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Enhanced Microfinance Services and Agricultural Best Management Practices: What Benefits for Smallholders Farmers?
An Evidence from Burkina Faso

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Enhanced Microfinance Services and Agricultural Best Management Practices: What Benefits for Smallholders Farmers? An Evidence from Burkina Faso

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Abstract

This paper analyses the crop production intensification credit [Crédit d'Intensification de la Production Agricole] (CIPA) and its impact on smallholders farmers in Burkina Faso. The methodological approach of the evaluation is based on a randomized experiment coupled to propensity score matching. For the latter, the strategy was to use the observable characteristics of producers and their farms to identify, in non-CIPA areas, producers who have characteristics that have an impact on the propensity to take a credit similar to the CIPA beneficiary producers. We used a Difference-in-Difference approach and analysed the changes in the results between the baseline (2015) and final (2017) surveys witch result in a total of 955 observations in the northern of Burkina Faso and 1,311 in the southern part. The results show that CIPA has a positive effect on area planted, yield, production and sales. However, there is heterogeneity regarding gender, province and perceived quality of services to producers (provided by extension agents, producers' organization and input suppliers). Development projects should therefore consider this heterogeneity in the design of their interventions.

Keywords: Burkina Faso, Microcredit, Agricultural Production, Agricultural Productivity, Impact Evaluation

JEL Codes: O13, Q14

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1 Introduction

In the past fourteen years, African countries' stakeholders introduced several innovations to improve agricultural productivity. Examples include the use of improved seeds and organic manure and better use of mineral fertilizers, water and soil conservation techniques, etc. (Ouedraogo, 2005; Sawadogo et al., 2008; Liniger et al., 2011; Debalke, 2014). Therefore, to increase farmers' adoption of these practices, conventional banks and microfinance institutions encouraged access to credit (AGRA, 2014; FAO, 2016). Indeed, the effects of microcredit have been the subject of several studies over the last fifteen years (Lawin, Tamini and Bocoum, 2018), and the results converge towards a positive effect of access to microcredit on the adoption of agricultural technology. Examples in African countries are Zeller, Diagne and Mataya (1998) in Malawi, Isham (2002) in Tanzania, Croppenstedt Demeke and Meschi (2003) in Ethiopia, Abdulai and Huffman (2005) in Tanzania, Dercon and Christiaensen (2011) in Ethiopia, Girabi and Mwakaje (2013) in Tanzania, Odozi and Omonona (2013) in Nigeria, Lambrecht et al. (2014) in the Democratic Republic of Congo and Tadesse (2014), Tigist et al. (2015) and Abate et al. (2015) in Ethiopia. Indeed, we should expect that access to microcredit has a positive impact on investment in agricultural activities, encourages a better-input use and favors adoption of new technologies. Moreover, potentially, because of better investment and/or inputs use and/or access to new technologies, access to microcredit has a positive impact on farms technical efficiency and productivity, which in turn improves the profitability of farms activities. Figure 1 summarizes the hypothesized impacts of the microcredit (Barnajee et al., 2015a; Lawin et al., 2018).

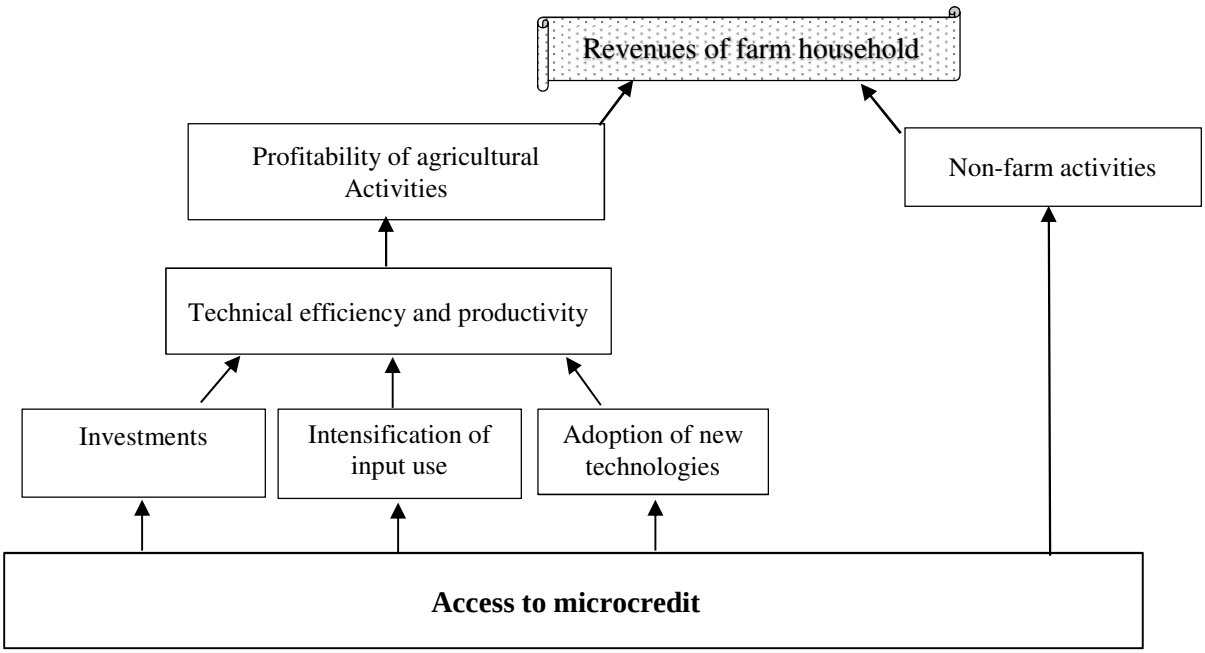

Figure 1. Impacts – postulated - of microcredit on farms and rural households (Source: Lawin et al., 2018).

However, the convergence of the literature on the positive impact of access to microcredit on the adoption of new agricultural technologies could hide methodological problems. As shown by Beaman et al. (2014), Attanasio et al. (2015) and Crépon et al. (2015), very often, farmers self-select to participate in microcredit programmes. The failure to account for this potential selection bias may result in inconsistent estimates of the impact of access to microcredit on the adoption of new technologies. Very few studies in the literature have made an explicit attempt in this direction, which implies that the above-mentioned results could suffer from sample selection bias. The double-hurdle approach used by Croppenstedt et al. (2003) and Hazarika, Bezbaruah and Goswami (2016), the Heckman's (1979) selection probit models in Lambrecht

et al. (2014) or the instrumental variable regressions in Tadesse (2014) have the advantage of accommodating for selectivity bias. However, such techniques do not mitigate biases stemming from observed variables that could explain the differences in adoption between beneficiaries and non-beneficiaries of microcredit. These difficulties in estimating the real causal effect led to the development of experimental studies that allow having a group of non-beneficiaries with similar characteristics to the group of beneficiaries to serve as counterfactual. The literature on experimental methods of impact evaluations shows that one of the best methods for the construction of the counterfactual is random assignment (Duflo, Glennerster and Kremer, 2007; Imbens and Wooldridge, 2009).[5] However, Banerjee et al. (2015a) identify three important elements to consider when designing experimental studies on microcredit, namely low demand for credit in general, weak demand for the form of credit offered by the experiment and the presence of close substitutes that may be formal or informal (loans between producers or from a local merchant). The literature then suggests using additional methods to encourage credit demand if it is too low (Banerjee, 2013). However, one concern that could be introduced by this practice is that of external validity (see Deaton, 2010).

In 2015, The International Development Research Center (IDRC) allowed funding to *Développement International Desjardins* (DID) for the implementation of the Financial Services and Deployment of Agricultural Innovations in Burkina Faso [*Services Financiers et Déploiement d'Innovations Agricoles au Burkina Faso*] (SFDIAB) project. This project

[5] However, there are ongoing discussions on the limitations of the experimental methods (see e.g. Deaton, 2010; Shaffer, 2013) and the best way for strong impact evaluation using them (see e.g. Imbens, 2014; Athley and Imbens, 2016).

intended to develop and test a financial service model for deploying and scaling up innovative practices designed to increase the productivity of agricultural smallholders in Burkina Faso. More precisely, the SFDIAB attempted to answer the following research question: to what extent is it possible to use adapted financial services to stimulate innovation deployment intended for smallholder farmers? Using the value chain approach, DID and the *Réseau des Caisses Populaires du Burkina* (RCPB)[6] designed the crop production intensification credit [*Crédit d'Intensification de la Production Agricole*] (CIPA) to improve services proximity and timely access to good inputs. This is done while allowing RCPB to meet its business objectives in terms of risk management, profitability and customer satisfaction and without additional incentives to encourage credit demand and intake, the latter being intended to insure external validity of the CIPA.

The objective of the present paper is to analyse the CIPA and its impact on smallholder farmers' well-being outcomes while controlling for selection bias as well as taking gender, the producers' organizations performances and the quality of services into account. Indeed, Abate et al. (2015) show that the impact of access to institutional finance is heterogeneous. The effect is significant on large farms, while there is no statistical difference for smallholders owning less than two hectares of land. Abate et al. (2015) explain it by the fact that the adoption of new, improved varieties may entail considerable risks. Fear of welfare repercussions if the improved seeds result in a poor harvest push small farmers to stick with conventional, low-risk practices even if their return is low (Dercon and Christiaensen, 2011). Lawin and Tamini (2019) show that this

[6] See the website at http://www.rcpb.bf/en/. Accessed March 21, 2019.

is also the case in Burkina Faso when considering production diversification. Risk-averse farmers tend to focus more on traditional crops to avoid risks associated with the production of other crops. We analysed the impact of the crop production intensification credit on the size of plots, the yield and production, the food available in the household and finally, the sale of cowpeas and maize. Even if positive, our results show that the impact of the CIPA is heterogeneous.

The rest of the paper is organized as follows. Section 2 presents the SFDIAB, and section 3 presents the experimental design. In section 4, we describe the empirical approach and analyse the results in section 5. The last section concludes the paper.

2 Crop Production Intensification Credit (CIPA) for the deployment of agricultural innovations in Burkina Faso

DID implemented the project in partnership with the RCPB and the Institute of Environment and Agricultural Research of Burkina Faso (INERA). RCPB was responsible for providing the financial services to producers, while INERA was involved in the design and implementation of extension activities.

The SFDIAB project followed a value chain approach and selected maize and cowpea given their high potential for food security and poverty reduction in Burkina Faso.[7] It included four major axes: first, the supply of adapted financial services; second, the technical capacity building activities to extension services for farmers; third, the capacity building of producers

[7] Maize is the primary cereal produced, while cowpea production follows that of cereals. See at https://www.agriculture.bf/jcms/c_5044/fr/accueil (Accessed November 11, 2018).

organizations' (PO) officers on governance and crop marketing; and fourth, the removal of supply chain bottlenecks and building of partnerships with the private sector (input suppliers) in order to ensure timely delivery of quality inputs in sufficient quantity to farmers.

The provinces of Nahouri and Ziro in southern Burkina Faso and the provinces of Zondoma and Passoré in northern Burkina Faso were the sites of the project (See Figure 2 and Appendix 1). In the southern region, the research project targeted maize production mostly done by men, while in the northern region, the project targeted cowpea production mostly cultivated on smaller plots by women.

Source : https://ambaburkina-sn.org/sites/default/files/imagespagedebase/Burkina-carte-provinces.jpg

Figure 2. Intervention area of the research project

2.1 Financial products

2.1.1 The design of the CIPA

CIPA is a short-term credit scheme allowing smallholder producers to buy an input kit (quality seed, fertilizers, adapted pesticides and conservation bags) specific to each crop (maize or

cowpea) and enough for the area cultivated. The minimum credit was 50,000 FCFA[8] and maximum was set at 500,000 FCFA. Those loans were reimbursed in one repayment (capital plus interest) when the crop was sold. The procedures for granting and monitoring of loans were reviewed to:

- offer proximity services to producers near their farm rather than asking borrowers to come to the RCPB branch;
- simplify procedures for granting and disbursement of the loan; and
- control the distribution of inputs to limit the diversion of the funds to be used for agricultural production.

To reduce management costs and facilitate follow-up, CIPA used a group methodology. This allowed consolidating small individual loan applications into a more important credit to their producers' organization. The risk of misappropriation of funds was limited by providing producers with direct inputs rather than an amount of funding.

Because DID and RCPB expected that the overall risk of the CIPA portfolio should be reduced by better lending methodology[9] and by the use of quality inputs available on time it was possible to reduce the guaranty requirements to get a loan. To qualify for CIPA, the borrowers had to deposit the equivalent of 15% of the value of the loan in the PO's account to create a mutual credit guaranty fund. This deposit serves to cover any default of one of the members of the PO

[8] 1 FCFA=0.001672 USD (See at https://business.westernunion.com/fr-ca/Resources/Tools/Currency-Converter , Accessed February 20, 2019).

[9] Also see Barnajee (2013).

and would be given back in full to the members if not used. Otherwise, it was refunded in pro rata of the initial deposit. Therefore, PO members will all have an advantage in ensuring that each member follows the technical path and does not divert inputs for other purposes. Finally, in the event of non-compliance of one member with the grant conditions, the PO is authorized to exploit that member's plot to ensure the full repayment of the loan and protect the assets of the other members. Beside the mutual credit guaranty fund, no other guaranty was requested. Figure 3 illustrates how the CIPA works.

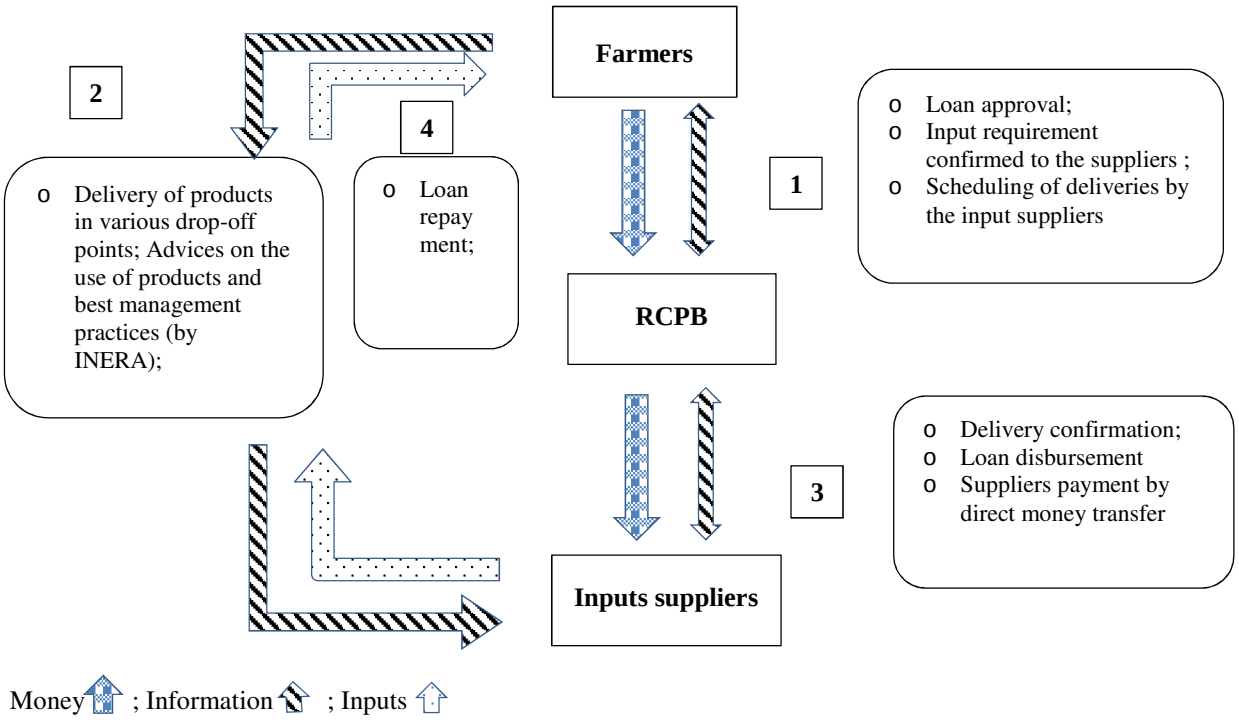

Figure 3. The CIPA system

2.1.2 The CIPA portfolio

The CIPA credit scheme was offered for the crop season 2016 and 2017, during which 93% of the credit requested was granted. Even with this high rate of credit granted, the delinquency rate was near to zero. In fact, aside from a few delays of one to three months, all CIPA loans were repaid. Considering an overall loan loss ratio of 1.29% in 2016 for the microfinance sector in Burkina Faso[10], the CIPA portfolio showed a strong performance. The average loan was lower for women than men were because women usually have smaller cultivated area and specialize in the cowpea value chain that requires less inputs.

Table 1 presents the main statistics of the CIPA granted for the seasons 2016 and 2017.

[10] See *Rapport 2016 de performance financière et sociale des membres del'AP/SFD-BF:* http://www.apsfd-burkina.bf/IMG/pdf/rapport_d_analyse_des_performances_financieres_et_sociales_des_membres_de_l_apsfd-bf_2016_vf-3.pdf. Accessed March 29, 2019.

Table 1. CIPA granted for the 2016 and 2017 crop seasons

2016

Provinces (site)	Number of PO	Number of credit Granted					Amount Granted (in FCFA)				
			By gender		By age			By gender		By age	
		Total	Male	Female	<=35	>35	Total	Male	Female	<=35	>35
Zandoma (Goursy)	18	136	57	79	33	103	5,551,650	2,529,450	3,022,200	1,182,600	4,369,050
Pasoré (Yako)	20	240	93	147	45	195	10,117,800	4,007,700	6,110,100	1,971,000	8,146,800
Nahouri (Pô)	9	104	69	35	25	79	10,450,900	6,946,025	3,504,875	2,867,625	7,583,275
Ziro (Sapouy)	14	157	127	30	36	121	21,985,125	18,543,975	3,441,150	4,397,025	17,588,100
Total	61	637	346	291	139	498	48,105,475	32,027,150	16,078,325	10,418,250	37,687,225

2017

Provinces (site)	Number of PO	Number of credit Granted					Amount Granted (in FCFA)				
			By gender		By age			By gender		By age	
		Total	Male	Female	<=35	>35	Total	Male	Female	<=35	>35
Zandoma (Goursy)	28	205	73	132	45	160	8,845,700	3,638,420	5,207,280	1,835,900	7,009,800
Pasoré (Yako)	24	225	72	153	36	189	9,947,240	3,171,100	6,776,140	1,568,860	8,378,380
Nahouri (Pô)	19	189	143	46	41	148	25,021,875	20,135,250	4,886,625	5,181,000	19,840,875
Ziro (Sapouy)	12	134	92	42	23	111	12,246,000	8,772,375	3,473,625	2,296,125	9,949,875
Total	83	753	380	373	145	608	56,060,815	35,717,145	20,343,670	10,881,885	45,178,930

2.2 Extension activities and capacity building

The timely application of quality fertilizers, pesticides and improved seeds are the best production practices targeted by the project. The project disseminated these practices as part of a value chain approach to foster the development of partnerships, the technical capacities of farmers and the communication between actors in the value chain. The SFDIAB also included capacity building of input suppliers, producers' organizations leaders and extension agents. These activities were (i) information and training of farmers in agricultural production practices through school fields; (ii) support for the development and management of producer organizations; and (iii) information and training of input suppliers for improving the quality of services offered to producers.

3 Experimental design

The methodological approach of the evaluation is based on the construction of a counterfactual to the beneficiaries of CIPA. The strategy was to use the observable characteristics of producers and their farms to identify, in non-CIPA areas, producers with characteristics that have an impact on the propensity to take credit similar to the CIPA beneficiary producers. Figure 4 presents the experimental design.

Two elements are important in the operationalization of the intervention in the field: the commune and the producers' organizations (PO). The commune is the administrative structure used by the RCPB and the technical services (agriculture support, extension,…) of Burkina Faso to organize their interventions in the field. The assignment of treated and control areas was done at the commune level (see discussion below). The RCPB was involved in financial services in

the treated as well as the control communes as are the inputs suppliers. POs are also already part of the national agricultural sector support strategy. Based on the POs, communication and extension activities were conducted in the treated as well as in control communes. Then as summarized in Figure 4, inputs suppliers, RCPB "classical" financial services, and communication and extension activities were present in the treated as well as the control communes. However, in the treated communes, the supply of financial services and those of inputs and capacity building were integrated as depicted in Figure 3. Then, what distinguishes the CIPA is the close integration of finance, inputs supply and training.

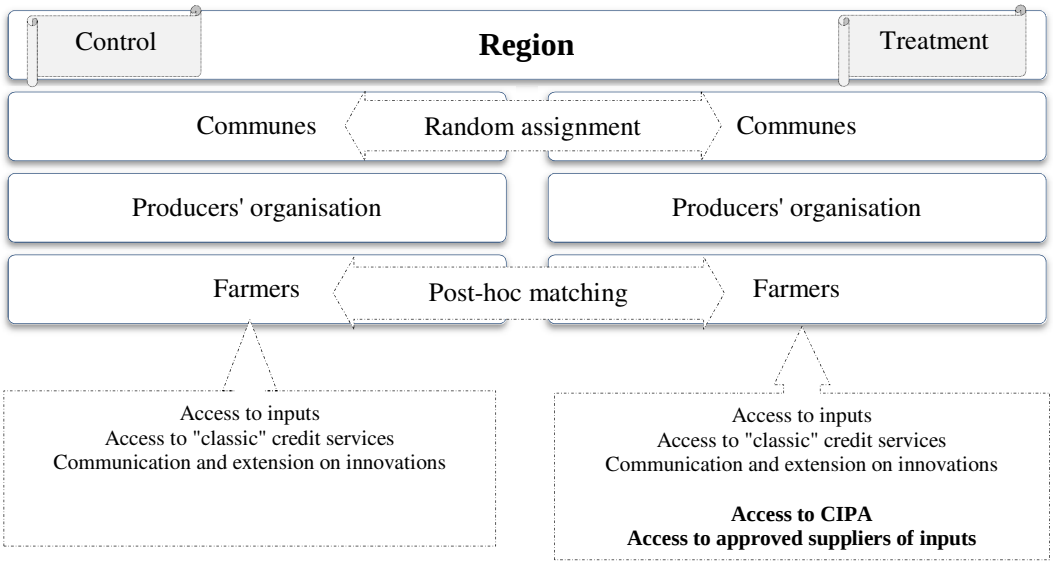

Figure 4. Schematic representation of the experimental design of the SFIAB

Preliminary characterization study of POs

The preliminary characterization of the POs was done in 2 steps. In the first step, the project team conducted meetings with producers' organizations to identify those meeting the eligibility criteria of the research project. Using secondary data (from organizations, technical institutions, financial institutions, etc.), the most detailed information possible was collected on these POs. At this stage, the project team selected approximately 260 farmers' organizations. In the second step, the project team met PO leaders and collected information on their PO. On this basis, the team carried out a mapping of the communes under study and generated random assignments of the treated and control communes.[11] Because the assignment unit was the commune, when a commune was assigned to the treatment group, all the producers who are members of the eligible POs of that commune were included in the treatment. The random assignment generated at the producer level would have made it possible to increase the power of the statistical tests because having a good control for the profile of the producers present in both the control and treated groups (Banerjee et al., 2015a; Banerjee, Karlana and Zinman, 2015b). However, in the context of this study, this would involve rejecting or accepting loan files not only based on their quality but also on a random basis. We choose not to take this approach. However, as shown in section 4, we made an *a posteriori* assignment of producers of control and treatment groups.

[11] Crépon et al. (2015), in their impact assessment study of microcredit in Morocco, adopted a methodology based on random assignment of treatments at the community level. Beaman et al. (2014), Angelucci, Karlan and Zinman (2015) and Attanasio et al. (2015) also used assignment at the community level (cluster). However, unlike Crépon et al. (2015), these studies randomly selected individuals or households regardless of their propensity to borrow.

To minimize the risk of mixing between treated and control areas, the project team defined buffer zones to ensure a minimum distance between the treated and control communes. Assignment at the commune level has the advantage of guaranteeing the integrity of the intervention and corresponds to the administrative structure chosen by the technical services of Burkina Faso to organize their extension activities in the field. All producers who are members of eligible POs in the treated and control areas were included in the baseline survey. Appendix 1 presents the municipalities included in the treated, control and buffer zones.

Baseline survey

The objective of the baseline survey was to identify the profiles of the POs and their members in the control and treatment groups. On this basis, we inferred their behaviour with respect to formal credit; we surveyed 5,583 producers. Correcting for outliers and missing data results in a final database of 1,662 and 1,581 producers for the northern and southern regions respectively.

Final evaluation survey

After two seasons of production, we implemented the final survey that targeted all the producers of the control and the treatment groups. Data from the survey questionnaire were supplemented by credit data whenever available.

4 Empirical approach

4.1 The outcomes

We analysed seven outcomes. The first one is the plot size measured in hectares (ha). While we did not have any expectation on the impact of the CIPA on the plot size, the availability of inputs

can lead to an increase in the areas planted with maize or cowpeas. On the other hand, the difficulties of access to land, especially in the north and for women, can make the intensification of production have no effect on the areas planted or even have a negative effect. Indeed, it is possible that producers reallocate part of the area to other crops. The second and third outcomes are production measured in kilograms (kg) and yield measured in kg per ha (kg/ha). We expect a positive impact because of the timely application of quality fertilizers and improved seeds. The fourth outcome analysed is food available in the household measured in kg per adult equivalent of all production. We analysed the sales in kg and in FCFA of cowpeas in the northern part of the project, and maize in the southern part of the project. However, we do not expect a positive or negative impact of the project on the latter outcome. In fact, it is possible that producers would wait for better market conditions before deciding to sell their crops.

Table 2. Mean of the outcomes

	Provinces of the north of Burkina Faso			
	2016		2018	
Outcomes	Control group	Treatment group	Control group	Treatment group
Plot size	1.112	0.970 (<)	0.514	0.781 (>)
Yield	291.643	372.170 (>)	464.207	356.483 (<)
Production	262.868	272.557 (!≠)	205.837	260.665 (>)
Food	41.217	37.115 (!≠)	39.850	42.920 (!≠)
Sales (kg)	158.874	119.000 (<)	29.885	88.167 (>)
Sales (FCFA)	37,567.630	30,911.270 (!≠)	7,942.073	21,543.960 (>)
Livestock	1.780	2.193 (>)	1.669	2.634 (>)
	Provinces of the south of Burkina Faso			
	2016		2018	
Outcomes	Control group	Treatment group	Control group	Treatment group
Plot size	2.118	1.754 (!≠)	1.983	1.859 (!≠)
Yield	1,062.990	1,504.900 (>)	1,624.706	1,246.966 (<)
Production	1,982.422	2,285.490 (!≠)	3,038.205	2,237.689 (<)
Food	391.089	333.158 (!≠)	640.025	376.743 (<)
Sales (kg)	711.856	645.608 (!≠)	592.673	613.184 (!≠)
Sales (FCFA)	92,651.750	90,901.960 (!≠)	78,954.670	82,589.990 (!≠)
Livestock	2.665	4.732 (>)	3.062	4.317 (>)

Results of the two-sample t-tests (percentage represents the probability to reject null hypothesis, i.e. no difference, wrongly): (!≠): mean of the treatment group is not different at 5% and less. (<): mean of the treatment group is smaller at 5% and less. (>): mean of the treatment group is higher at 5% and less.

presents the descriptive statistics of the outcomes and shows some heterogeneity between the results of the statistical tests on the means when comparing the control group to the treatment group. This implies that a methodological approach that takes into account potential heterogeneity within the groups should be selected.

Table 2. Mean of the outcomes

	Provinces of the north of Burkina Faso					
	2016			2018		
Outcomes	Control group	Treatment group		Control group	Treatment group	
Plot size	1.112	0.970	(<)	0.514	0.781	(>)
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Results of the two-sample t-tests (percentage represents the probability to reject null hypothesis, i.e. no difference, wrongly): (!≠): mean of the treatment group is not different at 5% and less. (<): mean of the treatment group is smaller at 5% and less. (>): mean of the treatment group is higher at 5% and less.

4.2 Propensity score matching (PSM)

As indicated above, assignment to the treatment/control group were done at the commune level. There is no guarantee, however, that the producers are identical in terms of their propensity to take credit. Therefore, we also made an *a posteriori* assignment at the producer level using matching methods to help delivering a precise estimate of the causal effect (Deaton and Cartwright, 2018), Matching methods allow identifying individuals who are not beneficiaries of the programme but who have the same observable characteristics as the beneficiary individuals to serve as a counterfactual. In other words, we matched the participants of the

programme to the non-participants who are *a priori* similar regarding some observable characteristics, using propensity score matching. Rosenbaum and Rubin (1983) show that under some assumptions, propensity score matching is as good as direct matching to observable characteristics. The propensity score is estimated using a logit model that uses the programme participation as the dependent variable. In our matching process, we considered access to formal credit as a treatment variable. In other words, we built a sample of producers in the CIPA and non-CIPA zones who have the same propensity to take formal credit. In the reference survey, we defined formal credit as credit that has been taken from a formal institution. We used the baseline survey data for matching and selected the explanatory variables of the probabilistic models based on a review of literature on credit taking in Africa and its role in the deployment of innovations (See Lawin et al., 2018). Due to certain differences (such as agro-ecological zones, agricultural production, interactions between agricultural activities and other income-generating activities, gender representation, etc.), we estimated the propensity scores and paired the producers for each zone separately. We adopted the nearest neighbour method in which each treated individual is matched with five control individuals who have the closest propensity scores.

Appendix 2 presents the results of the probability estimates. Figure 5 presents the distribution of propensity scores after elimination of unmatched observations for the north and south zones. It shows that we have substantial common support and that we can match the propensity scores of the treatment and comparison groups, as suggested by Smith and Todd (2005).

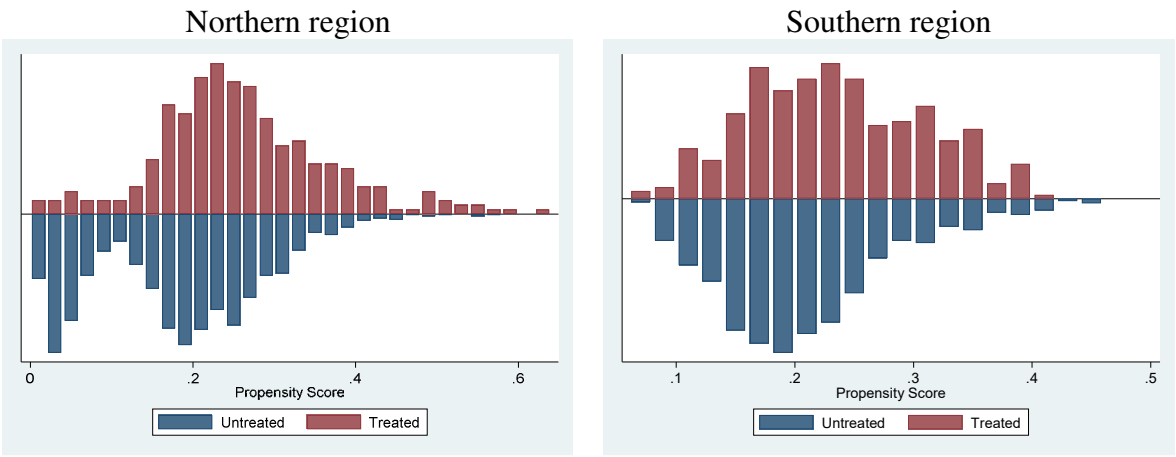

Figure 5. Common support of the treated and control groups

After the matching, we performed balancing tests (see Appendix 3) to ensure that the averages of the producers in the treatment group are similar to those in the comparison group for each of the observable characteristics and in all cases. The matching process resulted in 955 observations for the northern region and 1,311 observations for the southern. **Erreur ! Source du renvoi introuvable.** presents the mean of the outcomes after the PSM. However, these are the arithmetic means and the observed differences should not be confused with the impacts of the project.

Table 3. Mean of the outcomes after matching

	Provinces of the north of Burkina Faso					
	2016			2018		
Outcomes	Control group	Treatment group		Control group	Treatment group	
Plot size	1.074	1.011	(!≠)	0.475	0.776	(>)
Yield	292.778	367.744	(>)	468.572	334.948	(<)
Production	253.567	283.992	(!≠)	199.471	235.727	(!≠)
Food	39.841	36.995	(!≠)	39.178	40.200	(!≠)
Sales (kg)	155.241	119.978	(!≠)	28.971	85.382	(>)
Sales (FCFA)	34,965.410	31,332.760	(!≠)	7,564.987	21,500.000	(>)
Livestock	1.677	2.476	(>)	1.678	2.037	(>)
	Provinces of the south					
	2016			2018		
Outcomes	Control group	Treatment group		Control group	Treatment group	
Plot size	2.136	1.563	(<)	1.976	1.746	(!≠)
Yield	1,087.560	1,349.744	(>)	1614.398	1,253.668	(<)
Production	2,033.500	1,912.918	(!≠)	2999.682	2,115.661	(<)
Food	400.977	303.608	(<)	628.741	370.781	(<)
Sales (kg)	744.739	707.611	(!≠)	555.416	649.016	(!≠)
Sales (FCFA)	96,792.170	103,291.700	(!≠)	73,961.120	87,247.170	(!≠)
Livestock	2.719	5.859	(>)	3.128	4.446	(>)

Results of the two-sample t-tests (percentage represents the probability to reject null hypothesis, i.e. no difference, wrongly): (!≠): mean of the treatment group is not different at 5% and less. (<): mean of the treatment group is smaller at 5% and less. (>): mean of the treatment group is higher at 5% and less.

4.3 Causal effect identification

The used estimator measures the effect on the entire population. Individuals in the treatment group (treated or not) are compared to individuals in the control group to evaluate the effect of the microcredit programme. The estimates take into account all the observations and we estimate the average treatment effect of microfinance programmes on the entire population (Karlan and Zinman, 2011; Beaman et al., 2014; Takahashi et al., 2014; Angelucci et al., 2015; Attanasio et al., 2015; Banerjee et al., 2015; Basu and Wong, 2015; Crépon et al., 2015; Tarozzi, Desai and Johnson, 2015). We based our analysis on changes in the results between the baseline and final

surveys in both groups. In doing so, we mitigated biases related to unobservable characteristics that are invariant over time. Following Lechner (2011) and Puhani (2012), we estimated the effect of access to CIPA on outcome through linear regressions described by the following equation:

$$Y_i = \lambda_0 + \lambda_1 \Lambda_{EF} + \lambda_2 \Lambda_{EF} + \lambda_3 \left(T \times \Lambda_{EF}\right) + \sum_{i=1}^{n} \lambda_{4,i} \left(T \times \Lambda_{EF} \times Z_i\right) + \sum_{i=1}^{n} \lambda_{5,i} \left(T \times Z_i\right) + \sum_{j=1}^{n} \lambda_{6,i} G_j + \varepsilon_i \quad (1)$$

where Y_i is the outcome variable of producer *i* measured in log, which implies that the impact of the CIPA is measured in percentage of change. *T* is a treatment variable that is equal to 1 if the producer has benefited from CIPA and 0 otherwise. We consider baseline (2016) and final (2018) year data. The variable Λ_{EF} takes the value of 1 if the data relates to the final year and 0 otherwise, and Z_i is a vector of variables used to capture heterogeneity of the treatment effect. We hypothesize a different effect depending on the (1) gender of the respondent, (2) province, (3) perceived performance of the extension services, (4) POs and (5) input suppliers. The variable regarding the extension services takes the value of 1 if the answer to the question "*How often do you contact an extension agent to discuss your cornfield or cowpea?*" is less than or equal to 3 months. For PO perceived efficiency, we constructed an index using a factor analysis (Cameron and Trivedi, 2010) based on three questions. The first question is, "*In your opinion do the services provided by your farmer organization have a positive effect on the improvement of your agricultural production?*" (No=1; Yes=2). The second question is, "*Do these services facilitate access to agricultural inputs?*" (Always=4; Often=3; Rarely=2; Never=1). Finally, the third question is, "*Do these services make it easier for you to manage your agricultural*

products?" (Always=4; Often=3; Rarely=2; Never=1). We based the input suppliers' perceived quality on two questions: the first question is "*Are you able to get inputs on time from your suppliers?"* (1=Always or often and 0 otherwise), and the second is "*In your opinion, are your suppliers' inputs of good quality?*" (1=Yes; 0=No). The perceived quality takes the value of 1 if the value of the two variables is 1 and 0 otherwise. G_j is a vector of control variables. Because of the interest in credit, we introduce the perceived quality of credit as a control variable. We used a factor analysis to construct this index and based it on the following questions. "*Does the RCPB network make it easier for you to access credit?*" (2=Yes; 1=No); "*How do you appreciate the requirements of this network to obtain credit?*" (1=Too hard; 2=Hard; 3=Fair; 4=Very acceptable); "*Have you had difficulty accessing credit?*" (1= Yes; 2=No); and "*Does access to credit improve your agricultural production?*" (2= Yes; 1=No). Finally, the variable ε_i is an error term.

The average treatment effect (access to CIPA) is:

$$(2) \qquad \tau_{PSM}^{ATE} = \lambda_1 + \sum_{i=1}^{n} \lambda_{2,i} Z$$

Standard deviations were estimated by correcting for a heteroskedasticity of the error term using White's corrector. Table A6 and Table A7 in the appendix present the descriptive statistics of the variables used in the estimations.

5 Estimated results

5.1 Main results

Tables 4 and 5 present the estimated impact of the CIPA. The detailed tables of results are reported in the appendix (Table A 8 and Table A 9). Because the outcome variables are in log, the estimated coefficient multiplied by 100 gives the percentage of increase following the CIPA.

Plot size

As mentioned before, we did not have any expectation of the impact of the CIPA on the plot size. In the northern part of Burkina Faso, the "generic" impact of the CIPA is positive but not significant at 10%. For women who in the province of Zondoma, the impact is positive, with an increase of 113.9% in comparison to men. Note that the mean of the plot size for women in the province of Zondoma (Passoré) is 0.805 ha (0.866 ha), while it is 1.287 ha (1.342 ha) for men.

The results contrasted for southern Burkina Faso. For the women, the impact is positive and significant at less than 1% if belonging to Ziro while it is negative for those in Nahouri.[12] In the province of Ziro, the impact is positive (=0.545) if the services of the POs are perceived as of quality, while it is negative at -0.875 (=0.545-1.420) in the province of Nahouri. This result suggests that there is a reallocation of area to other crops because of smaller available area, the means of plot sizes being 1.736 ha and 2.164 ha in the provinces of Nahouri and Ziro, respectively.[13] It could also be because of more diversified agricultural activities. In 2016, the

[12] The test of the equality of the coefficients of CIPA X Female and CIPA X Nahouri X Female (F=7.44; Prob > F = 0.007).

[13] The density of the population in Nahouri is about 24% higher than the population of Ziro (INSD, 2016).

base year, the share of plot used in the production of maize was 49% in Nahouri, while it was 64% in Ziro. There is ongoing discussion about the relationship between plot size and productivity [see e.g., Kimhi (2006) and Barrett, Bellemare and Hou (2010)], which is explained by imperfection of the inputs market and the quality of soil. The first explanation could apply to the present study, as the positive impact of CIPA may occur if the suppliers of inputs are perceived to be of good quality in the province of Nahouri.[14] However, it is not significant in the province of Ziro.

Yield

We expected a positive and significant impact of the CIPA on the yield, which was the case for women in northern Burkina Faso. The perceived quality of the services of the PO and extension activities have a positive, significant impact at 1.194 and 0.906, respectively. These results confirm that to be efficient in enhancing producers' performance, the deployment of agricultural financial services must include capacity building of PO and good extension activities. [15]

In southern Burkina Faso, the "generic" impact of the CIPA is positive but not significant at 10%. Extension activities are important in the impact of the CIPA with an increase of yield by 253.5% and 14%[16] if they are perceived to be of good quality in the provinces of Ziro and

[14] We test the following null hypothesis: (Input suppliers) + (Inputs suppliers X Nahouri) = 0 (F = 3.84; Prob > F = 0.050).

[15] As indicated by Zongo et al. (2016) and Dabat, Lahmar and Guissou (2012), the production of cowpeas is mostly done in association with other crops. It is possible to speculate that the impact on the yield of other crops is also positive.

[16] We test the null hypothesis: Extension = Extension X Nahouri (F= 21.08; Prob > F = 0.000).

Nahouri, respectively. The negative result for the perceived quality of input suppliers is puzzling.

Overall, these results are in line with the literature on the impact of microcredit on agricultural productivity (e.g., Girabi and Mwakaje, 2013). However, they highlight the heterogeneity of the results, which must be taken into account. The availability of contraband inputs due to the proximity of Ghana could explain this puzzling result of the perceived quality of input suppliers. The province of Nahouri is also characterized by the presence of several gold panning sites being a source of revenue and thus competing with agricultural production (Ouédraogo and Mundler, 2019; Sangaré, Mundler and Ouédraogo, 2016).

Production and food availability

We also expected a positive impact on production because of the positive impact of the CIPA on plot size and yield. This is the case for women, who showed a 62.5% increase of the production in the province of Passoré and higher impact in Zondoma at 290% (=0.625+2.281). Extension activities, input suppliers and PO service quality have a positive effect on the impact of the CIPA. Because of this increase of production, there is also an improvement in food available at the household level.

In southern Burkina Faso, especially in Ziro, the impact of CIPA on production and food availability is positive if the PO and the extension activities are perceived to be of good quality. However, the impact is negative in the province of Nahouri when producers are female. In addition, the puzzling negative impact on plot size of CIPA when input suppliers are perceived to be of good quality are observed in production and food quality.

Sales

In the northern part of Burkina Faso, CIPA has a positive impact on sales for women, with an increase of 334.1% of sales in kg in the province of Zondoma (compared to men). Moreover, the impact is higher when the extension activities are considered to be of good quality. When considering sales in FCFA, the impact is higher when POs are of good quality. These results are interesting because they indicate that CIPA allows women to generate additional income from their agricultural activities and is therefore a factor in their empowerment. Indeed, Malapit and Quisumbing (2015) found that women's empowerment by access to credit has a strong impact on child nutrition. Moreover, Wouterse (2019) found that enhancing the empowerment of women leads to important productivity gains.

In the southern part of Burkina Faso, as indicated in Table 5, the impact of the CIPA on sales in kg as well as in FCFA is positive and significant at less than 1%. This is also the case for producers in the province of Ziro and perceiving extension activities to be of good quality. In the province of Nahouri, the impacts are also positive but smaller than those of Ziro: 274% versus 40% [17] for the sales in kg, respectively, and 265.7% versus 7.5%[18] for sales in FCFA, respectively.

[17] We test the null hypothesis: Extension = Extension X Nahouri (F = 20.97; Prob > F = 0.000).

[18] We test the null hypothesis: Extension = Extension X Nahouri (F = 19.52; Prob > F = 0.000).

Table 4. Estimated impact of the CIPA in the Northern of Burkina Faso using nearest neighbor matching

Variables		**Plot size**	**Yield**	**Production**	**Food**	**Sales (kg)**	**Sales** (FCFA)
CIPA		0.053	-0.539	0.003	-0.086	0	5.213
		(0.82)	(1.089)	(1.135)	(1.049)	(.)	(5.603)
CIPA X Female		0.164	0.927**	0.625*	0.269	0.932	2.116
		(0.377)	(0.517)	(0.43)	(0.412)	(0.702)	(3.212)
CIPA X Zondoma		-	-	-	-	-	-
		-	-	-	-	-	-
CIPA X Zondoma X Female		1.139**	0.902	2.281***	1.987***	3.341***	3.341
		(0.636)	(0.79)	(0.714)	(0.691)	(1.416)	(4.819)
CIPA X Perceived quality of	Extension	0.046	1.194***	1.186***	1.142***	1.832***	11.828***
		(0.389)	(0.529)	(0.516)	(0.482)	(0.868)	(2.807)
	Extension X Zondoma	-	-	-	-	-	-
		-	-	-	-	-	-
	PO	-0.358	0.906***	0.524***	0.595***	0.382	3.991***
		(0.327)	(0.459)	(0.25)	(0.243)	(0.646)	(1.732)
	PO X Zondoma	-	-	-	-	-	-
		-	-	-	-	-	-
	Input supplier	0.506	0.596	0.789*	0.573	0.695	0.801
		(0.373)	(0.597)	(0.505)	(0.527)	(0.659)	(4.005)
	Input supplier X Zondoma	0.375	-0.326	-0.269	-0.069	-0.002	-4.365
		(0.516)	(0.789)	(0.909)	(0.696)	(1.041)	(4.494)
Adjusted R-squared		0.528	0.131	0.283	0.32	0.417	0.168
Number of observations		955	955	955	955	700	955

Probability to reject null hypothesis (i.e. no effect) wrongly: ***: 01% and less; **: 05% and less; *:10% and less. Robust standard errors in parentheses. - : dropped because of collinearity.

Table 5. Estimated impact of the CIPA in the Southern of Burkina Faso using nearest neighbor matching

Variables		**Plot size**	**Yield**	**Production**	**Food**	**Sales (kg)**	**Sales** (FCFA)
CIPA		-0.197	0.221	0.023	0.000	4.063***	3.555***
		(0.298)	(0.318)	(0.281)	(0.279)	(0.583)	(0.572)
CIPA X Female		1.092***	0.653	1.744**	1.869**	-0.648	-0.564
		(0.412)	(0.538)	(0.727)	(0.748)	(0.550)	(0.591)
CIPA X Nahouri		-	-	-	-	-	-
		-	-	-	-	-	-
CIPA X Nahouri X Female		-1.323**	-0.801	-2.121**	-2.408***	-	-
		(0.525)	(0.709)	(0.855)	(0.891)	-	-
CIPA X Percceived quality	Extension	0.545*	2.535***	3.077***	2.987***	2.740***	2.657***
		(0.281)	(0.495)	(0.466)	(0.478)	(0.574)	(0.645)
	Extension X Nahouri	-1.420***	-2.395***	-3.807***	-3.480***	-2.340***	-2.582***
		(0.396)	(0.683)	(0.767)	(0.895)	(0.654)	(0.681)
	PO	-0.536	-0.099	-0.634	-0.575	-0.124	0.102
		(0.343)	(0.475)	(0.682)	(0.704)	(0.908)	(0.835)
	PO X Nahouri	1.373***	1.248	2.614**	2.397**	1.148	1.267
		(0.510)	(0.812)	(1.055)	(1.085)	(1.123)	(1.078)
	Input suppliers	0.158	-1.102**	-0.943**	-0.833*	0.349	-0.008
		(0.230)	(0.490)	(0.459)	(0.474)	(0.583)	(0.633)
	Input suppliers X Nahouri	0.539	0.586	1.123*	0.417	-1.61	-0.788
		(0.406)	(0.633)	(0.636)	(0.817)	(0.980)	(0.996)
Adjusted R-squar#ed		0.468	0.165	0.261	0.344	0.142	0.103
Number of observations		1,311	1,311	1,311	1,311	852	852

Probability to reject null hypothesis (i.e. no effect) wrongly: ***: 01% and less; **: 05% and less; *:10% and less. Robust standard errors in parentheses. - : dropped because of collinearity.

5.2 Robustness check

To check for robustness, we made our estimations using Radius and Kernel matching methods (Appendix 8.5). Overall, our results are constant with the matching approach used. Specifically, when producers are women and when the extension services and PO are perceived to be of good quality, the impacts of CIPA are robust. The puzzling result for the performant input suppliers is also robust when analysing the results of the southern part of Burkina Faso.

6 Conclusions

In 2015, The International Development Research Center funded *Développement International Desjardins* to implement the Financial Services and Deployment of Agricultural Innovations in Burkina Faso project. This project intended to develop and test a financial service model for deploying and scaling up innovative practices designed to increase the productivity of agricultural smallholders in Burkina Faso.

For DID, access to finance is essential but not sufficient to insure agricultural development. The objective of this research was therefore to validate if an improved financial scheme, the CIPA, based on improved and integrated access to credit, inputs and capacity building program have an impact on smallholder farmers' well-being while controlling for selection bias and taking gender, producers' organizations and the quality of services into account.

The methodological approach of the evaluation is based on the construction of a counterfactual to the beneficiaries of CIPA. The strategy was to use the observable characteristics of producers and their farms to identify, in non-CIPA areas, producers who have characteristics that have an impact on the propensity to take a credit similar to the CIPA beneficiary producers. In non-

CIPA areas, producers have access to conventional credit, inputs available on the market and training separately

We used a *Difference-in-Difference* approach and based our analysis on changes in the results between the baseline and final surveys in both groups. In doing so, we mitigated biases related to unobservable characteristics that are invariant over time.

The results show that CIPA has a positive effect on area planted, yield, production and sales. CIPA was successful at improving agricultural performances, because the project addressed at the same time the financial constraints of small farmers, the problem of limited access to improved and timely available inputs and the lack of supervision and coordination of the different agricultural stakeholders (credit suppliers, input suppliers, POs, farmers, extension agents). The results then suggest that support to smallholder farmers works best when a more integrated approach is taken.

However, there is heterogeneity regarding gender, province and perceived quality of services to producers (provided by extension agents, producers' organization and input suppliers). The perceived quality of services is important to ensure the ability of financial services to encourage innovations in cowpea and maize production in Burkina Faso; scaling up this intervention has to consider perceived quality. On the other hand, there is a higher positive impact for women than for men, which shows that intervention with women is more effective in improving the living conditions of rural households. Development projects should therefore be more supportive of women. Finally, in the southern provinces, the smaller impacts of CIPA are likely the result of a lack of producer interest due to factors such as easy access to contraband inputs and the presence and competition of gold panning. There is a need to better understand and

integrate contextual factors into decisions and intervention choices to ensure that the desired goals are achieved.

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8 Appendix

8.1 Annex 1: Maps of provinces and municipalities

Table A 1**.** Treated, control and buffer municipalities

Regions	**Provinces**	**Municipalities**		
		Treated	Buffer	Control
North	Zondoma	Lèba, Bassi, Tougou	Gourcy	Boussou
	Passoré	Arbolé, Bokin, Kirsi	Gomponsem, Yako, Pilimpikou	Ladoden, Samba, Bagaré
South	Nahouri	Zinko et Ziou	Tiébélé	Pô, Guiaro
	Ziro	Dalo, Gao, Bougnounou	Bakata, Kassou	Sapouy

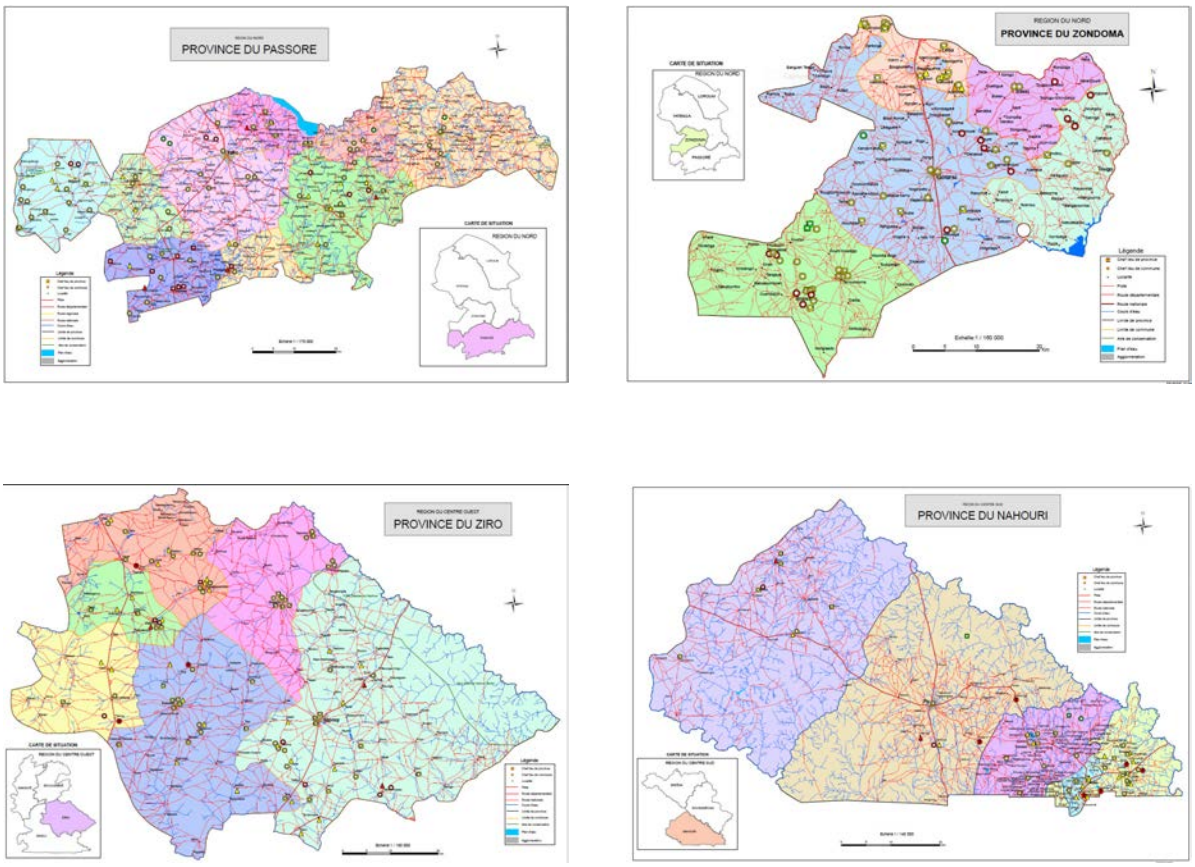

Figure A1. Maps of the different provinces and municipalities of treated, controls and buffer municipalities.

8.2 Appendix 2. Probability estimations of the propensity to take a formal credit

Table A 2**.** Estimate of the probability to take a formal credit – Northern of Burkina Faso

Variables	**Coef.**	**Std. Err.**	**z**	**P>z**
Number of children	0.032	0.012	20.680	0.007
Gender	0.489	0.236	20.070	0.038
Age	0.013	0.006	20.340	0.019
Livestock	0.032	0.024	10.340	0.181
Food shock	0.037	0.009	40.190	0.000
Other shocks	0.502	0.160	30.140	0.002
Plot size	0.132	0.077	10.700	0.088
Equipment	-0.136	0.071	-10.930	0.054
Remittances	0.250	0.112	20.240	0.025
Zondoma	-0.417	0.562	-0.740	0.458
Arbole	0.044	0.316	0.140	0.889
Leba	-20.027	0.819	-20.480	0.013
Bagare	-10.672	0.294	-50.680	0.000
Bassi	0.433	0.800	0.540	0.588
Bokin	-0.551	0.458	-10.200	0.229
Boussou	0.485	0.567	0.860	0.392
Constante	-30.633	0.472	-70.700	0.000
Number of observations	1,625			
Log likelihood	-730.680			

Table A 3**.** Estimate of the probability to take a formal credit – Southern of Burkina Faso

Variables	**Coef.**	**Std. Err.**	**z**	**P>z**
Age	-0.005	0.006	-0.990	0.323
Literacy	0.166	0.153	1.080	0.278
Sexe	0.120	0.158	0.760	0.448
Ethnicity	0.092	0.053	1.750	0.079
Religion	0.038	0.096	0.390	0.694
Number of adults	-0.111	0.048	-2.340	0.019
Number of men	0.174	0.081	2.140	0.032
Number of children	0.006	0.018	0.310	0.758
Other formation	-0.286	0.203	-1.410	0.158
Livestock	-0.016	0.017	-0.940	0.349
Plot size	0.124	0.077	1.610	0.108
Equipment	0.260	0.080	3.260	0.001
Remittences	0.186	0.118	1.570	0.116
Nahouri	-0.680	0.236	-2.880	0.004
Bougnounou	0.509	0.298	1.710	0.087
Dalo	0.770	0.464	1.660	0.097
Guiaro	-0.028	0.213	-0.130	0.896
Constante	-1.222	0.319	-3.840	0.000
Number of observations	1,547			
Log likelihood	-778.454			

8.3 Appendix 3. Balancing tests results

Table A 4**.** Balancing tests results – Northern of Burkina Faso

Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
nbre_enfants	U	8.3754	7.4149	16.8		2.81	0.005	1.34*
	M	7.9305	7.9397	-0.2	99.0	-0.02	0.983	0.83
sexe	U	.8959	.79103	29.1		4.31	0.000	.
	M	.89404	.89106	0.8	97.2	0.12	0.906	.
age	U	42.082	41.528	4.5		0.70	0.484	0.80
	M	41.861	41.518	2.8	38.1	0.35	0.725	0.84
mais_intensif	U	0	.00304	-7.8		-0.98	0.326	.
	M	0	0	0.0	100.0	.	.	.
betail	U	1.9339	1.7199	6.9		1.25	0.212	2.03*
	M	1.8763	1.8703	0.2	97.2	0.03	0.980	1.36*
CH_Q201	U	5.5804	3.9195	19.8		3.43	0.001	1.67*
	M	5.0464	4.903	1.7	91.4	0.20	0.843	0.97
CH_Q1	U	1.4858	1.4438	8.4		1.35	0.177	1.01
	M	1.4934	1.5086	-3.1	63.8	-0.37	0.709	1.00
plotsize_n	U	1.0596	.98033	9.8		1.54	0.124	0.86
	M	1.0153	1.0364	-2.6	73.4	-0.28	0.780	0.36*
agric_index	U	-.02255	.00338	-2.6		-0.42	0.677	1.11
	M	.02187	.00923	1.2	51.3	0.16	0.876	1.01
argent_recu	U	.70978	.58283	20.4		3.35	0.001	1.17
	M	.68212	.67748	0.7	96.3	0.09	0.928	1.03
Zondoma	U	.36593	.35486	2.3		0.37	0.712	.
	M	.35762	.36954	-2.5	-7.7	-0.30	0.761	.
Passore	U	.63407	.64514	-2.3		-0.37	0.712	.
	M	.64238	.63046	2.5	-7.7	0.30	0.761	.
Arbole	U	.05363	.04711	3.0		0.49	0.628	.
	M	.05298	.05497	-0.9	69.5	-0.11	0.914	.
Leba	U	.00946	.08587	-36.4		-4.78	0.000	.
	M	.00993	.01821	-3.9	89.2	-0.86	0.389	.
Arbole	U	.05363	.04711	3.0		0.49	0.628	.
	M	.05298	.05497	-0.9	69.5	-0.11	0.914	.
Bagare	U	.04416	.19225	-47.1		-6.48	0.000	.
	M	.04636	.03444	3.8	92.0	0.74	0.458	.
Bassi	U	.01262	.01064	1.8		0.30	0.762	.
	M	.01325	.01026	2.8	-50.5	0.34	0.735	.
Bokin	U	.02208	.01824	2.7		0.45	0.653	.
	M	.02318	.02517	-1.4	48.3	-0.16	0.874	.
Boussou	U	.33123	.23936	20.4		3.37	0.001	.
	M	.32119	.33146	-2.3	88.8	-0.27	0.788	.
Leba	U	.00946	.08587	-36.4		-4.78	0.000	.
	M	.00993	.01821	-3.9	89.2	-0.86	0.389	.
Tougo	U	.01262	.019	-5.1		-0.77	0.440	.
	M	.01325	.0096	2.9	42.9	0.42	0.674	.

Table A 5**.** Balancing tests results – Southern of Burkina Faso

Variable	Unmatched / Matched	Mean: Treated	Mean: Control	%bias	%reduct |bias|	t-test: t	t-test: p>|t|	V(T)/ V(C)
age	U	39.95	40.083	-1.1		-0.18	0.861	0.75*
	M	39.84	39.715	1.0	6.5	0.13	0.893	0.77*
alphabetiser	U	.25519	.21143	10.4		1.72	0.086	.
	M	.25078	.25643	-1.3	87.1	-0.16	0.870	.
sexe	U	.32344	.33714	-2.9		-0.47	0.637	.
	M	.32602	.3326	-1.4	52.0	-0.18	0.860	.
ethnie	U	3.3175	3.6318	-15.1		-2.49	0.013	1.13
	M	3.3668	3.2784	4.2	71.9	0.52	0.601	1.01
religion	U	1.6142	1.6514	-4.8		-0.78	0.434	1.08
	M	1.5893	1.5837	0.7	84.8	0.09	0.926	0.97
nbre_adultes	U	4.9021	4.8571	1.3		0.22	0.827	1.15
	M	4.8934	4.8658	0.8	38.6	0.10	0.918	1.16
nbre_hoe	U	2.6677	2.4988	8.5		1.44	0.149	1.36*
	M	2.6458	2.6097	1.8	78.7	0.23	0.820	1.25*
nbre_fem	U	2.2344	2.3584	-6.9		-1.11	0.265	0.92
	M	2.2476	2.2561	-0.5	93.2	-0.06	0.951	1.02
nbre_enfants	U	6.0504	5.6343	9.7		1.55	0.121	0.88
	M	5.9592	5.9458	0.3	96.8	0.04	0.967	0.91
autre_form	U	.13056	.12571	1.4		0.24	0.813	.
	M	.13166	.13229	-0.2	87.1	-0.02	0.981	.
betail	U	2.798	2.5983	5.0		0.77	0.440	0.69*
	M	2.7378	2.8574	-3.0	40.1	-0.37	0.710	0.52*
plotsize_n	U	1.0206	.94127	8.7		1.37	0.170	0.82
	M	.98338	.97155	1.3	85.1	0.18	0.859	0.77*
agric_index	U	.22479	-.05963	28.8		4.63	0.000	0.93
	M	.18899	.17526	1.4	95.2	0.18	0.857	1.05
argent_recu	U	.39169	.28082	20.1		3.42	0.001	1.37*
	M	.35737	.37429	-3.1	84.7	-0.38	0.706	0.99
Nahouri	U	.52819	.67265	-29.8		-4.93	0.000	.
	M	.55486	.53229	4.7	84.4	0.57	0.568	.
Bougnounou	U	.07122	.03429	16.6		2.99	0.003	.
	M	.05956	.05392	2.5	84.7	0.31	0.759	.
Dalo	U	.02967	.0098	14.3		2.75	0.006	.
	M	.0094	.01003	-0.5	96.8	-0.08	0.936	.
Gao	U	.00297	0	7.7		1.91	0.057	.
	M	0	0	0.0	100.0	.	.	.
Guiaro	U	.11573	.15673	-12.0		-1.88	0.060	.
	M	.12226	.11066	3.4	71.7	0.46	0.649	.
Sapouy	U	.36795	.28327	18.1		3.01	0.003	.
	M	.37618	.40376	-5.9	67.4	-0.71	0.476	.
Zecco	U	.00297	0	7.7		1.91	0.057	.
	M	0	0	0.0	100.0	.	.	.
Bougnounou	U	.07122	.03429	16.6		2.99	0.003	.
	M	.05956	.05392	2.5	84.7	0.31	0.759	.
Dalo	U	.02967	.0098	14.3		2.75	0.006	.
	M	.0094	.01003	-0.5	96.8	-0.08	0.936	.
Gao	U	.00297	0	7.7		1.91	0.057	.
	M	0	0	0.0	100.0	.	.	.
Guiaro	U	.11573	.15673	-12.0		-1.88	0.060	.
	M	.12226	.11066	3.4	71.7	0.46	0.649	.
Sapouy	U	.36795	.28327	18.1		3.01	0.003	.
	M	.37618	.40376	-5.9	67.4	-0.71	0.476	.
Tougo	U	0	0	.		.	.	.
	M	0	0	.	.	.	.	.
Zecco	U	.00297	0	7.7		1.91	0.057	.
	M	0	0	0.0	100.0	.	.	.

8.4 Appendix 4. Descriptive statistics of the control variables used in the estimation of the impact of the CIPA

Table A 6. Descriptive statistics of the control variables used in the estimation of the CIPA – Northern of Burkina Faso

Variables	mean	min	max	sd
Dtrait_f	0.083	0.000	1.000	0.276
Dtrait_tps_f	0.037	0.000	1.000	0.188
P_f	0.355	0.000	1.000	0.479
sexe_tps	0.000	0.000	0.000	0.000
sexe_tps_P	0.089	0.000	1.000	0.285
Province_tps	0.104	0.000	1.000	0.305
Dtrait_P	0.031	0.000	1.000	0.175
Dtrait_P_tps	0.014	0.000	1.000	0.116
Dtrait_P_f	0.014	0.000	1.000	0.116
Dtrait_P_t~f	0.005	0.000	1.000	0.072
vulga2_tps	0.043	0.000	1.000	0.203
Dtrait_V	0.017	0.000	1.000	0.128
Dtrait_V_tps	0.007	0.000	1.000	0.085
Dtrait_V_t~P	0.000	0.000	0.000	0.000
Dtrait_V_t~f	0.000	0.000	0.000	0.000
Dtrait_V_P	0.002	0.000	1.000	0.046
Dtrait_V_f	0.000	0.000	0.000	0.000
OPB2_tps	0.030	-2.178	0.547	0.518
Dtrait_O	0.021	-2.178	0.547	0.272
Dtrait_O_tps	0.024	-0.727	0.547	0.128
Dtrait_O_t~P	0.007	0.000	0.547	0.063
Dtrait_O_t~f	0.000	0.000	0.000	0.000
Dtrait_O_P	0.016	-0.727	0.547	0.097
Dtrait_O_f	0.000	0.000	0.000	0.000
Intrants2_~s	0.228	0.000	1.000	0.420
Dtrait_I	0.092	0.000	1.000	0.289
Dtrait_I_tps	0.041	0.000	1.000	0.198
Dtrait_I_t~P	0.012	0.000	1.000	0.107
Dtrait_I_t~f	0.025	0.000	1.000	0.157
Dtrait_I_P	0.027	0.000	1.000	0.163
Dtrait_I_f	0.065	0.000	1.000	0.247
time	0.303	0.000	1.000	0.460
sexe	0.879	0.000	1.000	0.327
Passore	0.606	0.000	1.000	0.489
vulga2	0.098	0.000	1.000	0.298
OPB2	0.034	-2.178	0.547	0.954
Intrants2	0.770	0.000	1.000	0.421

chef	0.290	0.000	1.000	0.454
age	41.645	19.000	72.000	12.080
EquiAdulte	7.323	1.000	25.158	3.808
alphabetiser	0.208	0.000	1.000	0.406
tontine	0.510	0.000	1.000	0.500
plotsize	1.605	0.030	6.000	1.003
plot_age	10.958	0.000	45.000	8.479
agric_index	0.071	-3.019	1.286	0.971
nbre_culture	2.117	1.000	3.000	0.607
nbre_parce~e	1.694	1.000	5.000	0.778
foncier	0.088	0.000	1.000	0.283
Pratiqueagro	0.931	0.000	5.000	1.066
fosse	0.557	0.000	1.000	0.497
Bassi	0.008	0.000	1.000	0.091
Boussou	0.363	0.000	1.000	0.481
Leba	0.013	0.000	1.000	0.111
Tougo	0.009	0.000	1.000	0.097
Arbole	0.024	0.000	1.000	0.153
Bagare	0.054	0.000	1.000	0.227
Bokin	0.020	0.000	1.000	0.140
Kirsi	0.045	0.000	1.000	0.207
La_todin	0.244	0.000	1.000	0.430
Samba	0.219	0.000	1.000	0.414
Bassi_tps	0.003	0.000	1.000	0.056
Boussou_tps	0.091	0.000	1.000	0.288
Leba_tps	0.005	0.000	1.000	0.072
Tougo_tps	0.004	0.000	1.000	0.065
Arbole_tps	0.007	0.000	1.000	0.085
Bagare_tps	0.008	0.000	1.000	0.091
Bokin_tps	0.010	0.000	1.000	0.102
Kirsi_tps	0.022	0.000	1.000	0.147
La_todin_tps	0.076	0.000	1.000	0.266
Samba_tps	0.074	0.000	1.000	0.262
reseau_cre~t	0.038	-2.217	2.094	0.990
reseau~f_tps	0.000	0.000	0.000	0.000
reseau_cre~f	0.000	0.000	0.000	0.000
reseau_cre~P	0.054	-2.217	2.094	0.577
reseau~P_tps	0.018	-2.217	2.094	0.348

Table A 7. Descriptive statistics of the control variables used in the estimation of the CIPA – Southern of Burkina Faso

Variables	mean	min	max	sd
Dtrait_f	0.011	0.000	1.000	0.106
Dtrait_tps_f	0.005	0.000	1.000	0.073
P_f	0.121	0.000	1.000	0.326
sexe_tps	0.055	0.000	1.000	0.228
sexe_tps_P	0.043	0.000	1.000	0.202
Province_tps	0.276	0.000	1.000	0.447
Dtrait_P	0.059	0.000	1.000	0.235
Dtrait_P_tps	0.039	0.000	1.000	0.193
Dtrait_P_f	0.010	0.000	1.000	0.099
Dtrait_P_t~f	0.005	0.000	1.000	0.068
vulga2_tps	0.035	0.000	1.000	0.184
Dtrait_V	0.011	0.000	1.000	0.103
Dtrait_V_tps	0.008	0.000	1.000	0.091
Dtrait_V_t~P	0.008	0.000	1.000	0.087
Dtrait_V_t~f	0.000	0.000	0.000	0.000
Dtrait_V_P	0.009	0.000	1.000	0.095
Dtrait_V_f	0.000	0.000	0.000	0.000
OPB2_tps	0.046	0.000	1.000	0.209
Dtrait_O	0.015	0.000	1.000	0.123
Dtrait_O_tps	0.004	0.000	1.000	0.062
Dtrait_O_t~P	0.002	0.000	1.000	0.039
Dtrait_O_t~f	0.000	0.000	0.000	0.000
Dtrait_O_P	0.005	0.000	1.000	0.073
Dtrait_O_f	0.000	0.000	0.000	0.000
Intrants2_~s	0.072	0.000	1.000	0.259
Dtrait_I	0.026	0.000	1.000	0.159
Dtrait_I_tps	0.018	0.000	1.000	0.131
Dtrait_I_t~P	0.009	0.000	1.000	0.095
Dtrait_I_t~f	0.000	0.000	0.000	0.000
Dtrait_I_P	0.012	0.000	1.000	0.110
Dtrait_I_f	0.000	0.000	0.000	0.000
time	0.434	0.000	1.000	0.496
sexe	0.194	0.000	1.000	0.395
Prov_ref	0.630	0.000	1.000	0.483
vulga2	0.075	0.000	1.000	0.263
OPB2	0.204	0.000	1.000	0.403
Intrants2	0.148	0.000	1.000	0.355
chef	0.757	0.000	1.000	0.429
age	41.708	19.000	72.000	11.950
EquiAdulte	6.019	0.536	23.580	3.193

alphabetiser	0.212	0.000	1.000	0.409
tontine	0.202	0.000	1.000	0.402
transfert	0.149	0.000	1.000	0.356
plotsize	5.433	0.163	52.000	3.946
plot_age	12.277	0.000	45.000	7.656
agric_index	0.316	-3.135	2.779	0.809
nbre_culture	2.405	1.000	6.000	0.715
nbre_parce~e	1.251	1.000	4.000	0.493
foncier_at~i	0.062	0.000	1.000	0.237
Pratiqueagro	0.195	0.000	2.000	0.435
fosse	0.423	0.000	1.000	0.494
Bougnounou	0.046	0.000	1.000	0.209
Dalo	0.005	0.000	1.000	0.068
Guiaro	0.114	0.000	1.000	0.318
Po	0.000	0.000	0.000	0.000
Sapouy	0.320	0.000	1.000	0.467
Ziou	0.039	0.000	1.000	0.193
Bougnounou~s	0.024	0.000	1.000	0.154
Dalo_tps	0.002	0.000	1.000	0.048
Guiaro_tps	0.042	0.000	1.000	0.201
Po_tps	0.000	0.000	0.000	0.000
Sapouy_tps	0.131	0.000	1.000	0.338
Ziou_tps	0.019	0.000	1.000	0.137
reseau_cre~t	0.034	-1.898	2.209	0.985
reseau~f_tps	0.001	-1.898	2.209	0.237
reseau_cre~f	0.024	-1.898	2.209	0.440
reseau_cre~P	0.021	-1.548	2.209	0.328
reseau~P_tps	0.038	-1.548	2.209	0.524

8.5 Appendix 5. Detailed results of the estimations of the impact of CIPA using nearest neighbor matching

Table A 8. Detailed results of the estimation of the impact of the CIPA in the Northern of Burkina Faso using nearest neighbor matching

Variables	Plot_size	Yield	Production	Food	Sales_kg	Sales_CFA
Dtrait	0.465	-0.937	-0.449	0.613	-0.13	1.351
Dtrait_tps	0.053	-0.539	0.003	-0.086	-	5.213
Dtrait_f	0.141	-0.609**	-0.209	-0.107	-0.272	-3.174
Dtrait_tps_f	0.164	0.927*	0.625	0.269	0.932	2.116
P_f	0.093	-0.518*	-0.173	-0.105	-0.193	-1.738*
sexe_tps	-	-	-	-	-	-
sexe_tps_P	-0.176	-0.353	-0.984***	-0.909***	-1.176*	1.649
Province_tps	-0.305	-1.841***	-2.347***	-2.120***	0.96	-6.849**
Dtrait_P	-	-	-	-	-	-
Dtrait_P_tps	-	-	-	-	-	-
Dtrait_P_f	-0.496	0.151	-0.482	-0.262	-0.313	-4.002
Dtrait_P_t~f	1.139*	0.902	2.281***	1.987***	3.341**	3.341
vulga2_tps	0.042	0.21	0.338	0.292	-0.084	0.461
Dtrait_V	0.497**	-1.050***	-0.620*	-0.667**	0.149	-4.065*
Dtrait_V_tps	0.046	1.194**	1.186**	1.142**	1.832**	11.828***
Dtrait_V_t~P	-	-	-	-	-	-
Dtrait_V_t~f	-	-	-	-	-	-
Dtrait_V_P	-0.34	0.590*	0.402	0.172	0.064	-1.931
Dtrait_V_f	-	-	-	-	-	-
OPB2_tps	-0.013	0.05	0.025	0.021	0.133	-0.401
Dtrait_O	0.031	-0.353***	-0.320***	-0.282***	-0.21	-0.727
Dtrait_O_tps	-0.358	0.906**	0.524**	0.595**	0.382	3.991**
Dtrait_O_t~P	-	-	-	-	-	-
Dtrait_O_t~f	-	-	-	-	-	-
Dtrait_O_P	-0.001	0.440*	0.541**	0.196	0.417	1.663
Dtrait_O_f	-	-	-	-	-	-
Intrants2_~s	-0.036	-0.13	-0.02	-0.064	0.021	1.24
Dtrait_I	0.691**	-0.818**	-0.233	-0.308	0.506	-3.874
Dtrait_I_tps	0.506	0.596	0.789	0.573	0.695	0.801
Dtrait_I_t~P	0.375	-0.326	-0.269	-0.069	-0.002	-4.365
Dtrait_I_t~f	-1.470***	-0.101	-1.006**	-0.664	-1.132	-4.664
Dtrait_I_P	-1.002***	1.583***	0.739*	0.12	0.492	4.479
Dtrait_I_f	0.295	0.214	0.25	0.204	0.281	5.567
time	-0.750***	0.618	-0.082	-0.094	-1.117**	-4.026**
sexe	-0.133	0.141	-0.213*	-0.237*	-0.274*	0.416
Passore	-0.881**	0.973	0.099	-0.797	1.707***	-1.983
vulga2	-0.023	-0.169	-0.132	-0.103	0.166	-0.242

OPB2	-0.002	0.014	-0.006	-0.014	0.006	0.278
Intrants2	0.001	0.006	-0.023	-0.007	-0.136	-0.888**
chef	0.008	0.106	0.117	0.137*	-0.113	0.522
age	-0.002	0	0	0	0	-0.002
EquiAdulte	0.003	0.011	0.011	-0.109***	0.022**	-0.016
alphabetiser	0.042	0.04	0.101	0.079	0.219***	0.296
tontine	-0.02	0.046	0.131**	0.132**	0.190**	0.711**
plotsize	0.421***	-0.177***	0.217***	0.185***	0.167***	0.347**
plot_age	0	0.002	0.004	0.003	0.006	-0.017
agric_index	-0.02	0.106***	0.154***	0.135***	0.179***	0.681***
nbre_culture	0.012	0.192***	0.128**	0.105**	-0.031	-0.418
nbre_parce~e	0.449***	-0.090**	0.313***	0.270***	0.179***	0.471**
foncier	0.052	-0.075	-0.076	-0.072	0.03	-0.439
Pratiqueagro	-0.017	0.012	0.027	0.022	-0.023	-0.115
fosse	-0.012	0.121*	0.061	0.052	0.054	-0.285
Bassi	-	-	-	-	0.576	-
Boussou	-	-	-	-	1.597***	-
Leba	-0.299	0.236	-0.081	-0.432	0.735	0.838
Tougo	-0.196	-0.468	-0.839*	-0.876*	-	-8.374***
Arbole	-	-	-	-	-0.858	-
Bagare	1.302***	-1.176*	0.11	1.095	-	2.004
Bokin	-0.135	0.814***	0.792***	0.763***	-0.6	0.951
Kirsi	-0.715***	1.321***	0.645**	0.590**	-0.997	1.738
La_todin	0.956**	-1.330*	-0.431	0.596	-0.494***	0.422
Samba	1.032**	-1.607**	-0.449	0.566	-0.742***	-0.311
Bassi_tps	-	-	-	-	-4.380***	-
Boussou_tps	0.830***	2.349***	3.364***	3.154***	-	6.466***
Leba_tps	0.089	0.66	1.018*	1.055*	-2.078***	2.227
Tougo_tps	0.381	1.554**	2.177***	2.000***	-	6.167
Arbole_tps	0.49	-0.031	0.195	0.486	-	-3.904
Bagare_tps	-	-	-	-	-0.463	-
Bokin_tps	0.726	-2.019*	-1.8	-1.367	-2.142*	-11.580*
Kirsi_tps	1.710*	-2.262*	-0.763	-0.447	-0.605	-8.349
La_todin_tps	0.562***	-0.261	0.09	0.096	-0.251	0.536
Samba_tps	0.304	0.054	-0.264	-0.252	-0.324	-1.399
reseau_cre~t	-0.054*	0.069*	0.03	0.041	0.047	0.196
reseau~f_tps	-	-	-	-	-	-
reseau_cre~f	-	-	-	-	-	-
reseau_cre~P	0.015	-0.065	-0.01	-0.019	0.03	-0.397
reseau~P_tps	0.097	-0.099	-0.092	-0.095	-0.19	0.394
_cons	-0.373	5.487***	4.082***	3.261***	2.905***	9.767***

***: 01% and less; **: 05% and less; *:10% and less. - : dropped because of collinearity.

Table A 9. Detailed results of the estimation of the impact of the CIPA in the Southern of Burkina Faso using nearest neighbor matching

Variables	Plot_size	Yield	Production	Food	Sales_kg	Sales_CFA
Dtrait	-0.029	-0.227	-0.255	-0.236	-4.528***	-3.998***
Dtrait_tps	-0.197	0.221	0.023	0.000	4.063***	3.555***
Dtrait_f	0.368**	-0.759**	-0.391	-0.597*	1.779*	1.890*
Dtrait_tps_f	1.092***	0.653	1.744**	1.869**	-0.648	-0.564
P_f	-0.038	0.111	0.072	0.064	0.407**	0.681***
sexe_tps	-0.203	-0.291	-0.494*	-0.559*	-0.219	0.027
sexe_tps_P	0.503**	-0.011	0.492	0.570*	0.146	-0.138
Province_tps	-	-	-	-	-	-
Dtrait_P	0.397**	-0.258	0.139	0.205	4.666***	4.601***
Dtrait_P_tps	-	-	-	-	-3.963***	-3.903***
Dtrait_P_f	-0.576*	0.824	0.247	0.633	-2.073**	-2.350***
Dtrait_P_t~f	-1.323**	-0.801	-2.121**	-2.408***	-	-
vulga2_tps	0.235**	-0.323*	-0.088	-0.13	0.133	-0.037
Dtrait_V	0.308**	-1.814***	-1.505***	-1.504***	-0.880***	-0.587
Dtrait_V_tps	0.545*	2.535***	3.077***	2.987***	2.740***	2.657***
Dtrait_V_t~P	-1.420***	-2.395***	-3.807***	-3.480***	-2.340***	-2.582***
Dtrait_V_t~f	-	-	-	-	-	-
Dtrait_V_P	0.082	2.176***	2.252***	1.908**	-	-
Dtrait_V_f	-	-	-	-	-	-
OPB2_tps	0.036	-0.13	-0.094	-0.089	-0.525**	-0.657**
Dtrait_O	0.195	0.385	0.579**	0.468	0.825	0.536
Dtrait_O_tps	-0.536	-0.099	-0.634	-0.575	-0.124	0.102
Dtrait_O_t~P	1.373***	1.248	2.614**	2.397**	1.148	1.267
Dtrait_O_t~f	-	-	-	-	-	-
Dtrait_O_P	-0.198	-1.200*	-1.393*	-1.202	-0.187	-0.259
Dtrait_O_f	-	-	-	-	-	-
Intrants2_~s	0.127	0.164	0.291*	0.275*	-0.068	0.124
Dtrait_I	-0.148	0.302	0.153	0.056	-0.566	-0.367
Dtrait_I_tps	0.158	-1.102**	-0.943**	-0.833*	0.349	-0.008
Dtrait_I_t~P	0.539	0.586	1.123*	0.417	-1.61	-0.788
Dtrait_I_t~f	-	-	-	-	-	-
Dtrait_I_P	-0.117	-0.343	-0.459	0.232	1.858***	1.134*
Dtrait_I_f	-	-	-	-	-	-
time	-0.256***	0.389***	0.133*	0.137*	-0.238**	-0.088
sexe	-0.260***	-0.052	-0.312*	-0.293*	-0.455**	-0.581**
Prov_ref	0.25	0.059	0.309	0.29	-1.496***	-1.496***
vulga2	0.058	0.087	0.145	0.166	0.17	0.362**
OPB2	-0.059	0.083	0.025	0.028	-0.155*	-0.052
Intrants2	0.014	-0.009	0.005	0.008	0.012	-0.174
chef	0.089*	0.015	0.103	0.106	0.054	0.105

Variables	Plot_size	Yield	Production	Food	Sales_kg	Sales_CFA
age	0	0.001	0.001	-0.001	-0.003	-0.003
EquiAdulte	0.004	0.017**	0.021**	-0.119***	0.006	0
alphabetiser	0.029	-0.034	-0.005	-0.003	0.034	-0.005
tontine	0.021	0.02	0.041	0.023	0.131	0.185**
transfert	-0.044	0.032	-0.013	-0.004	-0.151*	-0.144
plotsize	0.083***	-0.031***	0.052***	0.053***	0.053***	0.059***
plot_age	0.009***	-0.010***	-0.001	-0.003	-0.002	0.001
agric_index	0.105***	0.073**	0.177***	0.155***	0.227***	0.270***
nbre_culture	-0.197***	0.123***	-0.073*	-0.076*	-0.111**	-0.081
nbre_parce~e	-0.033	0.156***	0.123**	0.115*	0.1	0.063
foncier_at~i	-0.126*	0.042	-0.084	-0.088	0.294*	0.296*
Pratiqueagro	0.016	-0.170***	-0.154**	-0.143**	-0.025	-0.022
fosse	-0.022	-0.003	-0.025	-0.025	-0.095	-0.153*
Bougnounou	0.083	0.299	0.381	0.456*	2.722***	2.355***
Dalo	-	-	-	-	-	-
Guiaro	-0.01	-0.243***	-0.252***	-0.253***	-0.260**	-0.232*
Po	-	-	-	-	-	-
Sapouy	0.315	0.043	0.358	0.337	-1.410***	-1.455***
Ziou	-0.605**	0.377	-0.228	-0.34	-0.251	-0.114
Bougnounou	0.365	-0.646	-0.28	-0.33	-3.894***	-3.496***
Dalo_tps	0.685	0.452	1.137**	1.038*	-	-
Guiaro_tps	-0.009	0.921***	0.912***	0.936***	0.530*	0.451
Po_tps	-	-	-	-	-	-
Sapouy_tps	0.023	0.121	0.144	0.129	0.08	0.166
Ziou_tps	-	-	-	-	-	-
reseau_cre~t	0.022	-0.01	0.011	0.007	0.063	0.114**
reseau~f_tps	0.09	0.063	0.153	0.194	-0.084	-0.186
reseau_cre~f	-0.004	0.007	0.002	-0.034	-0.101	0.142
reseau_cre~P	-0.066	-0.059	-0.125	-0.094	0.19	-0.02
reseau~P_tps	0.011	0.262***	0.272***	0.278***	0.008	-0.02
_cons	0.293	6.287***	6.581***	5.870***	8.056***	12.709***

***: 01% and less; **: 05% and less; *:10% and less. - : dropped because of collinearity.

Table A 10. Estimated impact of the CIPA in the Northern region using Kernel matching

Variables		**Plot size**	**Yield**	**Production**	**Food**	**Sales (kg)**	**Sales** (FCFA)
CIPA		0.379	-0.362	0.283	0.251	-0.127	1.004
		(0.411)	(0.433)	(0.464)	(0.445)	(1.385)	(3.459)
CIPA X Female		-0.105	1.065***	0.855**	0.723*	1.162*	1.673
		(0.392)	(0.422)	(0.516)	(0.463)	(0.724)	(3.292)
CIPA X Zondoma		-	-	-	-	-	-
		-	-	-	-	-	-
CIPA X Zondoma X Female		1.610***	-1.214**	1.185**	1.091**	1.796*	2.682
		(0.539)	(0.641)	(0.691)	(0.644)	(1.123)	(4.093)
CIPA X Perceived quality of	Extension	0.143	0.681*	0.833***	0.752***	0.602	8.394***
		(0.300)	(0.423)	(0.403)	(0.379)	(0.543)	(2.304)
	Extension X Zondoma	-0.108	0.2	0.109	0.106	0.161	-1.76
		(0.380)	(0.659)	(0.666)	(0.614)	(0.795)	(4.407)
	PO	-0.137	0.456***	0.313***	0.375***	-0.689	2.644***
		(0.172)	(0.213)	(0.140)	(0.135)	(0.670)	(1.212)
	PO X Zondoma	-	-	-	-	-	-
		-	-	-	-	-	-
	Input supplier	0.307	-0.258	-0.086	-0.02	1.018**	-1.351
		(0.359)	(0.399)	(0.388)	(0.348)	(0.583)	(2.858)
	Input supplier X Zondoma	0.339	-0.037	0.341	0.397	0.284	1.149
		(0.429)	(0.642)	(0.690)	(0.527)	(1.234)	(3.827)
Number of observations		1,382	1,382	1,382	1,382	1,016	1,106
Adjusted R-squared		0.545	0.136	0.309	0.337	0.402	0.185

Probability to reject null hypothesis (i.e. no effect) wrongly: ***: 01% and less; **: 05% and less; *:10% and less. Robust standard errors in parentheses. - : dropped because of collinearity.

Table A 11. Estimated impact of the CIPA in the Northern region using Radius matching

Variables		**Plot size**	**Yield**	**Production**	**Food**	**Sales (kg)**	**Sales** (FCFA)
CIPA		0.399	-0.402	0.236	0.209	0.739	0.722
		(0.421)	(0.436)	(0.467)	(0.451)	(0.556)	(3.406)
CIPA X Female		-0.103	1.044***	0.834*	0.704*	1.153*	1.5
		(0.395)	(0.423)	(0.515)	(0.465)	(0.721)	(3.260)
CIPA X Zondoma		-	-	-	-	-	-
		-	-	-	-	-	-
CIPA X Zondoma X Female		1.555***	-1.150**	1.203**	1.115**	1.832*	2.974
		(0.534)	(0.639)	(0.684)	(0.639)	(1.118)	(4.087)
CIPA X Perceived quality of	Extension	0.234	0.558	0.749**	0.657**	0.525	7.711***
		(0.302)	(0.423)	(0.391)	(0.369)	(0.540)	(2.260)
	Extension X Zondoma	-0.212	0.319	0.173	0.171	0.264	-1.224
		(0.382)	(0.656)	(0.658)	(0.607)	(0.781)	(4.348)
	PO	-0.119	0.444***	0.320***	0.379***	-0.688	2.658***
		(0.169)	(0.212)	(0.139)	(0.135)	(0.670)	(1.214)
	PO X Zondoma	-	-	-	-	-	-
		-	-	-	-	-	-
	Input supplier	0.296	-0.257	-0.099	-0.031	1.014**	-1.408
		(0.357)	(0.396)	(0.384)	(0.350)	(0.583)	(2.826)
	Input supplier X Zondoma	0.344	-0.023	0.377	0.433	0.304	1.4
		(0.425)	(0.638)	(0.684)	(0.527)	(1.230)	(3.827)
Number of observations		1,388	1,388	1,388	1,388	1,018	1,018
Adjusted R-squared		0.543	0.137	0.305	0.336	0.402	0.184

Probability to reject null hypothesis (i.e. no effect) wrongly: ***: 01% and less; **: 05% and less; *:10% and less. Robust standard errors in parentheses. - : dropped because of collinearity.

Table A 12. Estimated impact of the CIPA in the Southern region using Kernel matching

Variables		**Plot size**	**Yield**	**Production**	**Food**	**Sales (kg)**	**Sales** (FCFA)
CIPA		-0.299	0.384	0.084	0.025	3.822***	3.311***
		(0.307)	(0.370)	(0.351)	(0.353)	(0.535)	(0.528)
CIPA X Female		1.037***	0.443	1.478**	1.583**	0.888	1.257
		(0.339)	(0.579)	(0.624)	(0.629)	(0.878)	(0.862)
CIPA X Zondoma		0.247*	-0.286	-0.038	-0.006	-3.969***	-3.798***
		(0.149)	(0.208)	(0.229)	(0.233)	(0.763)	(0.736)
CIPA X Zondoma X Female		-1.201***	-0.464	-1.662**	-1.927**	-1.33	-1.607
		(0.449)	(0.736)	(0.765)	(0.780)	(0.997)	(1.023)
CIPA X Perceived quality of	Extension	0.631**	1.762***	2.390***	2.288***	-0.535	0.218
		(0.264)	(0.582)	(0.559)	(0.557)	(0.640)	(0.678)
	Extension X Zondoma	-1.199***	-1.344**	-2.538***	-2.337***	0.66	0.182
		(0.348)	(0.678)	(0.727)	(0.751)	(0.744)	(0.755)
	PO	-0.4	-0.446	-0.845*	-0.875*	-0.052	0.202
		(0.271)	(0.401)	(0.506)	(0.513)	(0.825)	(0.771)
	PO X Zondoma	1.047**	0.655	1.697	1.639	1.809*	1.547*
		(0.445)	(0.936)	(1.088)	(1.099)	(0.988)	(0.937)
	Input supplier	0.004	-1.075**	-1.069**	-0.957**	0.009	-0.301
		(0.218)	(0.438)	(0.419)	(0.427)	(0.533)	(0.582)
	Input supplier X Zondoma	0.494	0.455	0.947*	0.399	-1.187	-1.078
		(0.378)	(0.578)	(0.552)	(0.657)	(0.851)	(0.847)
Number of observations		1,800	1,800	1,800	1,800	1,152	1,152
Adjusted R-squared		0.472	0.164	0.28	0.365	0.18	0.133

Probability to reject null hypothesis (i.e. no effect) wrongly: ***: 01% and less; **: 05% and less; *:10% and less. Robust standard errors in parentheses. - : dropped because of collinearity.

Table A 13. Estimated impact of the CIPA in the Southern region using Radius matching

Variables		**Plot size**	**Yield**	**Production**	**Food**	**Sales (kg)**	**Sales** (FCFA)
CIPA		-0.299	0.384	0.084	0.025	3.822***	3.311***
		(0.307)	(0.370)	(0.351)	(0.353)	(0.535)	(0.528)
CIPA X Female		1.037***	0.443	1.478**	1.583**	0.888	1.257
		(0.339)	(0.579)	(0.624)	(0.629)	(0.878)	(0.862)
CIPA X Zondoma		0.247*	-0.286	-0.038	-0.006	-3.969***	-3.798***
		(0.149)	(0.208)	(0.229)	(0.233)	(0.763)	(0.736)
CIPA X Zondoma X Female		-1.201***	-0.464	-1.662**	-1.927**	-1.33	-1.607
		(0.449)	(0.736)	(0.765)	(0.780)	(0.997)	(1.023)
CIPA X Perceived quality of	Extension	0.631**	1.762***	2.390***	2.288***	-0.535	0.218
		(0.264)	(0.582)	(0.559)	(0.557)	(0.640)	(0.678)
	Extension X Zondoma	-1.199***	-1.344**	-2.538***	-2.337***	0.66	0.182
		(0.348)	(0.678)	(0.727)	(0.751)	(0.744)	(0.755)
	PO	-0.4	-0.446	-0.845*	-0.875*	-0.052	0.202
		(0.271)	(0.401)	(0.506)	(0.513)	(0.825)	(0.771)
	PO X Zondoma	1.047**	0.655	1.697	1.639	1.809*	1.547*
		(0.445)	(0.936)	(1.088)	(1.099)	(0.988)	(0.937)
	Input supplier	0.004	-1.075**	-1.069**	-0.957**	0.009	-0.301
		(0.218)	(0.438)	(0.419)	(0.427)	(0.533)	(0.582)
	Input supplier X Zondoma	0.494	0.455	0.947*	0.399	-1.187	-1.078
		(0.378)	(0.578)	(0.552)	(0.657)	(0.851)	(0.847)
Number of observations		1,800	1,800	1,800	1,800	1,152	1,152
Adjusted R-squared		0.472	0.164	0.28	0.365	0.18	0.133

Probability to reject null hypothesis (i.e. no effect) wrongly: ***: 01% and less; **: 05% and less; *:10% and less. Robust standard errors in parentheses. - : dropped because of collinearity.