices and fertilization can yield up to 1,000 kg per hectare. As a result, the outcome of the research can increase production without increasing the area, which is particularly important given the shortage of land. To reach farmers, ANADER plays the role of an extension agency, providing training and assistance. This approach can produce appreciable results (Maiangwa et al., 2010), but there are limitations when the extension agency is weakened by a lack of government support or other types of institutional neglect. To mitigate this risk and to generate positive externalities, CDCs are used to demonstrate the results of research to farmers. This approach can accelerate the adoption of technologies. Another important mechanism, affecting the diffusion of new technologies among farmers in less-developed countries, is the copying of early adopters by late adopters (Pomp and Burger, 1995). By alleviating this information asymmetry, CDCs can accelerate the adoption of new technologies. In addition, to ensure the sustainability of productivity, CVCs have developed local nurseries that facilitate the commercial distribution of cocoa plants. Because CVCs are small and independent businesses, owned and managed locally, they provide an additional source of income and are thus likely to reduce beneficiaries' vulnerability to negative income shocks.

Could the CVC business model be sustainable? The answer to this question depends on (i) the equivalence between the services delivered by CVCs and the needs of producers, and (ii) the contribution of other partners such as input suppliers and donors. The interaction between stakeholders plays a key role.

The hypotheses underlying the theory of change for the productivity component of the V4C project can be summarized as follows. If research leads to improved varieties and improved practices, then new technologies will become available for use (Adekunle and Fatunbi, 2014). This leads to a second hypothesis: if the extension system is effective, technologies can be passed on to farmers. If these are accepted by farmers and meet their development needs, the technologies will be adopted. We expect this adoption to improve the agroecological balance in the landscape and enhance soil fertility, help conserve biodiversity, and reduce deforestation and forest degradation. Agroecological change is a key point here due to the pressure on land. In fact, one response to land constraints is agricultural intensification, as suggested by Boserup (1965). Furthermore, if the price of the technologies is affordable, technologies will be adopted and used. If all these changes occur, it will increase cocoa yields and provide additional income for farmers – mainly through the increase in production since the project does not directly influence the price. However, the program can indirectly influence price through improved information. Subsection 7.3 provides an analysis of the impacts of the program, including the effects on price.

Data, Summary Statistics and Empirical Strategy

This paper uses primary data collected from April to May 2018 in seven regions (Nawa, Gbokle, San Pedro, Haut-Sassandra, Goh, Guemon and Cavally) of Côte d'Ivoire. This section presents the sample and the survey design, summary statistics and the empirical strategy. The empirical strategy includes the econometric method for the impact evaluation, the methodology for analyzing CVC profitability, and the definition of outcome variables.

Data source

All the regions are in the western and southwestern parts of the country. The project is implemented in the Nawa region. This is, therefore, the intervention area and the other regions are the control areas. Two rounds of baseline surveys were conducted in 2012 and 2014 for the V4C project. For each round, a sampling strategy was designed, splitting the areas under study into three strata. The first stratum is the intervention area; the second and third strata were the control groups. The first control group (stratum 2) aims to capture the spillover effects of the intervention. Stratum three is outside the region of intervention, to ensure a proper control group. However, the 2012 and 2014 control groups are not the same (they vary in methodology). In the 2012 survey, stratum two areas were in Nawa region while stratum three areas were in the six neighboring regions. To date, the project has covered stratum two of the 2012 survey. For the 2014 survey, both strata two and three areas were in Nawa region. Only the localities in stratum three of the 2012 round were not affected by the intervention. Therefore, the control regions for this study were those of the first baseline survey conducted in 2012.

Firstly, the enumeration areas (EAs)[11] were selected. We kept the same EAs from the 2012 control areas. In each control EA, all the households were enumerated and 23 households were randomly selected for interview. In the treatment area, 25 EAs were randomly selected from the 2014 list. In each EA, the sample was split into beneficiaries and non-beneficiaries. We define a beneficiary as a person who (i) uses one of the technologies of the project (products or services), or (ii) has been exposed to a training related to the project and has adopted the techniques learned during the training, or (iii) participates in the ORPP (replanting). The beneficiaries were drawn from CVC customer databases and the ORPP list. As CVCs did not start their activities until 2012, we used the 2014 list to select the CVC clients. For stratum 2, we randomly selected non-beneficiaries from the 2014 baseline data and check to make sure that no beneficiaries were included. This last group within the intervention area was used to capture any spillover effects of the intervention. A summary of the surveyed households is given in Table 1. As we can see, only three producers (out of 231) benefit from the program in the control area. In the intervention area, 26% of producers do not benefit from the project. All the households are cocoa producers. A questionnaire was designed to collect information on household characteristics, the agricultural labor force, prices, yields and technology.

In addition to data collected from producers, a total of 32 CVC operators were interviewed. Among these, 24 were trained by ICRAF alone, two by ICRAF and another partner,

11. An enumeration area is a geographical unit for the collection of census data and has 200 to 300 households (around 1,000 inhabitants).

Table 1: Number of households per group and status

	Control	Intervention	Total
Beneficiaries	3	383	386
Non-beneficiaries	228	138	366
Total	231	521	752

Source: ENSEA 2018

and six by other partners. The two sources of information allow us to compare CVC operators and producers.

Summary statistics on the sample

Table 2 provides comparison tests between treated and control groups of cocoa producers for some key characteristics of farmers and their fields. Only 3.6% of the farmers are female and 30.2% of them are not Ivorian. The average age is 47 years old; 90.2% of them are living with a partner and 41.2% of them have never been schooled. There are no significant differences between the treated and control groups (outside of the intervention area) in terms of the average age of the farmers, their sex, nationality, schooling status and age of their field. However, more treated farmers live with partners than those in the control groups. In addition, the average household size for farmers in the treatment group is higher (9) than that of the control group (7). The same is true for field areas.

Among the CVC operators, only one out of the 32 surveyed is female. The average age of CVC operators is 36 and they have a high level of education (71.9% have secondary school level, and 21.9 have university level). In terms of marital status, 65.6% of the CVC operators live with a partner. They have been CVC operators for four years on average. Before becoming a CVC operator, 56.3% of them

Table 2: Balanced groups tests

	Overall mean	Mean treated	Mean control in IAs	Mean control out of IAs	Difference Treated vs Controls in IAs	Difference Treated vs Controls out of IAs
			CDC			
Age of farmer	46.73	46.50	48.49	46.05	-1.99 [-1.543]	0.45 [0.4326]
Female farmer	3.59	4.15	3.63	2.63	0.52 [0.2683]	1.51 [0.9749]
Not Ivorian	30.19	31.61	23.91	31.58	7.69 [1.6995]	0.03 [0.0070]
Never schooled	41.22	39.38	55.80	35.53	-16.42*** [-3.34]	3.85 [0.9503]
Living with partner	90.16	92.49	86.96	88.16	5.53* [1.95]	4.33* [1.80]
Has TV	46.68	49.74	35.51	48.25	14.23*** [2.88]	1.50 [0.3581]
Household size	8.35	9.21	7.85	7.20	1.36** [2.42]	2.01*** [4.47]
Field area	5.61	6.31	6.51	3.85	-0.19 [-0.25]	2.48*** [4.54]
Field area under 1 hectare	7.98	6.22	8.70	10.53	-2.48 [-0.99]	-4.31* [-1.92]
Field area between 1 and 3 hectares	35.51	32.64	28.99	44.30	3.66 [0.79]	-11.66** [-2.89]
Age of field	22,59	22,14	24,34	20,76	-2,21** [-2,49]	1,37 [1,40]
Number of children (under 18)	3,54	3,32	3,56	3,71	-0,24 [-0,82]	-0,38 [-1,41]

***: Significant at 1%, **: significant at 5%, *: significant at 10%. Source: ENSEA 2018.

were already involved in agricultural activities, while only one of them was unemployed.

Empirical strategy

Impact evaluation strategy

We focus, in this section, on the econometric strategy for estimating the impact of the interventions. In this paper, we aim to evaluate the impacts of the V4C interventions on three outcomes of interest, namely, cocoa productivity (or yield), farmers' income and the cocoa price per unit (kilogram). Specifically, we intend to establish the causal impacts of the interventions on the outcomes. As the intervention area for the V4C was not randomly selected, such causal impact identification requires controlling for selection bias from observable and unobservable factors. In addition, our work is based on non-experimental data because the project is not a Random Control Trial. The common approaches for identifying causal impacts in non-experimental data include different matching techniques, fixed effects (when panel data is available) and instrumentals regression. We use propensity inverse probability weighted regression adjustment (IPWRA) due to the cross-sectional nature of our data. We report results from propensity score matching (PSM) and inverse probability weighting (IPW) as robustness. Before presenting the IPWRA approach, we introduce briefly the matching approach for propensity score.

Propensity score matching reduces sample selection bias (Mallick and Yang, 2013; Borin and Mancini, 2016) by creating a carefully matched group. The aim of this approach is to create a control group which resembles (or matches) the treatment group by using a statistical method. This is commonly done by using control variables. The control variables used in this paper are demographic characteristics (age, gender, living with partner), household characteristics (number of children) and field characteristics (age of field, dummy variable for field area under one hectare, and dummy variable for field area between one and three hectares).

The challenge in the propensity score matching approach is that the estimates produce biased results in the presence of misspecification (e.g., Wooldridge, 2007), and such an approach does not consider unobserved factors. To control these challenges, the IPWRA combines regression (outcome model) and propensity score methods to achieve robustness in misspecification of the parametric model. More specifically, the estimator has a double robustness property, meaning that either the treatment model or the outcome model has to be correctly specified for the estimator to produce consistent treatment effects (Hirano et al., 2003). In addition to Monte Carlo analysis that supports the use of this estimator (Busso et al., 2014), other recent publications also rely on this method (Wossen et al., 2017a,b; Webster and Piesse, 2018, among others).

IPWRA consists of three steps. Firstly, we estimate the propensity score for the treatment model. Secondly, we estimate a series of regressions in which the inverse of the estimated propensity scores are used as weights on covariates and the treatment dummy. Thirdly, the average treatment effect for treated farmers is computed as the difference in the weighted averages of the predicted outcomes. These steps provide consistent estimates given the underlying assumption of the independence between the treatment from the predicted outcomes, once covariates are modeled in the first two steps (Webster and Piesse, 2018). We report Huber/White/sandwich type robust standard errors.

In addition, we perform a placebo test by using a 'fake' treatment variable as a robustness check for the causal impacts of the VC4 interventions.

Outcome variables and steps of the analysis

We use tables, comparison tests and figures to examine the availability and use of the technologies. Next, we use the econometric strategy described above to analyze the effects of the interventions on productivity, income and the price per unit. We analyze the effects of the whole program (all the interventions) and then focus on training, participation in ORPPs and the use of CVC services (hybrid cocoa plants, grafted plants, grafting service, replanting service, fertilizers, pesticides). We then look at spillover effects and conduct placebo testing by using a 'fake' treatment variable. Finally, we analyze the sustainability of the CVC business model. We focus on profitability, which is proxied by the net revenue of the CVCs. We then look at the potential threats to sustainability.

Table 3 reports summary statistics and comparison tests for the three outcome variables. Average cocoa productivity is 524 kilograms per hectare (kg/pa) in the full sample, but higher in treated (539 kg/pa) than in control (505 kg/pa) groups. The farmers in the treated groups sell their products at a higher price (804 XOF per kilogram) compared to those in the control group (769 XOF per kilogram). The higher productivity and higher price provide farmers in the treated group with a higher income.

Table 3: Comparison tests for the outcome (yield, price and income) variables

Outcome		G1	G2	G3	A	B	C	D	E	F
Yield Overall mean: 523.87 (12.99)	Treated	538.85	517.78	521.68	526.14	587.72	530.53	514.99	525.79	519.78
		(25.65)	(27.09)	(20.74)	(38.79)	(53.90)	(25.99)	(32.85)	(29.14)	(26.48)
	Controls	505.35	527.74	529.39	494.66	499.64	482.97	490.05	525.73	528.54
		(24.34)	(17.55)	(21.68)	(12.59)	(13.01)	(13.05)	(12.51)	(17.57)	(18.30)
	Difference	33.50	-9.96	-7.71	31.48	88.09**	47.55*	24.95	0.06	-8.77
		[0.9475]	[-0.256]	[-0.2558]	[0.7752]	[1.9733]	[1.7092]	[0.7650]	[0.0018]	[-0.2716]
Price Overall mean:795.61 (5.54)	Treated	804	836.67	802.49	811.05	811.38	825.05	812.36	794.61	800
		(10.13)	(18.98)	(10.47)	(21.73)	(25.68)	(17.80)	(20.34)	(13.67)	(12.17)
	Controls	768.76	775.36	771.67	783.68	783.83	776.64	781.60	783.11	779.33
		(8.33)	(6.78)	(8.17)	(6.89)	(6.79)	(6.87)	(6.86)	(7.49)	(7.77)
	Difference	35.24**	61.3***	30.82**	27.37	27.55	48.41**	30.76	11.50	20.67
		[2.6962]	[3.5769]	[2.3495]	[1.1677]	[1.1372]	[2.9343]	[1.6456]	[0.7609]	[1.4729]
Income (log of) Overall mean:13.81 (0.04)	Treated	14.12	14.53	14.08	14.07	14.52	14.55	14.43	14.24	14.03
		(0.08)	(0.10)	(0.08)	(0.24)	(0.13)	(0.09)	(0.12)	(0.10)	(0.09)
	Controls	13.60	13.71	13.65	13.83	13.79	13.68	13.75	13.72	13.76
		(0.07)	(0.06)	(0.07)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
	Difference	0.52***	0.83***	0.44***	0.24	0.73***	0.87***	0.68***	0.53***	0.27**
		[5.0290]	[6.1307]	[4.1992]	[1.2792]	[3.7966]	[6.8019]	[4.6159]	[4.4166]	[2.3576]

Note: This table compares the outcomes of the program between treated and control groups. G1= Whole program (all the interventions); G2= Replanting; G3= Use of at least one CVC service. The services are: A=purchase of hybrid cocoa plants; B=purchase of grafted plants; C=grafting service; D= replanting service; E= purchase of fertilizer; F= purchase of pesticide. t-test or z-test are in brackets. *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors.

Results

This section reports the principal findings from the data. First, we use tables and figures to present results related to the hypotheses of the theory of change. Then, we focus on the training activities. We report also the impact of the interventions based on the econometric model. Finally, we analyze the sustainability of the CVCs.

Availability and uses of technologies

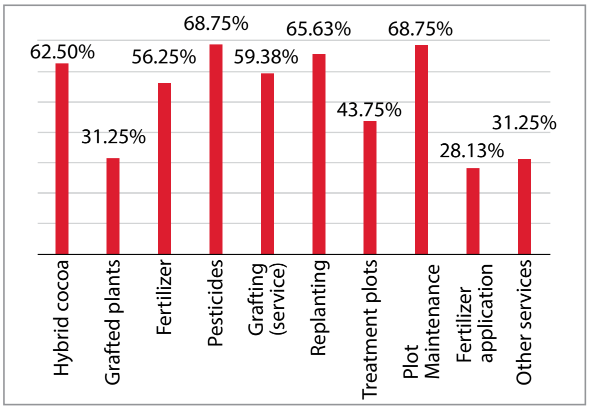
Technologies are available and used by producers

The outcomes of the research are improved clones and a new variety of fertilizers. The project also introduced grafting techniques to boost productivity. Statistics on the performance of the new technologies collected from the project management report were presented earlier in these part. Data collected from CVC operators were used to complement this analysis. Figure 2 shows that CVC operators sell plant material (more hybrid cocoa and less grafted plants), fertilizers and pesticides. Plant material comes from CNRA or CCC. This is not surprising, and consistent with the input supply and productivity improvement thematic group agenda. Indeed, CCC buys seeds from CNRA and sells it to the private stakeholders through the working group. In this way, it is possible to control the origin of the plant material.

CVC operators also provide extension services (grafting, replanting and treatment) and advice/coaching to farmers. All these results show that technologies are available for use, and that the technology can be accessed by farmers if they request it. Essentially, CVCs connect the research and manufacturing to the end-users (farmers).

We also examine the services and products requested by farmers. According to CVC

Figure 2: Services and products provided by CVC operators



Note: This figure displays the services provided by the CVCs. Each percentage indicates the proportion of the CVCs that offer the given service. For example, 62.50% of the CVCs provide hybrid cocoa. Source: ENSEA 2018, computation of the authors.

operators, the services they provide appear to meet the demand of producers (see Table 4). There are two main reasons for this. Firstly, governance of the cocoa sector has been reorganized through the PPP platform and, as a result, investments are made where needed (effective targeting).

Secondly, the work of the V4C project – particularly, background investigations, training and networking – has been instrumental in designing technologies adapted to farmers' needs. Fertilizers are a good example of this. As we can see in Table 4, fertilizers and pesticides are the two most requested services by producers (at least 75%). All the other services, including plant material, are most frequently or often requested. Grafted plants are less popular with producers – almost half (46.9%) of the CVC operators did not receive a request for this service. Training activities through CDCs or FFS have probably played a role in influencing farmers' behavior. Networking helps CVC operators understand the services and products that farmers require. CVC operators live in the villages with the farmers

Table 4: Services requested by the producers (in %) according to the frequency

	Most frequently	Often	Rarely	Number of CVCs that receive requests	No request
Hybrid cocoa plants	40.91	45.45	13.64	22	31.25
Grafted plants	35.29	29.41	35.29	17	46.88
Grafting (service)	50.00	30.00	20.00	20	37.50
Replanting	46.43	42.86	10.71	28	12.50
Fertilizer	75.00	20.00	5.00	20	37.50
Pesticides	76.19	23.81	-	21	34.38
Treatment plots	48.00	28.00	24.00	25	21.88
Plot maintenance	50.00	36.67	13.33	30	6.25
Fertilizer application	40.91	22.73	36.36	22	31.25
Other services	44.44	44.44	11.11	9	71.88

Source: ENSEA 2018

and visit most of them. This close relationship increases the level of social trust and the willingness of farmers to deal with the CVC operators. This is also strengthened by ethnic ties. CVC operators start trading with members of their own ethnic group because social trust within ethnic groups is high in rural areas. Then, farmers spread the message to other members of their community and nearby communities (similar to the copying of early adopters).

What services do producers request from CVCs?

Pesticides (68%), fertilizers (54%), grafting (33%) and replanting (29%) are the most frequently requested by farmers. This is consistent with data from CVC operators. Before the project, the main issues faced by farmers were availability (37.3%), cost (33%) and, to a lesser extent, payment method (19.1%) for the products and services – producers do not recognize quality as a big issue (only 3% mentioned it). The project appears to provide solutions for all three issues mentioned above. The cost of 50 kgs of fertilizer is between 13,500 and 18,000 CFA francs, compared to a baseline cost of 25,000 CFA francs (2012 baseline data). Almost one quarter of CVC operators sell the fertilizer at 15,000 CFA francs. The new fertilizer is therefore considerably less expensive than the fertilizer on the market at the beginning of the project. The MoU with IDH has played a role by providing economies of scale. In terms of payment, producers pay cash (76%), as before, or by credit (43%) – a new innovation introduced by the project. For some of them, the services are free of charge.

Are training activities useful?

Program statistics show that extension activities through CVCs reached 12,900 producers up to 2015. These producers have been trained in Farmer Fields Schools (FFS) and Demonstration Plots (PD). Visiting a CDC implies that farmers visit the related PD and are trained on good practices applied there. Table 5 gives a summary of the number of FFSs and PDs as well as the number of trained farmers. More than 100 FFSs and

Table 5: Number of farmers trained via FFSs and PDs

		2012	2013	2014	2015	Total
Farmers' Field Schools	Number of FFS	15	30	25	45	115
	Men	452	757	481	745	2,435
	Females	24	17	11	199	251
	Sub-total	476	774	492	944	2,686
Plots of Demonstrations	Number of PDs	29	44	124	24	221
	Men	641	726	1086	315	2768
	Females	9	16	14	5	44
	Sub-total	650	742	1100	320	2,812
Total	Men	1,093	1,483	1,567	1,060	5,203
	Females	33	33	25	204	295
	Grand total	1,126	1,516	1,592	1,264	5,498

Note: FFS and PDs denote Farmers Field Schools and Demonstrations plots respectively.
Source: Assessment report of the V4C project, 2016

221 PDs have been used to train 5,500 cocoa producers. Several of these producers have benefited and continue to benefit from the Orchard Rehabilitation Pilot Project, which aims to scale up grafting in cocoa production. In addition, through the CVC network, the producers have found solutions to problems related to quality (certified products), costs and limited availability of inputs. In 2015, 479 producers had access to the new fertilizer and 406 producers benefited from hybrid cocoa nurseries.

Do these trainings reach producers? To answer this question, we use data collected from producers to determine the extent of farmers' knowledge and attendance levels. Data show that 64.5% of beneficiaries and 37.7% of non-beneficiaries in the treatment area are aware of the CDCs. This proportion is only 5.3% in the control area. The figures show a similar pattern for CVCs: 98.4% of beneficiaries and 46.4% of non-beneficiaries in the intervention area, and 2.2% of non-beneficiaries in the control area. Beneficiaries are randomly selected from the CVC customer database or ORPP's list. Among those who are aware of the CDCs, three quarters in the intervention area and one third in control area have visited one (Table 6). The producers participate in open days or FFSs, particularly in intervention areas. In the control group, some of the non-beneficiaries (24% for open days and 35% for FFSs) attend these training sessions. Almost all participants find the sessions useful since they help them improve their productivity (94% for open days and 97% for FFSs).

The training sessions cover various topics such as grafting, weeding, pesticides, fertilizers, pruning and other good agricultural practices (GAPs). Figure 3 shows that the main topics are pruning, use of fertilizers and pesticides, and weeding. The focus of training sessions is on GAP, in accordance with project protocol. Combating swollen-shoot is only covered during the FFS or PD training sessions. Training on the swollen-shoot is one of the innovations of the project. There is no statistical difference between beneficiaries and non-beneficiaries in the intervention area as opposed to the control area in terms of the topics of the training sessions (Table 6).

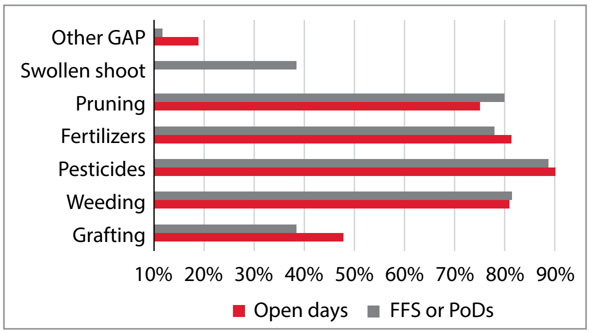
Table 6: Program statistics collected from producers

Variable	Overall mean	Mean treated	Mean control in IAs	Mean control out of IAs	Difference Treated vs Controls in IAs	Difference Treated vs Controls out of IAs	Difference Controls in IAs vs Controls out of IAs
CDC (in %)							
CDC visit	77.5	80.00	77.32	37.50	2.68 [0.4934]	42.5*** [2.8024]	39.82***[2.4768]
ANADER/ICRAF (in %)							
Open days (participate)	53.19	72.96	58.57	24.24	14.40***[3.4670]	48.72 ***[10.8726]	34.32***[7.6244]
Benefit from open days	99.5	100	100	96.43	-	3.57***[2.6630]	3.57**[2.3027]
Open days improves productivity	94	94.92	93.20	92.86	1.72 [0.6770]	2.07 [0.5969]	0.34[0.0855]
ANADER (in %)							
Participate in FFS	61.44	81.48	63.35	35.93	18.13*** [4.6450]	45.55***[10.3956]	27.42***[6.0139]
Benefit from FFS	98.27	99.09	98.74	95.18	0.35 [0.3279]	3.91** [2.1788]	3.56*[1.6914]
FFSs improve productivity	97.09	97.22	96.69	97.50	0.53 [0.2949]	-0.28 [-0.1309]	-0.81[-0.3422]
CVC (in %)							
Aware of CVCs	59.71	92.96	75.70	3.46	17.27*** [5.4621]	89.50*** [19.9835]	72.23***[16.1034]
Request services	83.30	92.03	73.68	37.50	18.35*** [5.2213]	54.53*** [5.1417]	36.18**[2.2383]
Plant material from CVC	22.85	38.95	18.80	0.98	20.16*** [3.8034]	37.97*** [7.0344]	18.82***[4.3154]
Services requested from CVCs (in %)							
Hybrid cocoa plants	17.91	18.18	17.14	33.33	1.04 [0.2536]	-15.15 [-0.6733]	-16.19[-0.7305]
Grafted plants	15.24	16.88	12.14	33.33	4.74 [1.2363]	-16.45 [-0.7520]	-21.19[-1.0948]
Grafting	33.16	41.99	19.29	0	22.71*** [4.4940]	41.99 [1.4669]	19.29[0.8445]
Replanting	28.61	31.17	25.00	0	6.17 [1.2714]	31.17 [1.1622]	25[0.9965]
Fertilizer	54.01	54.11	53.57	66.67	0.54 [0.1014]	-12.55 [-0.4337]	-13.1[-0.4502]
Pesticides	68.18	69.70	66.43	33.33	3.27 [0.6567]	36.36 [1.3559]	33.1[1.1951]
Other services	9.09	6.93	12.86	0	-5.93* [-1.9192]	6.93 [0.4723]	12.86[0.6643]
Topics of CDC open days (in %)							
Grafting	47.75	52.79	53.74	14.29	-0.95[-0.1746]	38.51***[5.1192]	39.46***[5.0772]
Weeding	81.00	85.79	87.76	46.43	-1.97 [-0.5306]	39.36***[6.1829]	41.33***[6.1936]

Pesticides	91.50	93.40	93.88	78.57	-0.48[-0.1787]	14.83***[3.2815]	15.31**[3.2005]
Fertilizers	81.25	86.80	85.03	51.79	1.77 [0.4682]	35.02***[5.6820]	33.25***[4.9478]
Pruning	75.00	76.65	83.67	46.43	-7.02 [-1.6007]	30.22***[4.3532]	37.24***[5.3676]
Other GAPs	19.00	19.29	16.33	25.00	2.96 [0.7072]	-5.71 [-0.9332]	-8.67[-1.416]
Topics of PDs (in %)							
Grafting	37.45	44.09	41.51	12.05	2.58 [0.5009]	32.04***[5.2045]	29.46***[4.6874]
Weeding	81.39	88.18	85.53	55.42	2.65[0.7580]	32.77***[6.2667]	30.11***[5.1498]
Pesticides	88.74	94.09	91.19	69.88	2.90[1.0816]	24.21***[5.6751]	21.32***[4.2811]
Fertilizers	77.92	84.09	82.39	53.01	1.70 [0.4389]	31.08***[5.6157]	29.38***[4.8485]
Pruning	79.87	84.09	79.87	68.67	4.22[1.0619]	15.41***[2.9845]	11.2*[1.9374]
Swollen-shoot	38.53	41.82	48.43	10.84	-6.61[-1.2775]	30.97***[5.1009]	37.58***[5.7988]
Other GAPs	0.1190476	0.1	0.0880503	0.2289157	1.19 [0.3916]	-12.89***[-2.9257]	-14.09**[-3.0312]
Application of techniques learned during open days CDC (in %)							
Grafting	30.05	42.49	19.15	13.46	23.34***[4.4929]	29.03***[3.8627]	5.69[0.9202]
Weeding	79.02	81.87	85.82	50.00	-3.95 [-0.9614]	31.87***[4.7164]	35.82***[5.1811]
Pesticides	89.90	90.67	92.20	80.77	-1.52 [-0.4889]	09.90 **[1.9924]	11.43**[2.2622]
Fertilizers	72.54	76.17	74.47	53.85	1.70[0.3561]	22.32***[3.1622]	20.62**[2.7461]
Pruning	68.39	71.50	72.34	46.15	-0.84[-0.1682]	25.35***[3.4279]	26.19***[3.3904]
Other GAPs	11.66	10.88	10.64	17.31	0.24 [0.0706]	-6.43[-1.2548]	-6.67[-1.2457]
Application of techniques learned in PDs (in %)							
Grafting	23.49	34.26	14.57	11.25	19.69***[4.2235]	23.01***[3.9137]	3.32[0.7042]
Weeding	77.18	84.26	80.13	52.50	4.13 [1.0253]	31.76***[5.6558]	27.63***[4.3844]
Pesticides	87.02	92.59	89.40	67.50	3.19[1.0655]	25.09***[5.4944]	21.9***[4.1068]
Fertilizers	70.02	74.07	74.83	50.00	-0.77[-0.1642]	24.07***[3.9293]	24.83***[3.7975]
Pruning	75.84	79.63	76.82	63.75	2.81[0.6442]	15.88**[2.8148]	13.07**[2.1121]
Swollen-shoot	32.66	37.04	37.09	12.50	-0.05[-0.0096]	24.54***[4.0755]	24.59***[3.9356]
Other GAPs	7.83	6.48	5.30	16.25	1.18[0.4700]	-9.77***[-2.5923]	-10.95**[-2.7549]

Note: IA is Intervention area, t-test or z-test are in brackets. ***: Significant at 1%, **: significant at 5%, *: significant at 10%. Source: ENSEA 2018, computations of authors.

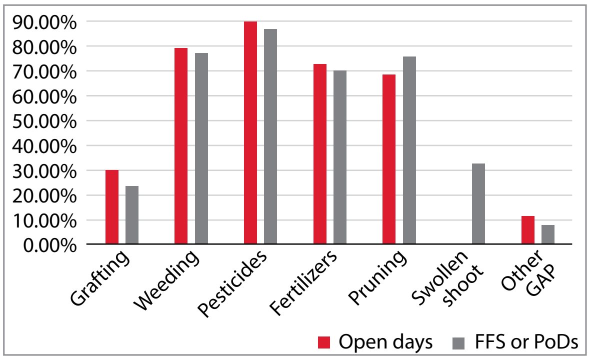
Figure 3: Topics of training sessions



Source: ENSEA 2018

However, do they apply the techniques learned? Figure 4 shows that more than two thirds of those who have attended training sessions apply the techniques – except for grafting, swollen-shoot disease and other GAPs. It is worth noting that grafting and combating swollen-shoot disease may require external expertise, which may explain why these techniques are not so common. There is no difference between beneficiaries and non-beneficiaries in terms of the application of the techniques in the intervention area – except for grafting. A comparison between control and intervention areas shows a difference in terms of application.

Figure 4: Proportion of producers who apply techniques learned



Source: ENSEA 2018

Impact of the interventions

We use a propensity score matching approach to estimate the effects of the interventions. The reliability of the matching results depends on the quality of the matching. Appendix B provides details on the regressions, the overall covariate balancing before and after matching and common supports. The results are related to all interventions (appendix B.2), replanting or ORPP interventions (appendix B.3) and the use of one CVC service (appendix B.4). In addition, appendix B.1 reports the results of the probit regressions. Overall, the matching reduces bias by between 66% (Table 18) and 86% (Table 20). We reject at 0.1 level the joint significance of covariates post-matching (p-value greater than 0.194) while the joint significance of covariates was not rejected before matching at 0.01 level (p-value=0.000). In each table, the pseudo R2 declines after matching. These indicators highlight a successful balancing of the distribution of covariates between participants and non-participants of the program. In addition, we provide figures on common support regions (Figure 5, Figure 6 and Figure 7).

The assessment of the impact of the program is based largely on IPWRA (inverse probability weighted regression adjustment) which is more robust than PSM. In addition, we provide the results for IPW (inverse probability weighted) and PSM (one-to-one, Epanechnikov kernel, k-nearest neighbor and radius) as robustness.

Impact of the program on producers regardless of the intervention

In this subsection, we consider all the interventions. A beneficiary is a person who (a) participates in a training session and applies the technique learned, or (b) uses at least one of the services provided by the CVC, or (c) participates in the ORPP (replanting). Table 7 summarizes the results of the estimations on the three outcomes:

productivity or yield (production per hectare), income and price.

We highlight the significant effect of the program on yield (productivity). The results show that participation in the program increased cocoa yield by 75.2 kilograms per hectare. This result remains robust when using the IPW approach and some matching techniques (k-nearest neighbor and radius). This result can be explained by the high adoption rate of the new technologies by the treated groups and improved skills through training, better information and the removal of credit constraints. The data shows that at least two thirds of cocoa producers implement the best practices learned in their fields.

This increase in productivity results in an increase in household income. The estimated increase due to the program is around 39% (see Table 7 below).

Finally, we examine whether the interventions affect the cocoa price. We find a positive and statistically significant effect of the program on the cocoa price. The results show that participation in the program increases the price of cocoa beans by 33 CFA francs. This unintended outcome of the project may be explained by improvements in the quality of information, the type of buyer and the quality of the beans (see Table 16 in appendix for additional data). Only 2.3% of the beneficiaries apply a discount when they sell their cocoa beans, compared to 8% of non-beneficiaries – due mainly to the quality of the beans and the type of buyer, as well as the quality of the roads. To improve the quality of the beans, a producer must sift out defective beans and sort them before selling. Only 4.6% (resp. 8%) of beneficiaries do not isolate sick (resp. do not sort the) beans before selling; these proportions increase to 13% (resp. 11%) for non-beneficiaries. In terms of buyers (Table 16 in appendix), the beneficiaries sell 61.42% of their cocoa production to cooperatives, while less than half (43.91%) of the cocoa production for non-beneficiaries is sold to cooperatives. In the control area, 21% of the cocoa production is sold to

Table 7: Effects of the program on yield, household income, and cocoa price

	Yield	Log of income	Price
Inverse probability weighted regression adjustment	75.21**	0.3891***	33.10**
	(34.64)	(0.0966)	(15.08)
Robustness check			
Inverse probability weighted	64.34*	0.3867***	32.78**
	(34.22)	(0.0965)	(15.08)
One-to-one matching	58.67	0.4431**	32.56
	(45.20)	(0.1703)	(21.36)
Epanechnikov kernel matching	49.61	0.3724**	32.83**
	(37.61)	(0.1274)	(16.09)
k-Nearest neighbors matching	83.30**	0.4145***	29.94*
	(40.78)	(0.1353)	(17.07)
Radius matching	45.37**	0.7152***	36.57***
	(22.27)	(0.0755)	(9.83)

Note: This table displays the effects of the intervention on productivity (yield), household income and cocoa price after matching. Yield is defined as the ratio of cocoa production to area (in kilograms per ha). Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: ENSEA 2018, computation of the authors.

itinerant buyers compared to 9% for the beneficiaries. The trade process, organized through cooperatives, seems well organized in the intervention area. It is worth noting that ICRAF does not provide direct support to any of the cooperatives. The effects of the cooperatives on the price might be indirect and due to their participation, as members of the community, in the community development component of the VC4 project. This component aims to empower local communities and help them to set up local development initiatives and local development councils, among others. Moreover, information and training activities related to the management of community investments have been delivered by the project. Cooperatives have improved their internal management as a result of attending the training. In addition, some cooperatives rely on CVCs to assist and coach their members to improve their production.

Impact of the ORPP intervention

In this subsection, we consider the ORPP (replanting) intervention only. A beneficiary is a person who participates in the ORPP. Table 8 summarizes the results of the estimations on the three outcomes: productivity (production per hectare), income and price. The results obtained for the whole program hold. However, participation in the ORPP increases yield by 65.63 kilograms per ha, which is lower than that in Table 7 (75.21 kilograms per ha). The effect on income (40%) is similar to that reported in Table 7 while the effect on the price seems greater (+42 CFA francs compared to 33 CFA francs). The ORPP intervention was authorized in 2015; we surveyed the beneficiaries of the first and second year of the project.

Impact of the training

In this subsection, we consider the training interventions only. A beneficiary is a person who participates in a training session and applies the techniques learned. Table 9 reports the results of the estimations on the three outcomes: productivity (production per hectare), income and price. The results show that participation in a training session and the application of the techniques learned during the training increase the yield, the

Table 8: Effects of the ORPP on yield, household income and cocoa price

	Yield	Log of income	Price
Inverse probability weighted regression adjustment	65.63** (28.49)	0.4013*** (0.1104)	42.42** (21.40)
Robustness check			
Inverse probability weighted	65.34** (27.50)	0.3934*** (0.1092)	41.54* (21.28)
One-to-one matching	88.36** (41.82)	0.3073* (0.1622)	31.62 (29.43)
Epanechnikov kernel matching	49.76 (31.79)	0.4807*** (0.1277)	52.10** (21.51)
k-Nearest neighbors matching	32.59 (34.20)	0.373** (0.1393)	46.30** (22.84)
Radius matching	40.39 (27.70)	0.8381*** (0.1011)	62.89*** (19.49)

Note: This table displays the effects of the ORPP intervention on productivity (yield), household income and cocoa price after matching. Yield is defined as the ratio of cocoa production to area (in kilograms per ha). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Source: ENSEA 2018, computation of the authors.

Table 9: Effects of the training on yield, household income and cocoa price

	Yield	Log of income	Price
Inverse probability weighted regression adjustment	109.57**	0.4834***	43.10**
	(42.39)	(0.0968)	(16.83)
Robustness check			
Inverse probability weighted	110.97**	0.4741***	42.01**
	(45.15)	(0.0969)	(16.93)
One-to-one matching	70.85	0.3526**	28.91
	(53.21)	(0.1817)	(22.84)
Epanechnikov kernel matching	80.36*	0.4595***	33.15*
	(44.25)	(0.1510)	(19.54)
k-Nearest neighbors matching	84.03*	0.3762**	26.58
	(45.99)	(0.1569)	(20.39)
Radius matching	62.40**	0.7885***	38.75***
	(25.76)	(0.0758)	(10.87)

Note: This table displays the effects of training interventions on productivity (yield), household income and cocoa price after matching. Yield is defined as the ratio of cocoa production to area (in Kilogram per ha). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors.

price and the income by 109.6 kilograms per ha, 43 CFA francs and 48.3% respectively.

To better understand which types of training are the most beneficial, Table 10 reports the effects of training sessions through CDC visits and open days (organized by ANADER and ICRAF) on yield. Visiting a CDC consists of visiting a PD and being trained on good practices applied in that PD. A beneficiary is a person who participates in a training session by visiting a CDC or attending an open day, and applies the technique learned. Participation increases yield by 115.2 for CDC visits and 111.8 for open days. Exposure to good agricultural techniques through the CDCs and open days, therefore, contributes to a significant increase in productivity.

Table 10: Effects of CDC visits and open day attendance on yield

	CDC visit	Open days
Inverse probability weighted regression adjustment	115.26**	111.84**
	(58.03)	(43.50)
Robustness check		
Inverse probability weighted	125.13*	113.21**
	(66.52)	(46.12)
One-to-one matching	79.17*	86.03*
	(48.61)	(48.31)
Epanechnikov kernel matching	71.20*	91.60**
	(42.33)	(45.78)
k-Nearest neighbors matching	78.54*	99.94**
	(42.82)	(44.73)
Radius matching	61.37*	65.69**
	(33.77)	(28.49)

Note: This table displays the effects of CDC visits and open day attendance on productivity (yield) after matching. A beneficiary is a person who attends the training session and applies the technique learned. Yield is defined as the ratio of cocoa production to area (in kilograms per ha). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors.

Table 11: Effects of extension services (CVCs) on yield, household income and cocoa price

	Yield	Log of income	Price
Inverse probability weighted regression adjustment	9.17	0.186**	31.61**
	(27.08)	(0.0898)	(14.62)
Robustness check			
Inverse probability weighted regression adjustment	9.96	0.1777**	30.67**
	(27.22)	(0.0894)	(14.61)
One-to-one matching	24.67	0.0591	18.88
	(36.58)	(0.1514)	(19.82)
Epanechnikov kernel matching	15.37	0.1853	24.95*
	(31.91)	(0.12)	(14.93)
k-Nearest neighbors matching	-0.59	0.1493	22.24
	(31.55)	(0.1248)	(15.53)
Radius matching	6.91	0.4407***	31.26**
	(20.03)	(0.1045)	(10.90)

Note: This table displays the effects of the extension services (use of at least one service provided by CVC operators) on productivity (yield), household income and cocoa price before and after matching. Yield is defined as the ratio of cocoa production to area (in Kilogram per ha). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors.

Table 12: Effects of the use of each CVC service and a combination of technologies on yield

	A	B	C	D	E	F	G
Inverse probability weighted regression adjustment	19.08	104.34	91.92**	-1.84	23.78	13.13	92.73**
	(36.20)	(80.17)	(36.56)	(35.80)	(43.59)	(41.11)	(41.16)
Robustness check							
Inverse probability weighted	18.03	91.95	104.53**	7.38	24.38	13.46	86.32**
	(37.19)	(63.83)	(49.73)	(34.28)	(44.86)	(41.91)	(40.42)
One-to-one matching	33.93	56.93	60.26	57.12	8.43	-9.62	60.67
	(54.22)	(76.05)	(42.27)	(48.90)	(43.68)	(49.83)	(50.25)
Epanechnikov kernel matching	31.14	104.55*	75.95**	53.39	11.52	-13.59	66.22*
	(41.34)	(56.82)	(33.23)	(39.54)	(35.29)	(33.48)	(37.32)
k-Nearest neighbors matching	21.45	88.19	64.88*	47.66	14.69	0.86	81.32**
	(44.22)	(58.90)	(35.26)	(40.20)	(37.53)	(36.84)	(40.59)
Radius matching	30.80	87.40	50.71*	24.22	2.50	-9.79	51.86**
	(39.25)	(54.26)	(26.62)	(33.32)	(30.07)	(27.31)	(23.65)

Note: This table displays the use of each of the CVC services on yield after matching. Column A reports the effects of the purchase of hybrid cocoa plants. Column B reports the effects of the purchase of grafted plants. Column C reports the effects of the grafting service. Colum D reports the effects of the replanting service. Column E reports the effects of the purchase of fertilizer. Column F reports the effects of the purchase of pesticide. The last column (G), reports a combination of participating in the program and the use of fertilizer. Yield is defined as the ratio of cocoa production to area (in kilograms per ha). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors.

Impact of extension services (CVC)

In this subsection, we consider the use of the services provided by the CVCs. A beneficiary is a person who uses at least one CVC service. Table 11 summarizes the results of the estimations on the three outcomes: productivity (production per hectare), income and price. The results do not show any statistically significant effects of CVC services on yield. In addition, we report (Table 12) the effects of each service to examine whether the use of some services have more of an effect than others.

We find that the grafting service (column C) increases yield by 91.9 kilograms per ha. The grafting service is one of the innovations of the program. Its effect may be explained by the fact that this service is performed by trained CVC operators. In addition, participating in the whole program combined with fertilizer use increases yield by 92.7 kilograms per ha (last column). Combining technologies may lead to higher impact. This last result is in line with the findings of ICRAF when testing technologies in the CDCs.

Spillover effects of the interventions

This subsection analyses the spillover effects of the interventions. The spillover analysis measures the effects of the intervention on non-beneficiaries in the treatment and the control groups. Table 13 reports the results of the estimations. We find no evidence of spillovers on yield for farmers who do not use any CVC services, or participate in training, or the ORPP. This result suggests that the positive effects on yield do not come at the expense of other farmers. Nevertheless, the intervention has a significant effect on income and price. This confirms that the effect on price is unintended or indirect. There is no sale agreement between Mars Inc. / ICRAF and the beneficiaries.

Placebo effects

In this subsection, we focus on awareness of a CVC without using its services as a falsification test to examine if our results are robust. For this test, we use a 'fake' treatment group; that is, a group that we know was not affected by the program. This result is used as a placebo test: being aware of a CVC without using its services (input or assistance) should not affect productivity. A significant effect implies the presence of spurious correlation and our results cannot be attributed, as causal effects, to the V4C interventions. Results are reported in Table 14. We do not find any statistical significant effects of the 'fake' treatment on productivity (yield), income and price. This serves as a robustness check for the reported causal impacts of the VC4 interventions.

Table 13: Spillover effects of the program on yield, household income and cocoa price

	Yield	Log of income	Price
Inverse probability weighted regression adjustment	38.71	0.3479***	42.26**
	(32.17)	(0.0919)	(13.55)
Robustness check			
Inverse probability weighted	38.32	0.3438***	42.60**
	(32.29)	(0.0922)	(13.57)
One-to-one matching	40.87	0.5438***	32.67*
	(43.38)	(0.1467)	(17.08)
Epanechnikov kernel matching	46.46	0.4187***	41.92**
	(34.75)	(0.1129)	(14.37)
k-Nearest neighbors matching	41.03	0.4156***	41.09**
	(37.97)	(0.1201)	(15.06)
Radius matching	22.66	0.4616***	39.70***
	(23.97)	(0.0745)	(10.42)

Note: This table displays the spillover effects of the interventions on productivity (yield), household income and cocoa price after matching. Yield is defined as the ratio of cocoa production to area (in kilograms per ha). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors.

Table 14: Placebo effects

	Yield	Log of income	Price
Inverse probability weighted regression adjustment	69.88	-0.0614	-23.50
	(55.01)	(0.1297)	(15.90)
Robustness check			
Inverse probability weighted	74.15	-0.0232	-22.08
	(59.13)	(0.1338)	(16.38)
Matched	31.74	0.0134	-29.33
One-to-one matching	(79.13)	(0.2188)	(24.86)
Epanechnikov kernel matching	49.76	-0.0220	-14.70
	(54.17)	(0.1798)	(17.43)
k-Nearest neighbors matching	61.87	-0.0515	-10.03
	(57.08)	(0.1885)	(18.62)
Radius matching	49.41	0.0196	-16.67
	(48.35)	(0.1623)	(14.59)

Note: This table displays the placebo effects of the interventions on productivity (yield), household income and cocoa price after matching. Yield is defined as the ratio of cocoa production to area (in kilograms per ha). Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: ENSEA 2018, computation of the authors.

Summary of the impact evaluation

We uncover a positive impact of the intervention on yield, income and price. Participation in the program – regardless of the intervention – increases productivity by 75.2 kilograms per ha. This average drops to 65.6 kilograms per ha when we focus only on the ORPP intervention. The use of the grafting service and attendance of training sessions (training and application of the techniques learned during the sessions) have a greater impact on productivity: 91.9 kilograms per ha for the use of grafting services and more than 110 kilograms per ha for training.

All these results imply that training (and application of the techniques) is the most effective way of improving productivity. In this respect, the CDCs play an important role. Grafting has the second highest impact. This technique – which is an innovation of the program – does not require any replanting and it takes less than one year for the regenerated plant to start producing. A combination of technologies can lead to higher impact. These results, although below the program target – to triple productivity by 2020 – are encouraging. Our findings are very short-term results.

The increase in income lies between 18% and 38%, depending on the intervention. The interventions improve the economic well-being of cocoa farmers by increasing their production and, indirectly, the price of their product.

We performed a placebo test to ascertain our results. We do not find any statistical significant effects of the 'fake' program on productivity (yield), income and price.

Could the CVC business model be sustainable?

CVCs are privately operating entities that rely on generating their own profit. Can this business be sustainable? This section seeks to provide an answer by focusing primarily on profitability. Although profitability is only one element in sustainability, we think it is a good place to start our sustainability analysis. Firstly, CVCs must be profitable as businesses to be sustainable. Indeed, they build capital largely through the retention of earnings. Secondly, our time-period (since we have cross-sectional data) does not allow us to perform a long-term analysis. To complement the analysis, we also discuss potential threats to sustainability, such as mismanagement.

The profit variable is the net revenue – that is, the difference between income (from product sales and other services) and expenses (acquisition, transport costs, rents, other fees). Table 15 reports the average total income, expenditure and profits for the CVCs. On average, a CVC operator earns 221,253 XOF (around 337.3 euros) per month or 2,655,038 XOF (€4,048) per annum. The annual net revenue of the CVCs lies between €1,067 and €13,034. Three CVCs (out of 32) have a negative profit for 2017. The three largest CVCs in terms of net revenue, excluding those with negative profit, earned almost half (47%) of the total net revenue in 2017. This share rises to 57% for total charge to income. The CVC market is moderately concentrated: using the Herfindahl-Hirschman Index we calculated an HHI of 1,807 (The US Department of Justice considers a market with an HHI of between 1,500 and 2,500 to be a moderately concentrated marketplace).

The revenue comes mainly from the sale of pesticides (an average of 45.8 clients per CVC operator), fertilizers (21 clients) and improved cocoa plants (10.3 clients). On average, each CVC operator provides grafting support to less than four (3.8) cocoa producers and less than three (2.6) for replanting.

The market in which the CVCs operate is moderately concentrated and, except for a few cases, each CVC earns a positive profit. Everything being equal, CVCs should remain profitable. The ORPP is an additional source of revenue for the CVCs. However, it is important that they effectively manage their cash flow. They are supplied on credit, which they have to pay back to renew their stock. Mismanagement of resources could, therefore, threaten their sustainability. To mitigate this threat, CVC operators have been trained in accounting and business management. The supply chain could also be another source of threat. For the business to be sustainable, CVCs need to be supplied on time. The MoU between ICRAF and its partners helps to mitigate this risk, assuming that CVCs pay off their credit. Finally, CVCs provide services for a fee. If producers refuse to pay for these services, CVCs will not generate money. The issue here is that ANADER – a public agency – provides extension services free of charge. If farmers confuse CVCs with ANADER, some of them may refuse to pay for the services. This risk is mitigated through sensitization of farmers.

Table 15: Average Income, expenditures and profit for CVC operators

	Annual average value in XOF (confidence interval in brackets)
Total income in 2017	3,263,846 [1,077,178 – 5,450,514]
Total expenses in 2017 (acquisition, transport cost, rents, other fees)	553,800 [303,300 – 804,300]
Net revenue (profit) in 2017	2,655,038 [612,313 – 4,697,763]

Source: ENSEA 2018, computation of the authors.

Discussion and Policy Implications

The aim of this paper is to assess the impact of Vision for Change (V4C), an agricultural PPP project, on the cocoa sector in Côte d'Ivoire – with a particular focus on productivity. The project aims to revitalize the cocoa sector in the Nawa region, the largest cocoa growing region in Côte d'Ivoire.

Administrative structure of the project

The project is a resourcing and frontier research partnership. It involves financing by a private US corporation (Mars Inc.), channeled through the World Agroforestry Institute (ICRAF), and involves numerous research (Centre National de Recherche Agronomique or CNRA, Ecole Supérieure d'Agronomie or ESA), extension (Agence National de Développemnt Rural or ANADER) and regulatory entities (Conseil Café Cacao or CCC) of the Ivorian Government. Mars Inc. – the donor – acts as a philanthropic organization. Through ICRAF, the CNRA investigated pests and diseases threatening the cocoa plant, particularly those related to swollen-shoot. Varieties tolerant to swollen-shoot were identified, and techniques were developed to rapidly multiply them, as well as to improve existing stocks through grafting. Once the scientific basis had been consolidated, multidisciplinary teams were established in 16 Cocoa Development Centers (CDCs) to test the new methods and plant materials under a variety of local conditions. These were then disseminated to farmers in the surrounding area through extension services (often organized as joint learning groups or farmer field schools). Each CDC in turn trained five Cocoa Village Centers (CVCs) – private firms which sell supplies such as fertilizers and pesticides – to be used in accordance with good agricultural practices established by the CDCs and the CNRA.

The design and implementation of the project are aligned with 2QC program within which a PPP platform – a deliberative forum – has been set up to coordinate, develop and implement (in a participatory manner), and monitor and evaluate programs and projects that are part of the Ivorian sustainable development plan for the coffee and cocoa sectors. Any intervention aligned with the 2QC program should belong to one of the thematic groups of the platform, where the challenges of the sector are examined in order to develop effective proposals. The activities of the V4C project are part of (i) input supply and productivity improvement, and (ii) the fight against swollen-shoot thematic groups. The platform (forum) brings together stakeholders from public and private sectors for dialog to generate mutual understanding and trust, which leads to joint actions to strengthen value chains. The platform helps to coordinate multiple initiatives by multinational firms (Mars Inc., Mondelez International, Nestlé, etc.) and initiatives for cocoa sustainability in Côte d'Ivoire.

Main results

We uncover six main results. First, technologies from the project are available *via* the CVCs and used by the cocoa producers. The products or services that are in most demand are fertilizers, pesticides, hybrid cocoa plants, grafting and replanting. Second, the producers attend training sessions organized through CDCs. The sessions cover good agricultural practices – pruning, weeding, and fertilizer and pesticide application – which are then applied by producers in their fields. Third, participation in the program significantly increases productivity by up to 115 kilograms per hectare, income by up to 48% and the cocoa price by up to 42 XOF (0.06 euros) per kg. Fourthly, participation in training sessions – followed by the application of the techniques learned – and grafting have the greatest impact on productivity. The same holds for participating in the whole program and the use of fertilizer. Fifthly, we find no evidence of spillovers for yield for farmers who do not use any of the CVC services or products, or do not participate in training or the ORPP. This suggests that the positive effects on yield do not come at the expense of other farmers. Finally, we show that the CVC business is profitable. The average annual net income is 2,655,038 XOF (€4,048) per CVC.

The effects of the interventions on productivity show that CDCs as well as CVCs have played an important role. While the greatest increase in productivity (+115.3 kilograms per ha or an increase of 22%) is below the target for the program, the results are still encouraging for two reasons. Firstly, these findings are very short-term results since the adoption of new technologies and the replanting program were only implemented two-to-four years ago. Secondly, an accurate measurement of productivity requires the laying of yield squares – grafting and replanting do not always extend over the total area of the field. Future end-line surveys and yield squares will, without doubt, show greater increases in productivity.

Success factors

One of the main reasons for the success of the project is the innovative approach used to provide high-yield and swollen-shoot tolerant technology. The latter is particularly important because producers often associate swollen-shoot with the HIV/AIDS virus, which means that some of them are reluctant to use varieties of cocoa that are not resistant to the disease. In addition, the PPP platform has been a useful mechanism for coordinating the interventions as well as generating learning among agents, thereby reducing the research and development (R&D) costs. Moreover, the agreements among institutions within the project lead to economies of scale, helping to make new technologies more affordable for producers.

The available technologies also meet the demands of producers. Background investigations at the beginning of the project helped to design technologies that are adapted to the needs of producers (plant material, fertilizers, pesticides, grafting service) and, through the PPP platform, investments are made where needed (effective targeting). In addition, training activities through CDCs or FFSs (innovation platforms) have played a role in the behavior of farmers, particularly in terms of adoption – by alleviating the information asymmetry that could lead to copying of early adopters by late adopters. Recall that, one output of the project is farmers trained in good agricultural practices. The external support provided by the CVC operators also helps to promote the new technologies. This promotion is strengthened by the social networks of CVC operators, particularly among their own ethnic groups – close (distance and language) relationships increase the level of social trust and the willingness of farmers to trade with CVC operators.

Clearly, CDCs and CVCs play a big role in the success of the project. These arms of the project complement the existing agricultural extension services provided by the public sector. It is worth noting, however, that the public extension agency has become less effective over the years due to a lack of government support.

Lessons

Technology production requires lumpy investment and results are not always guaranteed. This is largely because research is often poorly organized (see Chang, 2009): a lack of coordination across research projects, delinking of research from the real world, and the absence of links with extension services. However, the PPP platform helps to overcome these coordination failures and foster investment in research. By alleviating information asymmetry, the PPP platform avoids duplication of activities and helps to channel funds. The integrated approach of this project was also successful in reaching out to farmers. In fact, the project includes both *research* activities to produce better technologies, and *extension services* to pass the technology on to farmers and to teach them how to use them. The internal structure of the project helps to establish an effective link between research and the real world. Finally, V4C is a relevant project for the country because it is aligned with the 2QC program.

For the research component, the CNRA received a total of $US 1.4 million in support (financial and equipment) to undertake research activities from 2011 to 2016. With this funding, the center can continue to conduct high quality research to improve cocoa plant material. For instance, the new laboratory in Anguéledou can take the lead in developing a swollen-shoot resilient cocoa hybrid. The patenting of such a discovery may help the center to export the technology to countries where this disease is also an issue (eg. Ghana, Togo and Nigeria). Under the 2QC framework, the plant material is sold to the CCC. Therefore, the center can generate resources to sustain this activity. ICRAF also equips the CNRA library. Laboratories and the library could enhance training and capacity-building activities.

It is worth noting that the quality of extension services during the period of state-led agricultural development was poor in many developing countries, especially during the period of the Washington Consensus (Chang, 2009). The extension services in Côte d'Ivoire also suffered from funding cuts. The share of government capital in ANADER dropped from 90.3 percent in 1993 to 35 percent today. The V4C project appears to have reinvented extension services in the cocoa sector – from a public to privately owned business – through the CVCs. The partnership between ICRAF and public agencies is one of the main benefits of the CVC scheme. Through the partnership, the *Conseil Café Cacao* supplies the CVCs with hybrid cocoa seeds. The V4C project has also established partnerships with pesticide and fertilizer companies that support CVC operators. The new business model seems to work well, with limited risks. The activities of the CVCs have now spread beyond cocoa farming. For example, FIRCA sponsored the training of CVCs for new banana plant production techniques. Following the training, contracts were signed with 16 CVCs for the production and supply of 465,000 banana plants in 2016. In 2015, 25,695 banana seedlings were produced and sold. Nevertheless, the experience of privatization of extension services in Ghana and in Chile show limited results. Extension services have been more successful in developing countries because they are taken seriously by governments. The coordination between private and public sectors should continue to ensure that extension activities reach farmers.

Appendix

A. Additional summary statistics

Table 16: Variables related to price

	Share of production sells to			Sale practices	Worst practices: proxy of bad cocoa quality		
	Certified buyers	Informal buyers (pisteur)	Cooperatives	Applies discount	Do not sift out defective beans	Do not sort beans before sale	Number of drying days
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treated	22.84	8.92	61.42	2.27	4.55	7.95	6.84
Control	24.04	20.93	43.91	7.98	13.1	10.69	5.57
Difference	-1.20	-12.01***	17.51***	-5.71*	-8.56**	-2.74	1.27***
Use at least 1 CVC service	25.66	14.71	53.94	3.21	5.35	6.42	5.78
Do not use any CVC service	22.16	24.28	38.07	11.38	18.78	14.29	5.65
Difference	3.5	-9.57***	15.87***	-8.17***	-13.44***	-7.87***	0.13
Has replanted	26	13.37	56.03	1.99	5.97	5.47	5.63
Has not replanted	17.82	22.25	35.31	10.5	27.62	20.44	5.52
Difference	8.18**	-8.88**	20.72***	-8.49***	-21.65***	-14.97***	0.11

Note: This table shares means and proportion comparison tests between treated and controls on the sale behavior and the quality of cocoa beans proxied by practices from collection to sale. We consider the whole treatment, as well as two specifics component of treatment, namely the replanting and the use of at least one service, provided by CVCs. As an interpretation, we can say that (for column 3 rows 1, 2 and 3) the treated sell 61.4% of their production to cooperatives and 43.9% of the production of the controls is sold to cooperatives thus, between treated and control groups, there is a significant difference of 17.5% in the production sold to cooperatives. In column 4, we can read that 1.99% of those who have replanted apply a discount when selling their produce, while 10.5% of those who have not done any replanting apply a discount. From column 5, we see that 5.35% of the CVC service users do not sift out defective beans; this figure is 18.78% for those who do not use any CVC services. *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors

B. Matching: regression and quality

B.1 Main regression models for PSM

Table 17: Regression output for PSM

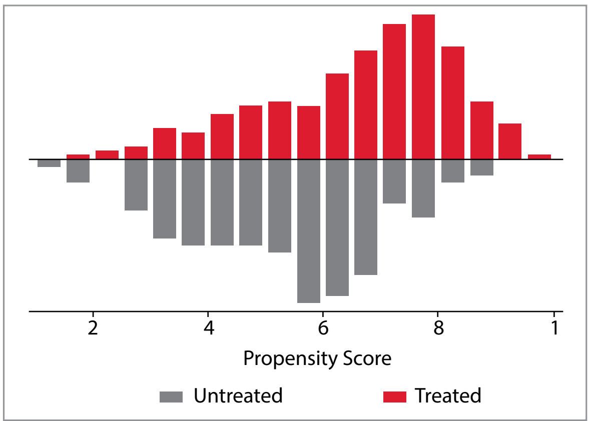
Variable	Treatment = program	Treatment = Replanting	Treatment = use of a CVC service
Age	-0.004	0.005	-0.005
	(0.006)	(0.006)	(0.006)
Female	0.947**	0.498	1.082**
	(0.462)	(0.523)	(0.455)
Couple	0.462	0.420	0.685**
	(0.287)	(0.398)	(0.309)
Number of children	0.107**	0.083**	0.098**
	(0.034)	(0.032)	(0.030)
Field area under 1 ha	-0.593**	-0.772**	-0.361
	(0.257)	(0.367)	(0.247)

Variable	Treatment = program	Treatment = Replanting	Treatment = use of a CVC service
Field area between 1 and 3 ha	-0.461**	-0.429**	-0.302**
	(0.158)	(0.179)	(0.147)
Age of field	0.019**	0.015**	0.017**
	(0.006)	(0.007)	(0.006)
Intercept	-0.619	-2.027***	-1.170**
	(0.443)	(0.528)	(0.432)
Pseudo-R2	0.1026	0.0913	0.0778

Note: Standard errors is parenthesis; *** p<0.01, ** p<0.05, * p<0.1. Source: ENSEA 2018, computation of the authors

B.2 Global model (all the interventions)

Figure 5: Common support of the matching (all interventions)



Source: ENSEA 2018

Table 18: Propensity score matching quality test (all interventions)

	Pseudo R2	LR χ2	p-value	Mean bias
Before matching	0.103	48.80	0.000	28.6
After matching	0.016	9.90	0.194	9.7

B.3 Tests for the model with replantation as treatment

Figure 6: Common support of the matching (replanting only)

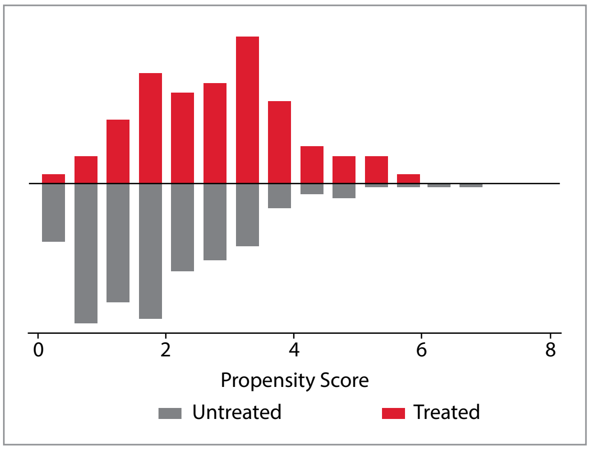


Table 19: Propensity score matching quality test (replanting only)

	Pseudo R2	LR χ2	p-value	Mean bias
Before matching	0.091	36.09	0.000	31.7
After matching	0.007	1.44	0.984	4.5

B.4 Tests for the model with use of at least one CVC service as treatment

Figure 7: Common support of the matching (use at least one CVC service)

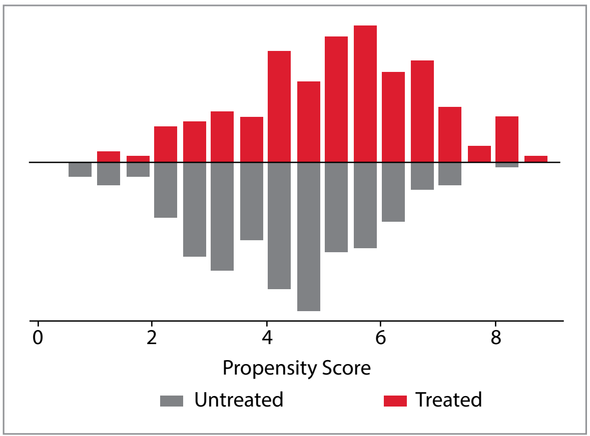


Table 20: Propensity score matching quality test (use at least one CVC service)

	Pseudo R2	LR χ2	p-value	Mean bias
Before matching	0.078	42.96	0.000	24.4
After matching	0.009	4.76	0.689	6.5

C. Theory of change

Theory of Change: The Vision for Change in Cocoa Industry Innovation

Inputs → **Outputs:** Agricultural innovation and best practices to improve cocoa production, quality, and land productivity; community development and empowerment. → **Outcomes** → **Impacts**

Inputs

Funding: US$50 million

- **Funding search and monitoring:** Ivorian Ministry of Agriculture.

- **Support Institution:** Mars Inc. (Private, for profit).

Management Institutions:

• **Government**
- Conseil Café-Cacao (CCC)
- ANADER

• **Private Not-Profit**
World Agroforestry Centre: ICRAF

Research Centers and Universities:
- CNRA
- 4 University Departments
- FIRCA
- IDH

Other Actors:

Outputs

Long-term Public-Private Partnership:
- Ivorian Government & Mars Inc.
- CCC-ANADER-CNRA-Universities & ICRAF

Agricultural Innovation:
- Research
- Best agricultural practices (e.g: regular pruning)
- Application of fertilizer & pesticides
- Improved hybrid seeds or grafted seedlings
- Grafting services and advice

Land Innovation:
- Land health surveillance & data gathering
- Incorporates shade trees (Agroforestry tree)

Community Empowerment Products:
- Support, demonstration & training
- Small & independent business
- Women's Empowerment Plan (Funded)
- Community Development Plan (Mars Inc. Funded US$2.6 million)
- Responsible communities (10% community, women 20% of start-up costs)

Industrial Innovation Products:
- Fiscal incentives
- Infrastructure reinforcement
- Democratic & transparent procedures

Outcomes

Agricultural & Land Innovation:
- Significant increase in yields
- Farmers increase their productivity
- Product qualities improved
- Land health & use enhanced

Community Empowerment:
- Currently, each CVC serves an average of 100 farms of varying sizes
- Communities income source diversified
- Communities income increased
- Women empowered
- Girls & boys education improved
- Poverty alleviated
- Community members small business owners
- Education, infrastructure, & health gaps mitigated

Impacts

Ensure cocoa sustainability in Côte d'Ivoire

Actors:

» ANADER-CNRA, ICRAF, IDH, & Other
- Develop and conduct agriculture research and extension public services
- Develop & monitor innovative platforms (CDC & CVC)
- Infrastructure construction and rehabilitation (school, clinic, road, …)

» CDC & CVC are delivering
- Demonstration & training
- Reinforce the rehabilitation of old cocoa orchards
- Easy to access and attractive
- High-quality planting material
- Land health surveillance data-gathering
- Grafts & clone nurseries
- Agroforest tree planting or managing the regeneration

» Village Savings and Loans (VSL)
- Marketing & financial management training for women

16 CDC
- 6 Funded by IDH

47 CVCs
- 25 Funded by Mars Inc. (ICRAF)
- 15 Funded by others (Cargill, Nestle, HKF, & ZAMACOM).

Implementations:
- Nawa Region
Kipiri, Petit-Bouaké, Koda, Kragui, Petit-Bondoukou, Abengourou, Gagnoa, Bouaflé, Divo and San Pedro.
- Ageing farms
- Farms with CSSV
- Smallholders
- Women (16 CVCs owned)
- 6-week training (New operators establish a CVC with guidance from local CDC technicians).
- 3-days diagnostic meetings have been held in 72 communities (to identify failures & income-generating activities).

The Global Development Network

The Global Development Network (GDN) is a public international organization that supports high quality, policy-oriented, social science research in developing and transition countries to promote better lives. It supports researchers with financial resources, global networking, and access to information, training, peer review and mentoring. GDN acts on the premise that better research leads to more informed policies and better, more inclusive development. Through its global platform, GDN connects social science researchers with policymakers and development stakeholders across the world. Founded in 1999, GDN is currently headquartered in New Delhi.

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www.gdn.int

NEW DELHI
HEAD OFFICE
Global Development Network
2nd Floor, West Wing, ISID Complex
4, Vasant Kunj Institutional Area
New Delhi-110070, INDIA
T: +91 11 4323 9494 / 2613 9494
F: +91 11 2613 6893