FCIP
Farm & Cooperative Investment Program

NEW INSIGHTS ON REACHING LIVING INCOME : IMPACT ANALYSIS

FARMER FIELD BOOK ANALYSIS COCOA CHALLENGE FUND PARTNERS - CÔTE D'IVOIRE

SEPTEMBER 2021

idh the sustainable trade initiative

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September 2021

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FOREWORDS

IDH initiated the Farm and Cooperative Investment Programme (FCIP) with the government of Cote d'Ivoire (Le Conseil du Café Cacao) in 2017 to improve cooperative investment and farmer prosperity. As part of this programme, 11 companies and financial institutions have facilitated access to finance and professionalization services to approximately 400 cooperatives and 190,000 farmers.

Understanding the impact of these interventions at farm level requires understanding better the farmers we work with. An important way to achieve this is to gather daily data on farmers' economics and activities.

We are proud to have been able to bring three FCIP company partners together – Cargill, Barry Callebaut and ETG-Beyond Beans – into a precompetitive collaboration to gather, feedback to farmers and cooperatives and publicly share aggregated farmer data from across various cooperatives using the Farmer Field Books (FFB) tool.

The analysis from this report provides valuable insight on the impact of interventions aimed at professionalising farmers and cooperatives including through access to financial and training services. It also provides us a critical reality check on the complexities involved in enabling farmers to reach a living income. It sheds light on the assumptions we make on the use of investments and how these investments lead to farmer profitability or not.

We owe it to cocoa farmers and cooperatives to use these insights to design future interventions and promote business practices that have a direct impact on farmer profitability and household incomes.

Jonas Mvamva
Cocoa Program Director IDH

At Cargill, we believe that improving the lives of cocoa farmers goes hand-in-hand with business success. Through the Cargill Cocoa Promise, we empower farmers to become agripreneurs who can maximize their farm's profitability and manage their farms as businesses. The Cocoa Challenge Fund has played a key role in the development of sustainable business models for cocoa farmers. We are pleased that 200 Cocoa Promise farmers had the opportunity to take part in the Farmer Field Book study to enable us to gain more and deeper insight into the interventions that help improve farmer livelihoods in a tangible, lasting way. It also helps us to evolve our approach to cocoa sustainability and optimize our programming so that we can continue to create lasting benefits for cocoa farmers, their families and communities, empowering them to own their futures and achieve business success.

Kate Clancy
Group Sustainability Lead
Cargill Cocoa & Chocolate

The granularity of the analysis provided by AgriLogic through its Farmer Field Book gives us an unprecedented detailed picture of the state of the cocoa sector in Ivory Coast and some clear guidelines on the real impact of sustainability activities on farmer livelihood. A fascinating piece of research!

Nicolas Mounard
Director Global Farm Services Barry Callebaut

Three years of participation in FCIP and the Farmer Field Book were very valuable for us as ETG – Beyond Beans. The data from the 200 participating farmers gives us great insight in the needs of farmers and their families to improve the production and their livelihoods. The lack or wrong use of fertilizers by many of the participating farmers can be seen as an example. The coming years we will try to tackle this, with for instance the installation of more practical demo plots and more personalized coaching sessions for farmers. Projects like FCIP give us the opportunity to test and evaluate innovative ideas and helps us to better focus our efforts in the coming future.

Anne van der Veen
Global Programs Manager Beyond Beans

We would like to thank IDH for convening this collaboration and facilitating the publication of this unique report. We commend our partners for pooling and sharing farmer field book data from their supply chains and sustainability programs, as well as for deploying field staff to visit cocoa farmers to collect data all year round. The expertise of AgriLogic has been invaluable to ensure that data collection was aligned and standardized, so that it could be aggregated. Finally, the data itself was generated by hundreds of cocoa farmers who kept written records of their activities, labor, inputs, yields and revenues, during one or more seasons. Let's listen to what farmers are telling us with their field book data. The evidence from farmer field books motivates us to rethink and improve our programs and step up our collaboration efforts with the cocoa sector to develop and implement more impactful approaches and interventions.

Henk Gilhuis
Manager Research and Impacts
Rainforest Alliance

01 Reader's guide

REPORT STRUCTURE

- After the reader's guide, **Summary** and **Recommendations** provide an overview of the main findings and resulting recommendations. Subsequent sections contain the background analysis on which the findings and recommendations are based.
- The **Introduction** section outlines the background of the programme, the sample size by treatment, what services were rendered to farmers in the programme and the analytical methods applied.
- The **Household and Farm Profiles** section outlines a characterisation of farmers in sample used for the analyses in this report.
- The **Farm Management** sections deals with labour use, payment of workers, the gender wage gap, nutrient management and the use of biocides.
- The **Yields and Production** section dives deeper into production and productivity figures, where deemed useful we used data segmentation with respect to investment levels, region and farm size
- The **Farm Economics** section shows cost of production, revenue and profit margins. Farming and household characteristics that drive higher profit margins are identified. We determine where farmers stand relative to the poverty line. Different scenarios with increased prices and productivity were used to show what is needed for poverty alleviation, if this were to be achieved based on cocoa income alone.
- The **Environmental Performance** section discusses the Environmental Impact Quotient and carbon emissions.

DEFINITIONS

The results presented in this report are the totals for the **period 1 March 2018 to 28 February 2021**. This means they include three mid-crops and three main crops.

Monetary values are in West African CFA francs (XOF) unless stated otherwise. The currency is pegged to the Euro at 1 EUR = 655.957 XOF.

Prices for dried cocoa beans, other crops and inputs were taken as reported by farmers. The following minimum farm gate prices for dry cocoa beans were in effect during the analysis period:

- Mid crop 1 April 2018 to 30 September 2018: 700 XOF/kg
- Main crop 1 October 2018 to 31 March 2019: 750 XOF/kg
- Mid crop 1 April 2019 to 30 September 2019: 750 XOF/kg
- Main crop 1 October 2019 to 31 March 2020: 850 XOF/kg
- Mid crop 1 April 2020 to 30 September 2020: 825 XOF/kg
- Main crop 1 October 2020 to 31 March 2021: 1,000 XOF/kg

Results in this report can be expressed Per Farm and/or Per Hectare.

- **Per Farm** means the total value (e.g. labour hours, yield, income) reported by the farmer for his/her entire cocoa area, which may consist of multiple separate plots.
- **Per Hectare** values are obtained by dividing the *Per Farm* value by the total cocoa area in hectares.

We define the farm economic terms Revenue, Costs and Profit as follows:

- **Revenue** is the gross income from the sale of cocoa and (in some cases) other crops.
- **Costs** include labour costs (wages), input costs (e.g. pesticides, fertiliser, seedlings), equipment rental costs, transport and fuel costs. The value of household labour is not included as a direct cost.
- **Margin** is defined as Revenue minus Total Costs; taxes, interest and amortisation of assets are not taken into account.

Cocoa Production and Yield:

- **Production** refers to the total amount of dry beans produced *per farm.*
- **Yield** refers to the amount of dry beans produced *per hectare***.** These variables are recorded by the farmer when selling the beans. We purposely do not ask the farmer whom the beans were sold to in order to limit under-reporting when farmers side-sell.

When we refer to a **significant difference** this is always calculated at a 95% confidence level, unless indicated otherwise.

- **Farm management activities:** with the FFB, farmers keep track of their daily farm management activities. Some of them take place before the harvest and impact production and yield, other activities depend on the level of cocoa pods to be harvested and processed and do not impact yield levels as such. Where necessary we distinguish between these two activity categories.
- **Pre-harvest activities** are: fertilising, spraying pesticides (referred to as 'spraying'), collecting diseased cocoa pods, weeding, pruning cocoa trees (referred to as 'pruning'), pruning shade trees, mulching, (re-) planting cocoa trees (referred to as 'planting') and attending any form of training (referred to as 'training')
- **(Post-) Harvest activities** are: harvesting cocoa pods, breaking cocoa pods, fermenting cocoa beans, drying cocoa beans and selling cocoa beans

In FFB data collection we disaggregate the time spent on farming activities by gender and age group and household and hired labour. Note that:

- Household labour includes work by all people who usually live in the compound/household, as well labour by caretakers.
- All labour that is not done by members of the household or caretakers is registered as hired labour. Communal labour is also part of this category, because despite the fact that farmers do not typically pay wages for this form of labour, there may be costs in the form of provision of food for a large group of people.
- Gender-specific labour data is collected for adults (above 16 years) for both household and hired labour.
- Child work is all labour that is executed by boys and girls younger than 16 years. This age-specific data is only collected for labour from household members. With the data at hand it is not possible to make a clear distinction between child work and child labour as defined by the International Labour Organisation.

02 Summary and recommendations

SUMMARY

Background

In 2017, The Sustainable Trade Initiative (IDH) and Le Conseil du Café-Cacao launched the Farm & Co-op Investment Program (FCIP) with the goal of developing sustainable business models for medium- and long-term financial solutions. To enable prototyping of finance mechanisms for cocoa farmers and co-ops, the program set up the Cocoa Challenge Fund (CCF). A dozen partners benefited from the CCF, largely financial institutions, but also three cocoa traders. In total CCF mobilized 214 million euros reaching more than 400 coops and 190,000 farmers with increased financial capacity resulting in more than 62 million euros in loans to farmers with the aim to support the professionalization of cocoa farmers in Côte d'Ivoire.

The three trading companies involved in CCF - Barry Callebaut, Cargill and the Beyond Beans foundation (part of ETG) - represent approximately 10% of the total CCF funded interventions (41 out of 400 cooperatives). During the program the companies were implementing farm management analysis through the Farmer Field Book (FFB) which was identified by IDH as an opportunity to gain insight on the effects of the interventions supported by CCF. IDH therefore decided to invest in gaining insights to better understand the impact on farmer professionalization.

The FCIP program was not originally designed to impact on living income but this is a dimension that is central to the FFB analysis to gain additional insights for future programs.

This report is the main report in a three-part series:

1. New Insights on Reaching Living Income: Baseline Analysis
2. New Insights on Reaching Living Income: Impact Analysis
3. New Insights on Reaching Living Income: Case Study Analysis

Methodology

The FFB is a data collection and analysis program that enables companies to keep track of their farmers' daily activities, investments, production and sales. Farm management data is collected and digitized two to four times per month to minimize recall bias and ensure accuracy. Data quality is further strengthened by giving farmers a stake in providing accurate information. To this end, each farmer in the programme receives an annual and personal farm management report and group report in which they can compare their own performance to that of their colleagues. Additionally, an annual household survey is deployed to collect information on the use of financial and other services.

Given the high frequency of data collection the FFB is labour intensive to apply. For that reason, a sample of the farmers in the CCF programme were included in the FFB. The partners selected the farmers for the purpose of gaining insights in the farm level situation in general and more specifically the impact of selected CCF funded farm-level interventions. Originally, around half of the FFB farmers were supposed to be in the CCF programme (hereinafter referred to as the CCF group), with the other half being associated with partners' supply chains and acting as a control group (the Non-CCF group). During implementation of project activities this did not always work out and the CCF group of farmers who received services was larger than intended.

This report uses data from 687 to 996 cocoa farmers in Côte d'Ivoire from 15 regions and 41 cooperatives. FFB implementation at one of the partners was in part funded by the Rainforest Alliance.

The analysis aims to answer the following question: Are farmers who benefit from inputs and finance - including those who receive any type of package that is the result of the CCF supported interventions - better off than farmers not benefitting from these?

Answering this question was more complex than anticipated since the range of interventions implemented under the CCF is vast and differs by partner. Moreover, not all farmers associated with a partner receive the same set of interventions. Some interventions may be more impactful than others on specific topics. We therefore also look at specific intervention effects that go beyond being in the CCF treatment group or not.

Services rendered to CCF farmers include different types of productivity packages, set of inputs made available on credit, access to loans, specific training programmes, Farm Development Plans/Farm Business Plans, promotion of Agroforestry and, at the level of the cooperative, Scope Insight assessments, which are intended to foster professionalisation of cooperative management which in turn is expected to result in more professional farmers. Additionally, the majority of farmers in the CCF and Non-CCF group received training on Good Agricultural Practices and a broad range of other topics.

The original research questions were very much focussed on access to finance, but as can be seen from the set of interventions, only two out of six interventions have a strong financial component to them. We therefore broadened the research scope to include improved professionalisation of farm management and uptake of agro-forestry strategies. Ultimately, the goal of this programme, and many others, is to have a sizeable effect on the reduction of poverty. To that end we also review achievements on decreasing the gap to the living income which is a key metric relevant to all partners today but was not part of the original design of the FCIP program in 2017.

Findings

Across the board, evidence on the impact of interventions supported by the CCF is mixed. We identified a number of aspects that worked out as intended while other aspects did not deliver the degree of professionalisation that was expected from them.

Tree Planting

We find that CCF farmers are more likely to engage in tree planting and have planted almost double the number of trees over the programme time frame compared to Non-CCF farmers. Where the interventions may have fallen short is in the promotion of agro-forestry, because while more planting took place, nearly all of it was of cocoa trees. It appears that farmers are hesitant to take up planting of non-cocoa trees at scale.

Farm Management Professionalisation

Company interventions towards professionalisation have not had much effect on the share of farmers applying Good Agricultural Practices. We looked in depth at three activities that were identified in the baseline study of the CCF farmers as having a significant and positive correlation with yield: fertilising, pruning and collecting diseased pods, as well as relationships between yield, investment and input use and margins. In most seasons a greater share of CCF farmers were allocating time to these activities (and to all pre-harvest activities combined), but for most of these we do not find a significant positive difference over time in the share of CCF-farmers doing these. The difference in the amount of change over time between the CCF and Non-CCF groups is not significant. CCF farmers do allocate more time to collect diseased pods. This can help to reduce the spread of disease on the farm and thereby enhance yields (or more accurately reduce potential yield loss). We attribute the greater time spent on this activity by CCF-farmers to the interventions they received.

Labour and Child Work

No difference was found between CCF and non-CCF farmers on the use of child labour. Across the board, some of the labour on farms tends to be provided by children. Both the CCF and Non-CCF group were exposed to activities intended to reduce the amount of work conducted by children. We find a reduction in the number of hours children work on farms in the CCF and Non-CCF groups. The majority of farmers have been trained on the application of the Child Labour Monitoring and Remediation (CLMR) programme, a community-based child labour reduction approach. Of this training we find no effect, but associated CLMR farm visits are very impactful. On farms where children were spotted working, receiving such a visit is associated with a significant reduction in working hours by children.

Input credit

Access to CCF-related credit has resulted in greater investment in fertiliser.

Fertilisers

Unfortunately, larger fertiliser expenditures are not associated with higher yields, but are associated with lower margins. Farmers tend to follow fertiliser applications that are biased towards P and K applications and generally neglect to apply N, contravening manufacturer's recommendations. We are unsure if this is because farmers do not know this, if they know but are not willing, or if they know but can not obtain the right mix of fertilisers. Whatever the case, this phenomenon is undermining the intended effect of interventions facilitating access to credit including access to CCF-related credit.

Yields

Yields have declined significantly over time, a Difference-in-Difference analysis attributes a significant negative yield effect to CCF farmers who used credit to invest in fertilisers. We also find this pattern among each specific project interventions. We are not able to pin-point the causes of this with complete certainty. We do find that farmers who did apply N are not displaying this, but instead have a significant positive yield effect compared to those that did not apply N, which is likely to be part of the explanation.

Yields

There have been reports of stock-piling of cocoa in February 2020 which could have resulted in us under-estimating yield as yields are calculated from sales by farmers. We checked this by looking at the correlation between yield and labour for harvesting and processing. From this we conclude that it is very unlikely that yield figures are an under-estimation resulting from stock-piling.

Income

We find no significant effect of the interventions on revenues, costs or margins earned. We do find that CCF farmers are more likely to have access to credit from formal sources and on average across that whole group have access to larger loans. As 55% to 60% of all credit received is spent on fertilisers and as we saw earlier fertiliser applications tend to be biased it is not surprising that having access to credit is not associated with earning higher margins.

Default Rates

Default rates on loans are hard to pin down, but we see that up to 40% of farmers had between 54% and 60% of loan value outstanding more than 30 days after the due date. We also find that having access to credit is associated with decreasing investment over time. This may well be because the investments in fertiliser are not yielding the expected additional revenues. These things combined are likely to explain why just 31% of farmer take out loans again after the first year in which they did so.

Non-cocoa income

Farmers tend to earn some income outside cocoa, this generally contributes around 10% to their income and comes mainly from other agricultural sources.

Gender

Less than 5% of the registered farmers are female. This group is too small to conduct analyses that investigate if CCF-related interventions had different effects on female-owned farms. In the baseline study we did find that households where spouses shared decision-making livelihood outcomes tended to be better, but in the current analysis this effect is no longer present.

Living Income

Given the importance of cocoa and lack of impact of the programme on cocoa margins, we also find no programme effect on a reduction of the gap to the Living Income. The share of farmers earning a Living Income was 7% in 2018 and 8% in 2020. Had the Living Income Differential not been enacted in late 2020, the situation would have been worse still with just 3.4% of farmers reaching a Living Income.The gap to the Living Income (i.e. the amount of extra money farmers who earn less than the Living Income need to earn to reach the benchmark) was stable from 2018 to 2020 at around 2 million XOF/household.

Income drivers

Yield and cocoa area are by far the most significant drivers of income and explain 60% of the probability that a farmer earns more or less than the Living Income benchmark. Price helps too, and including it in the model explains a further 10% of the probability that a farmer earns a Living Income or not. But its effect is more limited and accrues primarily to those with larger cocoa areas and/or higher yields who are already have a greater probability to earn more than the Living Income.

RECOMMENDATIONS

One of the key assumptions of the programme was that with more and better access to credit, farmers would be able to invest. Combined with professionalisation of farm and cooperative management this should result in yield improvements and increased profitability which would help closing the gap to the Living Income. Our findings are mixed on this.

Investment usage

- One aspect of the programme that may have been overlooked is once farmers have better access to more credit, which programme farmers do, then what do they invest it in? We find most credit goes towards fertiliser, but the biased applications are limiting returns on investment. An urgent **recommendation for IDH, CCC and company partners is to review the training and coaching messages that reach farmers, specifically on the topic of fertiliser recommendations**. If training and coaching messages already address this topic adequately, then further study would be needed to understand why farmers are not taking up such recommendations. This can then feed into new programme design that hopefully addresses this issue.

Fertiliser use

- Some of the partners make fertiliser available to farmers through productivity packages. It is not entirely clear to us if the packages with fertiliser by definition include a balanced mix of N, P and K fertilisers, but we suspect not. If this is indeed the case, then we recommend to **review the mix of fertilisers offered in packages such that farmers receive packages that contain the right mix of N, P and K**, ideally adjusted for local growing conditions, but failing that, then at least proportional to the rate at which N, P and K are extracted during harvest.

Soil Fertility Programmes

- IDH and all but one of the industry partners are members of the **Cocoa Soils initiative**, a 5-year research programme that seeks to improve soil fertility management options for cocoa farms in West Africa. If not already done, **we recommend to aim for close and immediate integration of their validated findings into training and coaching programmes**. We expect this will reduce ineffectual fertiliser applications.

Child work and labour

- CLMR visits appear to be effectful in reducing child labour. We **recommend to continue with CLMR visits and where possible scale them up to regions not currently (fully) covered**. Such targeting could be done using the child labour heat map.

Closing the living income gap

- **A large group of farmers is highly unlikely to bridge the living income gap**, even under scenarios of substantially higher yields or prices. For this group **alternative sources of income would need to be found**. Topics that could be looked at are **carbon credits, forest stewardship revenues and other agricultural or non-agricultural diversification. Unconditional cash transfers** to the poorest segment of cocoa farmers for a period of time may also be an option to consider in future programmes.

03 Introduction

INTRODUCTION

Programme background

IDH and CCC Farm and Cooperative Investment Programme. In 2017, The Sustainable Trade Initiative (IDH) and Le Conseil du Café-Cacao launched the Farm & Co-op Investment Program (FCIP) with the goal of developing sustainable business models for medium- and long-term financial solutions. To enable prototyping of finance mechanisms for cocoa farmers and co-ops, the program set up the Cocoa Challenge Fund (CCF). A dozen partners benefited from the CCF, largely financial institutions, and also three cocoa traders. In total CCF mobilized 214 million euros reaching more than 400 coops and 190,000 farmers with increased financial capacity resulting in more than 62 million euros in loans to farmers with the aim to support the professionalization of cocoa farmers in Côte d'Ivoire.

The three trading companies involved in CCF - Barry Callebaut, Cargill and the Beyond Beans foundation (part of ETG) - represent approximately 10% of the total CCF funded interventions (41 out of 400 cooperatives). During the program the companies were implementing farm management analysis through the Farmer Field Book (FFB) which was identified by IDH as an opportunity to gain insight on the effect of the interventions supported by CCF. IDH therefore decided to invest in gaining insights to better understand impact on farmer professionalization. Although the FCIP program was not originally designed to deliver impact on living income this is a dimension that is central to the FFB analysis to and helps gain additional insights for future programmes.

This report is the main report in a three part series:

1. **New Insights on Reaching Living Income: Baseline Analysis**
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Farmer Field Book (FFB) Analysis. This report on impact analysis is based on the data collected through the FFB program from the 2018/19 season to the 2020/21 season and provides an impact assessment of the CCF program.

We used daily farming records from up to 996 cocoa farmers about their farming activities, investments and returns that was of sufficient quality to be included in statistical analysis for this report. In addition, an annual household survey was carried among all farmers in the sample to capture information on aspects of finance and services and other household information that is not as subject to regular change as farm management is.

The seasons of analysis run from March 1 to the end of February. This timeframe covers the *agronomic* cocoa season, which is different from the more commonly used commercial season. Given that several of the aspects we look at have a strong bio-physical component to them (e.g. crop response to fertiliser applications) it makes sense to follow the agronomic season.

Over the course of the programme FFB data was delivered through four types of reports aimed at different audiences:

- Individual Farm Management Reports with detailed performance results aimed at each participating famer;
- Detailed Farmer Group Reports, allowing farmers to compare their own performance to that of their peers;
- A Company Report, containing in-depth statistical analysis on supply chain level, specific to each company; and
- **Cocoa Challenge Fund report** (this report) in which data from all the fund's grantees that keep FFBs is aggregated and consolidated to determine trends and generate sector wide insights

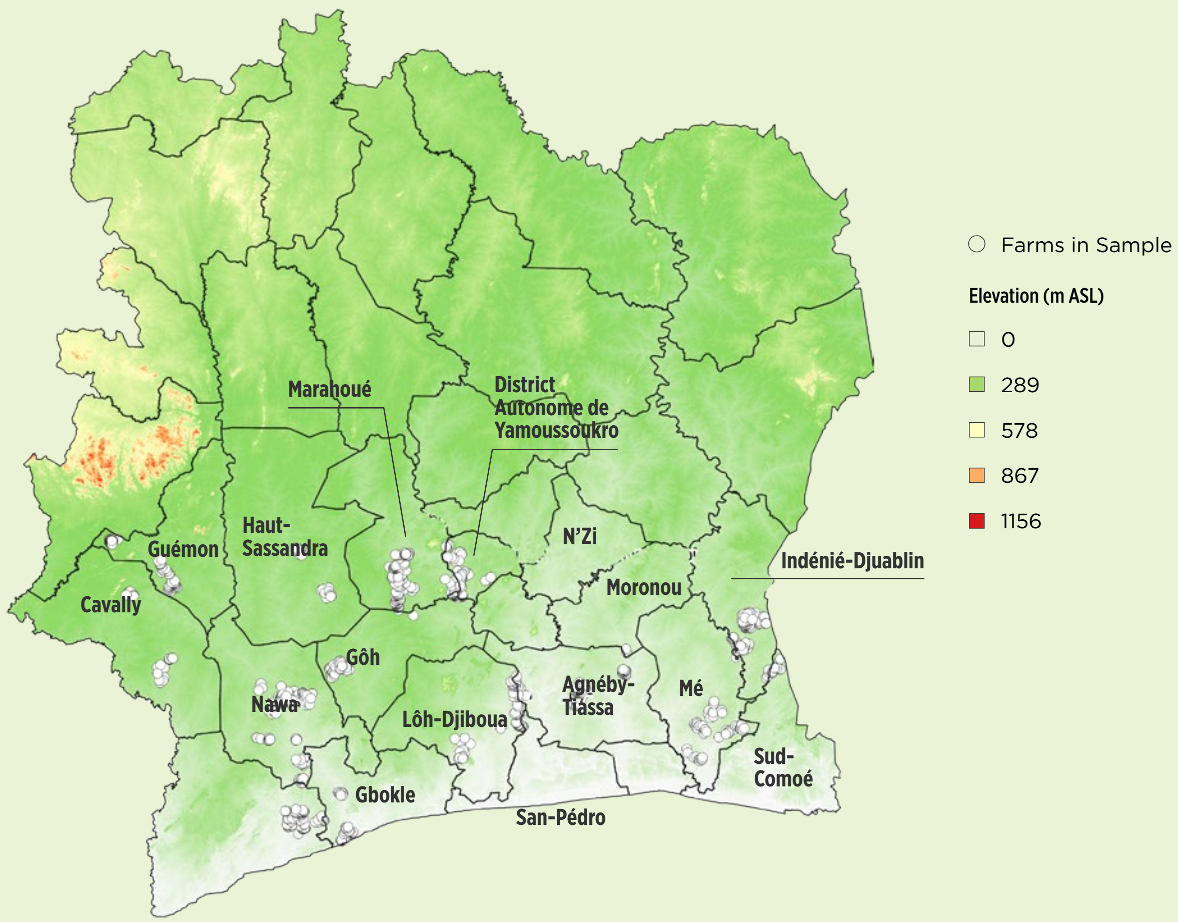
Data collection approach

- The data used in this study comes from three different sources. The majority of it was collected using the FFB approach. In this farmers receive weekly pre-printed forms that they fill out each day they worked on their cocoa farm. They record how many hours were worked on which activity and by whom. If labour was hired, the associated cost is recorded. Any inputs that were used are listed by name, volume and price.
- Every second week these forms are collected by field staff of the partners in whose supply chain this is implemented. At that point, and with the farmer present, a quick check is conducted to determine of the entries are complete and correct. For example, if a farmer indicates to have fertilised, the data collector checks if the associated pieces of information are present and in the correct units. If required, on the spot corrections or clarifications are added.
- These forms are then centrally deposited and entered into the FFB database using the FFB software and paper records filed for future reference.
- Half-way through the season we run an error-checking algorithm that flags potential data issues that are then corrected. Often issues stem from incomplete digital entries. These are cross-checked against the paper records and corrections made as needed.
- In addition to the FFB data, which focusses heavily on actual farm management activities, we use a once a year survey that is carried out at the end of the season to collect additional information on loans and repayments, services used and income from non-cocoa sources.
- Lastly, data from the implementing partners is used. They provide details on which interventions farmers used, GPS acreage data and certification status.

Sample size and geographical spread

- The analyses presented in this report are based on the data of up to 996 cocoa farmers who are associated with 41 cooperatives.
- The sample was not stable over the 3 years of implementation. Some farmers dropped out, others were in the sample, but their data was incomplete or of insufficient quality. Yet others were added to the sample as time progressed.
- Farmer data was collected in fifteen administrative regions in the southern half of Côte d'Ivoire.
- Farmers tend to be clustered around one or more coops within a region.
- In 2020, the farmers in the sample collectively have 4,784 ha of land under management, of which 3,560 ha is planted with cocoa.
- The cocoa area in the sample is planted with 4.30 million cocoa trees.

Figure 1 Sample size and geographical spread



Sample development over time

- In 2018, we started of with 674 farmers (Fig 2). In 2019, there was considerable drop out with 233 farmers moving out of the sample. This was in part because at one cooperative data was recorded by farmers and collected, but not properly entered. Other farmers may have found the approach too cumbersome or may have been inadequately supported and ceased recording all together.
- One of the partners added a significant number of farmers to the sample and in the 2019 analysis, some of the farmers who had kept records in 2018 that were not properly entered could be included again. Across the entire group this resulted in 441 farmers moving into the sample in 2019. The same number was carried over from 2018 and 233 dropped out.
- As implementing teams and farmers build up more familiarity with the approach the drop out rate in 2020 was reduced to 109 farmers. A smaller group of 223 farmers moved into the sample in that year, bringing the total to 996 farmers.
- To adequately assess the effects of the CCF programme we ideally use data from farmers that spans the three years of implementation. Of these we have 405 in our sample. The group with two seasons of data in 2020 consists of 449 farmers, while 142 farmers have a single season of data (Fig 3).

Figure 2 Sample Development by Season

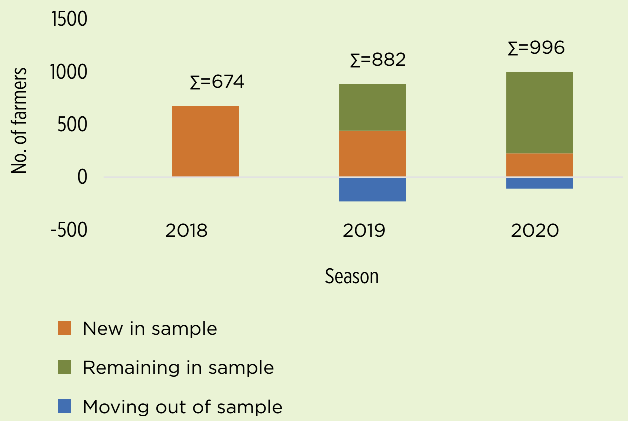
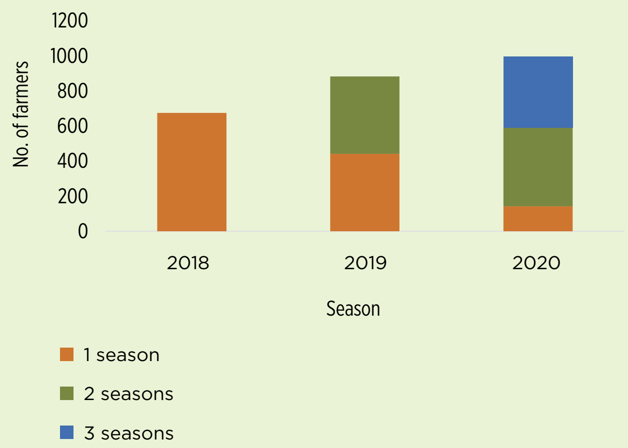


Figure 3 No. of Farmers and Seasons of Data by Season



Treatment and control groups

- Depending on the season, the sample consists of 387 to 662 farmers who received one or more of several treatment options (Fig 4). The treatments are diverse and not mutually exclusive, i.e. one farmer can receive several treatments and many do, which is why the sum of all treatments (Fig 5) is greater than the treatment group (Fig 4).
- Some treatments are straightforward in that they are directly linked to the CCF programme. Productivity packages, BUS training, Farm Development Plans and Farm Business Plans (FDP/FBP) and the Agroforestry intervention are examples of this.
- The provision of credit is more challenging as more farmers took out loans than the programme provided. To determine if a loan can reasonably be attributed to the CCF programme we look at the provider of the loan. Where the provider is either the project implementer, the cooperative or the MFI Advans we assume that the credit was made possible as a result of the CCF programme.
- The aforementioned interventions all take place directly at farm level. The last one, a Scope insight assessment, works at the level of the cooperative and has a less direct effect on farmers. The assessment is supposed to be a measure of the professionalism of the cooperative and the idea is that if cooperatives become more professional then their members will be better off as well.
- In the composition of the treatment group we assign farmers to it if they have received one or more of the six listed treatments.
- In addition to these treatments, nearly all farmers also received varying levels of training on a broad range of topics, irrespective of being in the treatment or control group.

Figure 4 No. of Farmers in Treatment and ControlGroup by Season

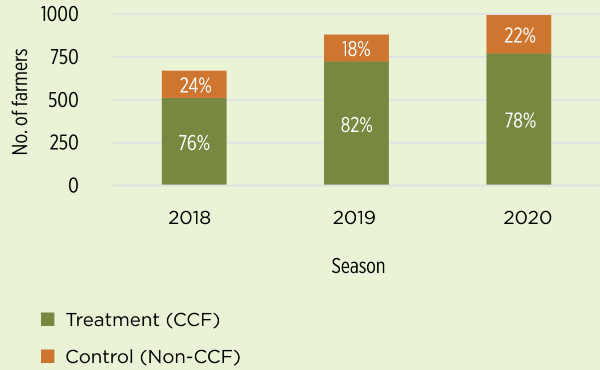
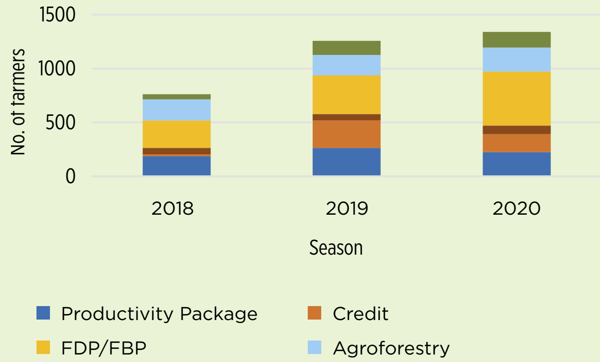


Figure 5 No. of Farmers by Treatment Intervention and Season



Treatment details

Productivity Package

- The Productivity Package is a combination of inputs (insecticides, fungicides and fertiliser) that are made available on credit to farmers, often this is combined with a Farm Business Plan (a slightly adapted variant of the more commonly know Farm Development Plan that was originally developed by Mars).
- The packages come in five different flavours. Different farmers have had different durations of use of different packages, ranging from a single season to three seasons.
- The idea behind is that access to affordable and good quality inputs is a limiting factor to raise yields and/or optimise cost of production and that by addressing this farmers can progress.

Credit

- Under the CCF programme different types of credit provision approaches are implemented. In many of these Advans, a lender, is involved.
- Farmers can take loans directly from Advans, but we also see situation where cooperatives receive loans from Advans which are in turn made available to farmers.
- In many cases such loans are used for inputs, but they may also be targeted towards the payment of other expenditures such as school fees.
- The logic is that access to finance may be a limiting factor to raise farm output and that by making credit available farmers are in a better position to invest and raise their production and income.

BUS training

- The BUS training is a training programme intended to develop farmers' skills at a personal level and at microenterprises level.
- The central tenet behind this is that with improved personal and entrepreneurial skills the resilience of farming household can improve. This is expected to translate into more productive farms and a reduction in poverty.

Farm Development Plan/Farm Business Plan (FDP/FBP)

- The FDP/FBP is centred on a digital application that allows farmers under the guidance of technicians to develop a multi-year plan for the development of their farm.
- After the plan is developed regular coaching visits are expected to take place during which implementation is reviewed and challenges discussed. This may be combined with credit to make the called for investments.
- Different partners use the FDP or FBP designation, but the approaches are largely similar, which is why we pool them in a single treatment option.
- The aim is that with a plan in pace and being implemented more productive farms will result.

Treatment details

Agroforestry

- Promotion of agroforestry is included in some of the CCF projects. In it farmers are trained on creating more diversified farms and often this is combined with setting up nurseries for cocoa and non-cocoa trees.
- Greater tree diversity may have several positive spin-offs such as improved climate change resilience, additional revenue steams from other marketable tee crops or, in the mid to long-term, timber sales.
- The above are expected to contribute to greater agronomic and economic resilience and hence greater or more stable incomes.

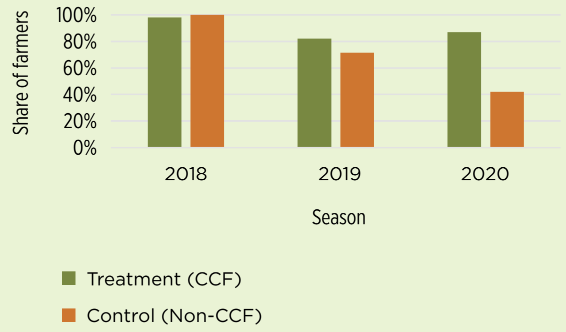
Scope insight

- Scope insight is an approach whereby cooperatives are scored on 8 aspects of professionalism for agribusinesses. The score achieved is a reflection of the level of investment readiness. Cooperatives that are more professional are expected to have better access to finance and have a higher probability of attracting investment. This is expected to ultimately benefit farmers who are members of such cooperatives.

Training

- We do not list training as a separate treatment, as this type of intervention is nowadays commonly offered to a broad range of farmers. Topics range from child labour remediation to farm management and gender relations. Across the sample we find that in all but the 2020 season the majority of farmers in both the treatment and control group received some training.
- So rather than taking training access as an explanatory variable we will use the number of sessions received in a season. In this treatment and control group farmers may still differ.

Figure 6 Share of Farmers Trained by Treatment, Control and Season



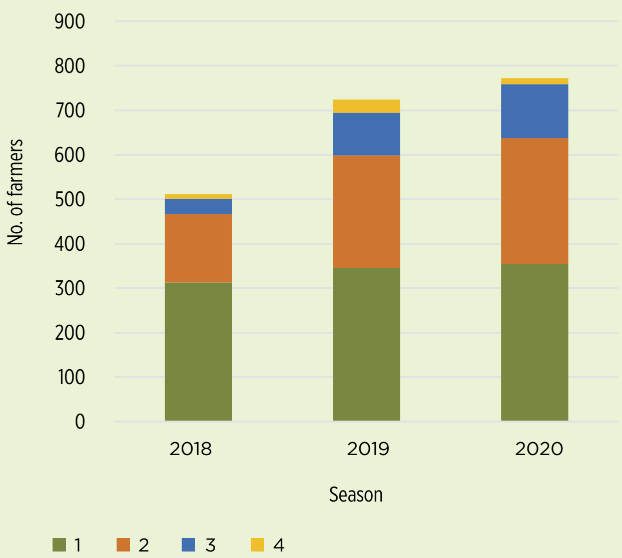
Combinations of treatments

- In principle we can have 64 possible treatment combinations (2^6), but in reality the majority of farmers (83%) have a single or double treatment.
- Productivity Packages (PP) and credit are often combined with FDP/FBP, but perhaps less than one would expect (table): 18% of farmers received a credit through the CCF programme in combination with an FDP/FBP, while 76% of all treatment group farmers received an FDP. This is odd in that the FDP/FBP is supposed to come with a credit to invest in the farm development plan.
- In principle all the PPs are made available on credit. The credit treatment listed here is any credit from a CCF partner (implemented, coop or Advans) is in addition to a credit a farmer with a PP may already have through the uptake of the PP.
- All the farmers who received BUS training also are part of the CEP Agroforestry intervention.
- Overall, the number of farmers that combine multiple treatments is not that large: 16% have taken up varying combinations of 3 treatments and 2% have received 4 of them.

Figure 7 Share of farmers with combinations of treatments

	Treatment					
	PP	Credit	BUS	FDP/	CEP AF	Scope insight
PP	34%			FBP		
Credit	12%	25%				
BUS	0%	0%	12%			
FDP/FBP	23%	18%	6%			
CEP Agroforestry	0%	2%	12%	76%	33%	
Scope insight	6%	6%	0%	10%	0%	22%

Figure 8 No. of Farmers and No. of Treatments by Season



Certification status

- In addition to the range of treatments, a large share of the farmers in the sample are also certified.
- Rainforest Alliance certification is by far the most popular. We find a smaller group of farmers under the Fairtrade standard and another group that is double certified.
- The uptake of both standards seems to have plateaued in 2016. In the period from 2013 to 2016 we see strong growth of Rainforest Alliance certification and a more moderate uptick in Fairtrade certification, but beyond that season the numbers are stable (Fig 10).
- Given that the vast majority of farmers are certified it does not make much sense to further disaggregate the analysis in different treatment types by certified versus non-certified farmers, but we will include the duration of certification as an explanatory variable in the regression models for yield, cost of production and poverty incidence.

Figure 9 No. of Farmers by Certification Status and Season

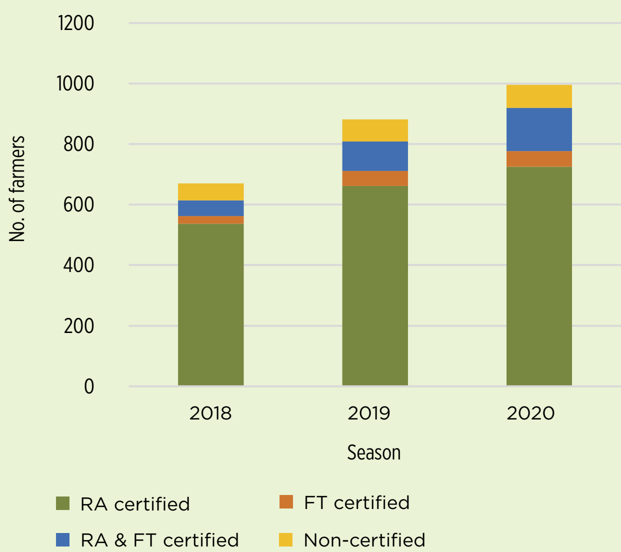
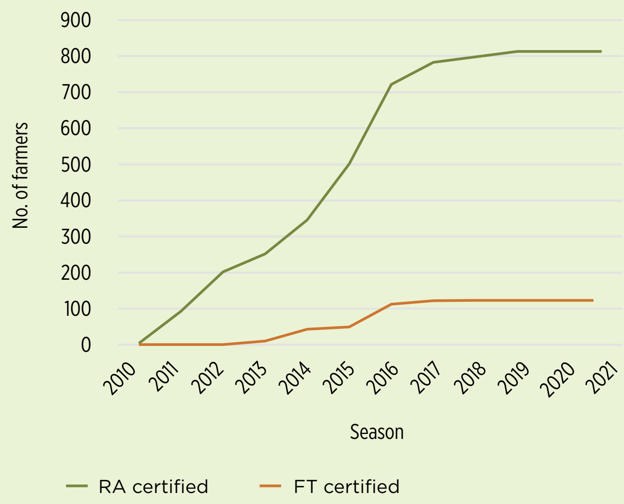


Figure 10 Cumulative Net No. of Farmers Certified by Standard and Season



Research goal and questions

- With six treatment options available that farmers can have used in varying combinations, we can have 64 unique treatment combinations in the sample[1]. The farmers with one or two treatments already yield 17 unique combinations and the ones with 3 or 4 combinations increase this further. Clearly, it is not feasible to analyse the effect of each possible combination. This was foreseen in the programme design and consequently the main research goal is to determine: **"Are farmers who benefit from the Cocoa Challenge Fund (i.e. those who receive any type of service that is the result of the CCF project) better off than farmers not benefitting from these services?"**

- To reach the research goal we will attempt to answer the following questions:

1. **How much access to finance do farmers in the sample have?**
    1. To what extent are farmers able to take loans?
    2. From what lenders?
    3. How does access to finance change over time? (I.e. do they continue to take loans? How does the size of the loan change over time?)
2. **To what extent can farmers repay their loans?**
    1. What is the default rate?
    2. How does repayment ability change over time? (I.e. are farmers getting more "bankable" or not?)
3. **In what type of activities do farmers invest as a result of these loans?**
    1. Which share of the borrowed sum is spent on farm activities?
    2. Which share of the borrowed sum is spent on non-farm activities?

1 1 2^6=64; where 2 is the number of choice options, receiving a treatment (1) or not (2) and we have 6 treatments in total

Analytical methods

- The aforementioned questions will be answered by comparing developments over time between treatment and control group farmers while controlling for pre-treatment differences through Propensity Score Matching.

- In the selection of participants in the projects that are implemented under the CCF programme it is unlikely that participant selection was fully randomised. It may be that larger farms were favoured, or farmers in certain geographical areas. It could be that males are more likely to participate than females, or that younger farmers are more likely to be selected or opt into a project. To control for this bias we apply Propensity Score Matching. With this we create sub-groups in both the CCF group and Non-CCF group based on observable characteristics that may affect farmers' propensity to participate, but are unlikely to be affected by their participation, such as cocoa area, age, gender, education level, location. This matching is done on basis of a single propensity score that reflects their probability to participate based on the observable characteristics. We then compare differences in outcomes of farmers in CCF and Non-CCF with similar propensity scores and arrive at a weighted treatment effect.

- On occasion we will also see how a variable has changed over time within each group. Any such comparison will start with a Kruskal-Wallis test to determine if the variable in question has a normal distribution. If it does, and we look at differences between 2 groups, then a student t-test will be used to determine if observed differences are statistically significant. If a variable is normally distributed and we compare multiple groups, then we use an ANOVA test in combination with a Tukey HSD test to determine significance. If the Kruskal-Wallis test is rejected, meaning a variable is non-normally distributed, then we apply a Dunn-test, a non-parameterized alternative for the ANOVA, to determine significant differences.

- The above will shed light on how the treatment group fared compared to the control group. Underlying this, may well be that some services are more effectful than others. We therefore run a number of step-wise regression models on e.g. yield, cost of production, poverty incidence, where the level of service uptake by farmers of each service is included as an explanatory variable. More effectful services will stand out as having a significant effect on the dependent variable.

- Some aspects such as yields or poverty incidence, may have a strong geographical component to them by being more concentrated in particular areas. To explore this, we create a number of maps where we think these may add value to partners in the design and targeting of new interventions or in refining of existing ones.

Limitations and challenges

- The CCF treatment intervention includes a wide-range of specific interventions. Content and mode of implementation varies from one partner to another. The advantage of pooling all the data is that it can help to build a more detailed picture across different regions in the country. The downside is that there is not really a single CCF intervention. We deal with this by splitting out specific activities by partners for closer scrutiny, but in our view it would be more insightful to have smaller studies done on very specific and well-documented interventions where in each study a limited number of interventions is introduced to farmers.
- For us a major limitation of this study, beyond the complex treatment set-up and varying approaches to interventions by different partners, is that while we have a good grasp on what farmers do on their farm, but we know little about why they do or do not do certain things.
- Another limitation is that while we are interested in understanding the effects of a number of interventions, not all farmers who used an intervention in a season, continue to do so in subsequent seasons. This makes it challenging to identify and quantify longer-term effects.
- Farmers in this study are not randomly selected. Many of them have self-selected into the respective programme interventions or were vetted to be included in certain programme activities. Especially activities around credit, both cash and in the form of inputs, are not open to all farms and are by no means randomly distributed. In an ideal study allocation of farmers to activities would have been randomised. We do control for this to some degree by isolating selection effects and through the use of PSM, but there may well be unobservable selection effects that are not factored in. This may bias the outcomes.
- Collection of FFB data across a large group of farmers is labour intensive and a large group of data collectors is involved. While all have been trained on how to collect data, conduct data quality checks and digitise information, differences in staff performance and diligence can affect quality of data. For some farmers it was clear that the data in their FFB files could not be correct and these have been excluded from the analysis, but it may well be that we did not spot all the faulty entries. Given the large sample size we doubt this has drastically skewed the results.
- Data that is recorded in near real-time tends to be quite accurate, but the additional once a year survey is likely to suffer from recall bias. We do try to limit the questions in that survey to aspects that are easier to remember, for example loan values can be expected to suffer less from recall bias than say production because farmers with a loan tend to have a single loan in any given year, whereas production comes in over time after each session of harvesting and pod breaking. Similarly, data on tree numbers and particularly tree age are difficult to obtain accurately. We are not overly confident in the tree numbers and tree age data and assume that there can be large deviations from the actuals on any given farm. We do not see a particular reason for farmers to consistently over or under-estimate tree numbers and age and so assume that at sample level the numbers are probably fairly accurate.

04 Household and farm profiles

Gender, age and family composition are largely similar among the CCF and non-CCF farmers

- The vast majority of farmers registered is male, irrespective of being in the CCF or non-CCF group (Fig 11). The Figure displays the situation in 2020; the data for 2018 and 2019 are nearly identical and we observe neither significant differences over time nor between the CCF and non-CCF groups. The rates of female farmers found here is in line with studies of the sector by Ingram et al (2014 and 2018).
- From this we conclude that the implementers of the CCF programme did not appear to have made a conscious effort to involve more women in the programme.
- Figure 12 shows the household composition in 2020 by treatment. The categories with an age indication belong to the household living on the farm. The category "other dependents" rely on the farm for their livelihood but may reside elsewhere or may live on the farm but be members of the extended family.
- We find two significant differences between CCF and non-CCF farmers: The number of adult men over 16 years of age (in 2018 and 2020) and the number of other dependents is (in 2020) are significantly higher ($p<0.05$) on CCF farms.
- None of the other differences between CCF and non-CCF for any of the other categories or in any of the three season is significant ($p<0.05$).
- In terms of gender and household composition we conclude that the households in both groups are sufficiently comparable.

Figure 11 Share of Farmers in Sample by Gender and Treatment in 2020

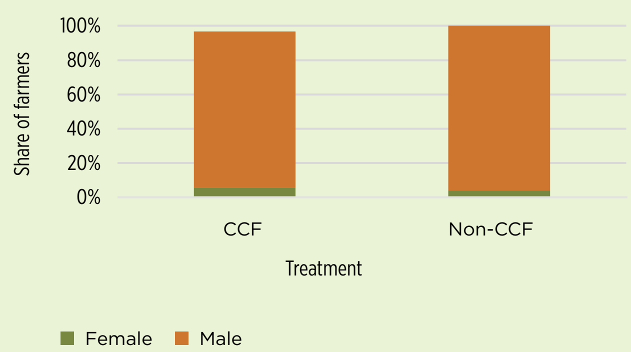
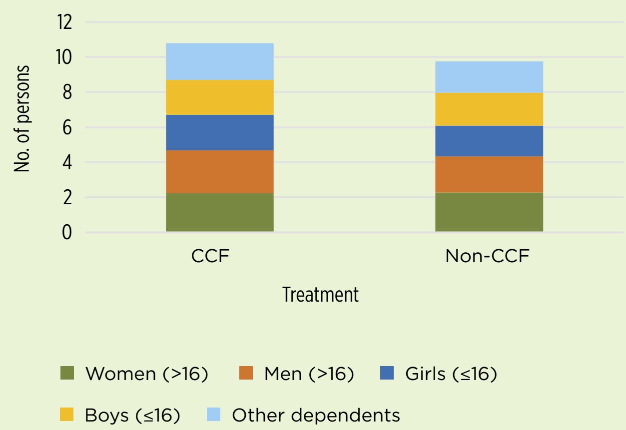


Figure 12 Household Composition by Treatment in 2020



CCF farmers are significantly older (48 versus 46 years), but we do not expect a two year age differential to affect outcomes

- Mean age between the two groups does not differ by much in real terms: 48 years of age on average for the CCF group versus 48 for the non-CCF group, but the difference is statistically significant ($p<0.05$). This is driven primarily by the differences in the $30<x\leq40$ and $40<x\leq50$ age groups (Fig 13).
- We often see that there is a positive correlation between age and farm size, whereby older farmers tend to have more land at their disposal. Since the CCF farmers are on average 2 years older than non-CCF farmers, we checked farm size and cocoa area across the age groups by treatment (Fig 14). We compared farm size between the treatments within each age category and while the oldest age group indeed has significantly more land available to them, the differences between CCF and non-CCF farmers within each age group is not significant ($p<0.05$).
- We conclude that CCF farmers tend to be slightly older, perhaps this is because several of the interventions involve a loan component and lenders are typically more inclined to borrow money to people whom they think likely to be able to pay back and older people generally have had more time to build up savings.

Figure 13 Share of Farmers by Age Group and Treatment in 2020

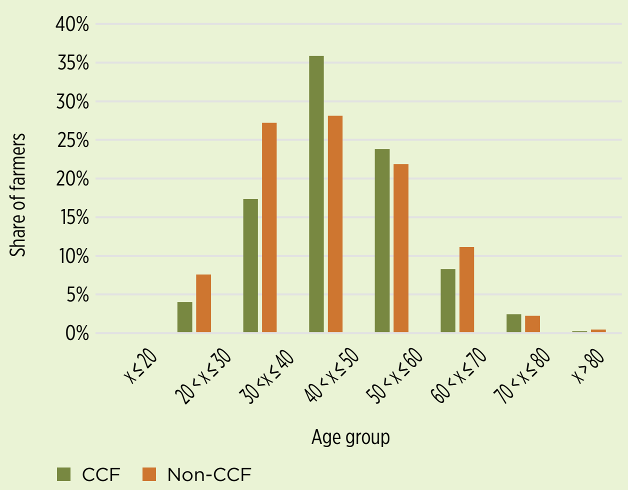
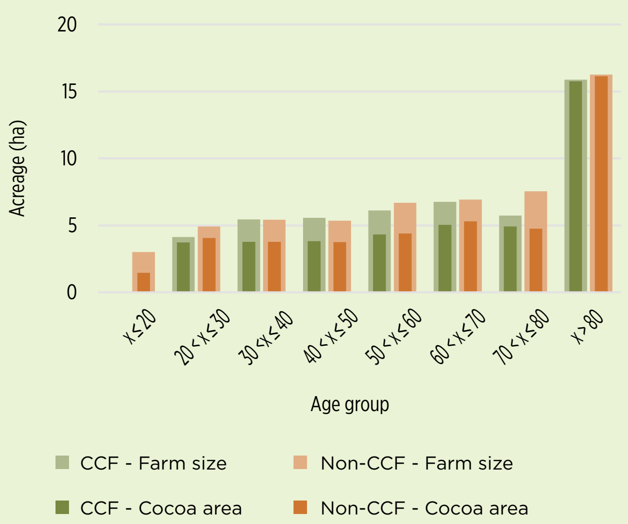


Figure 14 Farm Size and Cocoa Area by Treatment and Age Group



There is no difference in education level achieved between the CCF and Non-CCF groups. In both groups males have significantly higher formal education levels than females

- Educationally, the two groups have a similar profile as well. Males tend to have had significantly more formal education than females in both groups, but the differences between the groups are not significant (Fig 15).
- In Figure 16 we plot the mean education level by age group. The education levels range from 0 (no formal education) to 5 (higher than secondary school). The educational gap between males and females is age related with the gap widening among younger generations of farmers. Judging by the decline in education levels with age and the decreasing educational differential between the sexes among older age groups, in the younger days of the what is now the older generations access to formal education was apparently limited for both sexes (Fig 16).
- We conclude there is no educational differential between CCF and non-CCF farmers.

Figure 15 Education Level by Gender and Treatment in 2020

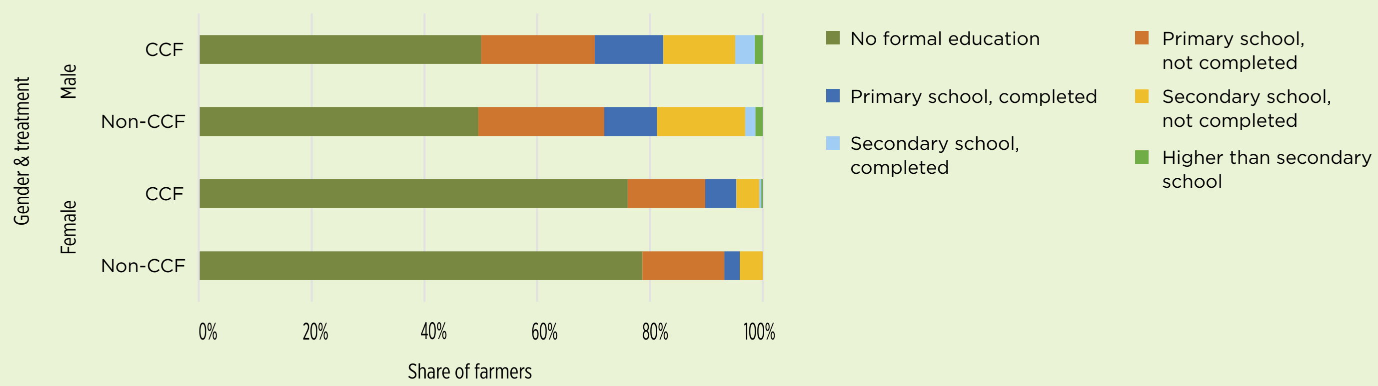
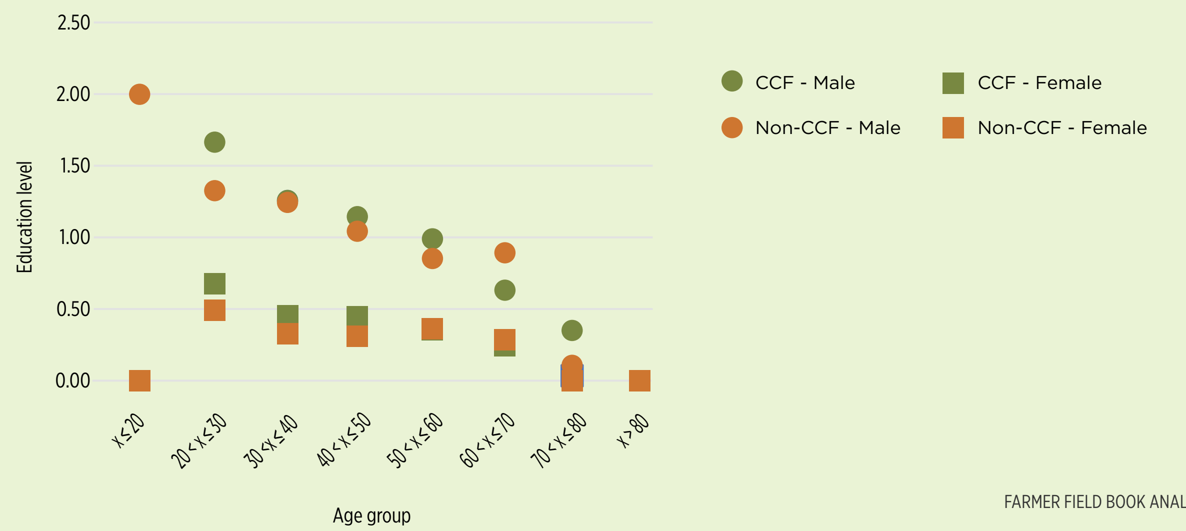


Figure 16 Education Level by Gender, Treatment and Age Group



The share of land under share-cropping has declined since 2018, but a comparable share of farmers make use of such arrangements. Decision-making is concentrated in the hands of farm owners and males

- Thirty seven percent of farmers have at least one caretaker who manages (part of) the farm in return of a share of the harvest, but the share of land under such arrangements has gone down significantly (*p*<0.05) since 2018 (Fig. 17).
- Despite fairly wide-spread use of share-cropping arrangements farm owners tend to remain in charge of farm management decision-making, it is rare for the caretaker, or share-cropper to be in complete control of decision making (Fig 18).
- The situation on share-cropping (Fig. 17) and decision-making between farmers and caretakers (Fig 18) is similar between the CCF and Non-CCF groups.
- On 5% of farms women are involved in making farm management decisions, irrespective of the treatment (Fig. 19).
- For regional differences in gender concerning decision-making: women are more often involved in decision-making in Marahoué and Indénié-Djuablin, while women are most likely to not be involved in Lôh-Djiboua and Agnéby-Tiassa.

Figure 17 Share of Farmers and Acreage with Share Cropping Agreement by Season

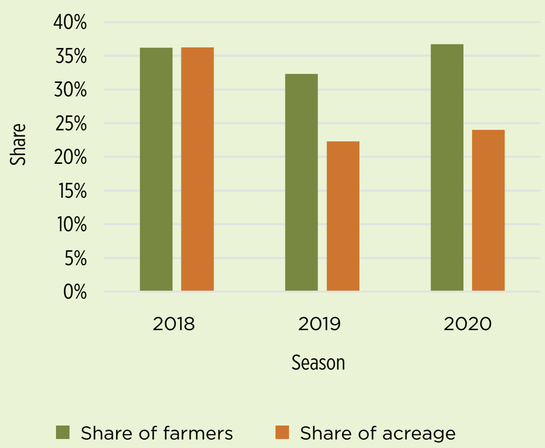


Figure 18 Farm Management Decision Making: Owners and Caretakers in 2020

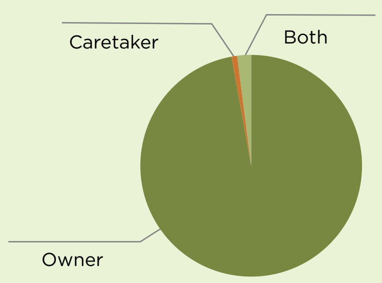
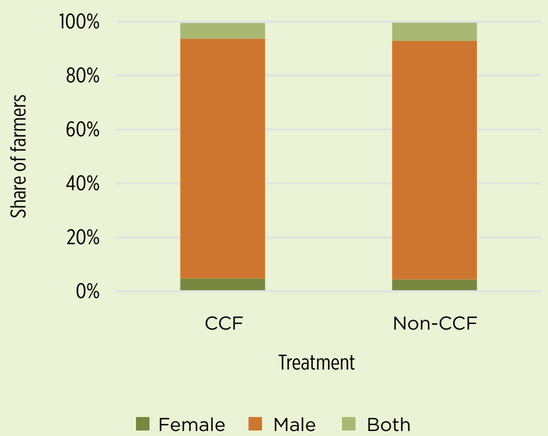


Figure 19 Share of Farmers by Gender of Decision Maker and Treatment in 2020



Farm sizes do not differ between CCF and Non-CCF farms. We do find significant regional differences with farms in Guemon, Gbokle and Indenie-Djuablin being larger

Figure 20 Farm size in ha by region

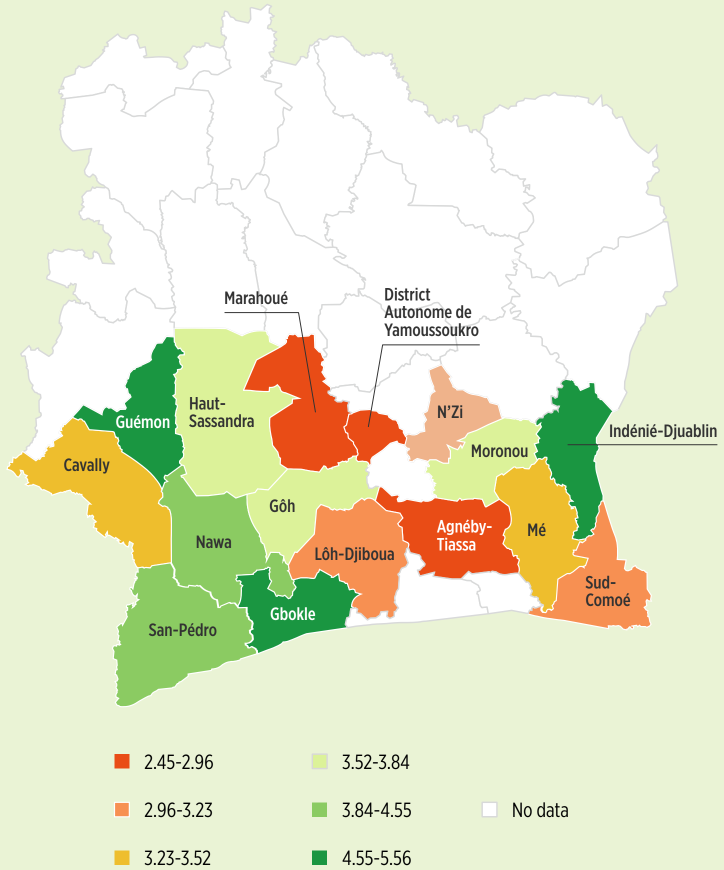
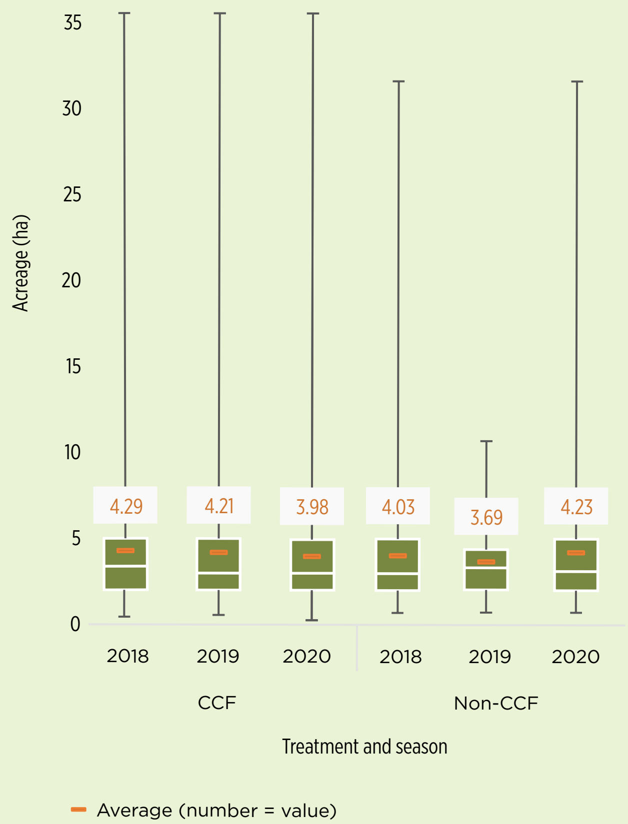


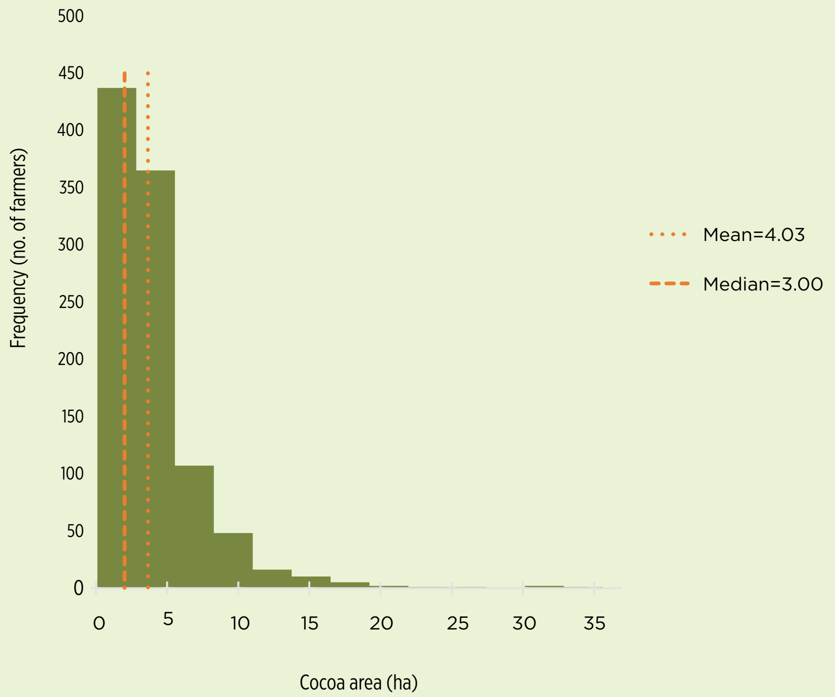
Figure 21 Box Plot of Cocoa Area by Treatment and Season



Mean cocoa area in 2020 was 4.03 ha. Eighty one percent of farmers have cocoa areas between 0.25 and 5.56 ha

- Figure 20 (previous page) shows the range of average cocoa areas by region. Across the entire sample average cocoa areas range from 4.23 ha in 2018, 4.10 ha in 2019 and 4.03 ha in 2020. The changes are caused by flow of farmers into and out of the sample.
- The map indicates we find larger farms in Guemon, Gbokle and Indenji-Djuabalin and the smallest plots are more likely to be found in Agneby-Tiassa, Yammoussoukro and Marahoue.
- Reviewing Figure 21 (previous page) on cocoa areas by treatment and season, we suspect that cocoa areas are not normally distributed. Indeed, a Kruskal-Wallis test indicates as much. A subsequent Dunn-test indicates that there is no significant difference ($p<0.05$) in cocoa area between the treatment groups.
- The in- and outflow of farmers in the sample does result in a lower maximum cocoa area in 2019 for the Non-CCF farmers, but this change is not enough to decisively shift the mean to a significantly different level.
- With the histogram displayed here, we see that the vast majority of farmers (81%) sit in the first two bins with cocoa areas ranging from 0.25 to 5.56 ha.

Figure 22 Histogram of Cocoa Area in 2020



Tree age and planting densities do not differ between the groups, in combination with similarly sized plots, we conclude that the CCF and Non-CCF are comparable

- Tree age and planting density can have significant influence on farm performance. It is therefore important to understand these and how, if at all, they differ between the CCF and Non-CCF group.
- Figure 23 shows seasonal box plots of cocoa tree age by group. Both groups at the start of the programme had mean tree ages of 20 years, with time and change in sample structure the mean tree age in 2020 is 21 among the CCF group and 22 years among the Non-CCF group. We observe more outliers in the form of older trees among the CCF farms, but the observed difference is not statistically significant ($p<0.05$), implying that the farms are sufficiently similar to make valid comparisons.
- In Figure 24 we plot the planting density, i.e. the number of cocoa trees per ha. On CCF farms in 2020 we find a value of 1,338 trees/ha versus 1,256 on Non-CCF farms. As with tree age, these values do not differ significantly, neither between the groups nor within the groups over time ($p<0.05$)

Figure 23 Box Plot of Cocoa Tree Age by Treatment and Season

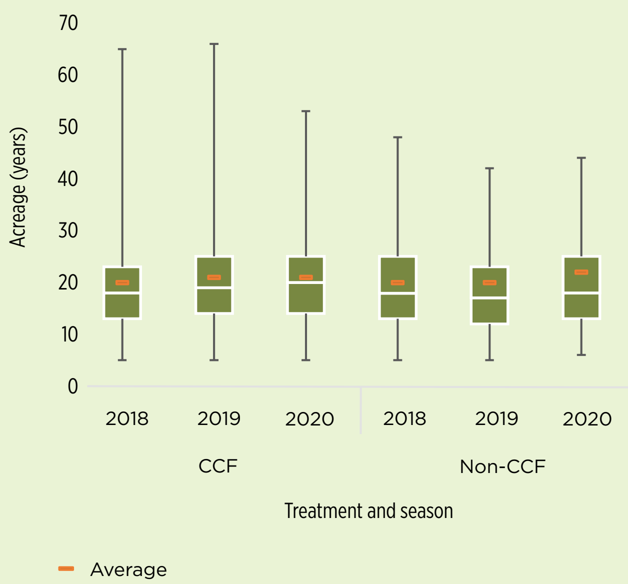
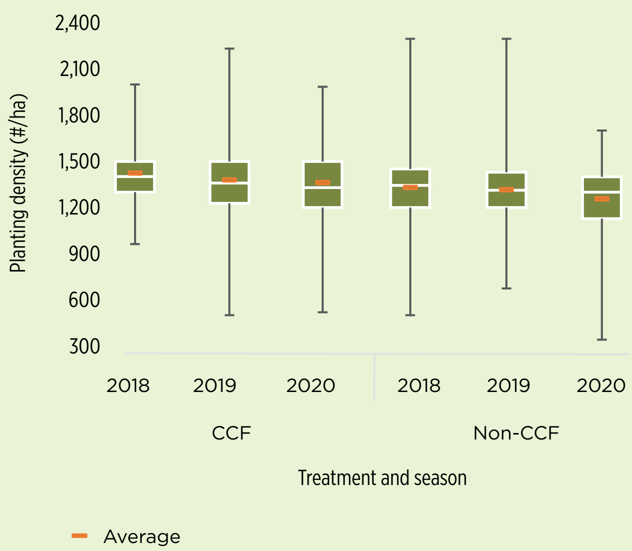


Figure 24 Box Plot of Cocoa Area by Treatment and Season



CCF farmers are more likely to engage in tree planting and have added almost double the number of trees, including cocoa, to their stocks over the duration of the programme...

- In addition to the specific agroforestry intervention we find that the majority of CCF farmers also received general training on this topic as part of the regular sustainability training curricula that partners implement.
- The agroforestry component and general training on this topic are expected to result in more tree planting and more diversified farms.
- We test this hypothesis by first analysing how many farmers engaged in tree planting and how many trees, including cocoa, are planted.
- Figure 25 shows the share of farmers by treatment that engaged in tree planting. We find that the share of CCF farmers doing this significantly larger in each season ($p<0.05$).
- In Figure 26 we illustrate how many trees are planted by each group as well as the cumulative tree stock added over 3 years. Also here the CCF farmers perform significantly better ($p<0.05$) and by 2020 the cumulative tree stock planted by CCF is a factor 1.9 higher than that of Non-CCF farmers.

Figure 25 Share of Farmers Planting Trees by Treatment and Season

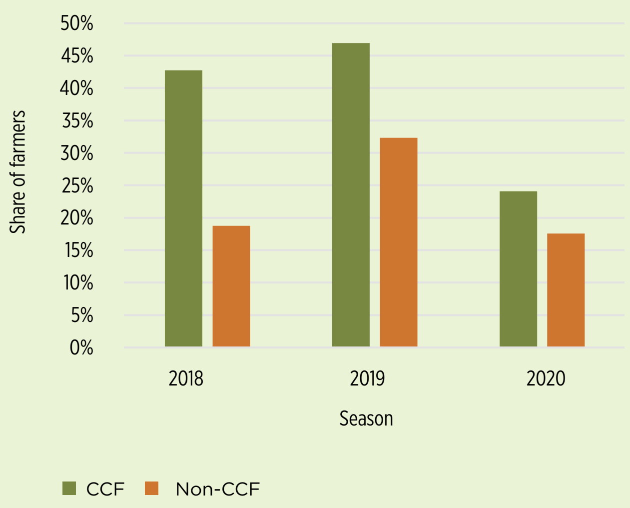


Figure 26 Number of Trees Planted and Cumulative Planting by Treatment and Season

...but the focus is nearly exclusively on the planting of cocoa. Non-cocoa trees make up less than 1% of the tree stocks added

- Breaking down the species planted in cocoa and non-cocoa trees reveals that nearly all planting was done with cocoa trees. Only in 2019 do we find some non-cocoa trees being planted (Fig 27).
- The number of non-cocoa trees is a factor 7.1 higher among the CCF farmers: 1,250 trees versus 175 trees among the Non-CCF farms, but as a percentage of all trees planted the amount is exceedingly small at less than 1%.
- The share of CCF farmers that planted non-cocoa trees is similarly small at 2.3% versus 0.7% for Non-CCF farmers. Another way of slicing this data is by looking at farmers who replanted with non-cocoa trees as a share of the farmers within each group who replanted. The rate then jumps to 5.4% for CCF farmers and 2.2% for Non-CCF farmers.
- We conclude that there is no shortage of interest to plant trees, and that the programme has had influence on this, but the impact is limited to the planting of cocoa. Apparently, farmers are not convinced of the need or desirability of planting non-cocoa trees on a meaningful scale.
- In 2018 the government of Cote d'Ivoire instituted a suspension of its cocoa seed plan in an effort to curtail continued planting of new cocoa. In the season that followed we find a significant reduction in the share of CRNA hybrids being planted (Fig 28), but we also find that farmers have resorted to increased direct seeding.

Figure 27 Number of Trees Planted by Species, Treatment and Season

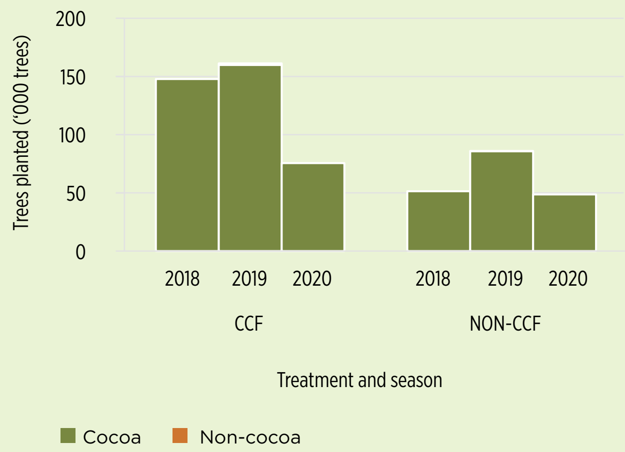
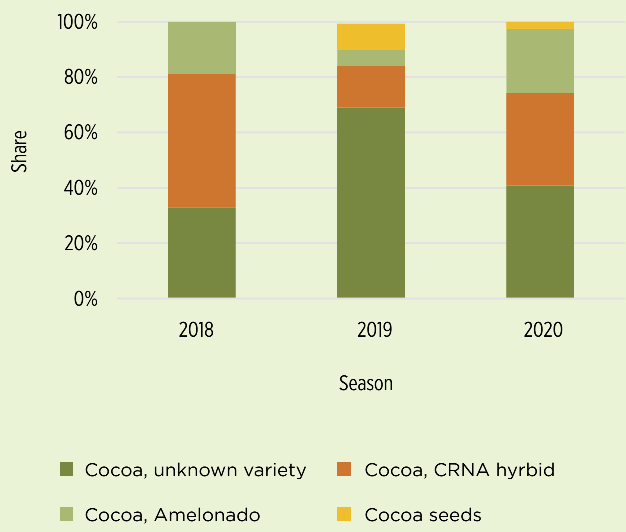


Figure 28 Break Down of Cocoa Varieties Planted by Season



05 Farm management

More active farmers are likelier to opt into programmes and we find that CCF farmers consistently invest more labour in their cocoa farms

- Total labour input per farm and per ha has declined significantly ($p<0.05$) within each group since 2018. Note that labour numbers in the first season may be over-estimated as varying degrees of recall bias were present resulting from not all partners being able to start FFB recording at the start of the season. This also explains a share of labour hours being in the unknown category in that season. Data for 2019 and 2020 are likely more reliable.
- We find that in each of the seasons the amount of labour invested by CCF farmers is significantly higher ($p<0.05$), both per farm (Fig 29) and per ha (Fig 30), but since this was the case from the start it seems probably that more active farmers display a greater probability to opt into a project, rather than project participation resulting in more labour invested.

Figure 29 Total Labour per Farm by Source, Treatment and Season

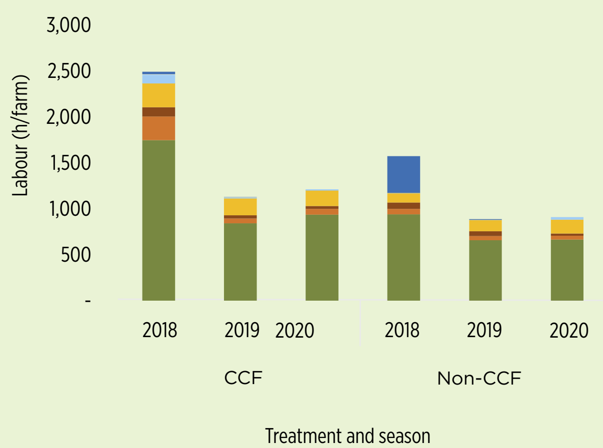
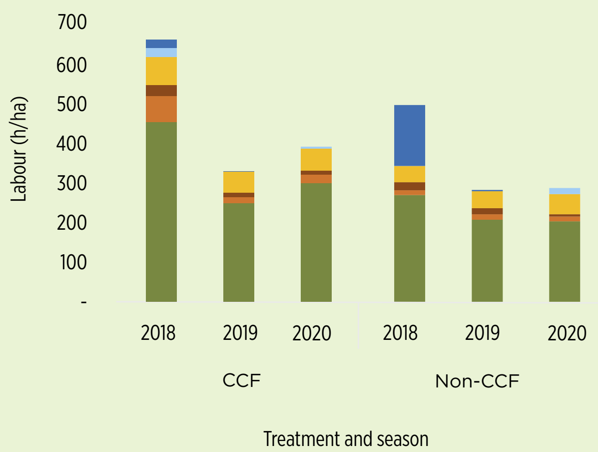


Figure 30 Total Labour per Ha by Source and Treatment and Season

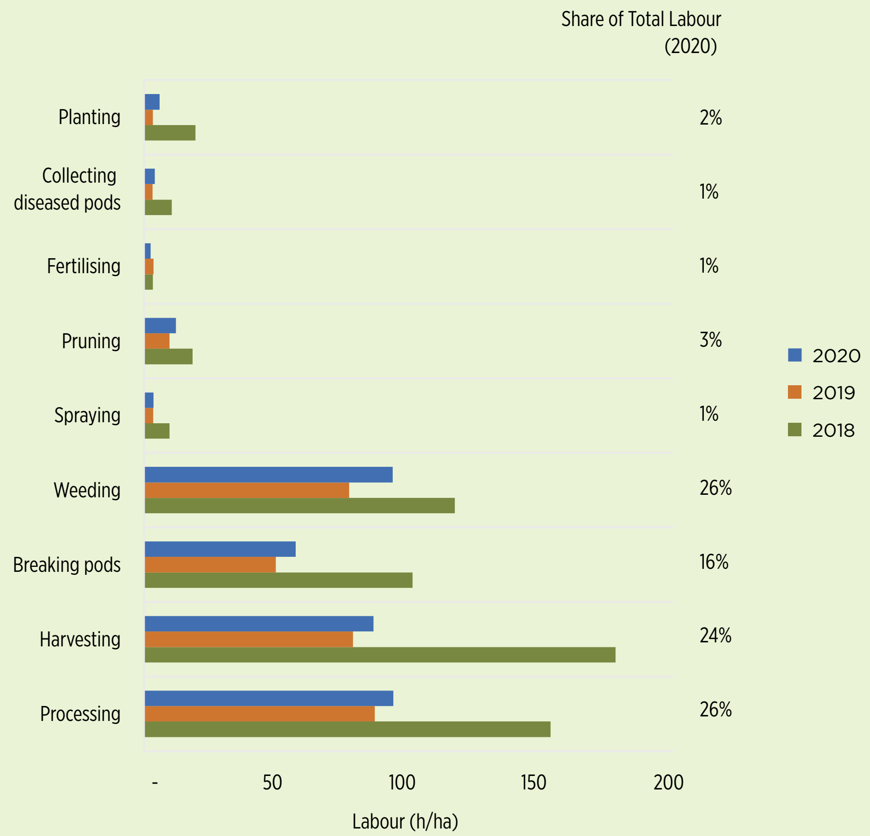


Household male | Household female | Household child | Hired male | Hired female | Unknown

Weeding, harvesting, pod breaking and processing make up 92% of total labour, indicating a high concentration of labour input around and shortly after the harvesting periods

- This figure shows the mean labour time per activity per hectare by season. We did not break this graph down by treatment as we find no significant differences between the groups on each activity individually.
- The vast majority of labour is used for harvesting, pod breaking and processing. Of the pre-harvest activities, only weeding is taking place on a large scale. This implies a high degree of seasonality in the labour cycle with peaks around the mid- and especially the main-crop period.
- Across all activities labour input has gone down since 2018. On most activities we see a slight uptick in labour use from 2019 to 2020, but none of the changes from 2019 to 2020 are significant ($p<0.05$).
- Given the situation around the covid pandemic, we expected to observe a decline in hired labour from 2019 to 2020, perhaps as a result of greater financial uncertainty and a concomitant hesitancy to pay for workers and/or farmers practicing distancing. This might then also be associated with an increase in family labour in 2020.
- Testing this, we find that the hypothesised decline in hired labour is not present but we do find a significant increase in household labour from 2019 to 2020 (both at $p<0.05$).

Figure 31 Labour Time per Ha by Selected Activities and Season



CCF farmers are investing significantly more pre-harvest labour in 2 out of 3 seasons. We find differences in the shares of farmers fertilising, pruning and collecting diseased pods

- Although we find no significant differences on individual activities between the CCF and Non-CCF group, the little insignificant differences start adding up and we find that CCF farmers invest significantly more pre-harvest labour than non-CCF farmers in 2018 and 2020 (Fig 32).
- This is relevant because if pre-harvest activities are done well enough and are combined with appropriate input application levels, they may shift the needle on yields, incomes and hence poverty. As such the labour of these pre-harvest activities constitute a proxy for application of Good Agricultural Practices.
- Another way to view this data is by looking at the share of farmers engaging in activities by treatment and season (Fig 33). A few things stand out: CCF farmers appear more likely to fertilise and the share of farmers pruning among the Non-CCF has caught up with the CCF group. On other activities the differences are less pronounced.

Figure 32 Box Plot of Pre-Harvest Labour by Treatment and Season

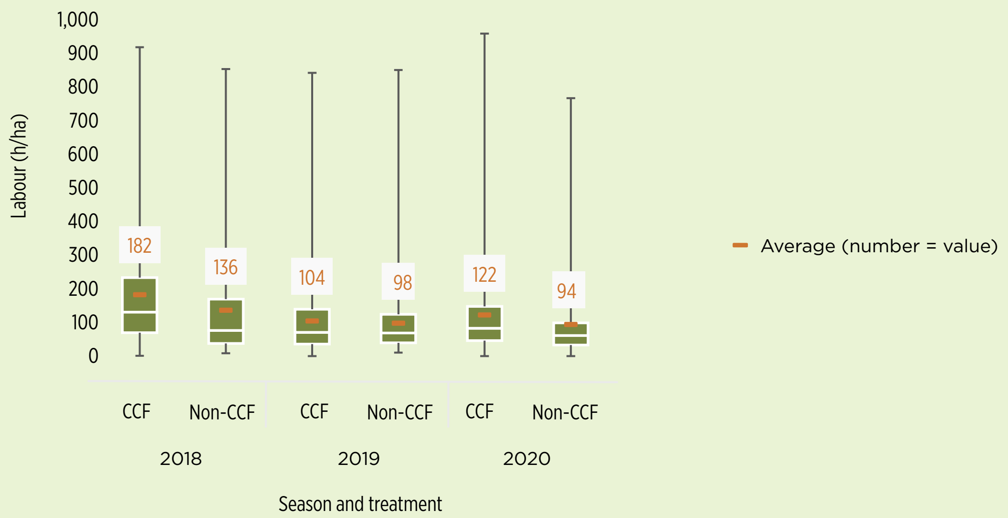
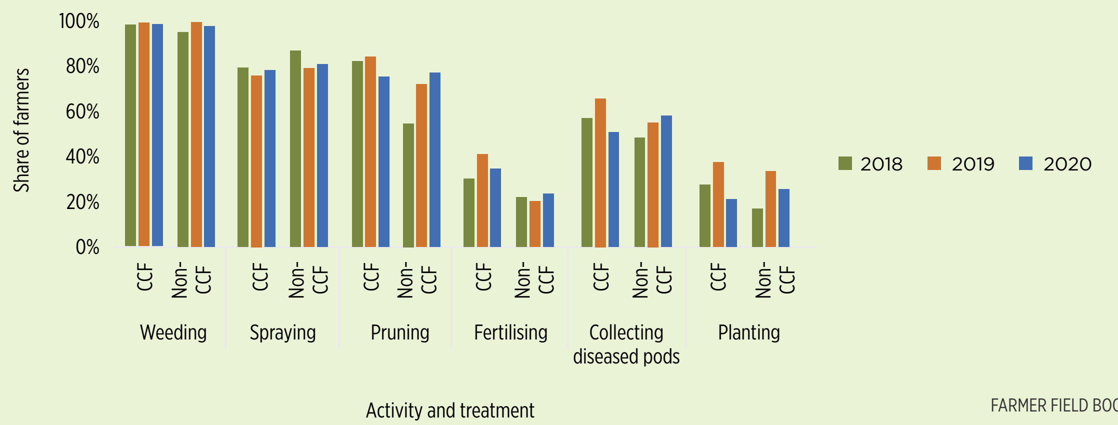


Figure 33 Share of Farmers Engaging in Activity by Treatment and Season



The greater share of CCF farmers fertilising can not be attributed to the CCF programme as such, but having access to credit does seem to be associated a greater probability to apply fertiliser

- To determine if CCF farmers have a greater probability to engage in GAP activities and that this is indeed due the CCF programme we apply a Diff-in-Diff analysis with PSM. The effect of the treatment, i.e. being part of the CCF programme, is change over time in the CCF group minus the change over time in the Non-CCF group, which is then checked for statistical significance.
- We analyse the share of farmers conducting activities that tend to be associated with obtaining higher yields (Kuit et al, 2019) *and* where we see up- or downward trends over time (Fig 34 to 36).
- The share of farmers fertilising among CCF farmers in 2020 remains significantly higher, as it was in 2018. The change over time among either group is not significant. Neither is the difference in change from 2018 to 2020 between the two groups. This means we conclude that being part of the CCF has not led a greater share of farmers fertilising. The difference-in-difference effects for pruning (Fig 35) and collecting diseased pods (Fig 36) are significant ($p<0.05$) and negative, indicating that the programme has not had an effect on the share of farmers in the CCF group conducting these activities, but that the improvement among the Non-CCF is positive and significant ($p<0.05$).

Figure 34 Share of Farmers Fertilising by Treatment and Season

Figure 35 Share of Farmers Pruning by Treatment and Season

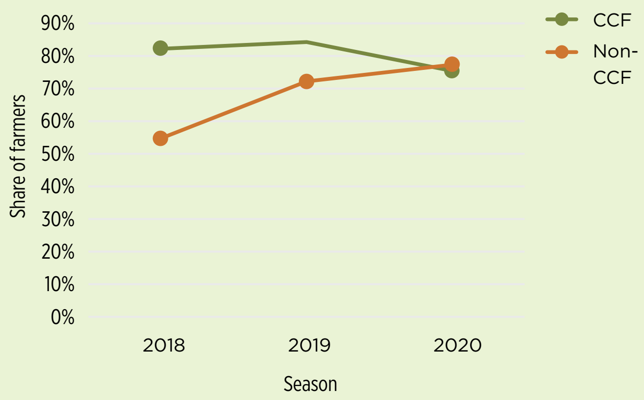
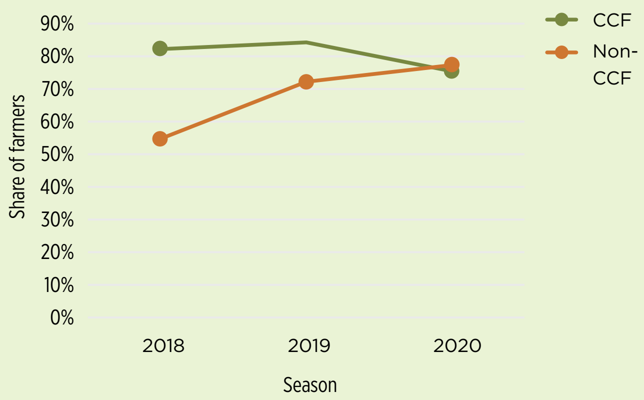


Figure 36 Share of Farmers Collecting Diseased Pods by Treatment and Season



Mean daily rate for hired labour is 3,292 XOF/day and increased by 6.5% per annum since 2018, more than 11 times the rate of inflation

- In 2020, 55% of farmers use hired labour for spraying pesticides, 52% of farmers hired labourers for weeding and 33% of farmers hired labour for breaking pods (Fig 37). For all other activities, only 13% of farmers or less hired labourers. None of these values changed significantly from 2018, nor do we find meaningful differences between the CCF and Non-CCF group.
- Note that the rate for spraying is pushed up by the use of spraying gangs, which are often paid a fixed amount that includes sprayer rental, fuel and pesticides. Activities such as pruning, where few farmers hire labour, can be subjected to large rate swings (Fig 37). Figure 38 shows a boxplot of weighted average daily rates by season, excluding the rates for spraying. In 2020, the rate came in at 3,292 XOF/day, up from 2,872 XOF/day in 2018.
- The Compound Annual Growth Rate (CAGR), the mean annual rate of change, of daily rates for hired labour excluding spraying comes in at 6.5% per annum from 2018 to 2020. Over the same timeframe the rates of inflation were 0.4%, -1.1% and 2.4% respectively (Worldbank, 2021), indicating that labour is becoming increasingly expensive at a rate of more than 11 times that of inflation(Fig 39)

Figure 37 Daily Rates for Hired Labour by Activity and Season

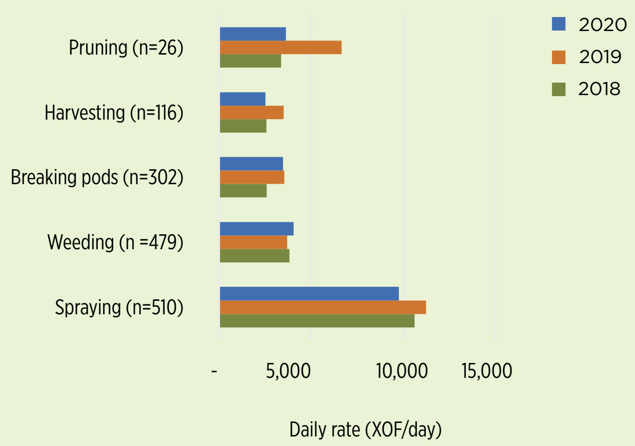


Figure 38 Box Plot of Daily Rates for Hired Labour by Season

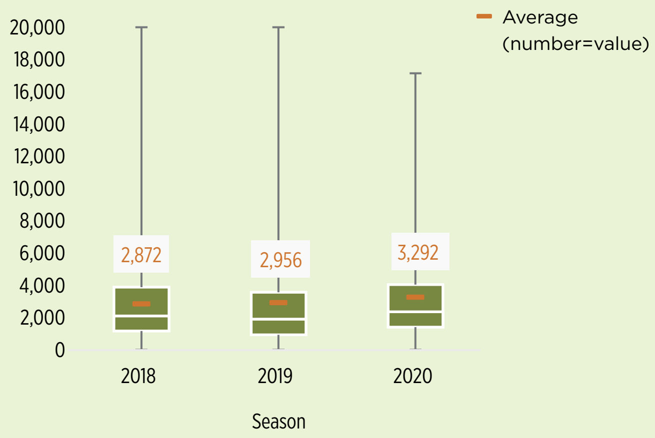


Figure 39 Daily Rate Change on Previous Season Versus Inflation by Season

Farmers respond to wage rate increase by reducing the use of hired labour and we observe an increase in labour productivity for harvesting

- We hypothesise that farmers can respond in a number of ways to try and cope with more costly hired labour: i) Fewer farmers could opt to use it, ii) Farmers could try and minimise the amount of hired labour used, or iii) Labour productivity might increase to offset the higher cost to some degree. We test each of these hypotheses.
- We do not see a significant ($p<0.05$) decline in the share of farmers using hired labour; neither across the sample nor by treatment (Fig 40).
- The reduction in hired labour time per ha from 2018 to 2020 is significant ($p<0.05$), so farmers do appear to respond to the labour cost pressure by minimising its use (Fig 41).
- As a proxy for labour productivity we take harvesting efficiency where we look at the amount of kg dry beans "harvested" per hour by season (Fig 42). If farmers respond to labour cost pressure, we might expect an increase in the harvesting efficiency. This is indeed the case: this increased significantly ($p<0.05$) year on year from 5.98 kg/h in 2018 to 7.82 kg/h in 2020.

Figure 40 Share of Farmers Using Hired Labour by Treatment and Season

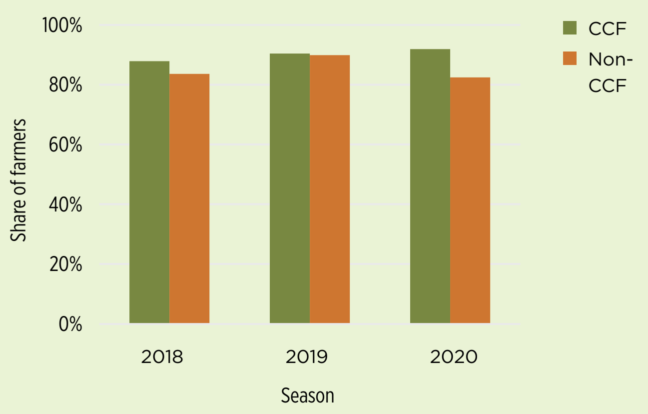
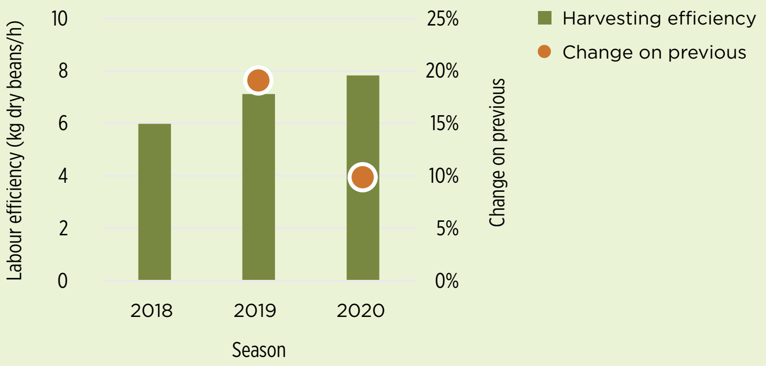


Figure 41 Hired Labour by Gender and Season

Figure 42 Harvesting Labour Efficiency and Change on Previous Season by Season



More costly hired labour could also be associated with more use of child labour, but this is not the case. Across the sample we see a significant reduction in the amount of time worked by children

- Mean working time from children under 16 years of age per farm across all farms is trending downwards from 82 h/farm in 2018 to 30 h/farm in 2020, a significant reduction ($p<0.05$; Fig 43). Among the CCF and Non-CCF group we observe similar trends in the amount of time children spent working on farms, but only among the Non-CCF group is the decline significant ($p<0.05$).
- The share of farms where children work is mostly stable, with no significant change over time among either group.
- A distinction is made in the sector between child labour and child work. The first is when children perform heavy or hazardous tasks, possibly during school hours. The latter is when activities are light duty and not hazardous and do not take place during school hours. There is no hard distinction between hazardous and non-hazardous activities. Much depends on how an activity is conducted by a child and which, if any, tools are used. This information we do not have and can therefore not make an uncontentious distinction between child work and child labour. Still, we think activities like breaking pods, harvesting, weeding and spraying have a higher hazard potential than other activities, hence the distinction in Figure 44.
- The allocation of child work to activities is similar between the CCF and Non-CCF groups, so we make no distinction between the two in Figure 43.
- There is a strong geographical aspect to the occurrence of children working on farms. Problem areas identified in 2018 have been remediated, while in 2020 we find more, but lower intensity hot spots (map on next page).

Figure 43 Child Work Incidence and Working Time per Farm by Treatment and Season

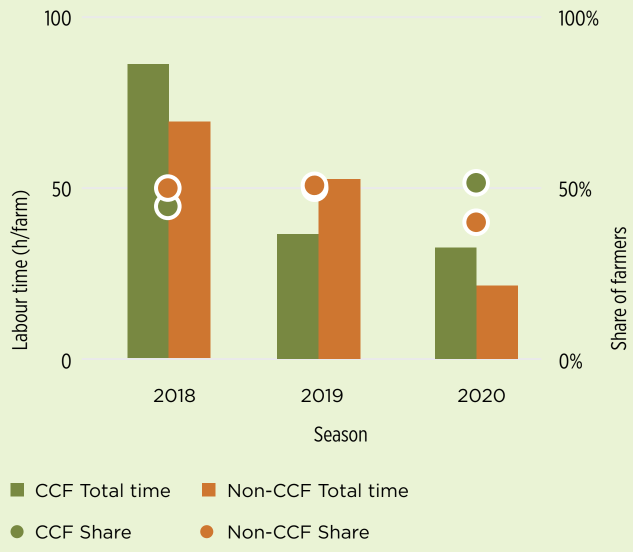
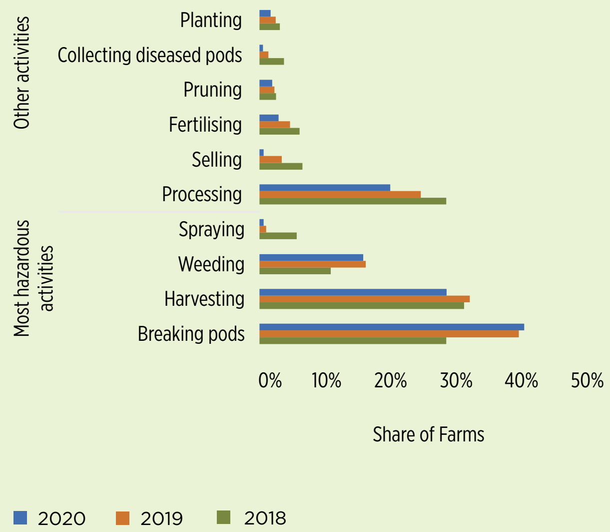
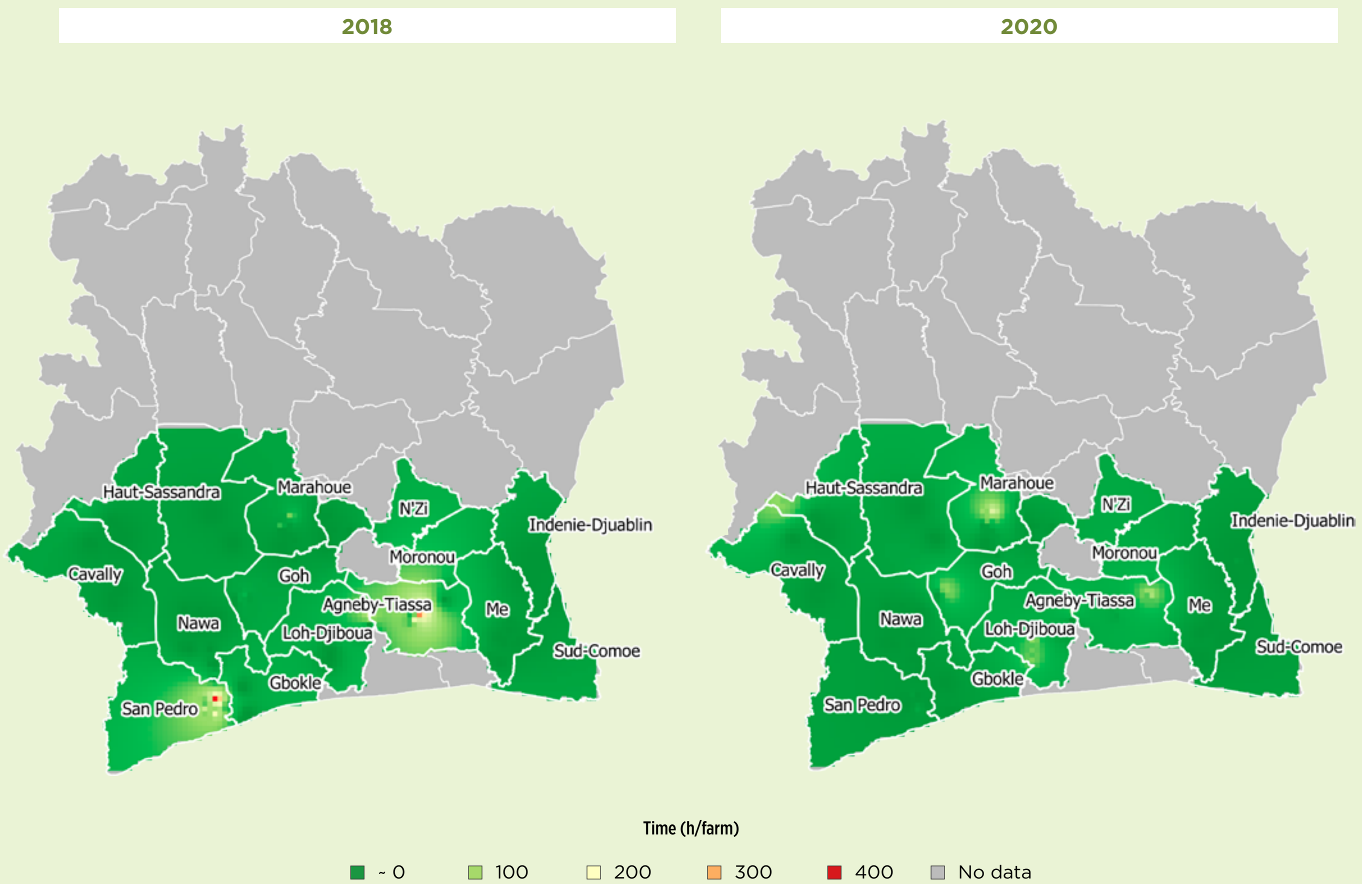


Figure 44 Child Work Incidence by Activity, Type of Activity and Season



Child work in 2 major hotspots (San Pedro and Agneby-Tiassa) has declined since 2018, but occurrence is more widely distributed in 2020 with 5 hotspots of lower intensity

Figure 45 Child working time per farm in 2018 and 2020



Modelling child work occurence shows significant positive effect of Child Labour Monitoring visits

- While a Diff-in-Diff analysis of the amount of hours worked by children over the CCF and Non-CCF groups allows us to attribute the change since 2018 to the programme, it may well be that specific activities geared towards child labour reduction are more effectful.
- The main such intervention is the Child Labour Monitoring and Remediation programme (CLMR) that all partners have worked on to varying degrees.
- We explore this by building a regression model with the amount of time spent working in farm by children over the past 3 seasons as the dependent variable while controlling for season, region, cocoa area, yield, gender, CLMR training and CLMR visits.
- This analysis confirms the reduction in child work over the time. It also reaffirms findings from the baseline report that larger cocoa areas and higher yields are both associated with more time being spent working by children.
- Also the regional concentration of child work hot spots from the previous page is confirmed as being signficant (p<0.05).
- Interestingly, we find no effect of the CLMR training, but the CLMR visits are strongly correlated with children spending less time working. Apparently, training in and off itself is not enough.
- The CLMR visits are often carried out on a community basis and indeed we find that receiving such visits is not limited to the CCF group. Field officers are typically instructed to address any farmer they meet whom they see with children working on his/her farm. Of the 380 farmers who indicate to have received such a visit, just over 8% are part of the Non-CCF group.
- The above point may seem to suggest that CCF participation should be associated with lower child work incidence or child wokring time. This is not the case, because while the CLRM visit approach ahs this effect, it was a minority of CCF farmers who received such a visit.
- Irrespective of the CCF or Non-CCF group a farmer belongs to, having received a CMLR visit is associzated with a 14 h/farm reduction in the working time spent by children.

Nutrient management continues to be an issue and is very likely a key limiting factor in raising yields and reducing poverty. CCF farmers are more likely to use N but this can not be attributed to the programme

- The nutrient balances are calculated by subtracting the amounts of nitrogen (N), phosphorus (P) and potassium (K) contained in the cocoa beans harvested from the volume N, P and K applied through fertilisers, compost and manure. This calculation does not take into account efficiency of uptake, availability to the tree, in-flow from sources such as rainfall deposition and losses from leaching.
- According to van Vliet (2017) a kg of dry cocoa beans contains 3.4% of N, 0.6% of P and 5.4% K. In other words, a Mt of dry cocoa beans removes 34 kg of N. To maintain soil fertility and yields such outflows need to be offset by sufficient applications of manure, compost or fertiliser. N can enter the farm through deposition and the decomposition of litter fall or be recycled through decomposition of cocoa pods, but to maintain higher yield levels additional N applications are needed.
- Figure 46 shows that N applications across the sample are far smaller than the rate at which N is removed through harvested products (N extraction) and consequently, the N balance is consistently negative.
- In each of the seasons we find that a significantly larger share of CCF farmers apply N compared to Non-CCF farmers. We also find that a significantly greater share of CCF is applying N in 2020 than in 2018, while this is not the case for the Non-CCF farmers (Fig 47).
- However, a Diff-in-Diff analysis of CFF versus Non-CCF farmers on both the volume of N applied per ha of those farmers who apply N and the share of farmers in each group that apply N shows no causal effect on either of the programme ($p<0.05$).

Figure 46 Nutrient Management per Ha by Season - Nitrogen

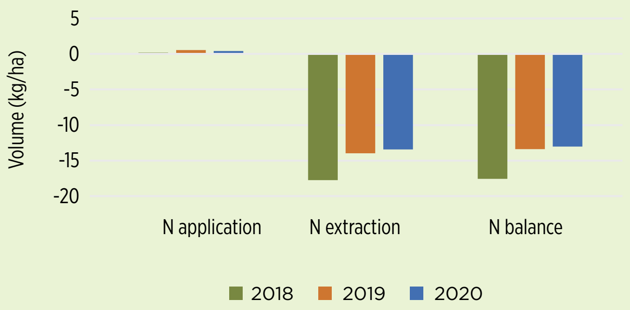
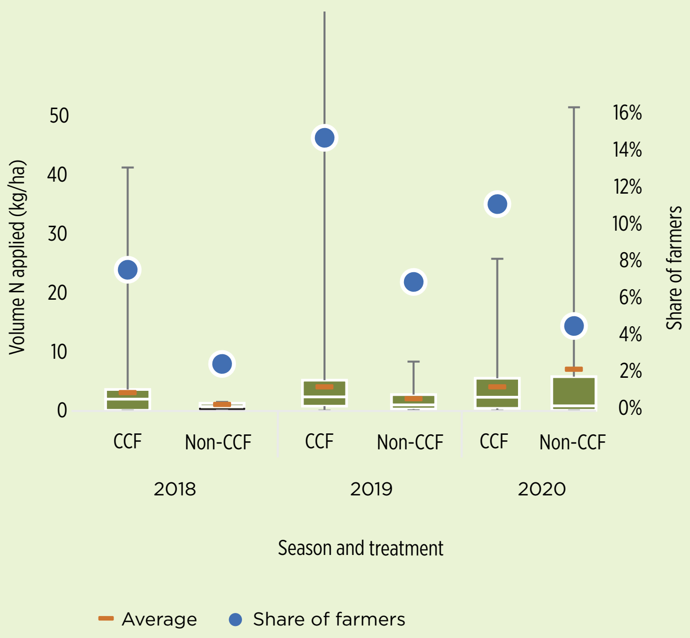


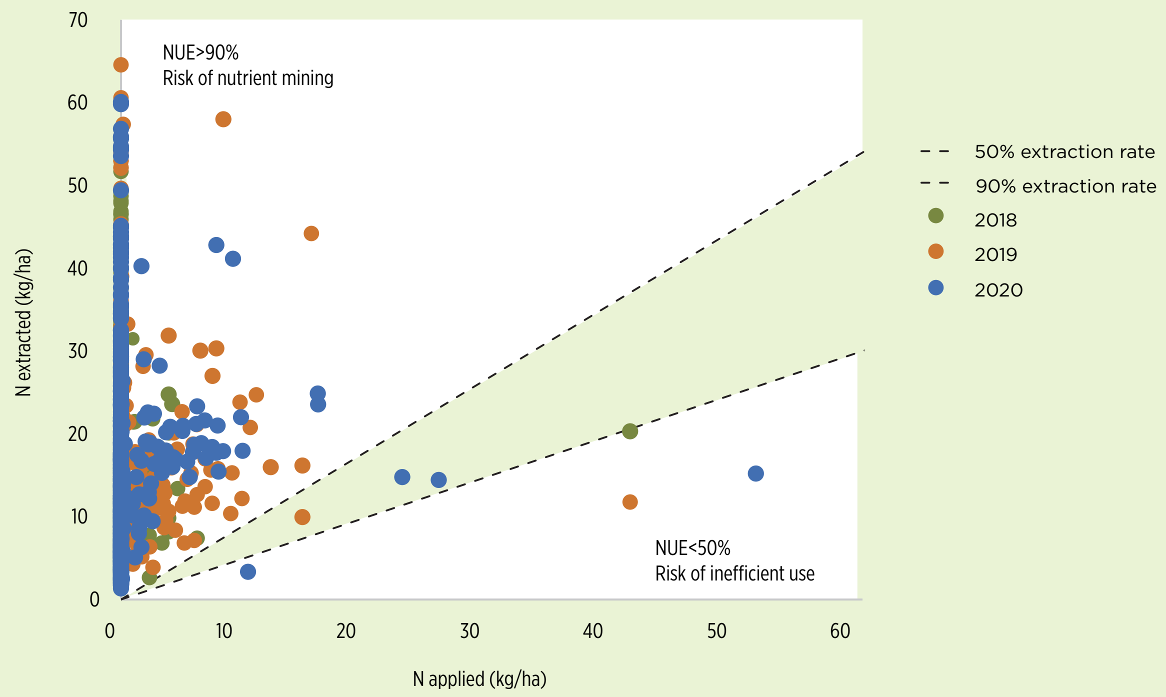
Figure 47 Box plot of Nitrogen Application and Share of Farmers Using Nitrogen by Treatment and Season



Farmers that do apply N do not yet do so in sufficiently large quantities. They remain at risk of lowering their soil fertility, albeit less so than those who do not apply N

- Nitrogen use efficiency (NUE) can also be calculated as the percentage of applied nitrogen that is removed during the harvest.
- In the graph below:
  - The x-axis shows the amount of nitrogen applied through fertilisers, manure and compost;
  - The y-axis shows the amount of nitrogen removed through the sales of cocoa beans;
  - For all points on the line 'NUE=90%' nitrogen removal through harvest is 90% of the amount of nitrogen applied through fertilisation;
  - For all points on the line 'NUE=50%' nitrogen removal through harvest is 50% of the amount of nitrogen applied through fertilisation;
  - Farmers above the NUE=90% line are removing more nitrogen from their field than they apply and run a risk of mining (depleting) their soil with a risk of lowering soil fertility in the mid-term.
  - Farmers below the NUE=50% line are using the nitrogen fertilisers inefficiently. This results in an increased risk of eutrophication of ground and surface water and also depresses farmers' profit margins.
- The wedge between NUE=90% and NUE=50% is a hypothetical optimal range which for now is based on values from the EU (EUNEP, 2015).
- The figure shows that very few of the farmers are within the hypothesised optimal nitrogen application range. Virtually all farmers (even those who apply nitrogen) are in the range "Risk of nutrient mining" and thus depleting the nitrogen stocks in their soils. It is recommended that farmers increase nitrogen fertilizer use.

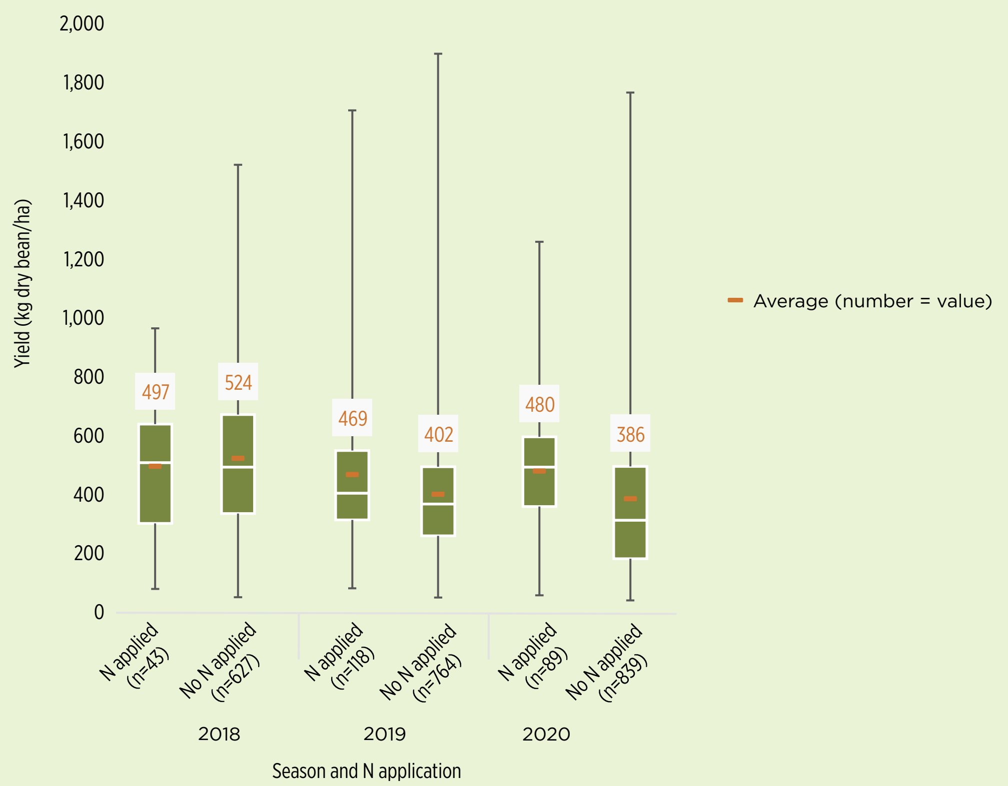
Figure 48 Nitrogen Use Efficiency by Farmer and Season



Farmers who apply N tend to obtain higher yields. Access to CCF related credit has resulted in greater fertiliser investment, suggesting that messaging on which fertilisers to use may neglect the importance of N

- In the absence of CCF programme effects on N management, we then dig deeper to determine if individual aspects of the CCF programme do show influence on the share of farmers using N and the volume applied. We identify 5 interventions farmers may have received that can influence this: i) any productivity package, ii) a productivity package with fertiliser, iii) GAP training, iv) FDP/FBP, v) coaching visit, and vi) a CCF-related credit.
- We performed a Diff-in-Diff analysis on both the share of farmers applying N in each group and the volume of N applied in relation to these six interventions. We find no significant effect on N management for any of the interventions.
- We have not reviewed the content of each intervention as farmers receive them in detail, but given the absence of any effect on N management it may well be that this topic is not or insufficiently covered in the interventions that may affect fertiliser use. This thought is reinforced by the fact that a regression model on fertiliser cost per ha does show a positive association with the CCF intervention and can be attributed to receiving credit (see page 72).
- This matters, as we find that in the 2019 and 2020 seasons farmers who apply N, even though we saw on page 47 that the volumes are generally not sufficient, do have significantly higher yields ($p<0.05$) than those that do not apply any N and rely solely on natural inflows from deposition and decomposition of organic materials.

Figure 49 Yield by N Applied or Not and Season



Mean P applications are well-aligned with extraction rates. Significantly more CCF farmers are applying P in each season. P application is enhanced by Productivity Packages and CCF related credit

- Figure 50 shows that P applications on average across the sample are pretty much in line with the extraction rates. Still, depending on the season, 60% to 70% of farmers don't apply any fertiliser, so locally P could be a limiting factor for yield and conversely, farmers that do apply P are likely to apply more than is needed.
- In Figure 51 we plot the P application levels by CCF and Non-CCF group of those farmers who apply P. We find no significant difference between the groups in the level of application. Mean application values range from 6 to 9 kg/ha and have not changed significantly over time, neither within each group, nor across the sample as a whole.
- We find that in each season the share of farmers in the CCF group that apply P is significantly larger ($p<0.05$): 33% versus 22% in 2018 and 28% versus 20% in 2020.
- The difference in change over time between the groups is however not significant. We can therefore not attribute the seasonal difference to the CCF programme.
- As with the analysis on N application, we hypothesise that the six interventions that are intended, at least in part, to influence nutrient management may show a stronger influence than the programme as a whole. Indeed some of them do. We find a strong positive effect of productivity packages and having access to a CCF-related credit (both at $p<0.05$). Oddly, the effect of coaching is also significant, but negative; i.e. farmers who received coaching show a significant decline in their P applications. Perhaps the coaching calls for reallocation of investments, perhaps towards rejuvenation. A Diff-in-Diff on (re-) planting labour by coaching does show a quadrupling of labour for planting trees among the treated group, while among the control (i.e. those without coaching) this went down by half.

Figure 50 Nutrient Management per Ha by Season - Phosphorus

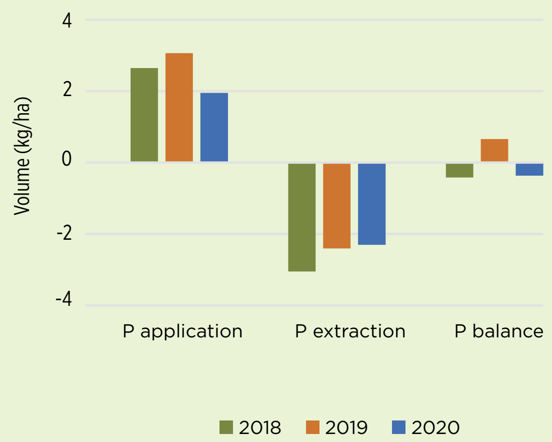
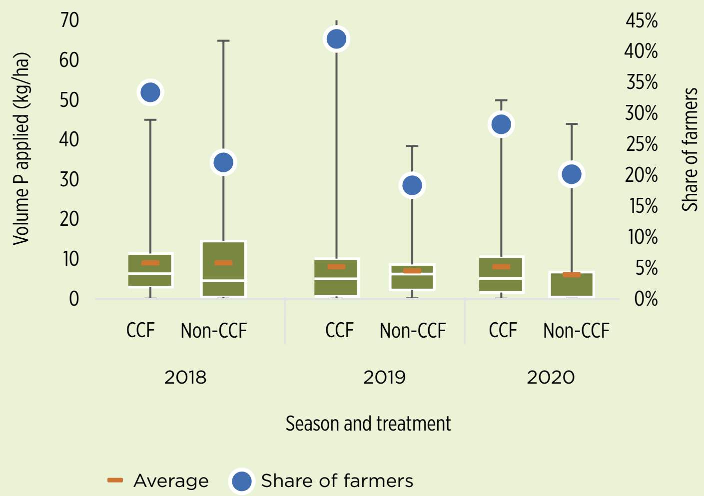


Figure 51 Box plot of Phosphorus Application and Share of Farmers Using Phosphorus by Treatment and Season



Similar to P applications, we find positive causal effects of Productivity Packages and CCF related credit. Despite this, K extraction far exceeds the rates of application

- Farmers who apply P also apply K and do so through fertilizers that contain both in fixed ratios, primarily SuperCao and NPK 0-23-19. while called an NPK fertiliser locally, the ratio of 0-23-19 indicates that this fertiliser does not contain any N.
- Given that composite fertilisers with only P and K are used most frequently (see also next page), it is not surprising that the share of farmers applying K is identical to the share of farmers applying P.
- Application rates have not moved significantly in either direction, neither for the sample as a whole, nor for the CCF and Non-CCF group individually.
- The effects of specific interventions around credit, coaching and productivity packages logically also show the same patterns as we found in relation to the application of P.
- Given that K is extracted in far larger quantities than P (5.4% versus 0.6%), and that the rates in which P and K are present in the most frequently used fertilisers are close (23% versus 19%), the implication of the close to optimal mean P application levels we observed is that K applications are falling far short of what is removed.

Figure 52 Nutrient Management per Ha - Potassium

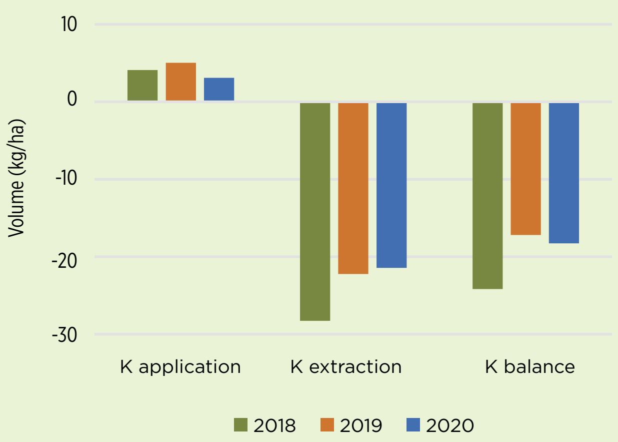
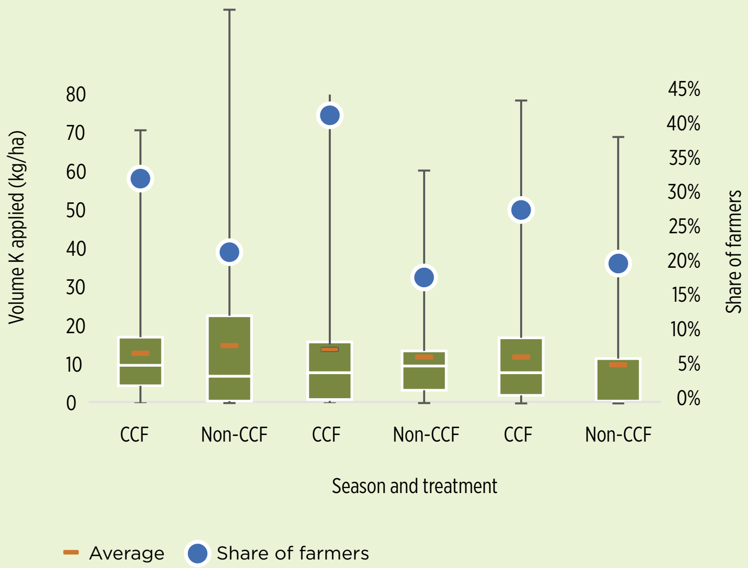


Figure 53 Box plot of Potassium Application and Share of Farmers Using Potassium by Treatment and Season



The bulk of the market is captured by products heavy in P and K. N-based fertilisers never make up more than 3% of the volume applied by farmers in the sample contravening the manufacturers recommendations

- As could be inferred from the previous pages on nutrient management, the share of farmers applying fertiliser has dropped in 2020, after an increase from 2018 to 2019 (Fig 54), but there are some regions where investment in fertiliser increased (see next page). As access to CCF-related credit showed a causal relation with applying P and K fertilisers the dip in application levels may in part be explained by reduced access to credit in 2020. By the end of the 2019 season, 40% of farmers indicated they had not yet repaid the loans they received for that season, which in turn may have hampered their access to renewed loans in 2020.
- Our earlier analysis of the skewness of nutrients applied towards P and K products is confirmed by a analysing the market share of fertilisers used. In 2018, 80% of the total volume of fertiliser applied was in the form of NPK 0-23-19 and SuperCao, the latter is essentially the same as the former but includes a small amount of magnesium oxide. The manufacturer (Yara) recommends to apply a combination of SuperCao and Nitrabor for optimal nutrition, but as we can observe from the Nitrabor market share, this rarely happens (Fig 55).

Figure 54 Fertiliser Application Rate and Share of Farmers Fertilising by Fertiliser Type and Season

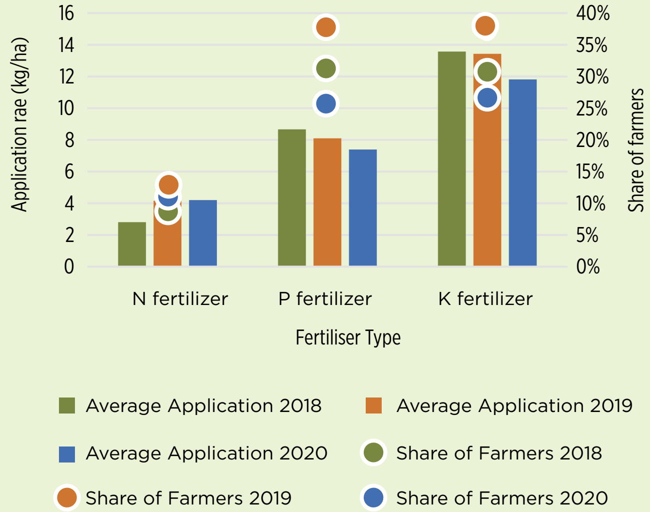
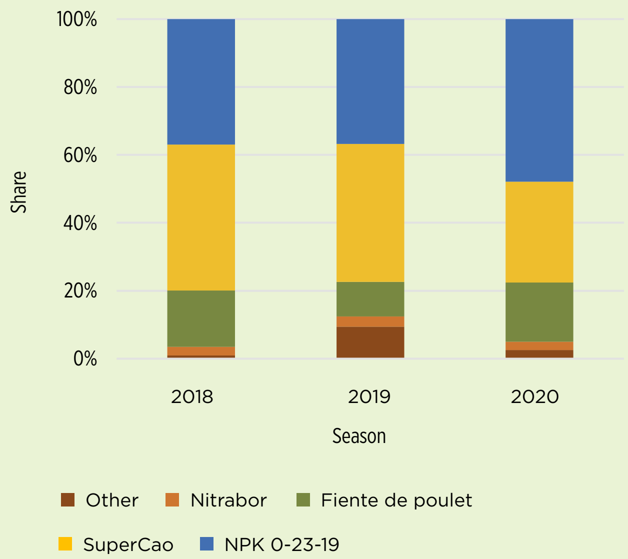
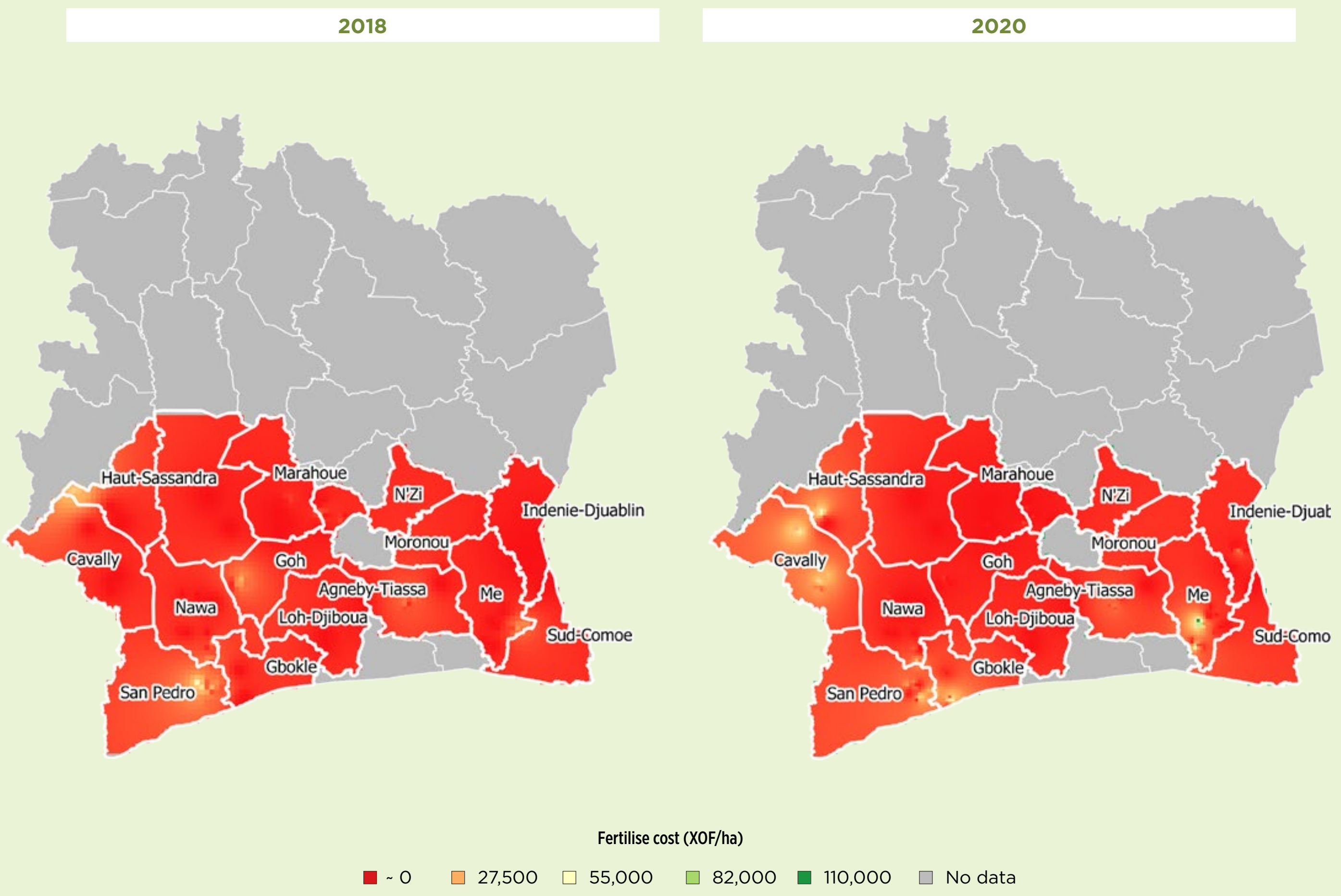


Figure 55 Fertiliser Market Share by Top-4 Most Used Fertiliser and Season



Fertiliser investment picked up since 2018 in Cavally, Me and Gbokle, with Cavally and Me in particular seeing relatively wide-spread uptake

Figure 56 Fertiliser cost in XOF/ha by region in 2018 and 2020



The vast majority of farmers are spraying pesticides with insecticides being used by most. The use of PAN HHPs has gone significantly. We find some use of Endosulfan, a product banned in Cote d'Ivoire

- Between 76% and 87% of farmers spray pesticides, depending on the year and the group to which they belong (Fig 57). We find no significant difference, either within seasons, over time or over time between the groups (Diff-in-Diff).
- Figures 57 plots the share of farmers using types of pesticides. As farmers can use more than one type, the totals of the stacked column exceed the rates of farmers who spray. Insecticides are most frequently used by 74% to 78% of farmers. Fungicdes are second, but their popularity has declined with just 10% of farmers using them, down from 17%. Herbicide use is very rare.
- Insecticides tend to be highly toxic. Their widespread use explains the fact that the share of farmers using Highly Hazardous Pesticides (HHPs) and defined by the Pesticide Action Network (PAN) is very high. On this list are active ingredients such as Bifenthrin, Thiomethoxam and Imidacloprid which are the predominant active ingredients of the insecticides farmers use.
- Unfortunately, we find some use of banned products too. Endosulfan is used by a small group of farmers who make up less than 1% of the sample, despite it being banned in Cote d'Ivoire since 2004 (UNEP). This occurs on both Rainforest Alliance certified and non-certified farms.

Figure 57 Share of Farmers Spraying Pesticides by Treatment and Season

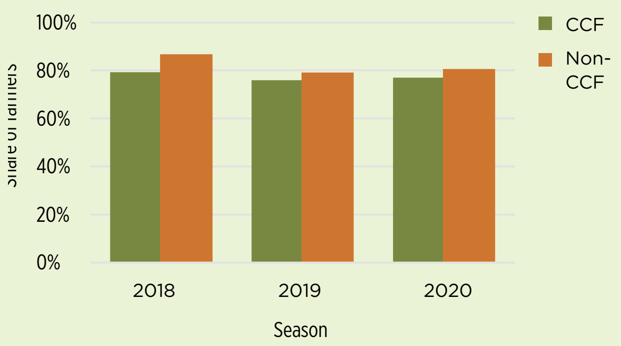
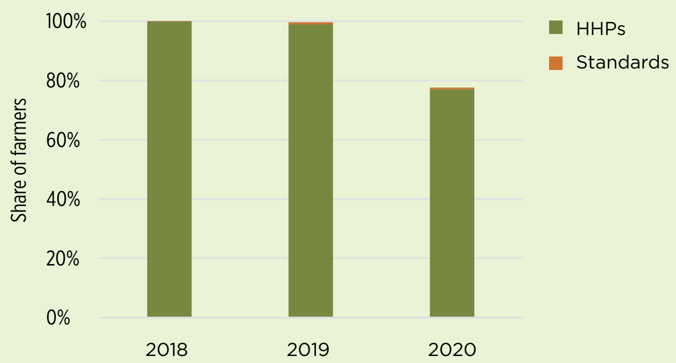


Figure 58 Share of Farmers Using Pesticides by Type and Season

Figure 59 Share of Farmers Using PAN HHPs and Pesticides Banned by Standards by Season



CCF farmers invest more labour in collecting diseased pods as a result of the programme. This matters as yields tend to be higher on farms where diseased pods are collected

- Besides spraying pesticides another way to control pests and diseases is to timely remove diseased pods in an effort to limit the spread of, in particular, black pod disease. Given that black pod disease is caused by the fungus *Phytophthora palmivora* and the observation that relatively few farmers use fungicides, the collecting and destruction of diseased pods is an important intervention to limit yield losses.
- We find no effect of the CCF programme on the share of farmers conducting this activity (Fig 60), but we do find that the decline in labour hours for this activity is stronger among the Non-CCF group. The Diff-in-Diff analysis confirms that this is a significant effect ($p<0.05$), indicating that as a result of the programme CCF farmers are more likely to invest a greater number of hours to the collection of diseased pods. Admittedly, the real world differences are not overwhelming, but allocating time to this activity does matter. Figure 62 plots the seasonal yields for farmers who do and do not collect diseased pods and in two out of three seasons the yields on farms where diseased pods are collected are significantly higher ($p<0.05$).

Figure 60 Box plot of Collecting Diseased Pods Labour and Share of Farmers Collecting Pods by Treatment and Season

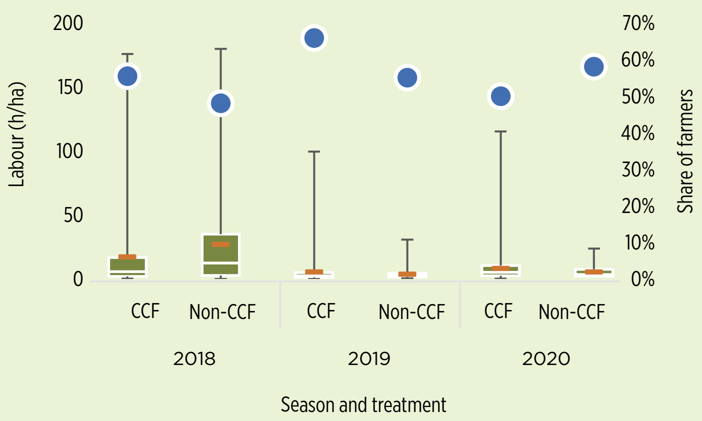


Figure 61 Collecting Diseased Pods Labour by Treatment and Season

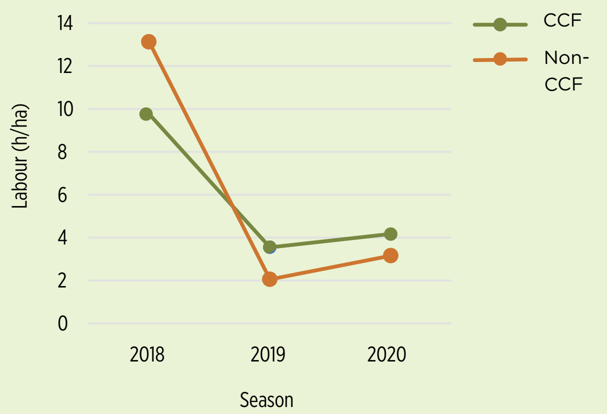


Figure 62 Yield by Farmers Who Collect Diseased Pods and Who Don't and Season

06 Yield and Production

Developments in yield have been negative year on year. Consequently, just 11% of farmers meet or exceed the Cocoa Action yield target, down from 23% in 2018

- Skewness and kurtosis values of the yield variable indicate that yield data is not normally distributed. In all seasons we find a tail of higher yields. For this reason we test how the seasonal median yield values compare to one another. We find that median yields have declined significantly year on year from 498 kg/ha in 2018 to 373 kg/ha in 2019 and 331 kg/ha in 2020 (Fig 62).
- Consequently, the share of farmers who meet or exceed the Cocoa Action yield target of 700 kg/ha has dropped as well. In 2018, 23% of farmers met the target, only for it to drop in 2019 to 7%. The situation improved somewhat in 2020 when 11% of farmers achieved 700 kg/ha or more (Fig 63).
- Production by treatment shows that among the CCF farmers production levels dropped significantly ($p<0.05$) and by 44% from 2018 to 2020 (Fig 64), about a third of the drop can be explained by the inflow of new farmers into the group who have smaller farms.

Figure 62 Box Plot of Yield by Season

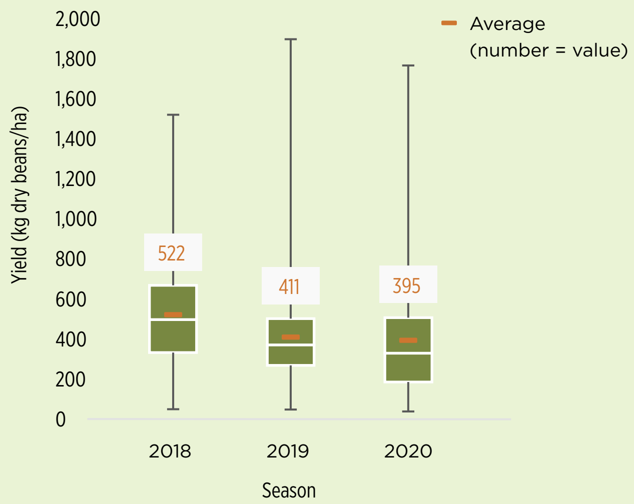


Figure 63 Yield by Farmer's Percentile Rank of Yield and Season

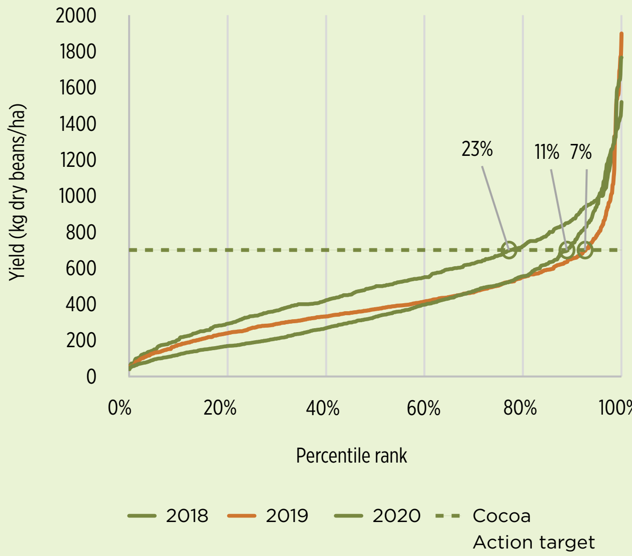
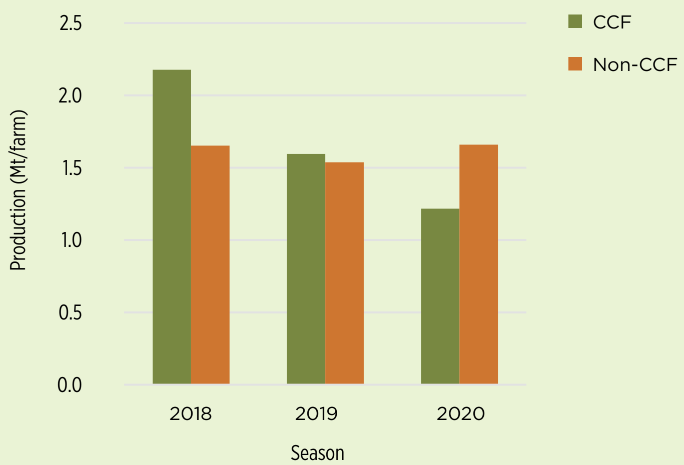


Figure 64 Production by Treatment and Season



Figures for 2020, despite being lower than in previous seasons are likely to be correct and not affected by stockpiling of cocoa

- The decline in yield raises the question if yield records are accurate. Production records, and therefore calculated yields in the FFB are based on the sales that farmers have reported. It is only at the point of sale that beans are weighed, so this tends to give the most accurate record of production. We emphasise to data collectors that we are not interested in whom the beans are sold to in order to avoid under-reporting in situations where farmers side-sell.
- We typically see that farmers tend to sell their cocoa quickly after it is processed and dried. In the 2020 season there were reports of cocoa stockpiling at farms, cooperatives and in ports amounting to about a third of the crop[1]. It is unknown to us what share of this one third is remaining at farms, but this situation could result in an under-estimation of yields in this season.
- If the yield values are indeed affected, then we would expect the relationship between harvesting labour and yield to have a much lower coefficient that in previous seasons.
- We plot the relation between harvesting labour and yield for each season and add a trendline that is set to cross at x=0 and y=0 (i.e. zero harvesting labour = zero yield). We find that the coefficient in 2020 has never been higher. With each hour of harvesting labour corresponding to 5.21 kg of dry beans harvested. Subsequent checks on relationships between labour for pod breaking and drying show similar consistency between hours worked and yields reported.
- We therefore conclude that current yield figures are very unlikely to be under-estimations.

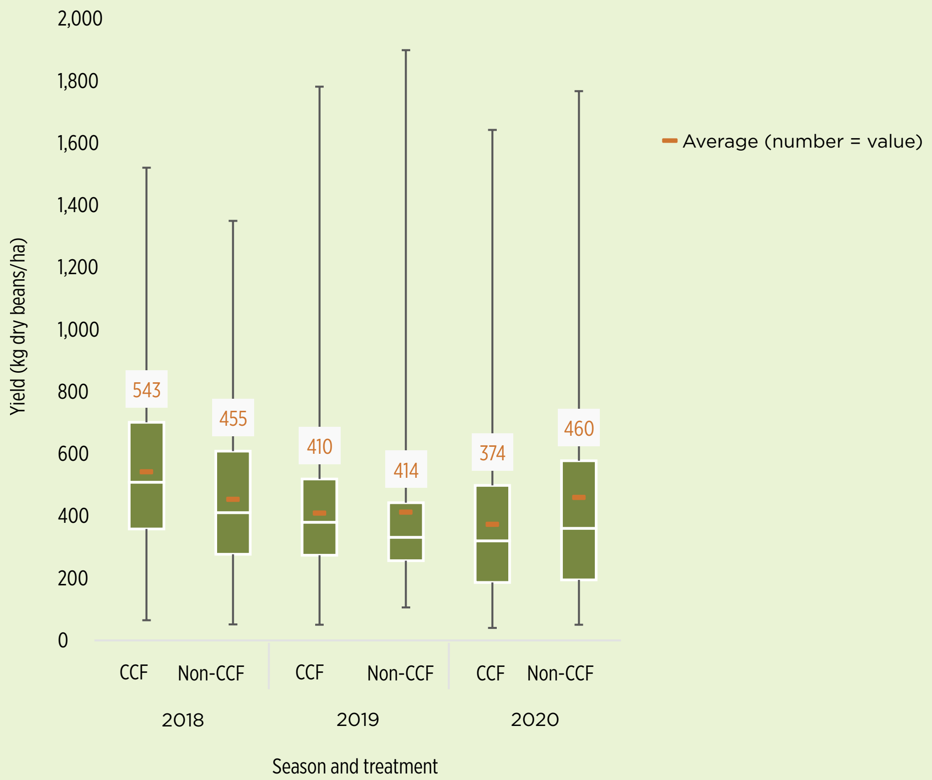
1 https://www.reuters.com/article/uk-ivorycoast-cocoa-stocks-idUSKBN29I0PV

Figure 65 Harvesting Labour versus Yield by Season

Yields have declined significantly among the CCF group of farmers. All but one of the interventions that took place under the programme show this pattern

- As noted in the baseline report, CCF farmers started out with higher yields than farmers in the control group. Over time yields have declined significantly ($p<0.05$) among the CCF group. Median yields in 2020 were lower than in 2019 and 2019 yields in turn were lower than in 2018.
- Among the Non-CCF group we do not see this pattern. There yields have not moved significantly ($p<0.05$) in either direction over time.
- As a result, the Diff-in-Diff analysis identifies a significant negative effect of the CCF programme on yield.
- It may still be that specific interventions under the CCF programme that can be expected to have a more direct effect on yields show a different pattern. We assessed the effects of having any productivity package, a fertiliser productivity package, credit, FDP/FBP, coaching and GAP training. The Diff-in-Diff analyses for each of these indicates significant negative effects ($p<0.05$) of all interventions, except GAP training, where no effect is found.
- We concluded earlier that nutrient management is biased towards P and K applications. When we slice the sample based on N applications (yes or no) and perform a Diff-in-Diff analysis we find a significant positive effect ($p<0.05$) on yield (see figure on next page).

Figure 66 Box Plot of Yield by Treatment and Season



We think that intervention design or implementation may play a role in the limited effects on yield of interventions. Farmers who followed a fertiliser strategy that includes N applications do show significantly higher yields

- The Diff-in-Diff analysis of farmers who invested in N applications show a significant positive effect (p<0.05) on yield of +120 kg/ha from 2018 to 2020 (Fig 67).
- What this tells us is that the theory behind the programme, i.e. better access to credit, technical support and inputs can have a positive effect on yield and consequently on poverty, may well be valid. But given that we find negative effects on all but one of the six interventions we analysed, it appears to us that intervention design or implementation may not work as intended. Either farmers have not received adequate decision-making support on what to invest in, and specifically around choosing which fertilisers to apply, or they did receive such information but are for various reasons unwilling or unable to effectuate such a change in management.
- This is reinforced when we analyse yield development between farmers who used fertiliser (of any type) and those that did not. Tellingly, we find no significant effect (p<0.05) of using just any fertiliser (Fig 68).

Figure 67 Yield by Use of N and Season

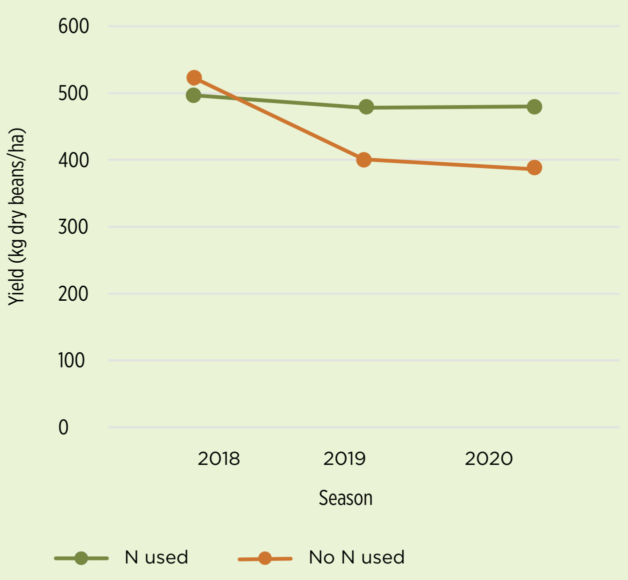
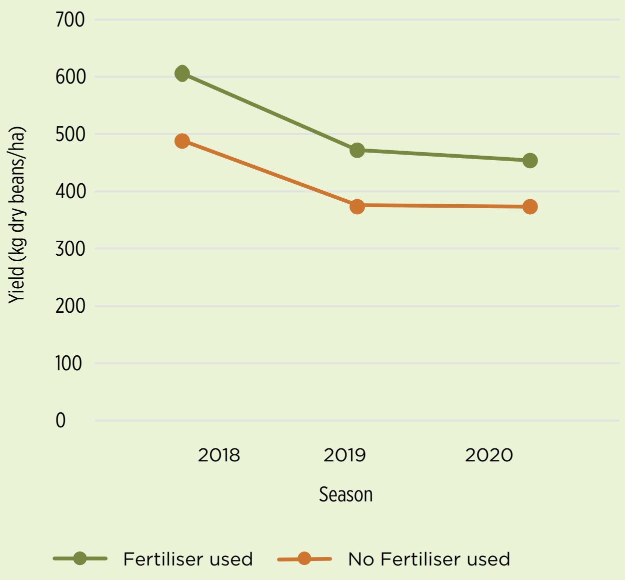
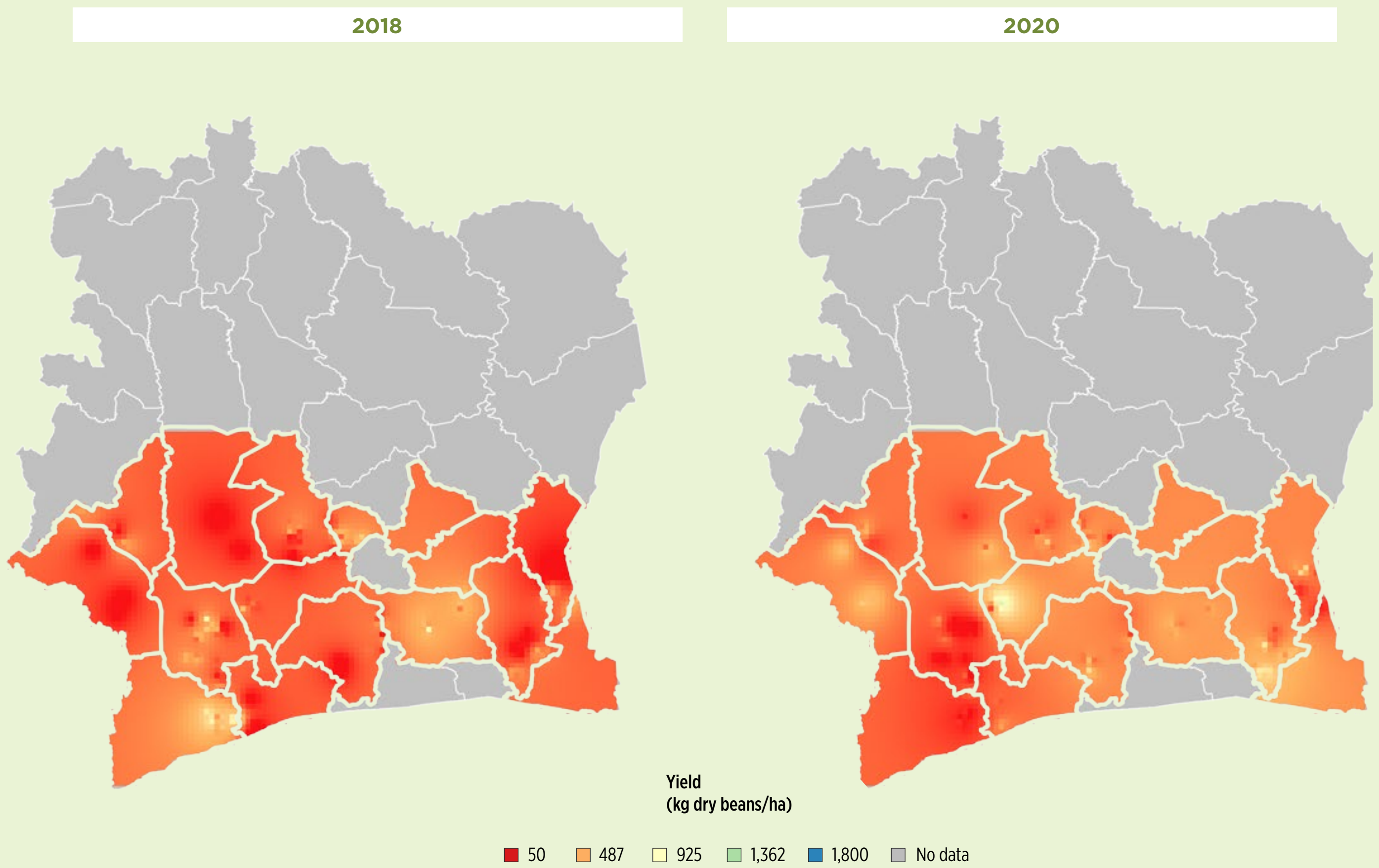


Figure 68 Yield by Use of Fertiliser and Season



Regional differences mask yield developments. Areas with high yields appear to have shifted away towards the east from the south west

Figure 69 Yield in kg/ha by region in 2018 and 2020



The majority of regions see lower yields in 2020 compared to 2018

- The map (Fig 69) shows the Inverse Distance Weighted interpolation of yield across the programme regions.
- Average yield levels vary by region. At 1,091 and 612 kg/ha respectively, yield levels in Gôh and La Mé are significantly higher than in most other regions. San Pedro, Moronou and Sud-Comoé display an odd development. Yields dropped by large margins without an immediately obvious explanation.
- Regional differences could be caused by geographic, climatic or infrastructure effects. There could also be a data collection bias as information from different regions was collected by different data collectors and partners. Additionally, differences with respect to the quality of organisation and service-provision of farmer cooperatives present in the different regions could also play a role.
- As including weather data was outside of the scope of this study, inclusion of the regions in our regression analysis for yield may function as a proxy variable for weather data to some extent, but we think inclusion of weather data would allow for better explanation of the regional differences.
- Another aspect that may play a role is that FFB records production through the sales that farmers make. Since the Living Income Differential was enacted we have heard anecdotal "evidence" that in some areas farmers had trouble selling their cocoa at the raised price. We have not been able to verify this, but it may be part of the explanation for strong yield declines in some areas.

Figure 70 Yield by Region and Season

Region	Yield Standard deviation)			2018 vs. 2020
	2018	2019	2020	
Agnéby-Tiassa	535 (239)	460 (286)	454 (253)	↓
Cavally		409 (150)	563 (107)	
Gbôklé		407 (171)	338 (159)	
Gôh	534 (193)	919 (525)	1091 (382)	↑
Guémon	764 (273)	220 (129)	345 (203)	↓
Haut Sassandra	362 (122)	379 (110)	258 (171)	↓
Indénié-Djuablin	505 (160)	325 (152)	345 (279)	↓
La Mé	392 (196)	528 (286)	612 (287)	↑
Lacs	413 (241)	372 (181)	411 (220)	↓
Lôh-Djiboua	369 (223)	450 (239)	358 (207)	↓
Marahoué	472 (250)	325 (185)	337 (188)	↓
Moronou	519 (261)	424 (236)	183 (76)	↓
Nawa	650 (201)	507 (130)	365 (319)	↓
N'Zi	444 (240)	304 (147)	331 (175)	↓
San Pédro	804 (296)	454 (141)	154 (46)	↓
Sud-Comoé	506 (141)	333 (139)	123 (67)	↓

Larger farms have a tendency for lower yield levels than smaller farms. This is driven by lower investment and labour input levels per ha

- Aside from regional effects, cocoa area plays an important role in explaining yield levels too. There is a tendency for larger farms – in terms of total crop area, as well as cocoa area – to have lower yield levels than smaller farms. We created deciles, i.e. ten groups of roughly 10% of the sample by cocoa area and plotted the yield for each (Fig 71).
- This seems logical as farmers who have large farms have to divide the time they can dedicate to their cocoa production over a larger area, especially when hesitant or unable to hire labour. We see this reflected in the pre-harvest labour, i.e. all labour input before harvesting (Fig 72). The smallest farms are notably more intensively managed and consistently so in each season. Beyond the 2.0 to 2.5 ha level differences in labour use intensity tail off.
- The pattern for material costs is also interesting. Here we see that the smallest farms apparently do not have the means or inclination to match their high labour input with high investment levels (in two out of three seasons) (Fig 73). Material cost investment peaks in the 1.11 to 2.5 ha before tailing off on farms that are larger.

Figure 71 Yield by Decile of Farm Size and Season

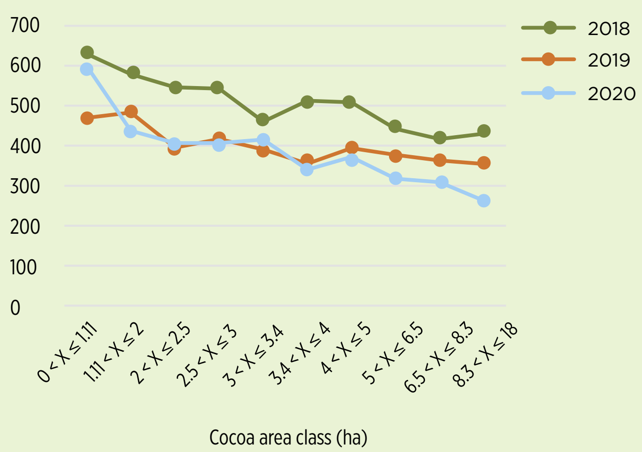


Figure 72 Total Pre-Harvest Labour by Decile of Farm Size and Season

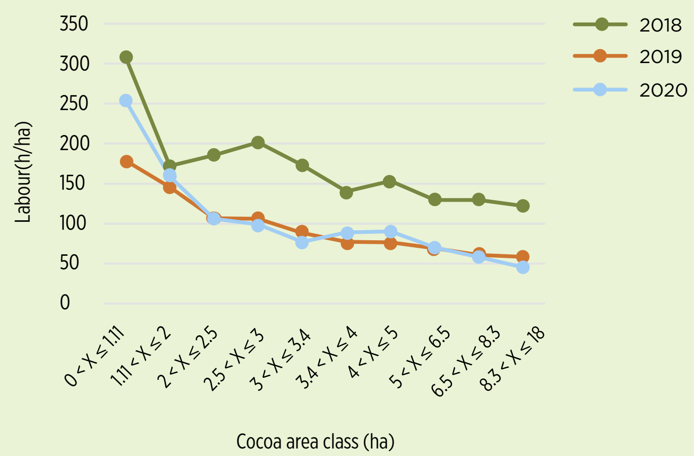
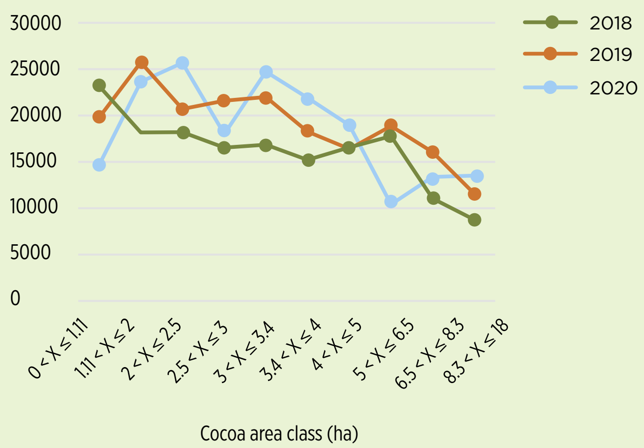


Figure 73 Material Cost by Decile of Farm Size and Season



Production is concentrated at a relatively small share of the population. The 20% largest producers are responsible for around 50% of the total cocoa production in the sample

- Production across quintiles of farmers by production differs considerably, see the table at the bottom of this page.
- The top 20% of farmers produce around half of the total production, the bottom 40% of all farmers together produce just 15% of supply.
- In programmes such as the CCF one, many of the costs incurred by implementers are accrued on a per farmer basis. It costs as much to send a field agent out to visit a small farm as it does to visit a large farm. Similarly, training a group of highly productive farmers will not be much different from training a group of less productive farmers.
- For (semi-) commercial service delivery where revenues from cocoa are used in part to finance services to farmers, it may be challenging to reach the lowest level of suppliers, yet these make up a significant share of the farmer numbers in the supply base.
- We believe this calls for more advanced segmentation and a clear differentiation of strategies. What works for a farmer in the top-20% group, who is likely to be relatively well-off, is unlikely to work as well for someone in the bottom-20% group.
- Where supply of loans is concerned we some efforts of this already, but it may also be prudent to investigate how this logic could be applied to other services.

Figure 74 Supply Concentration by Season

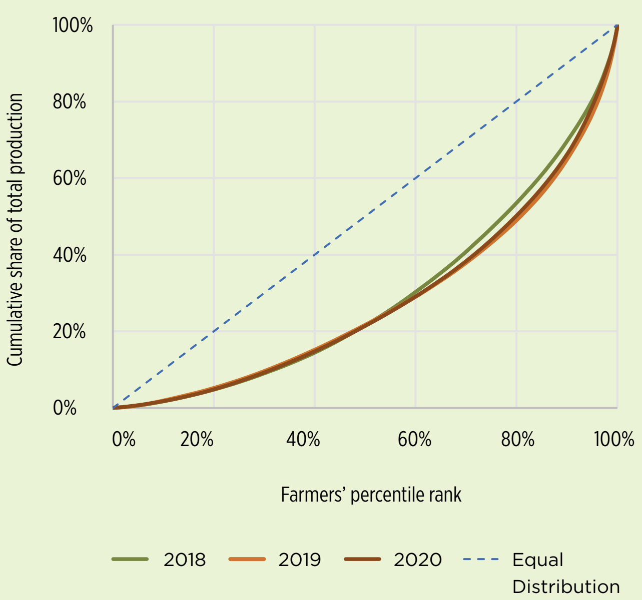


Figure 75 Share of Total Production by Quintile of Production

Quintile by production	2018	2019	2020
Bottom 20%	5%	6%	5%
Lower middle 20%	10%	10%	10%
Middle 20%	16%	14%	15%
Upper middle 20%	23%	20%	22%
Top 20%	47%	50%	50%

Average yield levels show some increase with labour time spent on weeding, pruning, planting, collecting diseased pods, fertilising and spraying pesticides

- To investigate variation in labour and yield we divided farmers in five equally sized groups (quintiles) according to their labour hours per hectare, excluding time spent on harvesting and processing. Classes range from 1 (20% farmers with the least time spent) to 5 (20% farmers with most time spent). We do this by treatment (C=CCF; N-c=Non-CCF) and for 2018 (Fig 76) and 2020 (Fig 77).
- The figures shows that there is a tendency that yield levels increase with time spent. Yield levels are significantly different between all quintiles except for quintiles 2&3 and 3&4. What is obvious is that weeding takes up a large share of total labour and we find that weeding labour is significantly different ($p<0.05$) between each quintile within each season. Weeding labour does not appear to infer a yield advantage among farmers in quintile 5, it may well be that economising on weeding labour is possible among farmers in this group without endangering yields.
- What we find concerning is that the amount of time spent pruning has dropped over time, most notably in quintile 5.

Figure 76 Yield and Labour Allocation to Activities by Quintile of Total Pre-Harvest Labour, Treatment in 2018

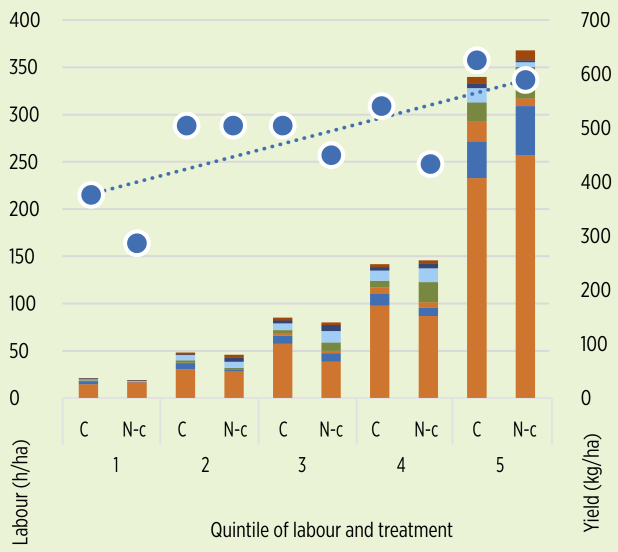
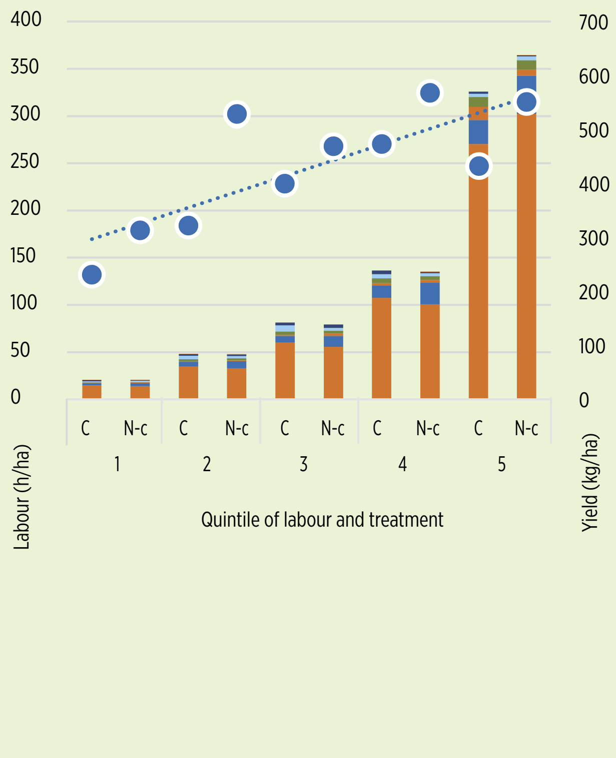


Figure 77 Yield and Labour Allocation to Activities by Quintile of Total Pre-Harvest Labour, Treatment in 2020



A regression model explains 32% of the observed variability in yield

- The table below shows the results of a stepwise regression using a range of control variables (time, region, household and farm characteristics) as well as farm management variables (inputs and labour). The resulting model can explain 32% of the long run variation in the dependent variable yield (kg dry beans/ha) at $p<0.05$.
- The earlier Diff-in-Diff analyses already outlined which treatments do and do not have a significant effect on farm management and yield.
- This model, where we maximise the number of observations by pooling the three seasons of data is intended to tease out some of the possibly more elusive drivers of yield. The coefficients of those variables that were earlier identified as drivers of yield will give us a better feel for the effect size. These should be seen in relation to the mean three-season yield of 457 kg/ha, where the coefficient is the amount that yield would change (in kg/ha) with each additional unit of the variable, all other things being equal.

Figure 78 Yield model outputs

Category	Variable	Unit	Coefficient
Time	**Season**	**Cal. year**	**-58**
Treatment	Any productivity package	Dummy	
	Fertiliser productivity package	Dummy	+43
	CCF-related credit	Dummy	
	FDP/FBP	Dummy	
	BUS training	Dummy	-159
	Scope Insight	Dummy	
	Agroforestry	Dummy	+131
	GAP training	Dummy	
Region (non-significant regions excluded)	Agnéby-Tiassa (baseline)		
	Nawa	Dummy	+106
	Gôh	Dummy	+458
	Lôh-Djiboua	Dummy	+85
	La Mé	Dummy	+63
	Cavally	Dummy	+91
	Lacs	Dummy	+79
Household	Women involved in decision making	Dummy	
	Household size	#	
	Gender of the farmer	Dummy	
	Age of farmer	Years	-1.34
	First year of growing cocoa	Years	
	Education	Dummy	
Farm	Cocoa area	Ha	-13.01
	Planting density	Trees/ha	-0.03
Inputs	Total N applied	Kg/ha	+5.62
	Total P applied	Kg/ha	
	Total K applied	Kg/ha	
	Fertiliser material cost	1,000 XOF/ha	+0.6
	Spraying material costs	1,000 XOF/ha	+9.89
Labour	Collecting diseased pods	Days/ha	
	Fertilizing	Days/ha	
	Pruning	Days/ha	+12.24
	Pruning shade trees	Days/ha	
	Weeding	Days/ha	+1.28
	Spraying	Days/ha	
	Planting	Days/ha	

YIELD AND PRODUCTION

- We earlier concluded that we there is no positive effect of CFF overall on yield. We therefore opted to leave CCF treatment out of this model and rather include the 7 treatments (page 19 and 20) where we split productivity package into fertiliser packages and any package.
- Those treatments we analysed earlier on their effect on yield that show up as significant in this model are showing up because of selection effects, i.e. farmers in this interventions already had higher or lower yields to start with.
- For regions, we use Agnéby-Tiassa as the baseline against which the effects of other regions are estimated. All programme regions were included in the model, we left out the non-significant ones to improve readability.
- Not shown here, but the effect of planting which could be expected to be negative on yield is not significant. This is because no farmers have done large scale replanting, generally a few percentage points of trees are replaced in any given season, not enough to seriously dent yields.

Region, farm size, nitrogen application, spraying material cost, pruning and weeding are significantly associated with yield

- **Region**
  Yield change for the regional variables are to be interpreted as changes with respect to baseline region of Agnéby-Tiassa (alphabetically the first region). The region where farms are located has a significant relation with yield. This could be explained in three ways: first, there could be geographic, climatic and infrastructure effects. Secondly, there could be a data collection bias as information from different regions was collected by different data collectors, each following their own approach in interviewing. Thirdly differences with respect to the quality of organisation and service-provision of the coops present in the different regions could play a role.
- **Women involved in decision making**
  There was a positive relation between yield and women being involved in farm management decisions in 2018, but when we pool data from 3 seasons as we did here, this effect lies outside the bounds of significance. The only household variable that comes out is **age of the farmer** with every additional year in age being associated with a -1.3 kg/ha lower yield. Not a large real world effect, expect when comparing very young and very old farmers.
- **Cocoa area**
  There is a negative correlation between farm size and yield which can probably be explained by limited time and resources. We saw earlier that on larger farms the amount of labour drops in line with the lower yield levels such farms tend to achieve.
- **Nutrient application**
  As we hypothesised in the Farm management section the nutrient management strategy of the vast majority of farmers appears to be too biased towards P and K applications. Whichever nutrient is in shortest supply will be limiting yield. In other words, applying more P when N is lacking is not going to have an effect the model bears this out. Of the three macro-nutrients, only with N do find a strong positive association with yield, where each additional kg of N is associated with 5.62 kg of additional yield. This just about makes economic sense. A kg of Nitrabor (as recommended to be applied in conjunction with P and K) costs 500 XOF and has an N content of 15.4%. An additional kg of N therefore costs 3,247 XOF and yields 5.62 kg of dry beans, worth 5,620 XOF during the 2020 main crop or 4,125 at the current mid-crop cocoa price of 750 XOF/kg.
- **Pest management**
  There is a positive correlations between spraying material costs and yield. This may seem surprising when assuming that farmers only apply pesticides in case of presence of pests. Yet, under the assumption that farmers only spray if they can afford it, it could well be that farmers who spray are better off than their non spraying peers who are also confronted with diseases and hence experience lower yields.
- **Pruning cocoa trees**
  We also see a positive correlation with pruning of cocoa trees. As yield usually has a delayed response to pruning, the pooling of three seasons of data allows the pruning effect to show itself more realistically than a single season model would allow for. Each additional day of pruning is associated with 12.24 kg/ha of yield. A sizeable effect, which makes the decline in pruning labour (page 38) all the more concerning.
- **Weeding**
  This is also positively associated with yield, but judging by the coefficient its effect is limited. The cost of an additional day of weeding with hired labour exceeds the additional revenue from 1.28 kg of cocoa, underwriting the observation we made earlier that on some farms economising on weeding labour seems opportune.

07 Farm economics

Farmer revenue from cocoa was on average 1.28 million XOF per farm or 388,177 XOF per hectare. On a per ha basis this is on par with 2018 as lower yields were offset by lower costs and the Living Income Differential

- Farmers in the sample generated an average revenue of 1.28 million XOF per farm (Fig 79) or 388,177 XOF/ha in the 2020 season (Fig 80). Compared to 2018 season, revenues per farm drop significantly, in part because of smaller farms moving into the sample. On a per ha basis, the yield decline we observed in the previous section is offset by a combination of lower costs and higher cocoa prices for the main crop from October 2020 onwards, when prices moved up from 825 XOF/kg to 1,000 XOF/kg after the LID (Living Income Differential) came into effect.
- This combination also allowed margins per ha to be maintained from 2018 to 2020, although ideally one would have seen higher margins per ha as a result of the LID, but lower yields prevented this from happening.

Figure 79 Revenue, Cost and Margin per Farm by Season

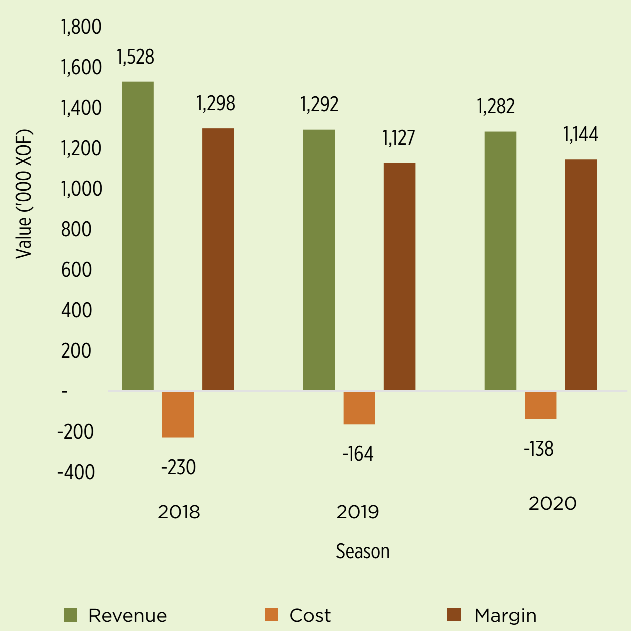
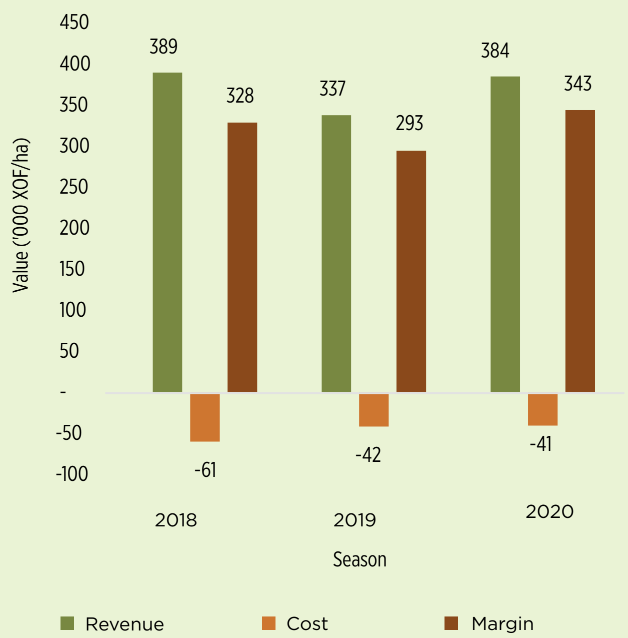


Figure 80 Revenue, Cost and Margin per Ha by Season



The reduction in cost per ha is primarily driven by the reduction in the use of hired labour. On a per Mt basis cost have increased, indicating that yields have gone down

- The reduction in cost per ha from 61,000 XOF/ha in 2018 to around the 40,000 XOF/ha mark in both 2019 and 2020 is largely driven by the reduction in the use of hired labour which we observed on page 37. Hired labour cost went down from just over 34,000 XOF/ha to between 18,000 to 20,000 XOF/ha in the subsequent seasons, but in relative terms its share of the total costs consistently makes about half of what is spent (Fig 81).
- Expenditures on inputs, mainly fertiliser and pesticides range from 30% to 46% of the cost per ha, with pesticide expenditure being most stable. It appears fertiliser in particular is most volatile. We expect that cocoa price and yield in the previous season (and hence farmers cash position at the start of the new season) is influencing this.
- On a per Mt dry bean basis, cost have jumped from 2019 to 2020 (Fig 82) while cost per ha was stable. This is explained by the decline in yields we have observed.

Figure 81 Cost Break Down per Ha by Season

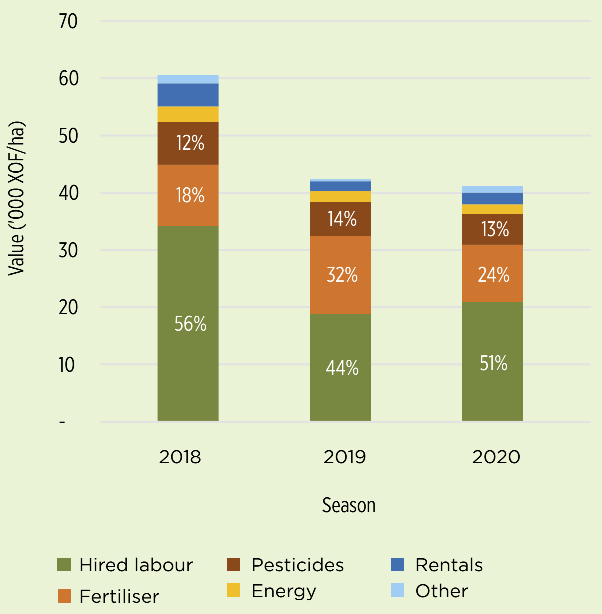
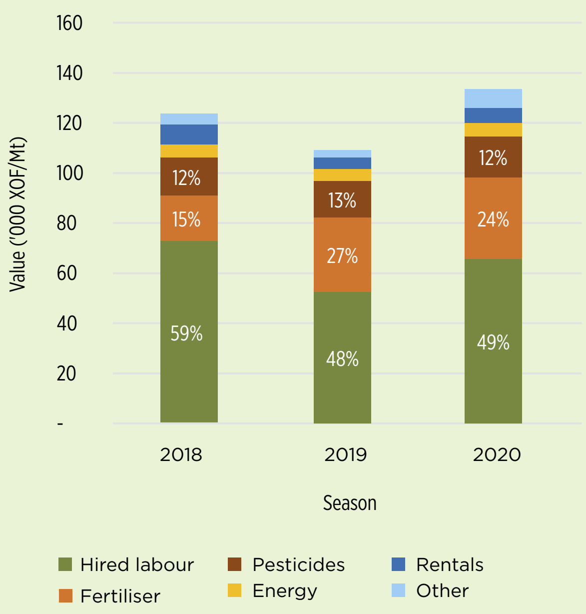


Figure 82 Cost Break Down per Mt by Season



We find no positive significant effect of the CCF programme on cocoa margins earned

- The revenue, cost and margin developments between the CCF and non-CCF groups have followed somewhat different trajectories. The CCF group started of with significantly higher (p<0.05) levels of each in 2018. The revenue differential disappeared in 2019, while cost remained significantly higher in that season for the CCF group. The distribution of margin values in 2019 is such that on that aspect the differences between the groups are not significant. In 2020 the situation is reversed with Non-CCF farmers obtaining significantly higher revenues at comparable cost, resulting in significantly higher margins.
- We therefore have to conclude that there is no positive effect on margins from cocoa as a result of the CCF programme. A Diff-in-Diff analysis actually identifies a significant negative effect on margins of the programme, but as with yield, specific interventions may be more effectful than others.

Figure 83 Box Plot of Revenue by Treatment and Season

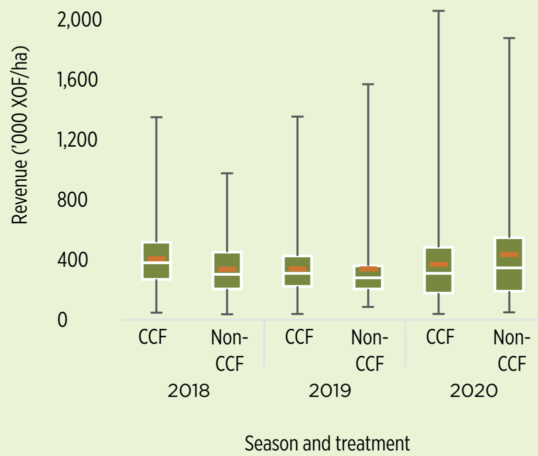


Figure 84 Box Plot of Cost by Treatment and Season

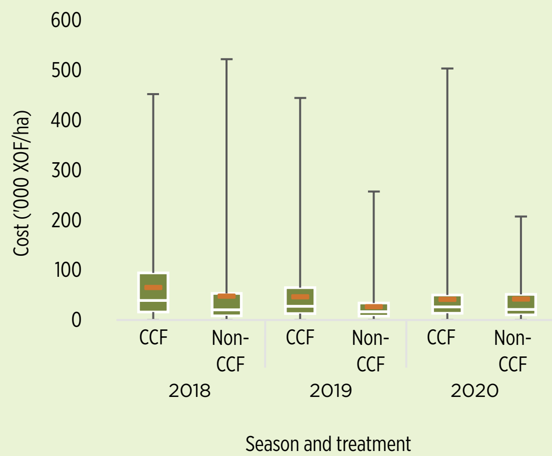
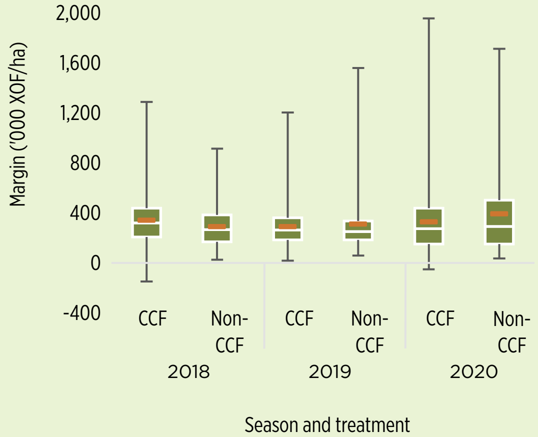


Figure 85 Box Plot of Margin by Treatment and Season

Average



The CCF programme is resulting in more farmers having access to credit and to larger loans being available, although the share of farmers with access to credit is trending down among both groups

- Farmers in the CCF group are able to access signifcantly larger loans in each of the season and the share of farmers being able to do so is 2 to 4-fold higer than among the Non-CCF group. Over time the share of farmers with access to credit in both groups is trending downward, but the decline less strong among the CCF group. As a result the Diff-in-Diff analysis attributes greater access to credit and average larger loan sizes to the CCF programme ($p<0.05$; Fig 86). This analyis looks at each group as a whole, but as Figure 1 indicates, among both groups the share of farmers that use a loan constitutes a minority.
- If we isolate from the sample only those farmers that accessed loans and compare loan sizes between each group and over time we find no clear or consistent trend. Once farmers have a loan, then average loan sizes are not signifcantly different ($p<0.05$; Fig 87).

Figure 86 Credit Value and Share of Farmers with Credit by treatment and Season

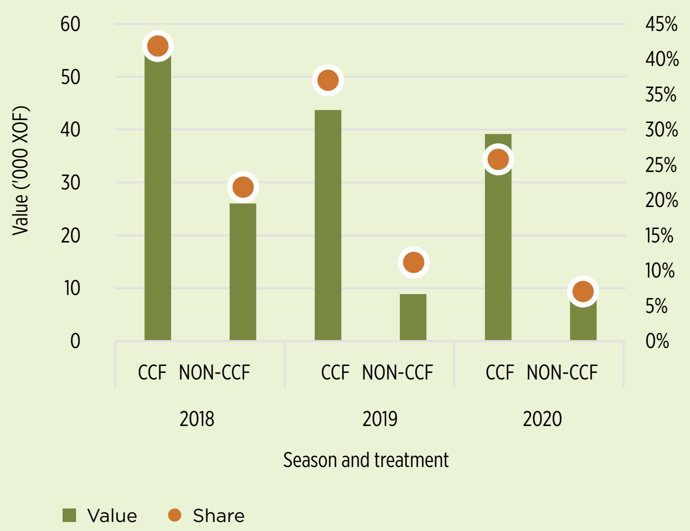
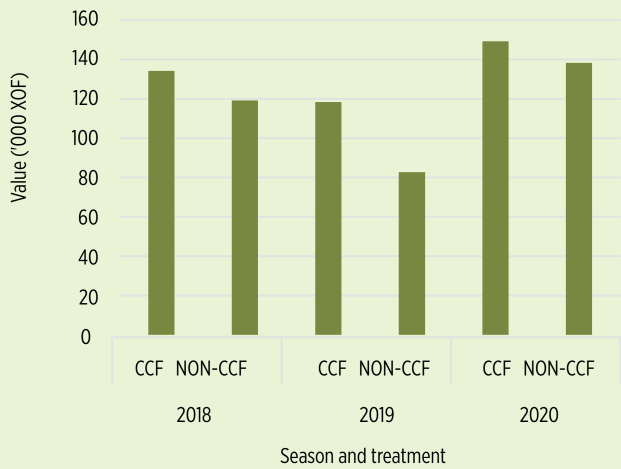


Figure 87 Mean Credit Value of Farmers Who Used Credit by Treatment and Season



CCF farmers are significantly more likely to make use of formal credit provivers. Much of their loans are used for fertiliser. The use of credit to cope with emergencies doubled during the pandemic year

- Reviewing sources of credit indicates that CCF farmers are significantly more likely to access credit through formal channels (Fig 88), predominantly finance institutions and cooperatives. Non-CCF farmers who access formal credit typically did so through the cooperative they are a member of, but are far less likely to access to do so via financial institutions.
- When we analyse allocation of credit across different categories by CCF farmers, a couple of things stand out. First is that fertiliser is by far the most important item that credit is spent on: it receives 55% to 60% of the amount of credit used. What is also notable, and may well be pandemic related, is that the share of credit allocated to family emergencies more than doubled from 8% in 2019 to 17% in 2020 (Fig 89).
- As a share of production costs per farm, the credit that is used for cocoa related activities equates to about a third of the cost on those farms that have access to credit.

Figure 88 Type of Credit by Share of Loans, Treatment and Season

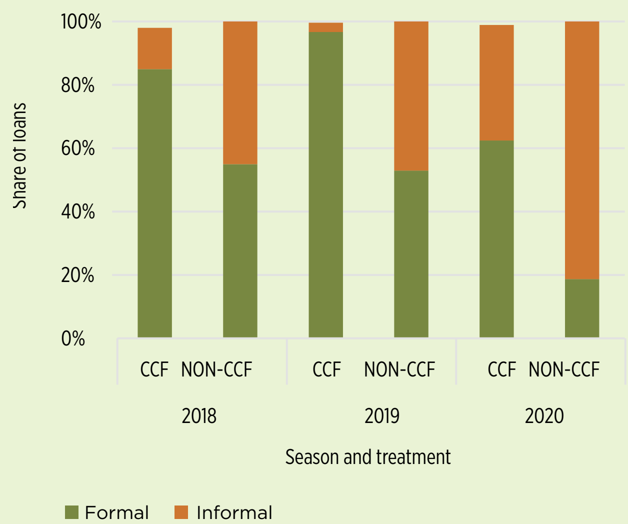
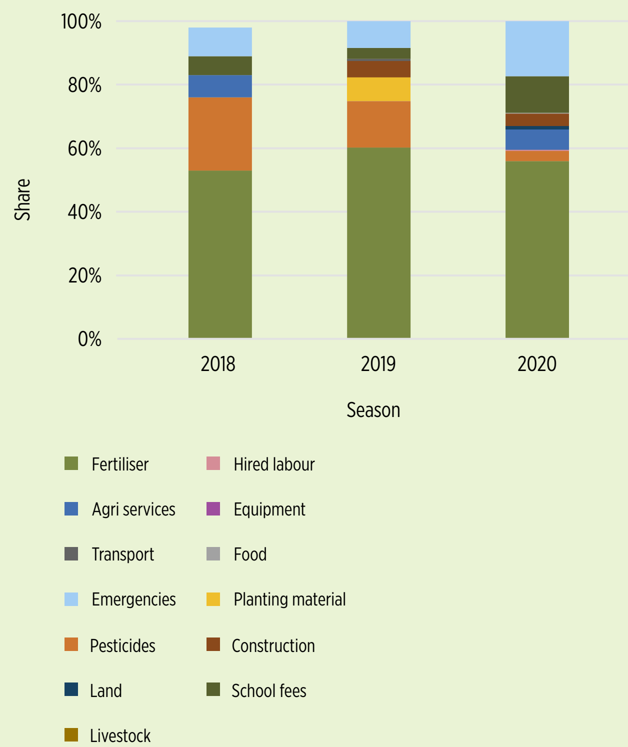


Figure 89 Share of Credit Provided by Purpose and Season



Access to credit is associated with decreasing investment over time, probably as a result of limited returns on borrowed capital resulting from ineffective investment in fertiliser

- Hired labour, fertiliser and pesticides make up between 83% and 90% of the total cost per ha, depending on the season and group. A Diff-in-Diff analysis of the allocation of capital to these combined line items and each item individually, reveals no significant effect of the CCF treatment.
- We also review the effects of specific interventions that may have an effect on investment: the use of productivity packages and credit. We find no effect of the amount of money spent on fertiliser or pesticides as a result of productivity packages. Farmers that use such packages, often were already using inputs before, so the package is replacing some of the inputs they previously bought on the open market. It is more rare for farmers who did not use fertiliser to start using it as a result of a productivity package.
- The situation around credit is more concerning. There we find that among farmers who used CCF-related credit, their investment levels drop of over time. Around half of all borrowing is done to invest in fertilisers, so as expected the amount of money spent on fertiliser is significantly higher on farms that have access to credit.
- We saw in the farm management section that fertiliser choice is not aligned with crop nutrient requirements. Consequently, farmers who take out credit for fertiliser (and use it for P and K fertiliser, as most do) are not seeing the expected increase in yields, revenues and margins because N is the limiting factor. This may explain why only 31% of farmers take out loans for more than a single season, it may also affect default rates on loans.

Figure 90 Cost by Category, Treatment and Season

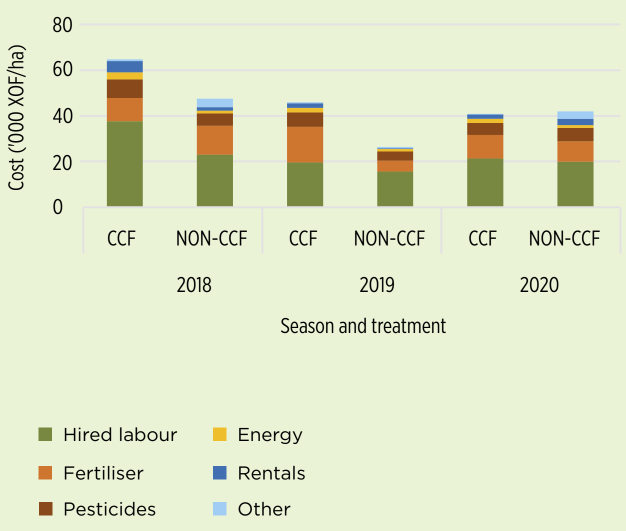
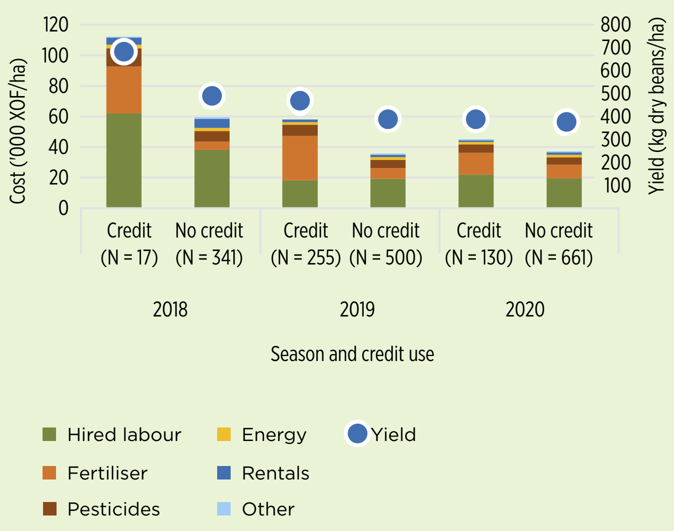


Figure 91 Cost by Category, Yield, Use of Credit and Seasonby Treatment and Season



Exact default rates are hard to pin down from farmer data alone, but 18% to 40% of farmers indicate they are in arrears at the end of each season at a time when loans to have been repaid

- The research questions ask for the default rates on loans. According to the FFB data, default rates, when defined as being 30 days or more overdue for repayment are in the low single digits. However, whether a farmer defaulted or not is ultimately decided by the issuer of the loan and investigating loan books of issuers was not within out remit.
- To still obtain some insight in this critical aspect we reviewed the sahre of farmers who indicate to have repaid in full or not at the time of the annual additional survey. This survey is conducted each year in January or February, by which time the main crop has been harvested. We expect that farmers who have no issues repaying their loan would have done so by that time, given that the majority of due dates fall in December and early January, and indeed the majority has (Fig 92).
- Still, there is a sizeable group ranging from 18% to 40% of farmers, depending on the season, who took out a loan and at the time of the survey had not yet repaid in full. When we compare the loan values of this group with the amount outstanding we find that this ranges from 54% to 69% of the loan. We expect these farmers to be at elevated risk of defaulting as they have on average surpassed the due date by more than 30 days.
- What is positive to take away from this is that the share of farmers at risk of default is lower in 2020 than in 2019.

Figure 92 Share of Farmers by Loan Repayment Status and Season

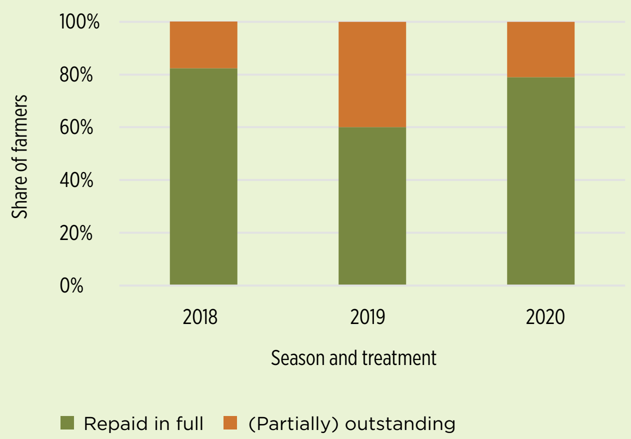


Figure 93 Loan and Remainder Outstanding of Farmers with Outstanding Loans

A regression model for margin per ha explains 89% of the observed variability

- The table below shows the results of a stepwise regression using a range of control variables (region, household and farm characteristics) as well as farm management variables (yield, inputs and labour). The resulting model can explain 89% of the variation in the dependent variable margin (XOF/ha).
- We used the same variables as for the yield model, and added cost variables to complement the profit model and take into account the (possible) profit-depressing effects of costs involved with particular farm management activities. We also include yield and cocoa price.
- This model, where we maximise the number of observations by pooling the three seasons of data is intended to tease out some of the possibly more elusive drivers of margin. The coefficients of those variables that were earlier identified as drivers of yield will give us a better feel for the effect size. These should be seen in relation to the mean three-season margin of 323,569 XOF/ha, where the coefficient is the amount that margin would change with each additional unit of the variable, all other things being equal.
- We earlier concluded that we there is no positive effect of CFF overall on yield. We therefore opted to leave CCF treatment out of this model and rather include the 7 treatments (page 19 and 20) where we split productivity package into fertiliser packages and any package.
- For regions, we use Agnéby-Tiassa as the baseline against which the effects of other regions are estimated. All programme regions were included in the model, we left out the non-significant ones to improve readability.

Figure 94 Margin model outputs

Category	Variable	Unit	Coefficient
Time	Season	Cal. year	
Price	Cocoa price	XOF/kg	+0.42
Treatment	Any productivity package	Dummy	
	Fertiliser productivity package	Dummy	
	CCF-related credit	Dummy	
	FDP/FBP	Dummy	
	BUS training	Dummy	
	Scope Insight	Dummy	
	Agroforestry	Dummy	-29,915
	GAP training	Dummy	
Household	Women involved in decision making	Dummy	
	Household size	#	
	Gender of the farmer	Dummy	
	Age of farmer	Years	
	First year of growing cocoa	Years	
	Education	Dummy	
Farm	Cocoa area	Ha	-1,636
	Planting density	Trees/ha	
	Yield	Kg/ha	+704
Inputs	Total N applied	Kg/ha	+3,981
	Total P applied	Kg/ha	
	Total K applied	Kg/ha	
	Fertiliser material cost	1,000 XOF/ha	-1.01
	Spraying material costs	1,000 XOF/ha	-1.50
Labour	Collecting diseased pods	Days/ha	
	Fertilizing	Days/ha	
	Pruning	Days/ha	+5,176
	Pruning shade trees	Days/ha	
	Weeding	Days/ha	-110
	Spraying	Days/ha	
	Planting	Days/ha	

Regional effects with Agneby-Tiassa as base: San Pedro=-23,616; La Me=-103,955; Goh=+38547; Sud-Comoe=-46,595; Haut Sassandra=-19,266; Marahoue=-33,479; Indenie-Djuablin=-35,396; Lacs=-25,122

Region, cocoa price, yield, fertiliser costs, N applications and pruning and weeding have a significant relation with profit

- **Region**
  The region where farms are located has a significant relation with margin. Similar reasons causing differences in yield within regions could explain the differences in profit.
- **Cocoa price**
  Over the three years of data, we find that cocoa price has a significant influence on margins, but perhaps less than might be expected. Every additional XOF in price corresponds to 0.42 XOF in additional earnings, all other things being equal.
- **Cocoa area**
  As with yield, a negative correlation is found between farm size and profit. All else equal, an extra hectare of cocoa area on a farm depresses profit levels per ha by 1,636 XOF, or 0.5%, while statistically significant the absolute differential is not meaningfully large.
- **Yield**
  Yield for obvious reasons has a strong association with margin and alone explains 80% of the variability in margin. A kg more yield is associated with 704 XOF/ha in additional margin. Given that the weighted average price received over the same time frame for this sample is 793 XOF/kg, we can see that while of an additional XOF in price 42% is added to the margin, this rate is 89% for an additional kg of yield.
- **Fertiliser material cost**
  Reinforcing our earlier conclusion that fertiliser applications are not very effective because of the application being biased towards P and K at the detrmiment of N application is the model outcome that associates an additional XOF spent on fertiliser with a reduction in margin of -1.01 XOF. Essentially, this means that no additional margin is earned on the fertiliser invested, all other things being equal. Conversely, and as expected, the effect of N alone is significant and positive.
- **Spraying material cost**
  Our earlier hypothesis that farmers could be spryaing out of habit and when they feel can afford is not exactly accepted, but it is interesting to see that spending on pesticides is associated with 1.5 XOF lower margins. Of course, the counter-factual of what would have happened with a farmer who sprayed had he or she not done so is difficult to determine, but *vis á vis* farmers who didn't spray or sprayed less one would expect a positive effect on margin.
- **Pruning and weeding**
  These show a similar direction of coefficients aas they did with the yield model where more pruning is associated wiht higher margins and the reverse for weeding. This reinforces our earlier idea that farmers at the far end of weeding labour distribution might be over-investing in this activity.

Average Non-Cocoa income is limited and ranges from 93,000 to 207,000 XOF per family. The majority is obtained from other agricultural activities

- Figure 95 shows the contribution of non-cocoa income to overall income. The values vary somewhat by season, but on average makes up about 10% of the total household income. We observe no significant change ($p<0.05$) over time across the sample as a whole.
- If we split this by CCF and Non-CCF farmers we find that in 2018 and 2020 the share and absolute value of non-cocoa income is significantly higher on Non-CCF farms. In the first year of the programme this could perhaps be explained by a preference of implementer for farmers who focus more on cocoa, but even then, the share of non-cocoa income on Non-CCF farms is not very high at 207,000 XOF. Over time the differences in non-cocoa income between the groups are reduced to the point where in 2020 CCF farmers earned 122,000 XOF and Non-CCF farmers 168,000 XOF from non-cocoa sources and the difference is no longer significant ($p<0.05$).
- Other agricultural income, mainly from non-cocoa crops, is the main source of other income. We find very few off-farm sources of revenue in the sample.

Figure 95 Cocoa and Non-Cocoa Income and Share of Farmers Earning Non-Cocoa Income by Season

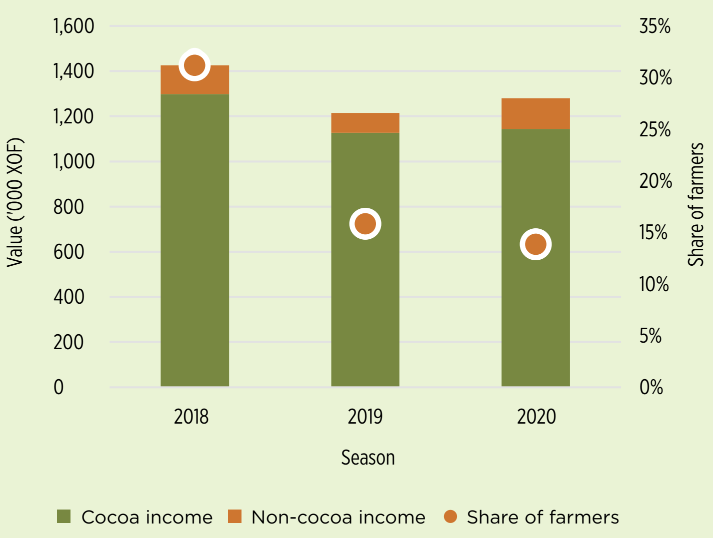
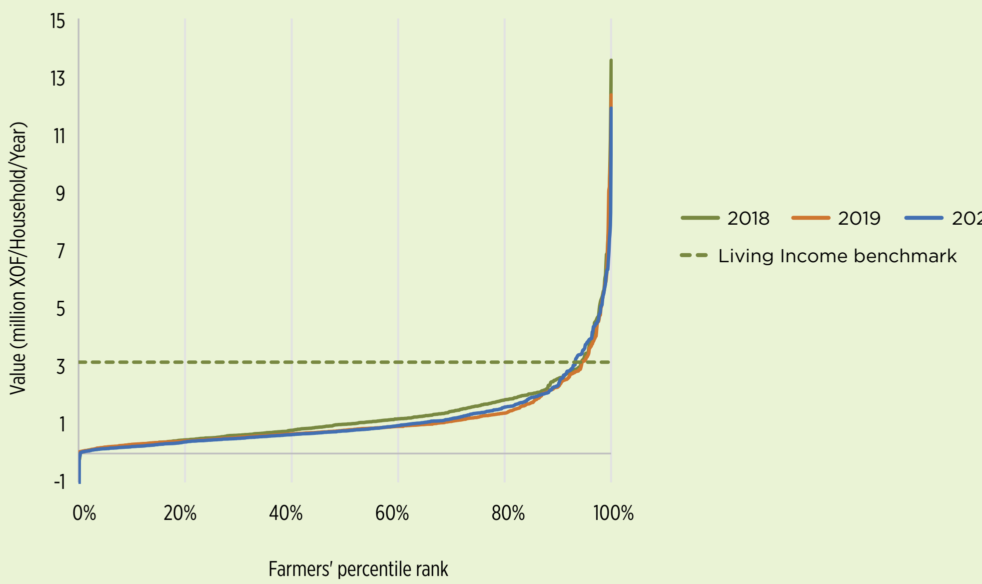


Figure 96 Cocoa and Non-Cocoa Income by Treatment and Season

The share of farmers earning a Living Income is 8% and comparable to what it was in 2018

- To analyse where farmers are compared to the poverty threshold **on basis of their total income**, we use the Living Income Benchmark of 2018 which comes in at 3,144,672 XOF/family and adjust the 2019 and 2020 to their 2018 equivalent using the Consumer Price Index (IMF, 2021).
- In the total income calculation we factor in the margins from cocoa and the revenues from other income sources, in other words, the actual cash that passes through the household. We explicitly do not factor in the hypothetical value of crops grown that are consumed at home. We do not have reliable data on the value of home consumption. By not including this, we run a risk of over-estimating the gap to the Living Income but we think this over-estimation is probably marginal.
- We find that despite lower yields, the share of farmers earning less than the Living Income benchmark has not dropped, but unfortunately, neither has it increased by much. The combination of somewhat lower costs of production and the Living Income Differential have ensured that the share of farmers earning a Living Income moved from 7% in 2018 to 8% in 2020.
- Diff-in-Diff analysis for the share of farmers earning a Living Income does not allow us to attribute change among the CCF group to the programme.

Figure 97 Farmers Percentile Rank by Total Income Distribution, Living Income Benchmark and Season



We find no positive effect of the CCF programme on reducing the gap to the Living Income. Across the sample, the size of the gap has not been reduced significantly over time

- Figure 98 outlines what share of the farmers by treatment earn more than the Living Income as well as those that earn less than the (CPI adjusted) 1.9 USD/day and those that sit in between these two poverty benchmarks.
- We find no significant effect of the CCF programme on a reduction of poverty against the Living Income benchmark. We do see that the Non-CCF group has a signifcantly greater share of farmers earning more than the Living Income benchmark (13% versus 5% for the CCF-group) which is explained largely by their higher yields in that season.
- Across the sample we regretfully observe that the gap to the Living Income has barely budged over 3 years. We analyse this by plotting the gap to the Living Income of farmers who do not reach it. We find that the gap stubornly sits at around the 1.9 to 2.2 million XOF mark in both groups (Fig 99).

Figure 98 Share of Farmers in Relation to Poverty Benchmark by Treatment and Season

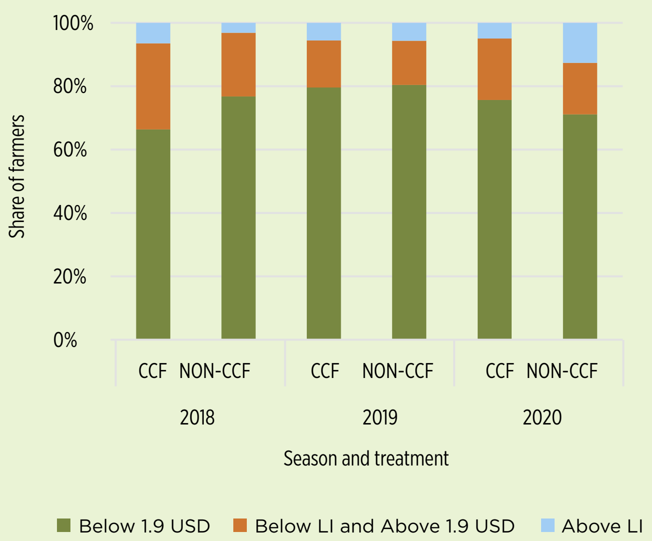
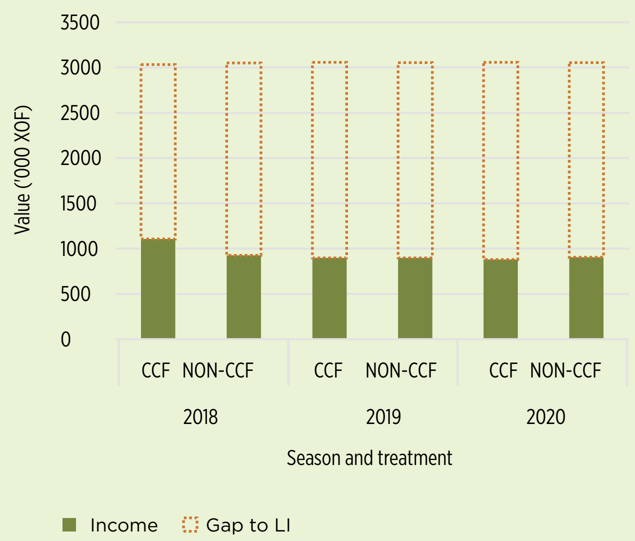


Figure 99 Gap the Living Income of Farmers Earning Less than Living Income by Treatment and Season

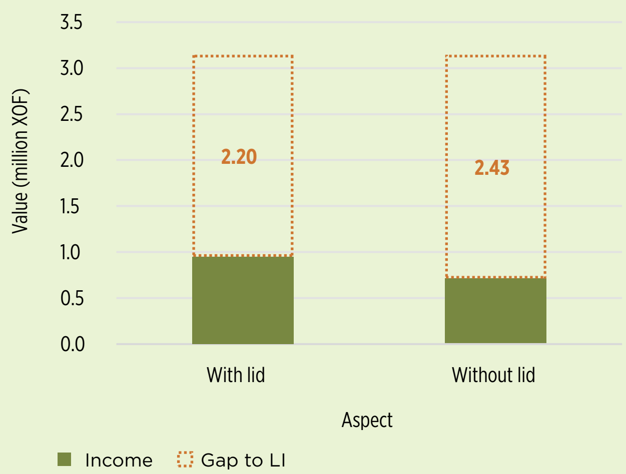


Had the Living Income Differential not been in place the situation would have been worse with just 3.4% of farmers reaching a Living Income

- The Living Income Differential was only beginning to be factored into the cocoa price from October 2020 onwards, but without it, the situation would have been worse. When we model income of farmers without the Lid being present and compare that the Living Income benchmark we find that without the LID, and all other things being equal, just 3.4 of farmers would have earned a Living Income in 2020 (Fig 100).
- In Figure 101, we display the mean income of those farmers who did not earn a Living Income and determine that without the LID the gap to the Living Income would have 2.43 million XOF per household instead of 2.20 million. In other words, the LID closed the gap to the Living Income by 10%. A significant effect, although we should point out that the gap remains large, even with the LID present.

Figure 100 Effect of Living Income Differential on Share of Farmers Earning a Living Income in 2020

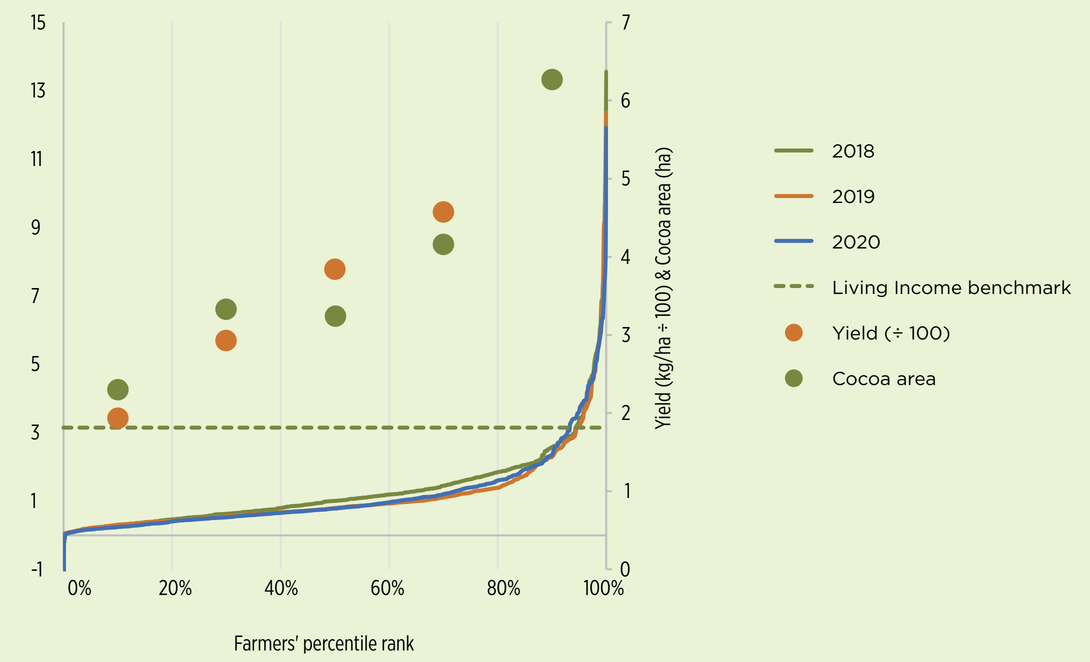
Figure 101 Gap the Living Income of Farmers Earning Less than Living Income with and without the Living Income Differential in 2020



Modelling shows that yield and cocoa area explain 60% of the variability in farmers being above or below the Living Income Benchmark. Adding price adds 10% point to the power of the model

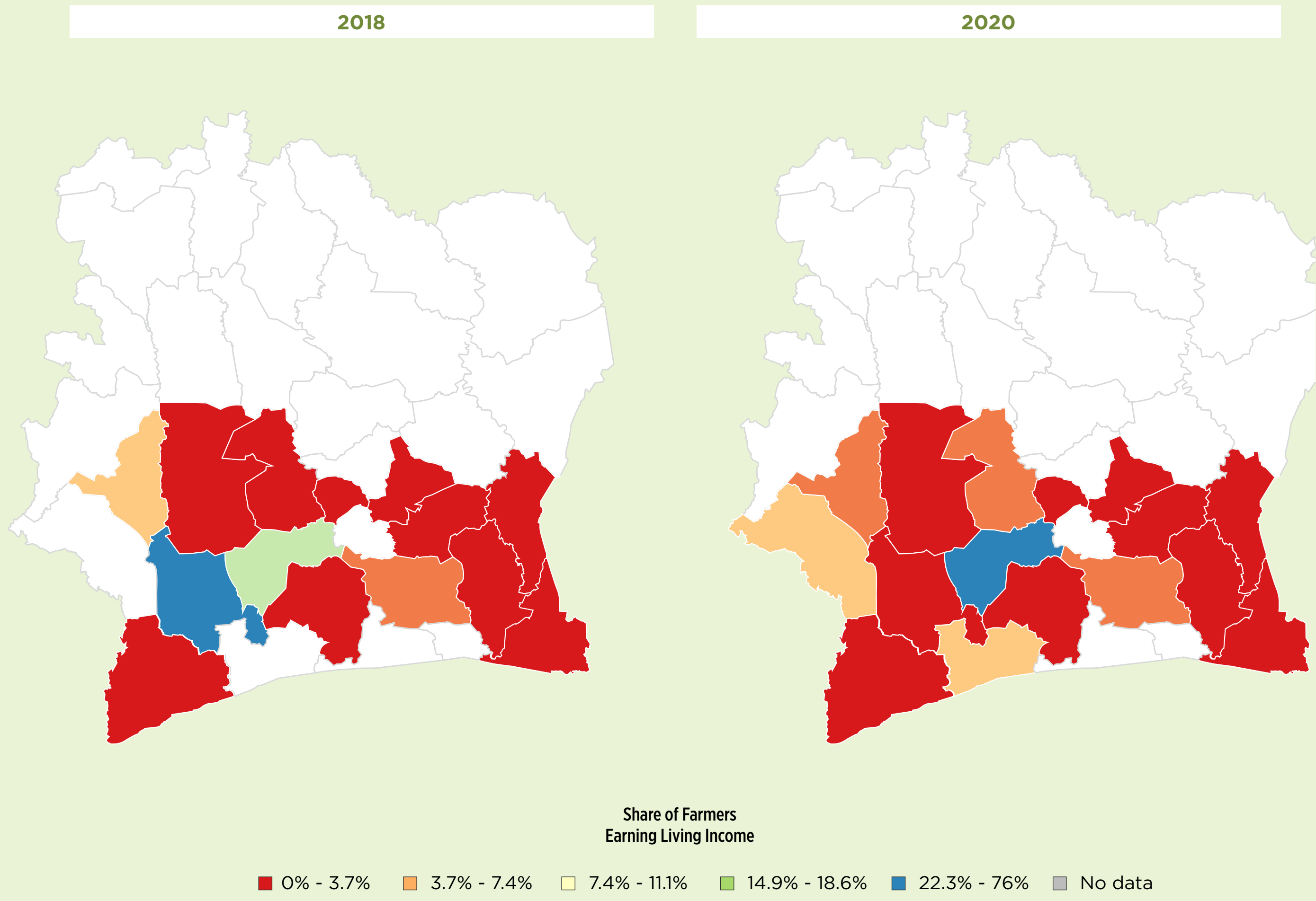
- We build a logistic regression where being above or below the Living Income benchmark is the dependent variable over the 3 year time frame for which we have data. We added cooa area and yield as explantory variables. These two variables alone explain 60% of the variability, i.e. being above or below the Living Income benchmark.
- When we add cocoa price to the model, it also comes out as a significant factor, but adds just 10% points to the power of the model, indicating its effect is more muted than that of area and yield.
- When we add the mean yield and cocoa area by quintile of total income to the percentile rank by total income figure it becomes clear what sets those who earn a Living Income apart from those that do not. We plot area and yield only for 2020 to improve readability, but the patterns for 2018 and 2019 are very similar.
- Cocoa prices can certainly help, but as an illustration consider the yields among the poorest 20%. At less than 200 kg/ha, a doubling of price would move these farmers from the first quintile (0%-20%) to the third quintile (40%-60%), where the gap to the Living income is certainly smaller but still far short of what it takes to meet or exceed the benchmark.
- Adding region to the model does not do much to improve the strength of it as yields tend to be correlated with region. Consequently, the poverty map (next page) follows a largely similar pattern to that of the yield map.

Figure 102 Farmers Percentile Rank by Total Income Relative to Living Income Benchmark and by Season with Yield and Cocoa Area in 2020 by Quintile of Income



Farmers in Goh and Agneby-Tiassa are more likely to have moved closer to the Living Income benchmark. These are also the regions with higher than average yields

Figure 103 Share of farmers earning a Living Income by region in 2018 and 2020



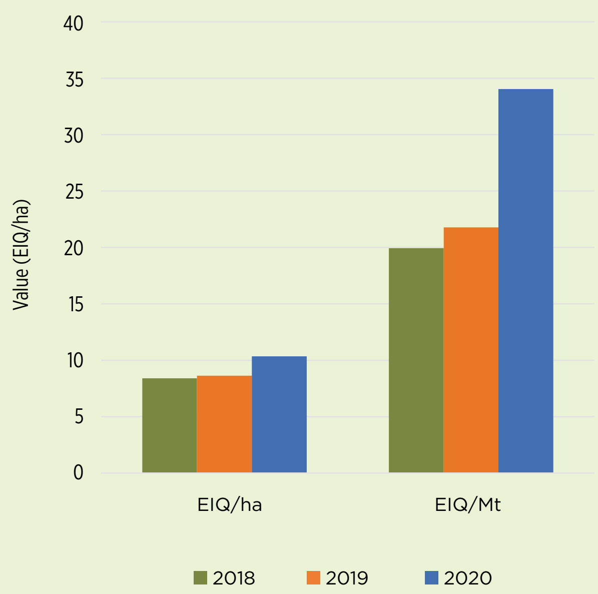
08 Environment

The Environmental Impact Quotient Field Use Rating, a measure for environmental toxicity of pesticide use, jumped significantly despite a reduction in the share of farmers using PAN HHPs

- The Environmental Impact Quotient (EIQ) Field Use Rating[1] is a measure to compare the environmental impact of pest management strategies.
- A higher EIQ Field Use Rating corresponds to a higher (detrimental) impact on the environment and health of the applicators of pesticides.
- The EIQ Field Use Rating = EIQ of a substance * % active ingredient * application rate.
- To calculate this, the FFB software draws the EIQ values of toxic substances from a database in which the EIQ of many substances is recorded as a compilation of acute toxicity levels and long term toxicity for various organisms, half life in soil and plants, as well as groundwater and run-off potential.
- The average EIQ Field Use Rating for all farmers, including those that do not spray, jumped from 8 to 10 per ha (see figure) and from 20 to 34 per Mt of dry cocoa beans, despite fewer farmers using PAN HHPs.
- This implies that those that did continue to use PAN HHPs use more of it. This happens across the sample and is not associated with being in the CCF treatment or not.

1 The EIQ and EIQ Field Use Rating were developed by members of the NYS Integrated Pest Management Program at Cornell University. More info here: https://nysipm.cornell.edu/eiq

Figure 104 Environmental Impact Quotient per Ha and by Mt



Twenty percent of the FFB farmers are responsible for 91% of the total EIQ for the production of cocoa up from 83% in 2018 confirming that a relatively small group is using the largest volume of most toxic substances

- The distribution of EIQ Field Use Rating values in figure 105 shows that 92% of the farmers are below an EIQ Field Use Rating of 10 per ha. Figure 2 shows that the 20% farmers with the highest total EIQ Field Use Rating are responsible for 91% of total EIQ Field Use Rating for the production of cocoa in the sample during the analysis period. In 2018 the top-20% was responsible for 83% of the total EIQ, this confirms what we concluded on the previous page that a relatively small group of farmers is using the most toxic substances in larger volumes than before. This phenomenon is not attributable to the CCF intervention.
- Practically, this means that if the pesticide footprint were to be reduced, one would need to work closely with a relatively small number of farmers and advise them on pesticide use reduction and/or switching to less toxic alternatives.

Figure 105 Distribution of EIQ per ha by Season and Yield in Latest Season by Quintile

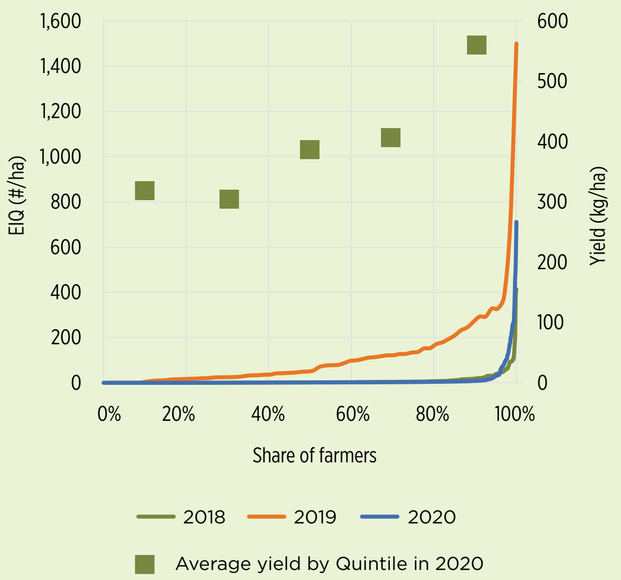
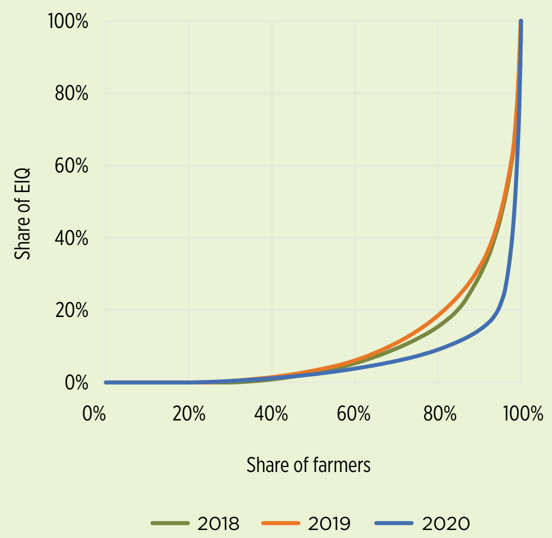


Figure 106 Cumulative Share of EIQ by Cumulative Share of Farmers and Season



ENVIRONMENT

Mean emissions from external inputs equal 38 kg CO_2e per Mt of produced cocoa. Just 20% of all farmers produce 82% total CO_2e emissions and on these farms yields are significantly higher

- Different types of emissions from different types of fertiliser are standardised according to their global warming potential in CO_2 equivalent values (CO_2e) to arrive at a single emission value for each type and a total value of emissions from external inputs. What is not taken into account in this analysis is the emissions associated with decomposition of cocoa pods in the field.
- Emission calculations are typically done over a 3-year period to account for seasonal fluctuations. On a per Mt dry bean basis we find that over the 3-year timeframe emissions from external inputs come in at 38 kg CO2e/Mt, of which fertilisers contribute 33%, energy 37% and pesticides 30%.
- Figure 108 shows that the 50% of farmers with the lowest per farm CO_2e emissions are responsible for only 10% of all emissions in 2018 and that this share dropped to 5% in 2020, whereas the top-20% emitters are responsible for 82% of emissions. What is notable that yields among the top-40% of emitters are significantly higher than in the lower emission groups. If yields are to rise, which given our previous analysis on Living Income is a critical component of poverty reduction, than this will likely be at the expense of rising emissions.

Figure 107 CO_2e Emissions per Ha by Source and Season and CO_2e Emissions per Mt

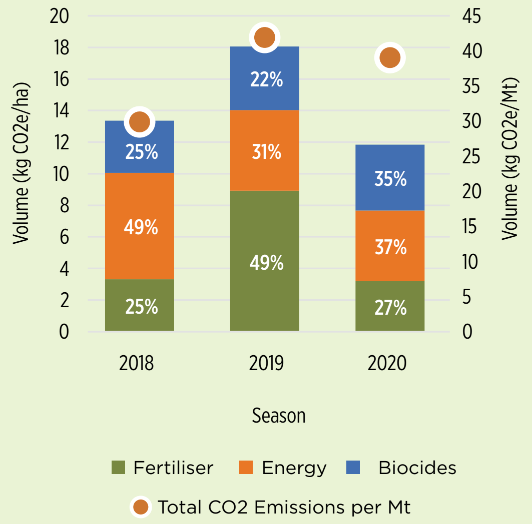
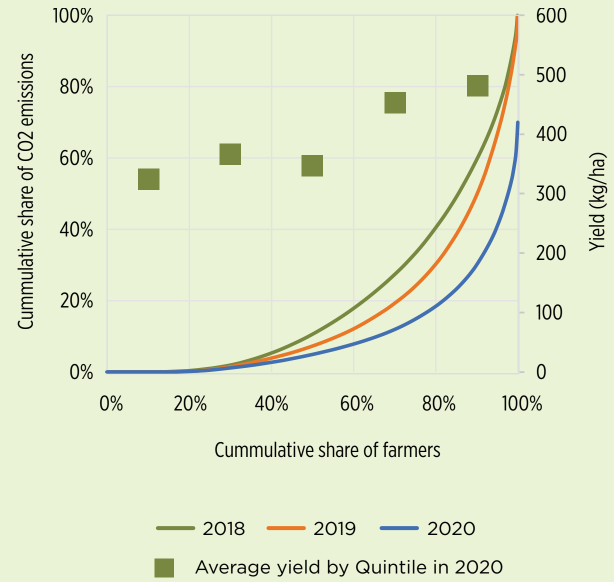


Figure 108 Cumulative Distribution of CO2 Emissions by Season and Yields in 2019 by Quintile



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- IMF date: https://data.imf.org/regular.aspx?key=61545849

FCIP

Farm & Cooperative
Investment Program

September 2021

the sustainable
trade initiative