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Designing a randomized impact evaluation on a Belgian development program:

The case of the PROFI program in Benin[1]

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List of acronyms

PROFI	PROgramme d'appui aux Fllières agricoles
MC	Mono-Couffo
AD	Atacora-Donga
MIC	MICro-project de production et de commercialisation
BDC	Belgium Development Cooperation
DGD	Belgian Directorate General for Development Cooperation
ODA	Official Development Assistance
ODAHA	The Organization for the Harmonization of Business Law in Africa
CARDER	Centre D'Action Régional Pour Le Développement Rural
PEA	Projet d'Entreprenariat Agricole
CCP	Comité Communal de Pré-selection
CRA	Comité Régional d'Approbation
LSMS-ISA	Living Standards Measurement Study – Integrated Surveys on Agriculture
OP	Organisation Paysanne

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Extended Summary

In 2016, the Belgian Technical Cooperation in Benin (BTC-Benin) launched a call for applications to a new program, denominated *PROgramme d'appui au développement des FIlières agricoles* (PROFI), to support agri-businesses involved in the value chains of rice, cashews, and vegetables in selected regions of the South (Mono-Couffo) and the North (Atacora-Donga). The program consists in providing agricultural entrepreneurs with equipment and materials, as well as in offering targeted technical assistance. Applications could only be submitted by organizations, i.e. groups of entrepreneurs organized into agri-business cooperatives, which could then decide how to allocate the support received among their members. At the demand of DGD, we have designed a randomized impact evaluation of this program and report in this paper about the different stages of implementation, which followed step by step the different phases of program development from the call for applications to the final selection of beneficiaries.

Taking into account local constraints and the needs of the BTC-Benin, we have opted for a "phase-in" impact evaluation. According to this design, organizations are randomly assigned to either the treatment group or to serve as control. In Phase 1, both groups receive non-financial support, while only the treatment group receives the requested materials and equipment. After about a year, in Phase 2, the control group also receives the materials and equipment that were solicited during the application.[2]

Through such a "phase-in" evaluation we will be able to assess what are the effects of the PROFI program on a number of agricultural performance indicators. In order to provide policy directions to support agricultural value chains in Benin, we will also further investigate the data along a number of research questions –such as: What is the impact of access to credit and inputs on the profits of agricultural enterprises? What are the effects of an improvement in irrigation facilities? Which agricultural practices positively affect productivity? How do organizations allocate subsidized equipment and materials among their members? Do the governance structure of an organization affect its performance? Does the PROFI program have beneficial effects on the well-being of the agricultural entrepreneurs in Benin?

To answer these questions, we have developed a very detailed and exhaustive questionnaire covering different agricultural domains. The baseline survey was conducted in collaboration with the BTC-Benin from December 2016 to February 2017. For each organization, the questionnaire was collected among five randomly selected members for a total of about 1,000 respondents. These individuals will be followed-up in 2018-2019 in order to identify changes from baseline and treatment effects.

The remainder of this summary provides a brief overview of the selection process and of the baseline data.

Selection of beneficiaries

As part of the first call for applications, a total of 485 applications were registered: 272 for the Mono-Couffo (MC) region and 213 for the Atacora Donga (AD) region. The first objective was to better understand the determinants of program take-up among the target population of registered agri-business cooperatives. In MC, more than 50% of the registered agri-business organizations submitted an application; whereas in AD, only 25% of registered cooperatives applied for the program. The selection process comprised different steps, including a pre-selection on the basis of a series of

2 Unfortunately, this procedure was not implemented in the field due to implementation problems as well as institutional constraints.

exclusion criteria, field visits, and a final selection on the basis of a number of priority criteria selected by the BTC. In the end, 195 organizations were selected as eligible for the PROFI program: 108 from the MC region and 87 from the AD region.

A probit model was used to further investigate the dynamics of the selection process. The results show that, in the MC region, organizations that are specialized in vegetable products, include more women, have a smaller size, have a more formal status, and required relatively larger budgets were more likely to be selected during the initial pre-selection step. Similarly, in the AD region, organizations with a more formal status and that requested a larger budget were more likely to be pre-selected, while groups producing rice were more likely to be selected that those specialized in producing vegetable crops. In terms of magnitude of the effects, the gender composition of the organization seemed to play the most substantial role in influencing the probability of selection in the MC region. Our findings indicate that when the percentage of female members increases by one point for an average organization, the probability of selection of the organization increases by 0.28. For the AD region, producing rice has the highest marginal effect. In particular, if we take any two average organizations where one is specialized in producing rice and the other in vegetable products, then the application submitted by the rice organization will be 24% more likely to be selected.

The results show that the indicators that influenced selection during the field visit phase differ between the two regions as well. In MC, applications submitted by organizations that specialize in the production of vegetables and requested larger budgets were more likely to be selected. In addition, the results suggest that only four of the nine prioritization criteria used played a significant role in the selection process: these are experience, formality status, value of investments already made, and degree of contractualization of product sales and input purchases. In terms of quantitative importance, the indicator linked to the contracting of sales and purchases played a more substantial role in the selection. However, the scoring chosen for this indicator is not completely clear and would require further adjustment. In the AD region, data limitations did not allow to carry out an analysis with the same rigor. Taking this into account, the results show that organizations producing vegetables were the most likely to be selected. The four prioritization criteria that played a role in this case are: experience, formality status, degree of contracting of sales and purchases, and the degree of work gender friendliness. It should be noted though that the levels of statistical significance of these results are relatively low and it was not possible to jointly test the effects of these indicators.

Baseline data: an overview

The baseline survey conducted in 2016-2017 collected detailed information at individual, season, crop, and plot levels. The questionnaire comprised questions on the socio-demographic characteristics of the respondents, the characteristics of their different plots, the quality of soil and water, the access and use of agricultural inputs (seeds, fertilizers, and phytosanitary products), and the use of labor (family and paid), as well as questions on yields and use of harvested products, equipment endowments, access to credit, and type of technical assistance services received.

On average, the producer population in AD is older and less educated than in MC. Also, in AD, producers have a mean of 2 more years of cooperative experience. Regarding crop-specific experience, producers from both regions have about 10 years of experience in producing vegetables; while for rice production, with a mean of nearly 15 years, AD producers have twice as many years of experience as MC farmers. This specialization in rice cultivation is all the more pronounced in the AD region as more plots are devoted to it compared to MC -where the plots are instead exploited mostly for producing vegetables. Thus, on average, rice contributes more to the income of AD producers (25%) than to those of MC famers (5%), whereas vegetables contribute more to the income

of MC producers (40%) that to those of AD farmers (15%). Other sources of income for producers include other agricultural crops, which play indeed an important role in AD (29%) as well as in MC (25%). Additional non-farm activities contribute more significantly to the incomes of MC farmers (30%) than to those of AD ones (10%). This suggests that AD producers are more vulnerable to the different constraints affecting the agricultural sector.

Among the constraints faced by producers, three barriers proved to be more important: the difficulties linked to managing water and to accessing credit and adequate training (e.g. advice on agricultural practices, environmental management, entrepreneurship, financial management, and processing of agricultural products). Regarding financing constraints, the majority of producers who did not receive funding during the 2015-2016 agricultural cycle deliberately refrained from asking credit mainly as they anticipated high interest rates and heavy administrative burdens. Some farmers also mentioned that they did not need funding, while others indicated that they did not feel comfortable going into debt. This information is very useful for any policy aimed at improving access to credit for agricultural entrepreneurs. It indicates that such policies should play on both the supply side of credit (financial institutions and their environment) and the demand side (producers and their environment). Demand-side policies should better target entrepreneurs with more "agricultural opportunities" and support the development of agricultural entrepreneurship, while recurring to other specific instruments for the so-called "necessity entrepreneurs".

Baseline: Performance indicators

To start, it is useful to note that agricultural entrepreneurs intervene in very complex environments. Producers work on both individual, shared, and common plots. Agricultural performance varies depending on the type of plot considered and this makes it difficult to estimate the costs and profits of the related agricultural activities. Program and policies that neglect this aspect can lead to many biases. We have tried to understand some of these differences, but additional efforts are needed to further explore the complexity of this environment.

Overall, for all the crops considered (rice, cashews, and vegetables), the average profit for the agricultural cycle is estimated at 1,277,072 CFA francs, with a unit production cost of 187 CFA/kg and a unit profit margin of 131 CFA/kg. The yields obtained by region are close to those (used as benchmark reference) of the Ministry of Agriculture, Livestock, and Fisheries (MAEP) for the 2015-2016 period. However, agricultural performance differs greatly between producers and we developed a simple linear model to identify the main correlates of performance. The indicators that we considered are: planted area, type of plot (individual, shared, or common), gender, region, and season (dry season, long rainy season, or short rainy season). A number of interesting results emerge. First, the results highlight an inverse relationship between plot size and realized yields; this may be related to the limited use of improved seeds and quality inputs. This information suggests that policies that provide access to improved seeds and relative instructions may be effective.

Second, farms that use common plots compared to individual plots achieve higher yields (but this is significant only for cashews), possibly because of the synergies and learning effects. On the contrary, productions based on shared plots are less efficient, especially for cabbage, okra, chilli pepper, and pepper. Third, regarding gender gaps, yields are higher for male-managed farms than for women-managed ones, probably because men have more access to resources and can invest more on production costs. This suggests that policies aimed at supporting joint farms might be beneficial. It should be noted though that organizations operating in common are effective only as long as they keep a high quality of internal governance. In the future, we plan to further explore the role of governance. Fourth, region fixed effects show that the performance of crin-crin and chilli pepper is

better in MC, while the opposite is true for okra and onion. Fifth, the production season plays an important role in influencing performance. Performance indicators are better in the dry season than in the rainy season. This result is likely explained by excessive supply in the rainy season, which lowers prices. It might also be that better-performing entrepreneurs work less during the rainy season to concentrate their resources in the dry season when prices are higher.

Finally, the results indicate that input expenditures (on seeds and fertilizers) and costs associated to family labor represent the largest burdens; while in the dry season, labor expenditures are more geared towards paid labor.

JEL Classification: O1, O2
Keywords: randomized impact evaluation, agri-businesses, agricultural productivity

Résumé étendu

La CTB a lancé en 2016 au Bénin, dans le Sud (Mono-Couffo) et dans le Nord (Atacora Donga), un nouveau programme d'appui aux acteurs impliqués dans les chaînes de valeur de trois filières agricoles: le riz, les noix de cajou et les produits maraîchers (le PROgramme d'appui au développement des FIlières agricoles (PROFI)). Ce programme vise à mettre à la disposition des entrepreneurs agricoles des équipements et matériels puis à proposer des appuis techniques ciblés. A la demande de la DGD, nous avons élaboré une évaluation randomisée des impacts de ces appuis et rapportons dans ce papier les différentes étapes de sa mise en œuvre. Pour ce faire, l'équipe de recherche a pu établir une collaboration efficace avec la CTB-Bénin et a effectué un suivi permanent des différentes phases du développement du programme, depuis l'appel à candidatures jusqu'à la sélection définitive des bénéficiaires. Les candidatures devraient être soumises par des organisations d'entrepreneurs, et celles-ci pourraient décider entre elles, des modalités d'utilisation de ces appuis entre leurs différents membres.

Dans notre approche de l'évaluation de ce projet, nous avons opté pour une « *évaluation phase-in* », en concertation avec la CTB-Bénin et compte tenu des contraintes spécifiques du terrain. Dans le cadre de cette approche, les organisations sont assignées de manière aléatoire, d'une part à un groupe de « traitement », d'autre part à un groupe de « contrôle ». Les deux groupes devraient recevoir, dans la phase 1, un appui non-financier, le groupe de traitement devrait être prioritaire. Ce groupe devrait également recevoir, et lui seul, le matériel et l'équipement sollicités. Plus tard, dans la phase 2, soit après environ un an, le groupe de contrôle devrait recevoir également le matériel et les équipements sollicités.[3]

L'approche d'« *évaluation phase-in* » permet d'identifier les effets du traitement, c'est-à-dire l'efficacité du programme PROFI dans ce cas-ci, sur un certain nombre d'indicateurs de performance, et ce avec un degré de confiance suffisamment élevé (« évaluation rigoureuse »). Plus généralement, elle permet de répondre à des questions qui ont un important enjeu pour les politiques d'appui aux filières agricoles, telles que: quel est l'impact des investissements agricoles sur le revenu des entreprises agricoles, sur l'accès au crédit et aux intrants? Quel est le rendement d'un forage de puits, d'une amélioration des installations d'irrigation ? Quelle utilisation d'intrants et quelles pratiques agricoles ont un effet positif sur la productivité agricole? Comment les organisations gèrent-elles la mise à disposition parmi leurs membres des équipements et matériels subsidiés obtenus? Et quels types de gouvernance interne de ces groupements, conditionnent les performances de leurs membres ? Le programme PROFI a-t-il des effets bénéfiques sur le bien-être des personnes les plus vulnérables aux différents chocs auxquels le secteur agricole est confronté au Bénin ?

Afin de mettre en œuvre cette approche, nous avons élaboré un questionnaire assez détaillé et exhaustif, couvrant différents domaines et structuré en plusieurs modules, afin de pouvoir identifier une série d'indicateurs caractérisant les membres des organisations appartenant à l'un ou l'autre des deux groupes de traitement et de contrôle. L'enquête de référence (« *baseline survey* ») a été menée en collaboration avec la CTB-Bénin de décembre 2016 à février 2017. Pour chaque organisation, le questionnaire a été soumis à cinq de ses membres. En particulier, la collecte de données a été réalisée effectivement avec un outil digital sur le terrain pour environ 1000 producteurs. Cette enquête sera répétée vers 2018-2019 pour comprendre des éléments de changements au niveau des structures appuyées.

Le reste de ce résumé rapporte brièvement des éléments d'enseignements sur le processus de sélection et sur les données baseline dont des analyses plus approfondies sont en cours.

3 Malheureusement, ce protocole n'a pu être suivi sur le terrain compte tenu de certaines difficultés d'implémentation et d'autres contraintes institutionnelles.

Sélection des bénéficiaires

Au total 272 candidatures recevables ont été enregistrées pour le Mono-Couffo (MC) et 213 pour l'Atacora Donga (AD) dans le cadre du premier appel à micro-projets (MIC). Nous avons d'abord porté notre attention sur le processus de sélection des bénéficiaires. Un premier objectif a été de mieux cerner l'intérêt pour le projet, son taux de *« take-up »* dans la population cible. Dans le MC, plus de la moitié des coopératives agréées (54%= 85 sur 157 immatriculées) ont introduit un dossier de candidature, alors qu'elles ne représentent que 25% seulement dans l'AD (79 sur 309 immatriculées). Cette première étape de l'analyse a aussi permis de bien documenter les phases successives du processus de sélection: une pré-sélection sur la base de critères d'exclusion, des visites de terrain et une sélection finale parmi les organisations candidates éligibles sur la base de scores attribués aux différents critères prioritaires retenus par le programme. Au final, 108 organisations ont été sélectionnées au MC et 87 dans l'AD.

Les résultats d'un modèle de probabilité, qui analyse le processus de sélection plus en profondeur, indiquent que pour la phase de pré-sélection, dans la région MC, les organisations qui sont spécialisées dans les produits maraîchers, qui comprennent plus de femmes, qui ont une taille plus petite, qui sont plus formelles, et qui ont demandé un financement relativement important, sont plus susceptibles d'être sélectionnées au cours de cette phase. L'effet du statut de formalité des OP ainsi que celui de l'importance du financement sollicité, sont également similaires pour les projets sélectionnés dans la région AD. A l'opposé, les organisations qui produisent du riz sont plus susceptibles d'être sélectionnées dans la région AD, par rapport à celles de produits maraîchers. En termes d'importance quantitative, la composition par sexe de l'organisation semble jouer le rôle le plus dominant sur la probabilité de sélection. En particulier, les résultats indiquent que lorsque le pourcentage de membres féminins d'une « organisation moyenne » quelconque dans la région MC augmente d'une unité, la probabilité de sélection de cette organisation augmente de 0,28. Pour la région AD, c'est la variable riz qui affiche l'effet marginal le plus élevé. En particulier, si nous prenons deux organisations moyennes quelconques où l'une est spécialisée dans le riz et l'autre dans les produits maraîchers, alors le projet soumis par l'organisation spécialisée dans le riz à 24% de plus de chance d'être sélectionné.

Les résultats du modèle de probabilité qui explique la sélection à la phase de visite de terrain montrent que les variables statistiquement significatives diffèrent aussi entre les deux régions. Dans la région de MC, les projets qui sont soumis par des organisations spécialisées dans le secteur des produits maraîchers, et qui demandent plus de subsides d'équipements et d'aménagement sont plus susceptibles d'être sélectionnés. De plus, les résultats suggèrent que seuls quatre des neuf critères de priorisation imposé par le programme ont joué un rôle dominant dans le processus de sélection pour la phase de visite de terrain dans la région MC: l'expérience, le degré de formalité, le niveau d'investissement déjà réalisé, et le degré de contractualisation des ventes de produits et d'achats d'intrants. En termes d'importance quantitative, le rôle de l'indicateur lié à la contractualisation des ventes et achats d'intrants a été plus important au cours de cette phase de sélection. Cependant, les scores attribués entre quelques modalités de cet indicateur ne sont pas assez clairs et nécessiteraient des ajustements pour le futur. En ce qui concerne la sélection sur base de la visite de terrain dans la région AD, il y a eu des problèmes de limitation des données, ce qui n'a pas permis d'effectuer l'analyse avec la même rigueur.[4] En tenant compte de ce fait, les résultats montrent que ce sont les projets impliquant des produits maraîchers et ayant trait à la commercialisation qui étaient les plus susceptibles d'être sélectionnés. De plus, seuls quatre critères de priorisation ont semblé avoir joué

4 Ces problèmes incluent: 1) Des information sont manquantes sur certains indicateurs dans AD e.g. l'indicateur lié à l'"*Investissement déjà disponible chez le promoteur*" n'est pas disponible dans les données de AD; 2) Quand l'analyse des projets prend en compte les caractéristiques spécifiques des communes (*commune fixed effets*) le nombre d'observations diminue drastiquement, limitant le pouvoir de l'analyse. Ceci veut dire que les caractéristiques et/ou les évaluations des projets étaient assez similaires et des investigations plus approfondies sont nécessaires pour mieux comprendre cet aspect.

un rôle lors de la sélection ici: l'expérience, le degré de contractualisation des ventes et achats d'intrants, le statut de formalité, et le degré de pénibilité du travail de la femme au sein de l'organisation. Mais ces résultats ne sont pas robustes car les niveaux de significativité statistique sont relativement faibles et il n'a pas été possible de tester conjointement les effets de ces indicateurs.

Données baseline : une vue globale

L'enquête de référence réalisée entre décembre 2016 et février 2017 a permis de collecter des informations par individu, par saison, par spéculation et jusqu'à trois parcelles par individu. En particulier, les informations collectées ont concerné les caractéristiques socio démographiques des répondants, les caractéristiques de leurs différentes parcelles, la qualité des sols et de l'eau, l'accès et l'utilisation des intrants agricoles (semences, engrais et phytosanitaires), l'utilisation de la main-d'œuvre (familiale et rémunérée), la récolte et l'utilisation des produits récoltés, les dotations en équipements, l'accès au financement et aux services d'appuis techniques.

Les caractéristiques socio démographiques ont montré qu'en moyenne, la population de producteurs de l'AD est plus vieillissante et moins instruite que celle du MC. De plus, les producteurs de l'AD ont en moyenne 2 années d'expérience de plus en pratique de coopérative. L'expérience des producteurs en agriculture varie en fonction des différentes spéculations. Ainsi, pour le maraîchage, les producteurs des deux régions ont en moyenne environ 10 années d'expérience. Par contre dans la production de riz, avec près de 15 ans d'expérience en moyenne, les producteurs de l'AD ont le double d'années d'expérience de ceux de MC. Cette expérience dans la culture du riz est d'autant plus prononcée dans l'AD où plus de parcelles y sont consacrées comparativement au MC où les parcelles sont plus exploitées pour le maraichage. Ainsi, en moyenne le riz contribue plus aux revenus des producteurs de l'AD (25%) que dans le MC (5%) tandis que c'est le maraîchage qui y contribue plus dans le MC (40%) comparativement à l'AD (15%). Les autres sources de revenus des producteurs incluent d'autres spéculations agricoles qui jouent un rôle assez important dans l'AD (29%) comme dans le MC (25%). Par ailleurs, les activités non agricoles contribuent plus aux revenus des producteurs dans le MC (30%) que dans l'AD (10%). Ces informations indiquent donc que les producteurs de l'AD sont plus vulnérables aux différentes contraintes qui affectent le secteur agricole. De même, elles suscitent des questions sur le ciblage des filières agricoles et le rôle que ceci joue par rapport aux autres activités génératrices de revenu au niveau des acteurs ciblés.

Au nombre des contraintes auxquelles font face les producteurs, trois se sont révélées plus importantes ; il s'agit : des difficultés d'accès au financement externe ; des difficultés de maitrise de l'eau ; et du manque de formations adéquates (sous forme de conseils sur les itinéraires techniques, la gestion de l'environnement, l'entrepreneuriat, la performance économique, la transformation des produits agricoles). Pour la contrainte de financement, la majorité des producteurs qui n'ont pas bénéficié de financement au cours de la campagne 2015-2016 s'en sont délibérément abstenus essentiellement parce qu'ils anticipent des lourdeurs administratives et des taux d'intérêt élevés. De plus, certains ont indiqué n'avoir pas besoin de financement tandis que d'autres indiquent ne pas aimer s'endetter. Ces informations sont assez utiles pour toute politique visant à améliorer l'accès au financement des producteurs. Elles indiquent notamment que ces politiques doivent exercer des leviers à la fois sur l'offre de crédit (les institutions financières et leur environnement) que sur la demande (les producteurs et leur environnement). Les politiques visant la demande doivent donc mieux identifier les entrepreneurs « agricoles d'opportunités » pour les objectifs de développement effectif de l'entreprenariat agricole et utiliser d'autres instruments plus spécifiques pour les « entrepreneurs de nécessité ».

Baseline : Indicateurs de performance

Avant de présenter ces indicateurs il est important de noter que les entrepreneurs agricoles interviennent dans un environnement assez complexe. En effet, les producteurs travaillent à la fois sur des parcelles individuelles, partagées ou communes et leurs performances varient aussi selon le type de parcelles considérées. Cette complexité rend difficile l'estimation des différents coûts et produits liés aux activités agricoles. Les politiques et actions opérationnelles qui négligent cet aspect peuvent conduire à beaucoup de biais. Dans le cadre de l'enquête baseline, nous avons essayé de comprendre un peu ces différences mais des efforts supplémentaires doivent être réalisés pour une meilleure appréhension de cet environnement afin que les indicateurs développés puissent bien refléter les activités agricoles.

Ceci étant dit, globalement et pour toutes les spéculations considérées (riz, anacarde, produits maraichers) le bénéfice moyen (à travers tous les producteurs) pour la campagne considérée est de 1 277 072 F CFA avec une capacité d'autofinancement de 1 279 009 F CFA, un coût de production unitaire de 187 F CFA/kg et une marge bénéficiaire unitaire de 131 F CFA/kg. Les rendements obtenus par région sont proches de ceux (utilisés comme référence) du Ministère de l'Agriculture, de l'Elevage et de la Pêche (MAEP) sur la campagne 2015-2016.

Les performances diffèrent cependant entre producteurs et pour apprécier les facteurs qui sont corrélés avec les indicateurs de performance, un modèle linéaire simple a été développé. Les facteurs étudiés sont: la superficie emblavée, le type de parcelle (individuel, partagé ou commun), le sexe, la région et la saison (saison sèche, grande saison des pluies et petite saison des pluies). Un certain nombre de résultats intéressants se dégagent. Premièrement, les résultats mettent en évidence une relation inverse entre la taille des parcelles et les rendements obtenus; ce qui peut être lié à l'utilisation limitée de semences améliorées et d'intrants de qualité disponibles à temps au cours de la campagne agricole. Ces informations indiquent donc que des politiques qui privigieraient l'accès aux semences et instrants de qualité peuvent se révéler plus efficaces. Actuellement, nous essayons de mieux comprendre les déterminants et les implications des performances de l'adoption de semences améliorées et de l'accèss au financement par les producteurs.

Deuxièmement, les exploitations qui portent sur des parcelles communes (comparativement aux parcelles individuelles) réalisent des rendements plus élevés (mais significatif seulement pour l'anacarde) certainement grâce au partage de connaissances et d'expériences qui améliorent la productivité. A l'opposé, les exploitations basées sur des parcelles en partage sont moins performantes pour le chou, le gombo, les piments long et rond. Troisièmement, pour l'effet genre, il est noté que les rendements sont plus importants pour les exploitations gérées par les hommes comparativement à celles gérées par les femmes, probablement parce que les hommes ont plus accès aux ressources, ce qui se manifeste cependant par des coûts de production plus élévés. Ces résultats suggèrent que toute action visant à favoriser le développement effectif des exploitations communes peut se révéler bénéfiques alors qu'actuellement, il y a assez de réticences pour ce type d'exploitations. Un élément important qui facilite l'émergence des organisations d'exploitation communes est la qualité de leur gouvernance interne. Nous planifions de comprendre cet élément. Quatrièmement, un contrôle des effets spécifiques des exploitations communes a permis de noter que les indicateurs dans MC sont meilleurs pour les cultures de crincrin et de piment, tandis que l'inverse est vrai pour le gombo et l'oignon i.e les indicatreurs pour ces produits sont meilleurs dans AD par rapport à MC. Cinquièmement, la saison de production a été importante dans les résultats de performance. En particulier, les indicateurs sont meilleurs en saison sèche qu'en saison de pluie. L'excès d'offre de produits agricoles en saison de pluie qui baisse les prix de vente, étant donné le manque de transformation conséquente, explique certainement ce résultat. De plus, il se peut que les entrepreneurs mieux performants aie décidé de travailler peu pendant la saison des pluies et de

cencentrer plus de leurs ressources sur les saisons sèches où les prix de vente sont plus conséquents afin de tirer plus de bénéfices. Nous essayons de mieux comprendre ce résultat.

Finalement, les résultats indiquent que les dépenses en intrants (semences et engrais) et celles concernant la main-d'œuvre familiale constituent les charges les plus importantes des entrepreneus étudiés. Néanmoins en saison sèche les dépenses de main-d'œuvre sont plus orientées vers la main-d'œuvre rémunérée.

0 | Introduction

In Benin, the agricultural sector accounts for about 32% of GDP and nearly 70% of total employment. Overall agricultural growth is around 3%, but it is often offset by the relatively high population growth (3.2%). The agricultural production systems rely mostly on family labour, with limited use of improved inputs, production methods, and farm equipment. Also, outside the cotton-crop sector, access to credit is scarce and limits the possibility of realizing strategic and needed investments in the agriculture sector and, specifically, in irrigation.

According to a recent study by Burney et al. (2013)[5] investments in 'distributed irrigation systems' (those in which the water access, distribution, and use occur at or near the same location) can be instrumental in improving rural development and nutritional outcomes throughout Sub-Saharan Africa. Efficient use of water is indeed critical for year-round crop production, for production of critical micronutrient crops like vegetables, for sustainable natural resource management practices, and for adaptation to projected scenarios of climate change. Investments in irrigation are particularly promising in Benin, where untapped irrigation potentials are estimated to more than 205,000 hectares.[6] Using a matched-pair comparison of villages in northern Benin, along with household survey data through the first year of harvest, Burney et al. (2010)[7] find that solar-powered drip irrigation significantly increased both household income and nutritional intake, particularly during the dry season, and was cost effective compared to alternative technologies.

Poor levels of investments in agriculture are mainly due to imperfections in the credit markets and development aid could play a catalytic role in alleviating these constraints (See the review paper in Dayé, Houssa, and Reding, 2015). In the case of the Belgium Development Cooperation (BDC), for instance, the majority of the ODA (Official Development Assistance) budget spent on private-sector support (over 85% in 2001-2013 of BTC and other NGO's)[8] is channelled to projects in support of the agricultural sector of its partner countries. Indeed, returns to capital can be high in the agricultural sector. For instance, Ambler et al. (2016)[9] analyse the short-term impacts of a program that offered cash transfers (of about $200) -supported by farm management plans- to smallholder farmers in Senegal. They show that, after one year, agricultural production and livestock ownership was higher (by significantly more than the amount of the transfer) in the transfer group compared to the group that received only visits and they suggest that increased investments in agricultural inputs increased productivity. Usually capital constraints are approached through increased access to credit, but high interest rates and a history of modest impacts leave doubt about the effectiveness of these programs. In this sense, conditional cash transfers and procurement of equipment offer greater promise.

In July 2016, the Belgian Technical Cooperation in Benin (BTC-Bénin) launched a call for applications to a new-agricultural program denominated *PROgramme d'appui aux FIlières agricoles* (PROFI). This program is a continuation of BTC-Bénin's support to agricultural entrepreneurs involved in the supply chain of vegetables, rice, and cashews in two regions of Benin: the Mono-Couffo (MC) in the South; and the Atacora-Donga (AD) in the North. The call for applications were launched in July 2016 and lasted for about three weeks.

5 Burney et al. (2013). The case for distributed irrigation as a development priority in sub-Saharan Africa, PNAS 110(31): 12513–12517

6 http://documents.worldbank.org/curated/en/690591468200934160/pdf/571770PAD0P1151e0only1910BOX358303B.pdf

7 Burney et al. (2010). Solar-powered drip irrigation enhances food security in the Sudano–Sahel. PNAS 107(5): 1848–1853

8 In 2001-2013, private sector support in Belgium ODA account for 18% of Belgium non-debt ODA

9 Ambler et al. (2016). Cash transfers and crop production in Senegal. NEUDC CP

There is, however, one important change with PROFI: applications have now to be submitted by groups of entrepreneurs. Groups can be formal or informal but they have to include a minimum of five individual entrepreneurs, present a project leader, and submit a business plan (*micro-project de production et de commercialisation* -MIC) for the enhancement of agricultural productivity through mechanical equipment and irrigation tools, as well as through non-financial support from BTC-Bénin. Applications have to respect a number of exclusion and prioritisation criteria that are checked during a selection process by BTC-Bénin that includes four phases (preliminary verification of selection criteria, ground verification of selection criteria, on-the-ground scoring of business viability, and final selection by a committee of experts).[10]

While the PROFI and other BDC projects on private-sector support in developing countries can be clearly justified, it is also critical that one is able to understand their effectiveness, in particular whether their underlying effects fit in the development goals pursued by the BDC and the recipient countries. In particular, these programs need to be well-designed, and their objectives clearly formulated on the basis of deep empirical studies tailored to the environment under consideration. Moreover, a convincing evaluation of the welfare impact of these supports is important in order not only to adapt existing programs by avoiding practices and instruments that have little return but also to make sure that the costs of the interventions do not outweigh their benefits.

This study contributes to the debate about the effectiveness of BDC projects in support to the private sector in agriculture in partner countries. For this purpose, we take the PROFI program in Benin as case study, in close collaboration with DGD and BTC staff both at the headquarters and in Benin. Especially, we use a phase-in approach where eligible organizations of entrepreneurs are randomly assigned to two groups: treatment and control groups. Furthermore, five entrepreneurs in each of the organizations have been selected for the purpose of the evaluation. During phase 1, entrepreneurs in both groups will receive non-financial support (with priority given to those assigned in the treatment group) and only the treatment group will receive the requested materials and equipment financed by the BTC program. During phase 2, the control group will receive the requested materials and equipment too.

To identify the baseline across the treatment and control groups, we designed a very detailed questionnaire including more than 9,000 indicators, similar to standard agricultural modules of the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA), adapted to the local context and targeted crops. In particular, the questionnaire covers a number of key areas allowing to assess treatment effects, but also to understand important dynamics, such as factors hindering agricultural efficiency including access to key markets and the role of family labour in productive activities. Besides, the questionnaire identifies key information at the plot and the agricultural-cycle levels for each of the entrepreneurs. The baseline survey has been conducted in December 2016-February 2017, in collaboration with BTC-Benin. In 2017-2019 we will design and implement new questionnaires and collect midline and endline data (at the plots and the agricultural-cycle levels) on the same indicators and across entrepreneurs of both the treatment and the control groups. We will also develop additional survey modules, where needed, after having analysed the baseline data.

This framework allows to explore a number of important policy-research questions, such as: What is the impact of agricultural investments on farm incomes? What are the economic returns to well drilling and other types of irrigation improvements? What types of inputs and practices are required

10 Apart from the MIC instrument that essentially focuses on agricultural producers PROFI also includes a PEA (*Projet d'Entreprenariat Agricole*) instrument that grants support to entrepreneurs that are specialized in the transformation of agriculture products. PEA projects are, however, very limited and hence our focus on MIC.

for agricultural productivity? What is the role of credit constraints, and other market inefficiencies, in magnifying or mitigating the effects of the program? We are also particularly interested in the question of additionality. Does the intervention get farmers organizations to undertake investments and new technological activities that they would not otherwise do, or does it merely subsidize investments that would take place anyway? And, do these investments crowd in or crowd out other soil management technologies? Furthermore, we will explore the heterogeneous effects of the intervention depending on a number of key baseline characteristics such as land formalization and security, or network governance and professionality.

The rest of the paper is structured as follows. Section 1 discusses the applications received and the selection process. Section 2 presents stylized facts on eligible entrepreneurs. Section 3 discusses the final-selection phase. Section 4 deals with the design of the evaluation. Section 5 presents preliminary insight from the baseline. We present the questionnaire and subsequently provide a very preliminary description about the baseline data.[11]

11 The baseline analysis is very preliminary and incomplete as data cleaning is still ongoing

1 | Received applications

1.1 Background

In the MC region, 275 applications (*fiches analysées*) were initially received across the 12 communes, but during the pre-selection phase 3 applications turned out to be more suitable for another BTC-Bénin project (PEA). Hence the analysis focuses on the 272 remaining MIC applications. To perform a preliminary study of the take-up rate for the project, we compare the distribution of applications by commune to the distribution of vegetable and rice producers according to the 2015-16 Census data from the MC region. We consider the mean level of education as a proxy for the suitability of agricultural producers to prepare a business proposal and apply to the program. The level of education is measured with an index from 0 to 4 where 0 corresponds to formal analphabetism, 1 to a basic level of literacy, 2 to having finished primary education, 3 to secondary education, and 4 to higher education. The data reported in Table 1.a shows that the MC communes of Athiémé, Lokossa, Dogbo, and Grand-Popo that received more applications are also the communes where producers have on average at least a basic level of literacy (i.e. mean education greater than 1).

Table 1.a. MC Region: Applications and producers by commune

	Number of applications	Number of producers	Mean level of education
		Census data	
Aplahoué	15	1,255	0.03
Athiémé	59	571	1.26
Bopa	8	812	0.52
Comé	18	343	1.37
Djakotomey	21	605	0.79
Dogbo	29	1,454	1.05
Grand-Popo	25	1,329	1.87
Houéyogbé	16	730	1.25
Klouékanmè	14	1,121	0.36
Lalo	11	1,680	0.62
Lokossa	44	718	1.15
Toviklin	12	405	0.42
Total	**272**	**11,023**	

Sources: Data on registration is obtained from CARDER MC in July 2016

In the AD region, 213 MIC applications (*fiches idées*) were received across the 13 communes. Unfortunately, the unavailability of Census data for this region does not allow to compare the number of applications received to the total number of local producers.[12]

Table 1.b. AD Region: Applications by commune

	Number of applications	%
Bassila	15	7.0
Boukoumbe	16	7.5
Cobly	9	4.2

12 There is an ongoing discussion to develop a census for the AD region on which we aim to cooperate with BTC-Benin.

Copargo	13	6.1
Djougou	29	13.6
Kerou	17	8.0
Kouandé	28	13.2
Matéri	24	11.3
Natitingou	7	3.3
Ouaké	12	5.6
Pehunco	14	6.6
Tanguiéta	15	7.0
Toucountouna	14	6.6
Total	**213**	

To provide further insights into the take-up rate of the project, we present the distribution by commune of registered cooperatives that applied to the program vs. existing registered cooperatives in the eligible value chains.[13] By "registered", we mean cooperatives that were registered according to the uniform act relating to cooperative societies under the OHADA (the organization for the harmonization of business law in Africa) law. The other cooperatives are also likely to be registered but under the 1901 law.

In the MC region, the overall interest in the program among registered cooperatives seems sufficiently high: more than half of registered cooperatives applied; there are evident gaps, though, in a few communes (i.e. Comé, Djakotomey, and Houéyogbé). In the AD region, the interest in the program among registered cooperatives seems relatively low since only a fourth of cooperatives applied. In a number of communes, i.e. Tanguiéta, Toucountouna, Boukoumbe, Cobly, and Natitingou, less than a fifth of registered cooperatives applied. At present, we do not know the explanation of the low level of applications in AD. We plan to clarify this issue with the baseline survey.

Table 2. Number of registered cooperatives by commune

	Application data	Registry of cooperatives
Panel A. MC region		
Aplahoué	9	11
Athiémé	11	16
Bopa	6	9
Comé	5	11
Djakotomey	3	13
Dogbo	9	11
Grand-Popo	11	19
Houéyogbé	1	16
Klouékanmè	7	14
Lalo	9	12
Lokossa	9	16
Toviklin	5	9
	85	**157**
Panel B. AD region		
Bassila	9	36
Boukoumbe	1	10
Cobly	2	21

[13] Data on registration is obtained from CARDER MC in July 2016 and from CARDER AD in September 2016

Copargo	6	14
Djougou	14	38
Kerou	5	23
Kouandé	8	35
Matéri	6	25
Natitingou	3	24
Ouaké	8	20
Pehunco	14	22
Tanguiéta	2	27
Toucountouna	1	14
	79	**309**

Applications were received by groups formed under different governance structures. In the MC region, we received further information on the group categories by the CARDER institution that identified 4 structures: "registered" cooperatives, cooperatives, associations, and informal groups ('groupements'). Most of the applications came from cooperatives, with ODAHA registered cooperatives representing about one third of the sample.

Table 3: MC Region: Applications by group type

	Number	%
Registered cooperative	85	31.4
Cooperative	107	39.5
Association	25	9.2
Group	54	19.9
Total	**272**	

Applications were examined through two stages, a preselection and a field verification stage by a CCP (*Comité Communal de Pré-selection*) committee.

1.2 Pre-selection

In the application sheet, the promoter had to clarify whether s/he satisfied the following exclusion criteria:

- The promoter is active in the targeted location;
- S/he has experience in the proposed business;
- S/he does not have pending loans;
- S/he has not received unjustified subsidies;
- S/he is proposing to cultivate crops that are eligible for the project (vegetables and rice in the MC region; vegetables, rice, cashews and nuts in the AD region);
- S/he is proposing to focus on a main activity that is eligible for the project (production, transformation, or commercialization); and
- S/he represents a group of producers.

Table 4 below presents a summary of the applications across the criteria. A majority of the promoters declared to satisfy the 5 exclusion criteria (over 90% of applications). A selection committee reviewed the submissions and defined whether the applications were indeed eligible (passing all the criteria).

In the MC region, 85% of the applications (n. 231) were identified as eligible. Of the 41 applications that were rejected, a majority did not pass the first selection criteria - requiring the presence of the promoter in the area of production. In the AD region, about 90% of the applications (n. 189-191) were identified as eligible. Of the 22 applications that were rejected, a majority did not pass the selection criteria about eligibility of the proposed crop and activity. However, it is difficult to justify these rejection decisions without a field verification and, in several cases, no formal explanation was given for the rejection.

Table 4. Applications – Selection criteria (not mutually exclusive)

The promoter	Number	%	Total obs
Panel A. MC region			
Is active in the targeted location	249	91.5	272
Has experience in the business	257	94.5	272
Does not have pending loans	266	97.8	272
Has not received unjustified subsidies	267	98.2	272
Proposes crops that are eligible for the project	268	98.5	272
Panel B. AD region			
Is active in the targeted location & has experience in the business	208	97.7	213
Does not have pending loans or past unjustified subsidies	212	99.5	213
Proposes crops that are eligible for the project	204	95.8	213
Proposes an activity that is eligible for the project	204	95.8	213
Represents a group of producers	211	99.1	213

Finally, we analyse which project and organization characteristics are correlated with the probability of being selected during the first phase by using a simple *probit model* with standard errors clustered at the Arrondissement level. Moreover, the regressions include commune dummies to capture any commune specific characteristics or the composition of CCP that have affected in one way or another one the selection process.[14]

Before going to the results of the probability model it is important to highlight a number of issues. First, given the exclusion nature of the criteria reported in Table 4 we do not include them as repressors because they would perfectly predict the outcome variable and drop out. Second, it is difficult to compare the values of some indicators across the organizations because it is not clear how they have been aggregated across members (average, sum, etc.) and using them would introduce some bias in the analysis. For instance, we cannot understand the aggregation of data related to production, sales, and experience across organization members. Moreover, there are missing observations on these indicators leaving less data points to be used for the estimations, which would affect the quality of our inference. Due to these reasons, we concentrate on the following indicators: crop type; formality status of the organisation, budget requested, organization size, and gender composition of the organisation. Note, however, that a number of cross-section units also drop when we run the probit model controlling for the commune fixed effects. This happens because within communes some observations were very similar across organizations and using them did not add any extra variations to the models.

Table 5 shows that the variables that statistically influenced the probability of selection, at the pre-selection phase, differ by region. In the MC region, 'rice', 'percentage of female members', 'formality' which is a dummy variable representing the degree of formality of the organization (with 1=registered and 0-otherwise), organization size, and the budget requested appeared to be statistically significant

14 That being said we will not be able to control for everything. For instance, it happened that some CCP members were not present to the selection meetings. See more on application data issue in next paragraph.

correlates of the probability of being selected during the first phase. In particular, groups that produce vegetables, include more women, have a lower size, have a more formal structure, have requested a relatively big budget, or perform better in terms of agricultural productivity were more likely to be selected in the first phase. The role of formality status as well as the one of the requested budget size are also similar for the selected projects in the AD region. On the contrary, organizations that produce rice instead of vegetables were more likely to be selected in the AD region. In term of quantitative significance, the gender composition of the organization seems to play a dominant role on the probability of selection. In particular, the results indicate that when the percentage of female membership of an otherwise "average organization" in the MC region increases by one unit the probability of selection of that organization increases by 0.28. For the AD region it is the rice dummy that displays the highest marginal effect. Especially, if we take two otherwise average organizations where one is specialized in rice and the other in vegetable, then the project submitted by the organization that is specialized in rice will have 0.24 more chance to be selected.

As the role of the commune specific factors are concerned, only the Boukoumbé dummy is barely statistically significant and negative for the AD region. Overall, these results suggest that the selection was implemented with similar standards within that region. They may also suggest that commune specific factors did not play a dominant role for the selection of projects at this stage. On the contrary, in the MC region, we find that the projects submitted in the Communes of Grand-Popo and Lokossa had a higher chance to be selected. A further analysis should shed lights on this findings.

Table 5. Probit model: Pre-selection

	MC		AD	
VARIABLES	select1	dy/dx	select1	dy/dx
Rice	-0.552*	-0.08261	1.637**	0.249374
	(0.298)		(0.772)	
Cashews			-0.120	-0.01827
			(0.967)	
Transformation			-0.648	-0.09866
			(0.607)	
Commercialisation			-0.270	-0.04114
			(0.723)	
Formality	0.761**	0.114009	1.018***	0.155019
	(0.370)		(0.337)	
Ln(Budget Requested)	0.318**	0.047586	0.944***	0.143798
	(0.159)		(0.275)	
Ln(Organization Size)	-0.969***	-0.14517	0.248	0.037731
	(0.309)		(0.368)	
Female Membership (%)	1.889***	0.282909	-0.766	-0.11672
	(0.349)		(0.739)	
Commune FE	yes		yes	
Observations	240		121	

Notes: Robust standard errors in parentheses. *** Significance at 1%, ** significance at 5%, * significance at 10 . The columns dy/dx show the marginal effects evaluated at mean values.

1.3 Verification (*visite de terrain*)

In the second phase, the remaining eligible projects were screened through field visits. During this field verification, eligible groups had to pass two steps.

In the **first step**, the committee verified the information submitted in the application. Specifically, it verified that the promoter was still actively producing in the specified area and that the location of the project was secured, accessible, and not subject to frequent floods. In addition, among groups with an active promoter, it verified that the promoter was a new beneficiary of subsidies, knew the submitted business plan, and was reliable enough as group leader.[15] Furthermore, it also checked that the group had access to a plot of minimum 1 hectare to be used for the project. As shown in Table 6 below, this field verification highlighted that the situation on the ground was often different from the information provided in the application.

In 5% (AD region) to 20% (MC region) of the cases, the promoter was not (or no longer) active in the activity; another 11% (AD) to 15% (MC) of the initially eligible organizations were located in areas not suitable for business enhancement (i.e. sites not easily accessible, far from the market, unsecure, or subject to natural disasters); and, in another 12%(MC) to 13%(AD) of the cases, the promoter did not pass all the eligibility criteria – in particular, s/he did not appear to know the business plan. Therefore, after the field verification, in the MC region only 52% of the organizations (n. 122) were identified as actually eligible, while in the AD region 71% of the organizations (n. 133) were identified as eligible.

Table 6. Verification – Selection criteria (not mutually exclusive)

	Number	%	Total obs
Panel A. MC region			
The promoter is active in the targeted location	184	79.7	231
The site is accessible and secure	196	84.8	231
The promoter is a new beneficiary	213	92.2	231
S/he knows the business plan	211	91.3	231
S/he is credible	218	94.4	231
Panel B. AD region			
The promoter is active in the targeted location	179	94.7	189
The site is accessible and secure	168	88.9	189
The promoter is a new beneficiary	176	93.1	189
S/he knows the business plan	165	87.3	189
S/he is credible	181	95.8	189

In the **second step** of the selection, the committee collected on the ground basic information regarding the promoter, and the proposed business activity, and scored each proposal based on its business viability and on its gender and environmental friendliness. In particular, the committee used the following scoring components and scored each on a range from 1 to 5:

1. Proportion of agricultural production that was sold in the last season;
2. Formality of contractual arrangements for the sale of production and the purchase of inputs;
3. Years of experience in the activity;
4. Formality of group structure;
5. Use of non-household labour in the last season;
6. Existence of previous business capital;
7. Percentage of female members;
8. Gender-friendliness of the activity; and
9. Environmental-friendliness of the activity.

15 Criteria: 1. 'Présence effective du promoteur dans la localité et dans l'activité'; 2. 'Le site sur lequel l'activité est censée être menée est sécurisé et accessible'; 3. 'Le promoteur n'a pas bénéficié de financement antérieur'; 4. 'La connaissance par le promoteur du contenu de la fiche de projet'; and 5. 'La crédibilité du promoteur'.

These components were scored based on self-reported information. Again it is not clear how the values on certain indicators were aggregated across organization members. For instance, how were the aggregate values on indicators such as non-household labour, available capital, and gender-friendliness obtained? It would be important to improve this aspect in the future.

The data reported in Table 7 show that a majority of the groups scored high in terms of sales and years of experienced, while in most cases groups relied on rather informal contractual arrangements. Most of the business plans also resulted to be sufficiently gender-friendly, whereas fewer activities were identified as environmentally 'smart' (i.e. promoting biological products, using 'green' inputs, etc.). Table 7 summarizes how the eligible groups scored on average along the different components.

Table 7. Business plans – Average scores by component across eligible projects

	MC region		AD region	
	Total obs	Mean	Total obs	Mean
Index for sold production [1-5]	122	4.3	133	4.44
Index for contract formality [1-5]	122	2.26	133	2.4
Index for years of experience [1-5]	122	3.7	133	3.33
Index for group functionality [1-5]	122	3.25	133	2.67
Index for use of labour [1-5]	122	3.08	133	3.09
Index for business capital [1-5]	122	3.08		
Index for % of females [1-5]	122	3.45	133	3.61
Index for gender-friendliness [1-5]	122	3.81	133	3.58
Index for environmental-friendliness [1-5]	122	2.96	133	2.44

These various components were assigned different weights. As a result, eligible business plans were scored on a scale from 70 to 167. As a final suitability requirement, the selection committee defined a cut-off score around 90. Thus, a few groups were rejected in the last step because they scored below the cut-off (5 in the MC region and 9 in the AD region). The remaining groups were deemed as eligible for the PROFI program. Non-eligible groups differed mostly in terms of business readiness: they did not use contractual arrangements and relied on on-the-spot negotiations, they had poor group governance, limited experience, and no business capital.

We conclude this session by analysing the correlates of the probability of being selected during the second and last phase of the pre-selection of PROFI. Table 8a below shows that, again, the variables correlated with selection differ by region. In the MC area, bigger projects, i.e. projects submitted by organizations that are specialized in the vegetable sector and requesting for equipment of higher value, were more likely to be selected. The likelihood of being identified as eligible for the program is significantly and positively associated with all the prioritisation criteria - except for the one related to female, when we use them one by one and controlling for the commune fixed effects. However, when we include all the characteristics together only the following criteria are statistically significant: years of business experience of the organizations, realized investment level, contracting for sales, and proportion of sales. The results suggest that four prioritisation criteria have played a more dominant role for the selection process of the second phase. In term of quantitative significance the role of the indicator related to the proportion of sales is more important. Moreover, the projects submitted by organizations located in the Dogbo Commune had a higher probability to be selected.

For the AD area, data limitation problems prevent us from performing the same analysis. Many observations drop because of missing observations or lack of variation within communes. Table 8b show that projects involving vegetable and commercialisation were more likely to be selected, while there is a weak evidence that the following prioritisation criteria played a role in the selection process: years of business experience, formal contracting for sales, and gender-friendless.

Table 8.a. Probit model: Verification in MC

VARIABLES	(1) select2	(2) select2	(3) select2	(4) select2	(5) select2	(6) select2	(7) select2	(8) select2	(9) select2	(10) select2	dy/dx
Sales	1.153**									1.216***	0.123704
	(0.545)									(0.444)	
Contract formality for sales		0.907*								0.524**	0.053246
		(0.484)								(0.238)	
Experience in the sector			1.110***							0.814***	0.082746
			(0.363)							(0.299)	
Non-household labor				0.669*						-0.0734	-0.00747
				(0.393)						(0.457)	
Female					0.599					0.401	0.040805
					(0.419)					(0.366)	
Realized Investment						0.983***				0.435*	0.044235
						(0.310)				(0.236)	
Environ-friendliness							1.278**			0.320	0.032539
							(0.499)			(0.423)	
Gender-friendliness								1.053**		-1.019	-0.10366
								(0.521)		(0.790)	
Formality status									1.244***	0.249	0.025314
									(0.352)	(0.396)	
Rice	-0.739	-1.498***	-1.343**	-1.232***	-1.277**	-0.659	-1.399**	-1.051*	-1.326***	0.503	
	(0.502)	(0.532)	(0.586)	(0.477)	(0.608)	(0.568)	(0.578)	(0.578)	(0.476)	(0.559)	
Ln(Budget Requested)	1.093*	1.640**	1.404**	1.153**	1.356**	0.869	1.701**	1.377**	0.913	0.186	
	(0.596)	(0.697)	(0.567)	(0.554)	(0.613)	(0.584)	(0.685)	(0.631)	(0.599)	(0.363)	
Ln(Organization Size)	0.0377	0.316	-0.0158	0.177	0.0440	0.345	0.0514	0.133	0.201	0.0951	
	(0.351)	(0.317)	(0.377)	(0.372)	(0.366)	(0.343)	(0.343)	(0.389)	(0.378)	(0.339)	
Constant	-20.04**	-27.83**	-23.76**	-19.23**	-21.91**	-14.89	-29.15***	-24.01**	-17.01*	-8.946	
	(9.388)	(11.51)	(9.237)	(9.134)	(9.972)	(9.231)	(11.25)	(9.903)	(9.607)	(6.557)	
Commune	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	
Observations	81	81	81	81	81	81	81	81	81	130	

Table 8.b. Probit model: Verification in AD

VARIABLES	(1) select2	(3) select2	(4) select2	(5) select2	(6) select2	(7) select2	dy/dx
Sales	1.868*						0.007418
	(1.078)						
Contract formality for sales		2.687**					0.001176
		(1.180)					
Experience in the sector			1.766				0.002957
			(1.370)				
Non-household labour				1.456			0.008893
				(1.366)			
Environ-friendliness					1.150*		0.013672
					(0.685)		
Gender-friendliness						5.262**	0.044787
						(2.335)	
Rice	-4.732***	-2.605*	-6.787***	-4.208***			
	(0.843)	(1.464)	(2.032)	(0.593)			
Cashew	-16.78***	-15.43***	-19.75***	-14.25***	-11.95***	-10.63***	
	(2.496)	(2.320)	(3.265)	(2.487)	(1.838)	(2.577)	
Transformation	-0.372	0.427	1.649	-0.130	-0.797	-0.418	
	(0.901)	(0.639)	(1.461)	(0.628)	(0.886)	(0.812)	
Commercialisation	6.401***	6.234***	7.366***	6.154***	5.590***	5.395***	
	(1.207)	(1.514)	(1.149)	(1.159)	(0.964)	(1.682)	
Ln(Budget Requested)	0.949	0.606	1.331	0.959*	0.790	1.603**	
	(0.650)	(0.966)	(0.819)	(0.575)	(0.550)	(0.668)	
Ln(Organization Size)	0.0706	0.108	-0.403	0.156	-0.0671	-0.347	
	(0.468)	(0.279)	(0.531)	(0.415)	(0.394)	(0.416)	
Commune	yes	yes	yes	yes	yes	yes	
Observations	59	59	59	59	59	59	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2 | Descriptive statistics of eligible organisations

The following tables present interesting descriptive statistics regarding the eligible organisations that have passed the pre-selection process. In the Mono-Couffo region, as shown in Table 9.a., the distribution of groups by product category, vegetables vs. rice, corresponds well to the distribution of producers in the Census data of 2015-16 – with vegetable producers representing around 85% of the sample and rice producers around 15%. These sub-regional distribution seem to correspond well to their relative productivity (for instance, the two communes in the department of Mono, Athiémé and Grand-Popo, that have the highest percentages of accepted applications are also the two communes with the highest agricultural productivity).

Table 9.a. MC region: Groups by product type

	Number	%	% of producers - Census
Vegetables	97	82.9	86.5 (9,535/11,023)
Rice	20	17.1	13.5 (1,488/11,023)
	117		

In the Atacora-Donga region, the distribution of groups by product category -i.e. vegetables, rice, or cashews- and by main activity –i.e. production, transformation, or commercialization- is shown in Table 9.b. Half of eligible groups (62 over 124) specialize in the production of rice or vegetables. The impact evaluation will focus on these groups in order to ensure comparability with the MC sub-sample.

Table 9.b. AD region: Groups by product type and main activity

	Production	Transformation	Commercialization	
Vegetables	**25**			25
Rice	**37**	29	1	67
Cashews	18	2	12	32
	80	31	13	**124**

Data on organisation type is not available for the whole sample. Among eligible organisations that could be identified by type, about 80% are formed as cooperative, a majority of which are registered – suggesting that groups with a stronger governance structure had higher likelihood to be selected. Among registered cooperative, the average capital "libre" is about 104,000 West African Francs (XOF) or USD 180 in the MC region and 38,783 XOF/ 66 USD in the AD region. The remaining groups are formed as associations or informal groups. Data from MC also suggests that, on average, eligible groups have 6-7 years of experience in the proposed activity (minimum 1 and maximum 20).

Table 10. Groups by type

	MC region		**AD region**	
	Number	%	Number	%
Registered cooperative	49	41.9	54	58.1
Cooperative	41	35.1	24	25.8
Association	8	6.8		
Group	19	16.2	15	16.1
	117		93	

The available data during the selection process show that eligible groups have a minimum of 3 members and a maximum of 250 members, and include a mean of 9 members in the MC region and 25 members in the AD region– with number of members well distributed, on average, among men and women.

Table 11. Groups by number of members

	MC region		AD region	
Group size	Number	%	Number	%
3			1	0.8
5	16	13.68	2	1.7
6	14	11.97	2	1.7
7	32	27.35	6	5.0
8	6	5.13	6	5.0
9	4	3.42	8	6.7
10	6	5.13	3	2.5
11	6	5.13	6	5.0
12	6	5.13	7	5.8
13	5	4.27	5	4.2
14	3	2.56	4	3.3
15	5	4.27	9	7.5
>=16	14	11.96	61	50.9
	117		120	

Among vegetable producers, the majority chose to cultivate as primary product tomatoes and peppers –long or round-, mirroring well the relative importance in the Beninese agricultural economy of these market garden crops. In the AD region, the distribution of groups between paddy rice and parboiled rice mirrors the distribution of groups specializing on rice production vs. rice transformation/ commercialization.

Table 12. Groups by main product

	MC region		AD region	
	Number	%	Number	%
Tomato	34	29.1	6	4.9
Pepper	20	17.1	7	5.7
Jew's mallow (Crin-crin)	20	17.1		
Onion	12	10.2	4	3.2
Cabbage	11	9.4	3	2.4
Okra			5	4
Paddy rice	20	17.1	37	29.8
Parboiled rice			30	24.2
Nuts			30	24.2
Almonds			2	1.6
	117		124	

Relying on data from the MC region, we also present the average level of productivity, i.e. tons per hectares produced in the last agricultural year, and the average percentage of sold production among eligible groups.

Table 13. Average productivity and percentage of sold production (MC region)

	Number of producers (not mutually exclusive)	Average productivity	Number of sellers (not mutually exclusive)	Average percentage of sold production
Tomato	53	11.53	54	94%
Jew's mallow	27	15.30	27	96%
Onion	14	26.80	14	96%
Cabbage	12	15.70	12	96%
Long pepper	27	25.53	22	91%
Round pepper	28	13.55	25	97%

Rice	21	2.57	21	76%
Overall sample	117	13.58	112	92%

Finally, we analyses the access to finance of eligible groups. More than half of the groups have an account at a non-bank financial institution, such as a microfinance organization, while less than a fifth has a formal bank account.

Table 14. Groups by access to finance

	%
Does not have account	26.5
Has account at a microfinance org.	55.56
Has a bank account	17.95

2.1 Estimated budget

On average, the estimated budget for implementing a proposal is XOF (CFA) 8,331,330 or USD 14,180/ EUR 12,700 in the MC region and XOF 6,634,191 or USD 11,367/ EUR 10,116 in the AD region – with budgets ranging from a minimum of XOF 1,500,000 (approximately USD 2,570) to a maximum of XOF 19,200,000 (approximately USD 32,900). Generally, average project budgets are equally distributed among small vs. larger groups (correlation between budget and size not significant, with correlation coefficient around 0.1) and among low vs. high scoring projects (correlation between budget and score also not significant).

Table 15. Average project budget (estimated – West African Francs x 1,000)

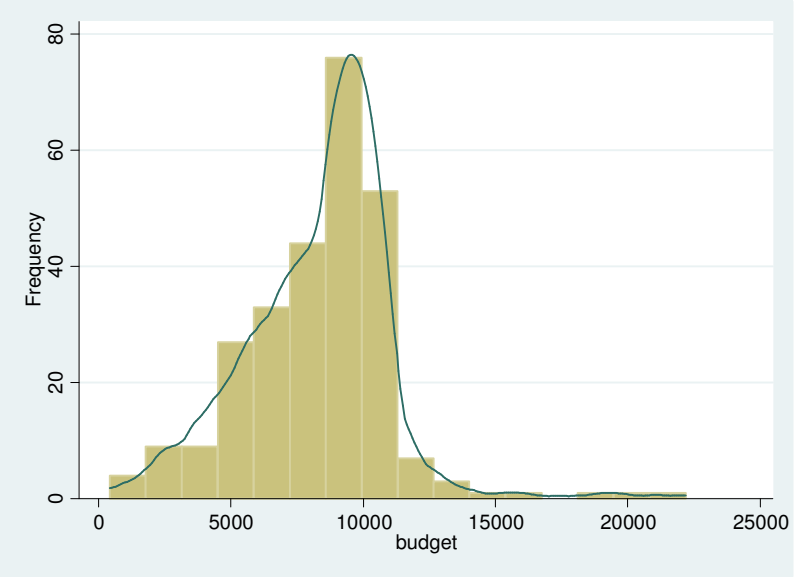
	Obs	Mean	Min	Max
MC region	117	8,331.33	1,643	12,275
AD region	123	6,634.19	1,500	19,200

The kernel distributions of project budgets are shown in Figure 1. They appear to be more stretched to the left, suggesting that fewer projects asked more than the average. In the AD region, there seems to be a peak, though, above the average value at just below 10,000,000 XOF.

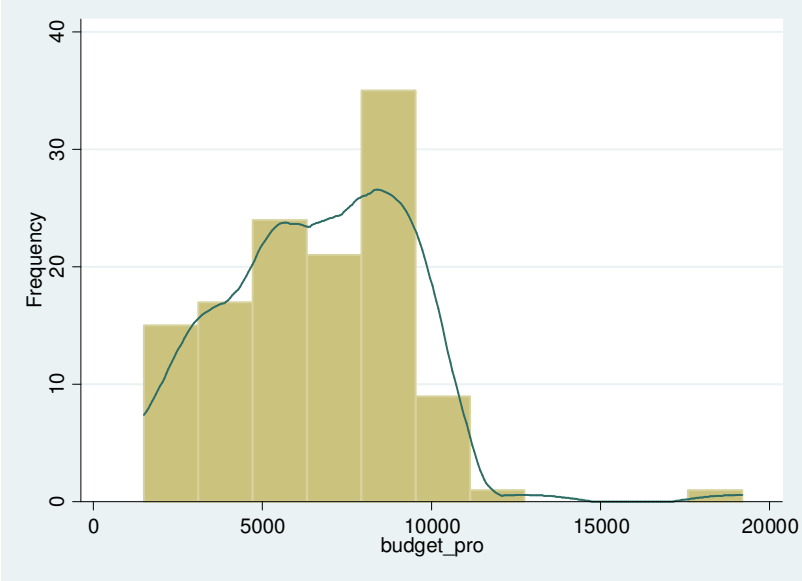
Mostly, proposals focus on requests for irrigation equipment and material. Groups asked for plumbing tools, (submerged) motor-pumps, mechanical drills, solar panels for irrigation, water towers, and water tanks. Transportation vehicles and storage/ drying facilities were also frequently demanded.

Figure 1. Histogram and Kernel distribution of estimated budget (XOF x 1,000)

a. MC region



b. AD region



3 | Final selection of projects

As a final step, a technical committee (CRA-*Comité Régional d'Approbation*) reviewed all the proposals, adjusted the definition of eligibility, rejected some outlier applications, and revised the budget allocation. As a result, the committee selected 227 groups as eligible, 108 from the MC region and 119 groups from AD.

Table 16 presents the distribution of the sub-sample from the Atacora-Donga region. To ensure comparability with the sub-sample from Mono-Couffo, we primarily focus the Impact Evaluation on the 56 groups of vegetable and rice producers that are not sole producers in their commune (identified in the table below in parenthesis), while the comparability of information on cashew producers will be assessed based on the findings of the baseline data collection. This leaves aside 4 projects that are in the sectors of rice and vegetables and 27 projects in the sector of cashew. In another version of the IE we include the 27 projects on cashew.

Table 16. Distribution of selected groups (AD region)

Depart-ment	Commune	Vegetables	Rice - Production	Rice - Transformation	Cashews	
Atacora	Boukoumbé		5	2		**7**
Atacora	Cobly		5	2		**7**
Atacora	Kérou	2		7	2	**11**
Atacora	Kouandé	(1)		1	3	**5**
Atacora	Matéri		15	3		**18**
Atacora	Natitingou	(1)	3			**4**
Atacora	Péhunco	3			8	**11**
Atacora	Tanguiéta	(1)	2	5*		**8**
Atacora	Toucountouna			3	3	**6**
Donga	Bassila	2		3	4	**9**
Donga	Djougou	6	6	3	4	**19**
Donga	Copargo	5			1	**6**
Donga	Ouaké	2	(1)	1	2	**6**
*1 Commercialization		**23**	**37**	**30**	**27**	

Below we analyse descriptive information for the sample of selected groups.

Table 17.a. MC region: Characteristics of selected groups

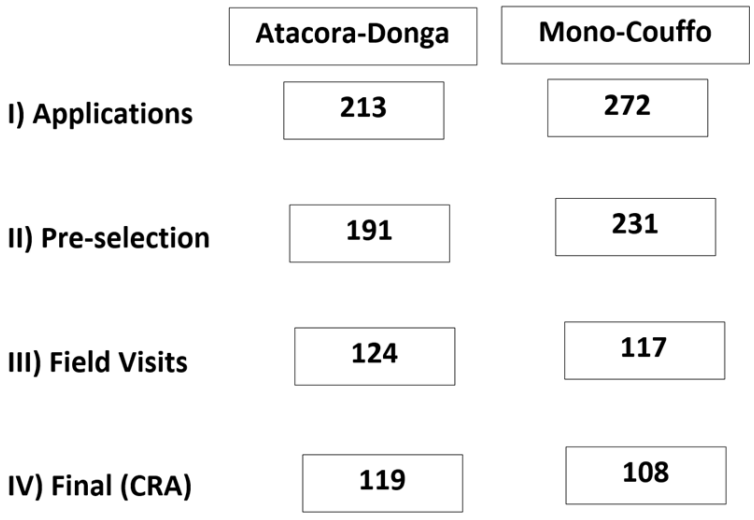
	Obs	Mean	Std. Dev.	Min	Max
Number of members	108	9.76	5.26	5	36
Percentage of females	108	0.51	0.25	0	1
Productivity (tons/ha)	108	14.07	19.82	0.21	85
Percentage of sold production	103	0.92	0.15	0.02	1
Years of experience	88	6.38	4.33	1	20
Index for group type [1-4]	108	3.00	1.08	1	4
Index for access to finance [0-2]	108	0.89	0.66	0	2
Index for sold production [1-5]	108	4.38	0.82	1	5
Index for contract formality [1-5]	108	2.29	1.01	1	5
Index for years of experience [1-5]	108	3.76	1.31	1	5
Index for group functionality [1-5]	108	3.35	1.23	1	5
Index for use of labour [1-5]	108	3.07	1.22	1	5
Index for business capital [1-5]	108	3.15	1.89	1	5

Index for % of females [1-5]	108	3.48	1.07	1	5
Index for gender-friendliness [1-5]	108	3.83	0.90	2	5
Index for environmental-friendliness [1-5]	108	2.96	0.91	1	5
Total score	108	133.96	16.41	100	167
Estimated budget (ln)	108	8.97	0.34	7.40	9.42
Assigned budget (ln)	107	8.94	0.36	7.75	9.21

Table 17.b. AD region: Characteristics of selected groups (to be included in the IE sample)

	Obs	Mean	Std. Dev.	Min	Max
Number of members	54	26.54	22.07	3	110
Percentage of females	54	0.51	0.36	0	1
Index for sold production [1-5]	56	4.18	1.11	2	5
Index for contract formality [1-5]	56	2.68	1.32	1	5
Index for years of experience [1-5]	56	3.64	1.24	1	5
Index for group functionality [1-5]	56	2.89	1.20	1	5
Index for use of labour [1-5]	56	3.66	1.21	1	5
Index for % of females [1-5]	56	3.64	1.38	1	5
Index for gender-friendliness [1-5]	56	3.64	0.82	1	5
Index for environmental-friendliness [1-5]	56	2.29	1.02	1	5
Total score	56	120.04	16.28	93	155
Estimated budget (ln)	56	8.71	0.39	7.70	9.20
Assigned budget (ln)	56	8.71	0.39	7.70	9.20

Figure 2: Overview of PROFI selection process



4 | Evaluation design

4.1 Design details

Against such a background, the evaluation of the PROFI program is of particular interest from both a policy and research perspective. Specifically, the evaluation employs a **Randomized Controlled Trial** (RCT) approach at the group level. In each producer category (i.e. producers of vegetables and rice) and in each commune, half of the selected organisations are randomly assigned to receive the program during the first year of program implementation and the other half serves as control group.

The randomized experimental design guarantees the most accurate analysis of the effect of the intervention. By randomly assigning subjects to be in the group that receives the treatment or to be in the control group, it will be possible to measure the effect of the program regardless of other factors that may make some individuals or groups more likely to benefit from agricultural investments since treatment and control groups differ solely due to chance. For this reason, RCT designs represent the 'gold standard' of evaluation methods and are preferable to other approaches such as Difference-in-Differences or comparisons based on Propensity Score Matching.

The design of the impact evaluation uses a **Phase-in approach**. During phase 1, all groups will receive non-financial support around December 2016 (with priority given to treatment groups) and treatment organizations will receive the requested materials and equipment around January 2017.[16] During phase 2, the control group will receive the requested materials and equipment too (around March 2018). A phase-in design was preferred in this case since BTC-Benin can and wants to finance all eligible applications. Phase-in designs are generally used in contexts where it is not acceptable not to offer treatment to part of the eligible population. In fact, the first programs that were evaluated with a randomized approach, such as the Progresa Cash Transfer in Mexico and the Primary School Deworming project in Kenya, all used a phase-in design. This design offers indeed some advantages compared to a pure lottery because, for example, the expectation of future benefits provides subjects an incentive to maintain contact with researchers and thus alleviates issues associated with attrition. However, randomized phase-in designs have a few drawbacks too. They often prevent researchers from estimating a program's long-run effects. It is crucial then that the time between phases is sufficient to encompass any treatment lag. Also, they are problematic when the comparison group is affected by the expectation of future treatment. For example, in the case of a phased-in agricultural subsidy program, individuals in the comparison groups may delay investing in anticipation of cheaper options once they have access to the program. This would lead researchers to overstate treatment effects. Alternatively, the expectation of a future subsidy could act as a form of insurance and increase investment, leading researchers to understate impacts.

To account as much as possible for anticipation effects, baseline data are collected in December 2016 before implementation of the program, midline data will be collected around March 2018, and endline data will be collected at least one year after that. Thus, the midline data will allow to detect changes for groups of phase 2 that might be driven by expectation of future treatment. Moreover, the questionnaire allows to derive information about future actions related to investment of each of the respondents.

16 The dates of the intervention will be updated according to developments in the field.

Whereas the randomization is performed at the organization level our interest is to understand the performance of individual producers. For this purpose, we collect detailed information from each of five[17] selected members for all the organizations in the sample. Three of the five selected members are members of the organization management: president, treasury; and secretary. The two other individuals are randomly selected among the remaining members.

4.2 Preliminary balance tests

In this evaluation, the randomization was carried out privately through Stata. The research team implemented four different randomization attempts by changing the initial seed (i.e. 1000, 2000, 2016, and 3000). The results in terms of balance of these four attempts were then compared to the results of a fifth attempt in which the randomization classes had been manually identified (based on the shortest distance in total scores within each category). In testing for balance, we regressed each variable on the treatment dummy controlling for the randomization category dummies and clustering the standard errors by arrondissement. Table 18 presents the results of the various trials (standard errors are presented in parenthesis on the right). The randomization that started with seed 1000 performed best and was, therefore, preferred.

Table 18.a. MC region: Balance tests

	Seed 1000		Seed 2000		Seed 2016		Seed 3000		Manual classification	
Productivity (tons/ha)	-1.52	(3.865)	2.54	(4.246)	-2.00	(3.628)	1.28	(3.752)	-1.24	(3.169)
Percentage of sold production	0.01	(0.0222)	0.02	(0.0301)	-0.02	(0.0283)	-0.03	(0.0311)	-0.02	(0.0266)
Years of experience	-0.46	(0.893)	0.26	(1.072)	0.61	(0.898)	1.70	(1.124)	-0.81	(1.149)
Index for group type [1-4]	0.17	(0.217)	0.20	(0.197)	-0.18	(0.189)	-0.175	(0.144)	0.20	(0.165)
Number of members	-0.53	(0.955)	1.10	(0.867)	-0.46	(0.927)	-0.69	(0.999)	-1.10	(0.935)
Percentage of females	-0.03	(0.0463)	-0.03	(0.0360)	0.03	(0.0488)	0.01	(0.0339)	-0.05	(0.0362)
Index for access to finance [0-2]	-0.01	(0.1000)	-0.05	(0.101)	-0.01	(0.119)	-0.04	(0.110)	0.14	(0.129)
Index for sold production [1-5]	-0.22	(0.156)	0.05	(0.174)	-0.10	(0.156)	0.24	(0.152)	0.13	(0.131)
Index for contract formality [1-5]	0.03	(0.190)	0.23	(0.139)	0.4*	(0.210)	0.21	(0.156)	0.18	(0.161)
Index for years of experience [1-5]	-0.18	(0.252)	0.17	(0.190)	0.06	(0.204)	0.49**	(0.234)	0.14	(0.247)
Index for group functionality [1-5]	0.00	(0.187)	0.19	(0.201)	0.13	(0.219)	0.22	(0.218)	0.21	(0.193)
Index for use of labor [1-5]	-0.19	(0.178)	0.20	(0.184)	0.48**	(0.189)	-0.14	(0.181)	-0.13	(0.174)
Index for business capital [1-5]	-0.14	(0.254)	0.25	(0.319)	0.29	(0.294)	0.30	(0.262)	0.06	(0.260)
Index for % of females [1-5]	0.03	(0.191)	0.03	(0.188)	0.06	(0.202)	-0.01	(0.156)	-0.17	(0.185)
Index for gender-friendliness [1-5]	-0.07	(0.146)	-0.04	(0.166)	0.10	(0.160)	0.07	(0.162)	0.14	(0.151)
Index for environmental-friendliness [1-5]	0.01	(0.180)	0.21	(0.144)	0.11	(0.169)	0.02	(0.149)	-0.04	(0.143)
Estimated budget (ln)	0.02	(0.0633)	0.07	(0.0626)	-0.09	(0.0659)	0.04	(0.0644)	-0.01	(0.0575)
Assigned budget (ln)	0.06	(0.0722)	0.01	(0.0763)	-0.04	(0.0633)	0.05	(0.0620)	-0.05	(0.0681)
Average	**-0.17**		**0.30**						**-0.14**	

Table 18.b. AD region: Balance tests

17 We are exploring the possibility to increase this number to seven (where possible), which will correspond to about 50% of the median organization size.

	Seed 1000		Seed 2000		Seed 2016		Seed 3000	
Number of members	-1.78	(4.116)	-5.43	(3.315)	-6.46	(8.050)	4.81	(6.231)
Percentage of females	-0.06	(0.0680)	-0.16**	(0.0625)	0.10	(0.0629)	0.09	(0.0593)
Index for sold production [1-5]	0.19	(0.184)	-0.33	(0.242)	-0.03	(0.296)	0.26	(0.218)
Index for contract formality [1-5]	0.02	(0.251)	-0.57**	(0.256)	0.09	(0.319)	0.24	(0.329)
Index for years of experience [1-5]	-0.09	(0.354)	-0.46	(0.339)	0.35	(0.344)	0.13	(0.236)
Index for group functionality [1-5]	0.15	(0.269)	-0.15	(0.296)	0.29	(0.356)	0.22	(0.265)
Index for use of labor [1-5]	-0.03	(0.416)	-0.10	(0.442)	-0.10	(0.310)	-0.10	(0.371)
Index for % of females [1-5]	-0.16	(0.270)	-0.38*	(0.218)	0.06	(0.243)	0.42*	(0.206)
Index for gender-friendliness [1-5]	-0.16	(0.182)	-0.01	(0.184)	0.06	(0.161)	0.21	(0.169)
Index for environmental-friendliness [1-5]	0.12	(0.287)	0.12	(0.333)	-0.47	(0.361)	0.34	(0.323)
Total score	0.02	(3.519)	-8.61*	(4.632)	0.68	(3.484)	7.78**	(3.338)
Estimated budget (ln)	0.07	(0.0980)	0.02	(0.108)	0.14	(0.0921)	-0.04	(0.0740)
Assigned budget (ln)	0.07	(0.0980)	0.02	(0.108)	0.14	(0.0921)	-0.04	(0.0740)
Average	**-0.13**				**-0.40**			

4.3 Power calculations

The experimental sample primary includes the **164 groups/ clusters** described in the above section.[18] Considering the focus on agricultural productivity and relying on the Census data for Benin of 2015-16; the research team relied on the information described below for the power calculations. In this regard, it is useful to explain that power calculations involve making a number of assumptions, for example, about what the final outcomes will likely be. These assumptions can be informed by real data, but are often imperfect. In any case, making wrong assumptions does not affect accuracy (i.e, does not bias the results). It simply affects the precision with which it is possible to estimate a treatment impact.

The assumptions used are the following:

- **Primary outcome**: agricultural productivity (tons per hectare) among producers of rice or vegetables. Descriptive statistics based on data from the census are reported in Table 19.
- **Intra-Cluster Correlation** (ICC): The ICC of productivity at the village level is estimated to be low (<0.05) and equal to 0.02. Specifically, depending on crop type (vegetables or rice) and season, the ICC of productivity varies from a lower bound of 0.015 to an upper bound of 0.205 – with an average of 0.11
- **Significance level**: 0.05 - The standard level of significance
- **Proportion of variance that can be explained by control variables** (to be included in the baseline survey): 0.3

Table 19. Descriptives of primary outcomes – Census data

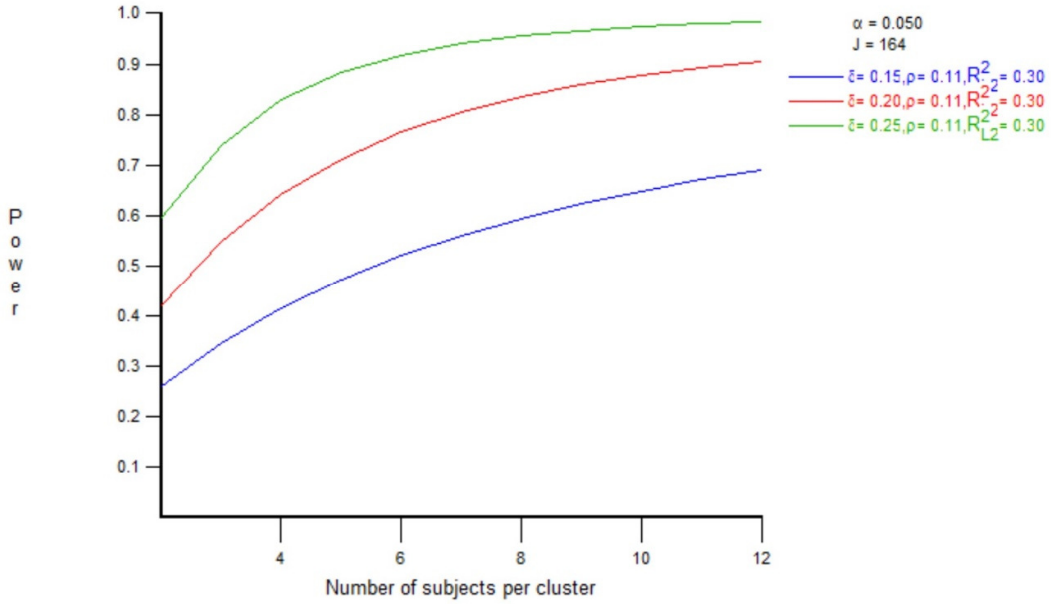
Variable	Obs	Mean	Std. Dev.	ICC
Productivity - seasonal average	11023	52.51	1531.5	0.0175
Productivity - 1st agri season	10172	69.18	2660.1	0.0173
Productivity - 2nd agri season	4193	20.86	524.1	0.154
Rice productivity - 1st agri season	1349	2.55	2.4	0.2052
Vegetables productivity - 1st agri season	9118	88.07	2895.6	0.0146
Vegetables productivity - 2nd agri season	4124	21.2	528.4	0.1541

18 Those 164 OP involve projects in the sectors of rice and vegetables. Later, we add the 27 projects on cashew leading to 191 MIC.

Power calculations are performed with the program Optimal Design. Specifically, we try to determine the sample size that allows to detect a specific effect with at least 80% power, which is the commonly accepted level of power. Note that **power** is the likelihood that when a program has an effect, you will be able to distinguish it from zero in your sample. Therefore at 80% power, if an intervention's impact is statistically significant at exactly the 5% level, then for a given sample, we are 80% likely to detect that impact.

The power calculations are showed in the figure below. They suggested that with 164 clusters and an average ICC of 0.11, a sample with about 5 individual producers per group/ cluster should be well powered (80% power) to detect (standardized) treatment effects on agricultural productivity ranging from 22 to 25%.

Figure 3: Power calculation



5 | Baseline survey

5.1 Questionnaire design and research questions

The research team, in collaboration with BTC-Benin, prepared two types of questionnaires. First, we designed a questionnaire to collect the basic information at an organization-level including the date of creation, number of members, and plots used by each of the five members for the targeted crops, as well as the type of occupation of the plots (individual, shared, or common). Second, we prepare a very detailed questionnaire, similar to standard agricultural modules of the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) program- to collect information at the individual level. This questionnaire covers a number of key areas in order to assess treatment effects, but also to understand important dynamics, such as factors hindering agricultural efficiency or the role of family labour in productive activities. In particular, the research team focused on measuring productivity of the targeted crops on PROFI plots, with emphasis on indicators of plot-specific production.

Key areas covered in the individual-level questionnaire include the following:

- Land holdings and title formalization
- Type of soil, erosion controls, and irrigation systems
- Water management
- Input use and technology adoption
- Seed varieties
- Fertilizer, pesticides/herbicides applications
- Farming practices/ Use of machines and farming equipment
- Family and hired labour
- Access to markets and information
- Access to common property resources
- Access to and use of agricultural services
- Access to credit (both for agriculture and other purposes)
- Governance and group characteristics (forthcoming round)

These indicators will allow to explore a number of important research questions, such as:

- What is the impact of agricultural investments on farm incomes?
- What are the economic returns to well drilling and other types of irrigation improvements?
- What types of inputs and practices are required for agricultural productivity?
- What is the role of credit constraints, and other market inefficiencies, in magnifying or mitigating the effects of the program?

We are also particularly interested in the question of additionality (e.g. McKenzie et al., 2016[19]): Does the intervention get farmer groups to undertake investments and new technological activities that they would not have done otherwise, or does it merely subsidize investments that would have taken place anyway? And, do these investments crowd in or crowd out other soil management technologies?

19 McKenzie et al. (2016) The Additionality Impact of a Matching Grant Program for Small Firms: Experimental Evidence from Yemen. Mimeo

Furthermore, we will explore the heterogeneous effects of the intervention depending on a number of key baseline characteristics such as land formalization and security (see Goldstein et al., 2015[20]), or network governance and professionality.

5.2 Design details and survey methodology

More specifically, the questionnaires were designed to understand respondents' agricultural productivity and, thus, collected detailed information on various indicators assumed to play an important role in the production function of rural micro-entrepreneurs. Interviews took place between December 2016 and February 2017.

The individual survey included questions at both the plot, the season, and –where relevant- the crop levels, and covered over 14,000 indicators summarized in the Appendix. In particular, it covered the following areas:

1. Personal profile: gender, age, level of education, years since membership, years of experience in crop-specific production, number of plots exploited, income sources, and ownership of financial accounts
2. Financing opportunities: main constraints to growth, sources of financing constraints, number of loans received in the last year (with details on the following: from which institution, amount received, interest rate, repayment timeline, collateral, loan use), and reasons for not having received a loan
3. Services received: technical training, environmental-friendly practices, entrepreneurial capabilities, managerial practices, and transformation techniques (with details on service providers and quality)
4. Plot roster: plot location and distance from key points, surface, exploitation mode, age, ownership or rent details, percentage of harvest kept
5. Soil: soil type and quality, erosion problems and solutions adopted, topography
6. Plot utilization: plot use, main crop, intercropping, surface used per plot-season, identification of plot decision-makers
7. Water: main water sources, frequency of water use, water quality
8. Seeds: type of seeds used, planting time, seed sources, quantity and value of planted seeds
9. Fertilizers: Quantity, value, and sources of various types of phytosanitary products, including organic fertilizers, urea, NPK, other chemical fertilizers, herbicides, insecticides and pesticides, and other products
10. Labour: number of household members employed (by gender and age categories), and relative days and hours worked, plus number of non-household members employed (by gender and age categories), relative days and hours worked, and paid salaries – per each phase of the agricultural cycle
11. Other costs: renting of animals or equipment, water, electricity, transport, stocking costs, losses, membership fees, interest payments, etc.
12. Harvest: harvest surface, quantity and value of produce, subjective harvest quality, and determinants of performance
13. Sales: quantity and value of produce sales, sale timing, identification of buyers, quantity and value of sales of transformed produce
14. Other sales: quantity and value of private consumption, keeping produce as seeds or as fodder, gifts, and stocking, plus details on stocking techniques

20 Goldstein et al. (2015): Formalizing rural land rights in West Africa: Early evidence from a randomized impact evaluation in Benin. World Bank Policy Research Working Paper 7435

15. Equipment: use and ownership of different agricultural equipment, material, and tools, ownership or renting details, value of the equipment, and sources of financing

Given the interest in assessing productivity, the above-mentioned measures were summarized in a series of performance indicators used by BTC-Benin, defined as follows:

- Yield ("*Rendement*")= Produce quantity over surface (kg/ha)
- Gross margin ("*Marge Brute*")= Produce value minus the input costs of seeds and fertilizers
- Added value ("*Valeur Ajoutée*")= Produce value minus production costs (excluding own labour)
- Profit (*Excédent brut d'exploitation*")= Produce value minus all costs (labour and non-labour)
- Gain ("*Résultat net/Bénéfice*")= Produce value minus all costs, after deduction of taxes and amortization
- Financing capacity ("cash flow")= Gain plus amortization
- Unit production cost= All costs over produce quantity
- Margin= Unit price minus unit production cost
- Threshold= Unit costs over unit price
- Threshold in kg per ha= Threshold over surface cultivated

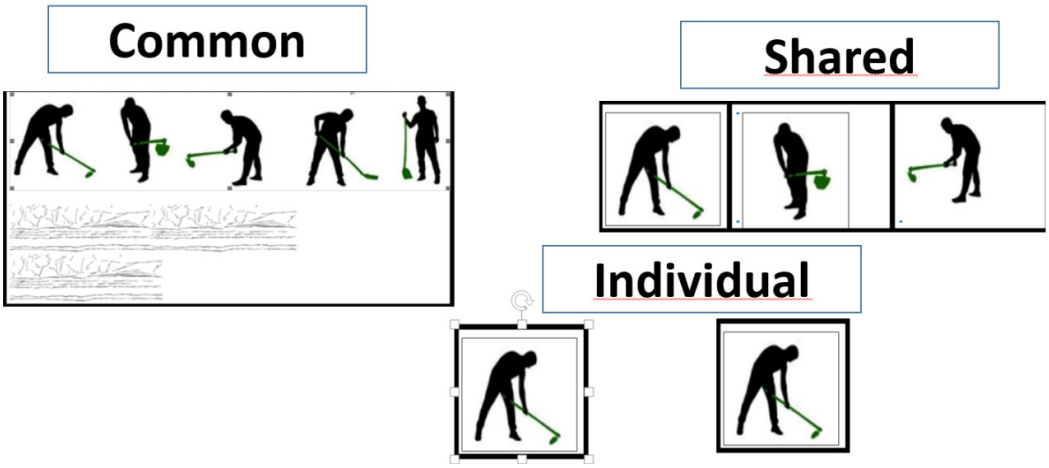
The group survey was administered to the five targeted members. It gathered details at the group level. It is also at this level that replacements of members to be surveyed for the individual level questionnaire took place.[21] For issues related to efficiency and data quality, we rely on three principles. First, we code the questionnaires in digital language such that they can been administrated with tablets during the field visits. Second, enumerators were recruited after training and field tests. The field tests also provided the opportunity to adjust the questionnaire were needed. Third, for the implementation, we involved in data collection four type of actors, i.e. enumerators, controllers, supervisors, and a coordinator. In total, we had 3 supervisors and 5 controllers. In order to facilitate communication, we used a digital communication tool allowing to facilitate both horizontal and vertical coordination among them.[22] Furthermore, field missions were undertaken to continue trainings and corrections on the data being collected.

Baseline data at the group and individual level are described in the next sections. Note an important clarification about the three different types of existing agricultural plots: individual plots; shared plots; and common plots (See Figure 4). Common plots are the ones where farmers work together and share the product of their activities through some pre-defined rules. Shared plots are plots are the ones where farmers work separately on a plot that is shared among organisation members. The product of their activities are kept separately by each member. Finally, individual plots are also managed separately and are not (necessarily) connected to each other.

21 A portion of the five targeted entrepreneurs could not be surveyed for several reasons: no longer or not a member of the organization, moved outside the country, etc.

22 This platform has been very useful for additional trainings and corrections regarding the questionnaire while the survey was ongoing.

Figure 4. Agricultural plot types



5.3 Group-level data

Tables 20 and 21, below, summarize the group-level data.

Table 20. Group-level data

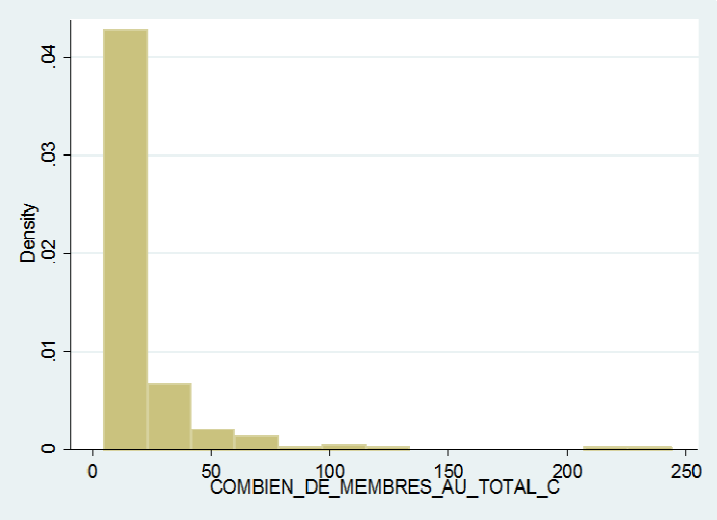
Variable Name	Obs	Mean	Std.Dev	Min	Max
Birth year of the group	195	2009	6	1970	2016
Number of members	195	19.82	27.94	5.00	244.00
Presence of common plots (0-1)	195	0.41	0.49	0.00	1.00
Number of common plots	80	1.18	0.41	1.00	3.00
Identifies a 1st common plot	80	1.00	0.00	1.00	1.00
Percentage of members included	80	0.96	0.17	0.12	1.00
Identifies a 2nd common plot	13	2.00	0.00	2.00	2.00
Percentage of members included	13	0.99	0.04	0.86	1.00
Common plots under MIC	195	0.45	0.50	0.00	1.00
Numb. of MIC common plots	87	1.01	0.11	1.00	2.00
Presence of shared plots (0-1)	195	0.35	0.48	0.00	1.00
Number of shared plots	69	1.51	1.78	1.00	15.00
Identifies a 1st shared plot	69	1.00	0.00	1.00	1.00
Percentage of members included	69	0.85	0.26	0.10	1.00
Identifies a 2nd shared plot	17	2.00	0.00	2.00	2.00
Percentage of members included	17	0.61	0.32	0.08	1.00
Number of plots of the president	194	2.10	1.03	1.00	6.00
Number of plots of the secretary	194	1.91	1.01	1.00	6.00
Number of plots of the treasurer	193	1.96	0.94	1.00	5.00
Number of plots of member n.1	194	1.91	0.97	1.00	6.00
Number of plots of member n.2	194	1.83	0.90	1.00	5.00

Table 21. Group-level data by region

Variable Name	Obs	Mean	Std. Dev.	Min	Max
AD					
Birth year of the group	87	2008	5	1987	2016
Number of members	87	32.32	38.03	6.00	244.00
Presence of common plots (0-1)	87	0.01	0.11	0.00	1.00
Number of common plots	1	1.00	.	1.00	1.00
Identifies a 1st common plot	1	1.00	.	1.00	1.00
Percentage of members included	1	0.12	.	0.12	0.12
Common plots under MIC	87	0.13	0.33	0.00	1.00
Numb. of MIC common plots	11	1.00	0.00	1.00	1.00
Presence of shared plots (0-1)	87	0.55	0.50	0.00	1.00
Number of shared plots	48	1.65	2.11	1.00	15.00
Identifies a 1st shared plot	48	1.00	0.00	1.00	1.00
Percentage of members included	48	0.79	0.29	0.10	1.00
Identifies a 2nd shared plot	13	2.00	0.00	2.00	2.00
Percentage of members included	13	0.49	0.26	0.08	1.00
Number of plots of the president	86	1.97	0.66	1.00	3.00
Number of plots of the secretary	86	1.80	0.75	1.00	5.00
Number of plots of the treasurer	85	1.87	0.67	1.00	3.00
Number of plots of member n.1	86	1.80	0.70	1.00	3.00
Number of plots of member n.2	86	1.65	0.66	1.00	3.00
MC					
Birth year of the group	108	2011	6	1970	2016
Number of members	108	9.74	4.83	5.00	36.00
Presence of common plots (0-1)	108	0.73	0.45	0.00	1.00
Number of common plots	79	1.18	0.42	1.00	3.00
Identifies a 1st common plot	79	1.00	0.00	1.00	1.00
Percentage of members included	79	0.97	0.14	0.14	1.00
Identifies a 2nd common plot	13	2.00	0.00	2.00	2.00
Percentage of members included	13	0.99	0.04	0.86	1.00
Common plots under MIC	108	0.70	0.46	0.00	1.00
Numb. of MIC common plots	76	1.01	0.11	1.00	2.00
Presence of shared plots (0-1)	108	0.19	0.40	0.00	1.00
Number of shared plots	21	1.19	0.40	1.00	2.00
Identifies a 1st shared plot	21	1.00	0.00	1.00	1.00
Percentage of members included	21	0.98	0.09	0.58	1.00
Identifies a 2nd shared plot	4	2.00	0.00	2.00	2.00
Percentage of members included	4	1.00	0.00	1.00	1.00
Number of plots of the president	108	2.20	1.24	1.00	6.00
Number of plots of the secretary	108	1.99	1.18	1.00	6.00
Number of plots of the treasurer	108	2.04	1.11	1.00	5.00
Number of plots of member n.1	108	2.00	1.14	1.00	6.00
Number of plots of member n.2	108	1.97	1.03	1.00	5.00

On average, organisations were formed 6 years ago and include about 20 members (32 members on average in the AD with a min. of 6 and a max. of 244 against about 10 on average in the MC with a min. of 5 and a max. of 36). The difference in the membership across the two regions could be related to the fact that in AD the organisations are usually more at the village or sub-village level. The distribution of the number of members is also represented in Figure 5 where the data show that the majority of organizations have size lower than 25 members and the median size is around 12.

Figure 5. Histogram of organisation size

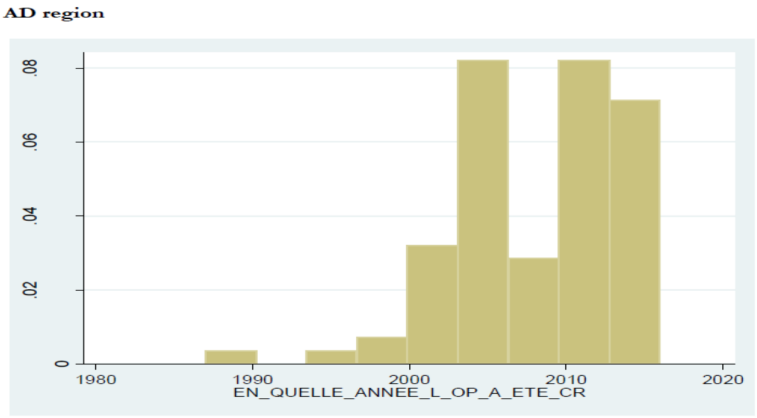


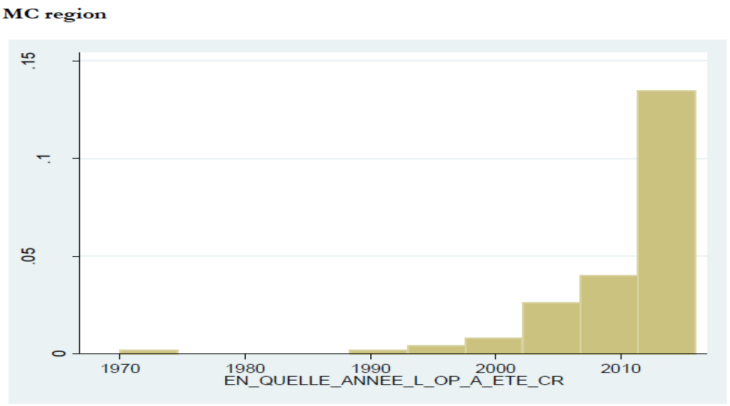
The data in Table 20 also show that about 40% of groups have common plots. Typically this concerns one plot which all organization members can work on. About 35% of groups have shared plots. Usually there are about one to two plots shared with 60-85% of group members. All members of the organization report having about two plots, with the president tending to report a higher number of plots (ranging from 1 to 6).

Table 21 reports also the summary values across the AD and MC regions where some interesting differences can be observed. For instance, there is very limited presence of common plots in AD as compared to MC, whereas the reverse holds true for shared plots. It is also interesting to note that most organizations in the AD region are older than their counterparts in the MC region, this finding is confirmed by looking at the relative distributions of birth years - shown below in the figure below where it can been seen that the majority of organizations were created after 2000 with a peak in 2016 especially in the MC region. In general, the average year of creation in both regions is 2009 (2011 in the MC and 2008 in the AD). However, the oldest organisation (OP-*organisation paysanne*) was created in 1970 in the MC (1987 in AD) and the most recent is in 2016 in both regions. One could associate the dynamics of OP creation with the PROFI intervention of the BTC which imposes beneficiaries to be an organisation. It will be interesting to understand whether these newly created organisations function properly and persist over time. We plan to further elaborate on these issues during the implementation of a governance survey.

Moreover, the data in Table 21 show that in the AD region only 1.15% (1/87) of the OPs reported working on common plots versus 73.15% (79/108) in the MC region. When asking about the PROFI plot, however, the use of common plots improves slightly in the AD region, going from one OP to eleven OPs (i.e. 1.15% to 12.64%). In MC, the usage of common plots is already high and does not seem to change significantly (79 vs. 76 OPs.). Finally, note that, although parcels are declared to be for common use, on average, few members of the OP are involved in their exploitation.

Figure 6. Year of organisation creation by region





In the next page, Tables 22 summarizes the group-level data by commune.

	Aplahoué	Athiémé	Bopa	Comé	Djakotomey	Dogbo	Grand-Popo	Houéyogbé	Klouékanmé	Lalo	Lokossa	Toviklin
Birth year of the group	2012.8	2013.1	2003.4	2010.5	2012.2	2010.6	2009.1	2006.6	2008.5	2008.2	2011.8	2012.6
Number of members	7.8	9.0	11.8	9.5	10.4	7.8	13.1	10.4	10.3	11.6	6.3	10.3
Presence of common plots (0-1)	1.0	0.9	0.2	1.0	1.0	0.5	0.3	1.0	0.8	0.4	0.9	0.8
Number of common plots	1.0	1.2	1.0	1.1	1.5	1.2	1.0	1.0	1.3	1.0	1.0	1.2
% of members included, 1st plot	1.0	1.0	1.0	1.0	1.0	1.0	0.6	1.0	0.9	1.0	1.0	1.0
% of members included, 2nd plot	.	1.0	.	1.0	1.0	1.0	.	.	0.9	.	.	1.0
Common plots under MIC	1.0	0.9	0.2	1.0	1.0	0.5	0.2	1.0	0.8	0.2	0.8	0.8
Numb. of MIC common plots	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Presence of shared plots (0-1)	0.0	0.1	0.8	0.0	0.0	0.4	0.1	0.0	0.3	0.8	0.1	0.3
Number of shared plots	.	1.0	1.0	.	.	1.5	1.5	.	1.5	1.0	1.0	1.0
% of members included, 1st plot	.	0.8	1.0	.	.	1.0	1.0	.	1.0	1.0	1.0	1.0
% of members included, 2nd plot	.	.	.	.	.	1.0	1.0	.	1.0	.	.	.
Number of plots of the president	2.8	1.7	1.2	1.3	3.5	2.3	1.6	1.0	4.0	3.2	1.4	3.1
Number of plots of the secretary	3.0	1.5	1.2	1.3	3.0	2.2	1.1	1.0	3.8	2.8	1.1	3.1
Number of plots of the treasurer	2.4	1.7	1.2	1.3	3.1	2.3	1.4	1.0	3.4	2.8	1.3	3.0
Number of plots of member n.1	2.8	1.6	1.0	1.3	2.8	2.3	1.2	1.0	3.5	3.2	1.4	2.8
Number of plots of member n.2	2.8	1.7	1.0	1.1	3.0	2.1	1.1	1.0	3.4	3.0	1.3	2.9

	Bassila	Boukombé	Cobly	Copargo	Djougou	Kerou	Kouandé	Matéri	Natitingou	Ouaké	Pehunco	Tanguiéta	Toucountou
Birth year of the group	2008.3	2006.4	2008.4	2012.3	2008.6	2004.5	2009.5	2005.1	2010.5	2006.2	2009.3	2011.0	2009.3
Number of members	9.8	78.2	41.6	10.8	23.6	19.3	31.5	45.0	36.0	14.4	46.7	23.7	11.0
Presence of common plots (0-1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Number of common plots	.	.	.	.	.	.	.	1.0	.	.	.	.	.
% of members included, 1st plot	.	.	.	.	.	.	.	0.1	.	.	.	.	.
Common plots under MIC	0.2	0.0	0.0	0.3	0.2	0.0	0.3	0.1	0.0	0.6	0.0	0.0	0.0
Numb. of MIC common plots	1.0	.	.	1.0	1.0	.	1.0	1.0	.	1.0	.	.	.
Presence of shared plots (0-1)	0.0	1.0	1.0	0.3	0.7	0.5	0.0	0.9	0.8	0.4	0.1	1.0	0.0
Number of shared plots	.	4.2	1.4	1.0	1.2	1.0	.	1.6	1.3	1.0	2.0	1.3	.
% of members included, 1st plot	.	0.7	0.8	0.8	1.0	0.6	.	0.7	0.7	1.0	0.5	0.9	.
% of members included, 2nd plot	.	0.3	0.4	.	1.0	.	.	0.4	0.5	.	0.5	0.4	.
Number of plots of the president	2.2	1.6	2.0	2.2	2.3	1.5	2.0	1.8	2.0	2.0	1.9	2.0	1.3
Number of plots of the secretary	1.7	1.4	2.0	2.2	1.6	1.5	2.3	2.1	2.0	1.8	1.7	1.3	1.7
Number of plots of the treasurer	1.7	1.6	2.0	1.8	2.1	1.3	2.3	1.7	2.8	2.0	1.9	1.3	1.7
Number of plots of member n.1	2.0	1.4	1.8	1.8	1.9	1.0	2.3	1.6	2.5	2.0	1.6	2.0	2.0
Number of plots of member n.2	1.7	1.0	1.6	1.3	1.6	1.3	2.5	1.8	2.3	2.0	1.4	2.0	1.7

5.4 Balance tests

Table 23 below presents the results of the balance test relative to all the basic level characteristics. As expected, all the indicators are well balanced at baseline and none of the p-values is smaller than 0.05.

Table 23. Balance test for group-level indicators

Variable Name	Treatment Mean	Control Mean	Treatment dummy	(p-value)
Birth year of the group	2009	2010	-0.29	(0.709)
Number of members	20.60	18.96	1.63	(0.686)
Presence of common plots (0-1)	0.42	0.42	-0.02	(0.669)
Number of common plots	1.10	1.25	-0.14	(0.156)
% of members included, 1st plot	0.96	0.95	0.00	(0.867)
% of members included, 2nd plot	1.00	0.98	0.03	(0.368)
Common plots under MIC	0.45	0.45	-0.01	(0.834)
Numb. of MIC common plots	1.00	1.02	-0.02	(0.374)
Presence of shared plots (0-1)	0.33	0.37	-0.01	(0.794)
Number of shared plots	1.69	1.37	0.51	(0.454)
% of members included, 1st plot	0.82	0.86	-0.05	(0.484)
% of members included, 2nd plot	0.46	0.69	-0.16	(0.425)
Number of plots of the president	2.05	2.15	-0.07	(0.548)
Number of plots of the secretary	1.90	1.94	-0.04	(0.746)
Number of plots of the treasurer	2.02	1.91	0.12	(0.283)
Number of plots of member n.1	1.89	1.94	-0.05	(0.646)
Number of plots of member n.2	1.82	1.81	0.02	(0.859)

5.5 Individual-level data

Table 24 reports data about the replacement of members that were initially targeted to be surveyed. Among the 975 producers that were targeted to be surveyed, 61 were replaced (representing about 1.3%). We distinguish replacements between those related to organisation committee members and others. Replacements were fairly balanced between the MC and AD regions, but were relatively more among committee members in AD than in MC. Replacements of committee members can be problematic because PROFI contracts had to be signed by committee members.

Table 24. Member replacements

	Committee members	The rest	Total
AD	17	13	30
MC	14	17	31
Total	**31**	**30**	**61**

5.5.1 Demographic and social-eco characteristics: Introduction module

This section presents a selected list of stylized facts based on the mean-values derived from 975 individual entrepreneurs.

Demographic and Education

On average, entrepreneurs are a bit older in AD than in MC. The oldest entrepreneurs are 91 and 81 in AD and MC respectively whereas, the youngest are 23 and 13.

Table 25.1.a. Individual-level data, Introduction module

Year of birth	Global	AD	MC
Mean	1974	1972	1976
Min	1926	1926	1936
Max	2004	1994	2004

The gender composition of the sample is relatively balanced in AD, whereas in MC, male entrepreneurs dominate. In MC, entrepreneurs are also more educated than in AD. In particular, more than half the sample of entrepreneurs in AD has no education whereas the corresponding figure for MC is only 39%. Moreover, the proportion of entrepreneurs with at least a secondary education level is double in MC as compared with AD (about 40% vs. about 20%).

Table 25.1.b. Individual-level data, Introduction module

Gender and Education (%)	Global	AD	MC
Female	41.6	48.34	33.18
No education	46.31	55.76	38.75
Primary	22.85	23.27	22.51
Secondary 1	17.22	15.9	18.55
Secondary 2	08.5	04.61	11.62
Higher	5.02	0.46	8.67

Experience of producers in the targeted crops

Apart from the rice producers in MC, entrepreneurs have at least 10 years of experience in the targeted crops. For rice producers, experience is higher in AD than in MC; whereas for vegetable producers the average years of experience are roughly equal across the two regions.

Table 25.1.c. Individual-level data, Introduction module

Experience of entrepreneurs (years)	Global	AD	MC
Rice	12.00	14.76	7.15
Vegetable	10.34	10.03	10.42
Cashew	14.40	14.40	0

Composition of the organizations

On average agriculture entrepreneurs have about 6 years of experience within their organizations, but those in AD display two more years compared to MC (about 7 in AD vs. 5 in MC). This difference between the two regions is in line with the years of existence of the organizations. The data also show that more family members belong to organizations in AD than in MC (about 2 vs. 1). It is surprising that across the two regions organization include few family members.

Table 25.1.d. Individual-level data, Introduction module

Composition of organizations (numbers)	Global	AD	MC
Years of membership with organizations	5.70	6.94	4.71
Number of family members	1.28	1.72	0.92

Plots used and their distribution across crops

On average, the entrepreneurs work on at least 2 plots for the production of the three targeted crops.

There are, however, some interesting heterogeneities across the two regions. The percentage of entrepreneurs working on one plot is comparable across the two regions, but relatively more of them work on 2 plots in AD than in MC. On the contrary, there are relatively more entrepreneurs who work on 3 plots in MC than in AD.

Table 25.1.e. Individual-level data, Introduction module

	Global		AD		MC	
Nbs of plots	Number	%	Number	%	Number	%
1 plot	312	0.32	145	0.33	167	0.31
2 plots	391	0.40	222	0.51	169	0.31
3 plots or more	272	0.28	67	0.15	205	0.38

Plot size	Global	AD	MC
First (MIC plot)	2.13	1.91	2.30
Second	1.28	1.85	1.05
Third	1.26	2.04	1

The MIC plots are relatively new compared to others and this is more pronounced in the MC region, where they were first used about 4 years ago.

Table 25.1.f. Individual-level data, Introduction module

Time since plots were used (months)	Global	AD	MC
MIC	69.14	96.37	46.89
Plot 2	90.78	102.5	81.67
Plot 3	99.27	110.1	95.73

Producers specialize relatively more plots to rice in AD than in MC, whereas the reverse holds true for vegetables. Also, entrepreneurs allocate more plots to other crops than the three crops targeted by BTC. It would be interesting to understand what determines the choice of crops.

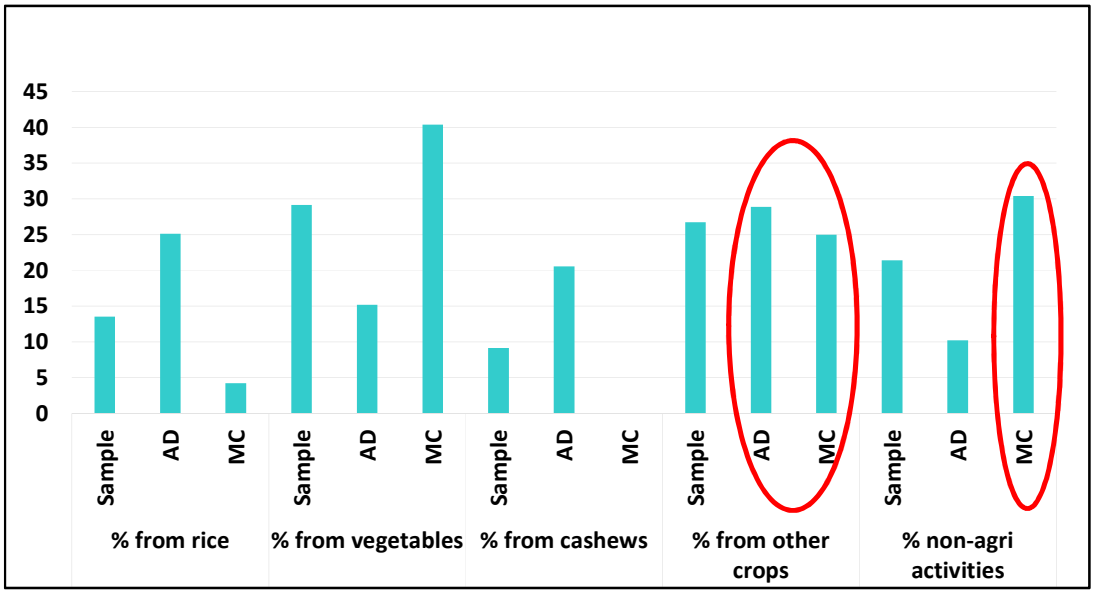
Table 25.1.g. Individual-level data, Introduction module

Distribution of plots across crops	Global	AD	MC
Rice	0.95	1.15	0.58
Vegetables	1.26	0.96	1.34
Cashews	1.33	1.33	
Other crops (e.g. maize, manioc, sorghum, etc.)	1.97	2.48	1.51

Sources of income

The figure below shows that entrepreneurs derive relatively more income from rice in AD than in MC, whereas the reverse holds true for vegetables. An important part of income is derived from non-targeted crops (around 30%). Besides, entrepreneurs in MC rely more on non-agriculture activities for their livelihood (30%). Further research should shed light on how entrepreneurs can efficiently allocate time across different activities.

Figure 7. Sources of income (%)



5.5.2 Constraints that entrepreneurs have to face

The top three constraints that entrepreneurs have to cope with are: i) financing constraints; ii) poor distributed irrigation systems, difficulties in controlling water or weather shocks; and iii) lack of training opportunities. These are also the areas in which BTC provides supports to the entrepreneurs. In the next two sections, we elaborate on the issues related to access to finance and services.

Table 25.2.a. Individual-level data, Constraints

Constraints (%)	Global	AD	MC
Difficulties in obtaining financing	**0.28**	**0.25**	**0.30**
Lack of/ insecurity of land	0.03	0.04	0.02
Difficulties in controlling water	**0.20**	**0.11**	**0.27**
Access to markets	0.02	0.02	0.02
Problems with customs	0	0	0
Problems with the electrical supply	0	0	0
Lack of/scarcity of trainings	**0.16**	**0.15**	**0.17**
Competition	0.02	0.02	0.02
Crime/ theft	0.01	0.02	0.00
Political instability	0	0	0
Problems with the legal framework/ regulation	0	0	0
High taxes	0	0	0
Lack of storage spaces/ technologies	0.03	0.02	0.04
Lack of outlets	0.02	0.04	0.01
Conflict with other producers, input sellers, buyers, etc.	0.07	0.10	0.05
Climate constraints	**0.12**	**0.18**	0.08
No constraints	0.02	0.02	0.02
Other	0.03	0.05	0.01

5.5.3 Access to finance

Over the 12 months preceding the survey, only about 24% of the entrepreneurs obtained a loan. Microfinance institutions are the main lenders (62%), followed by informal institutions in the form of ROSCAs (18%) and relatives (11%). There are no clear differences between the two regions - except that informal institutions are more important in MC than AD (32% vs. 5%).

Regarding the use of loans, we distinguish among five categories: equipment, irrigation system, land purchase, working capital, and labour costs. Loans are mostly used for working capital and labour costs (62 to 69%), equipment/ materials (24 to 29%), and expenditures on irrigation systems (9 to 16%). There is no significant difference between the two regions, except for expenditures on irrigation systems that count slightly more in MC than AD.

Table 25.3.a. Individual-level data, Access to finance

Use of loans (%)	Global	AD	MC
Equipment	**0.26**	**0.29**	**0.24**
Irrigation systems	0.12	0.09	0.16
Purchase of agricultural land	0.01	0.01	0.01
Working capital excluding labour (inputs, rent of land, transport, stocking, etc.)	**0.66**	**0.69**	**0.63**
Non-household labour cost	**0.68**	**0.68**	**0.69**
Others (activities on other crops, inputs, sales, etc.)	0.11	0.12	0.11

Note: Entrepreneurs could indicate more than one destination for the loan, so the sum does not add to 100%

Entrepreneurs who did not obtain a loan were asked to explain their reasons. Surprisingly, the majority of entrepreneurs self-exclude themselves from external finance.

Table 25.3.b. Individual-level data, Access to finance

Reasons of not obtaining a loan	Global	AD	MC
I did not need a loan	0.10	0.14	0.07
I asked for loan but did not obtain	0.08	0.07	0.08
I did not ask for loans	**0.78**	**0.73**	**0.82**
Others (availability of lenders, short period to repay and high administrative or repayment costs, etc.)	0.04	0.05	0.03

Furthermore, the data indicate that perceptions of high administrative and repayment costs account for about 45%-60% of self-exclusion reasons. Besides, entrepreneurs self-exclude themselves because they dislike to be indebted and probably perceive this as a burden. This suggests that both demand and supply factors are important in addressing the financing constraints that entrepreneurs face.

Table 25.3.c. Individual-level data, Access to finance

Explanation of self-exclusion	Global	AD	MC
Perceived high administrative costs	**0.2**	**0.36**	**0.22**
Perceived high interest rates	**0.18**	**0.09**	**0.25**
Collateral	0.07	0.07	0.07
Fear that loan demand will not be satisfied	0.06	0.05	0.06
Unavailibility of lenders	0.03	0.06	0.01
Dislike to be indebted	**0.21**	**0.18**	**0.22**
Short-repayment period	0.11	0.11	0.1
Other (lack on information, high administrative cost, uncertainty, etc.)	0.07	0.09	0.07

5.5.4 Access to services

We use the five broad categories of services defined by BTC: agricultural techniques; management of the environment; entrepreneurship; economic performance; and transformation of agro-products. Figure 8 below reports information related to access to these services by the 975 entrepreneurs over the last 12 months. Three services dominate: agricultural techniques; management of environment; and entrepreneurship. In particular, services related to agricultural techniques are by far the most received by the entrepreneurs. Moreover, access to services is relatively more important in AD than in MC but the difference is only significant for agriculture techniques and management of the environment. Surprisingly, entrepreneurs received little services related to the transformation of agro-products.

Figure 8. Access to services (%)

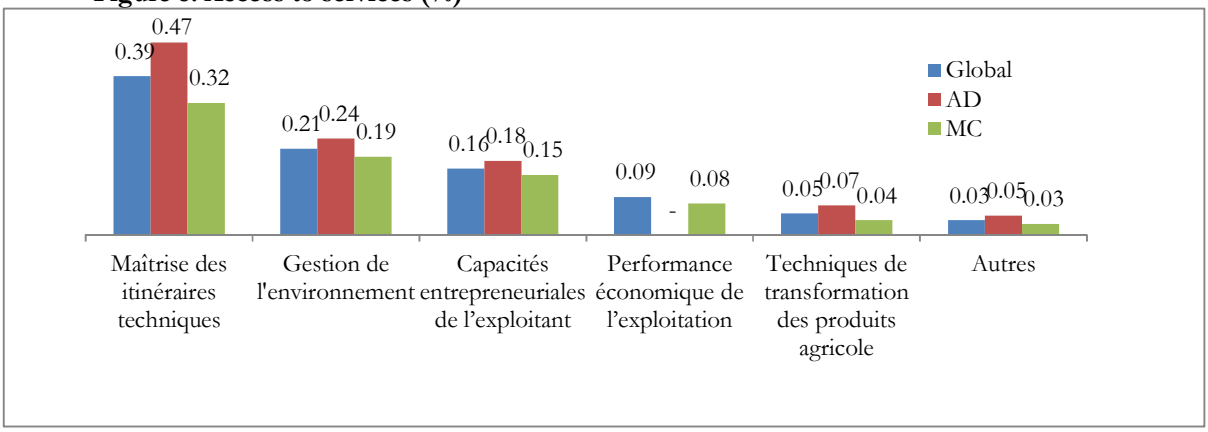
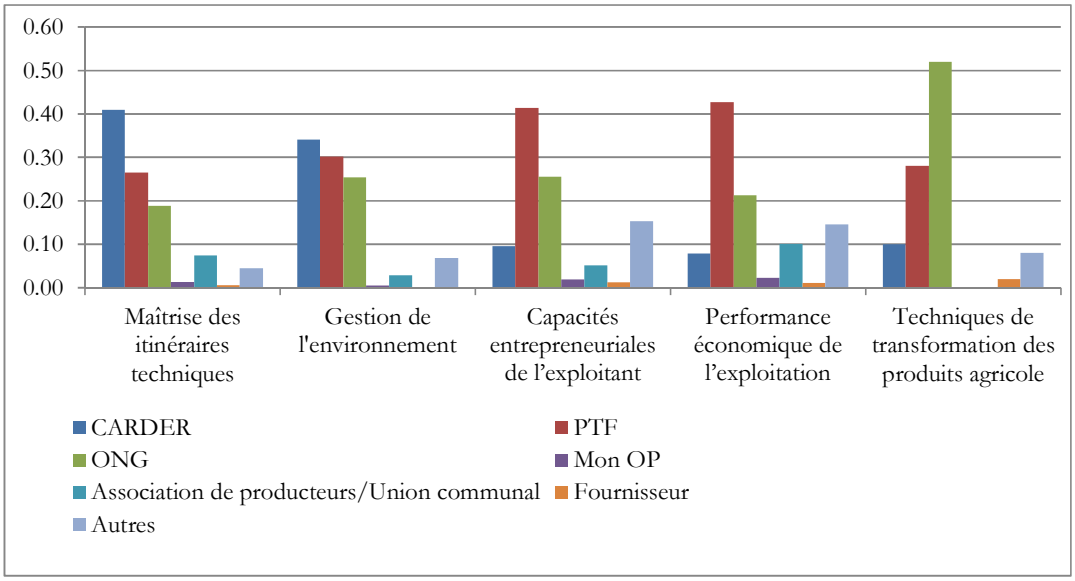


Figure 9 displays information on the providers of these services. The data indicate that the government institution (i.e. CARDER) dominates the provision of services related to agricultural techniques and management of the environment. It is followed by the donors and NGOs which play a dominant role for the remaining services. Specifically, donors provide most of the services related to entrepreneurship and economic performance. They are followed by NGOs, which focus more on the provision of services related to the transformation of agro-products. Finally, note that the organization seems not to provide much services and neither do the three other providers of services listed in Figure 9. We plan to dig into this issue in a future module on governance.

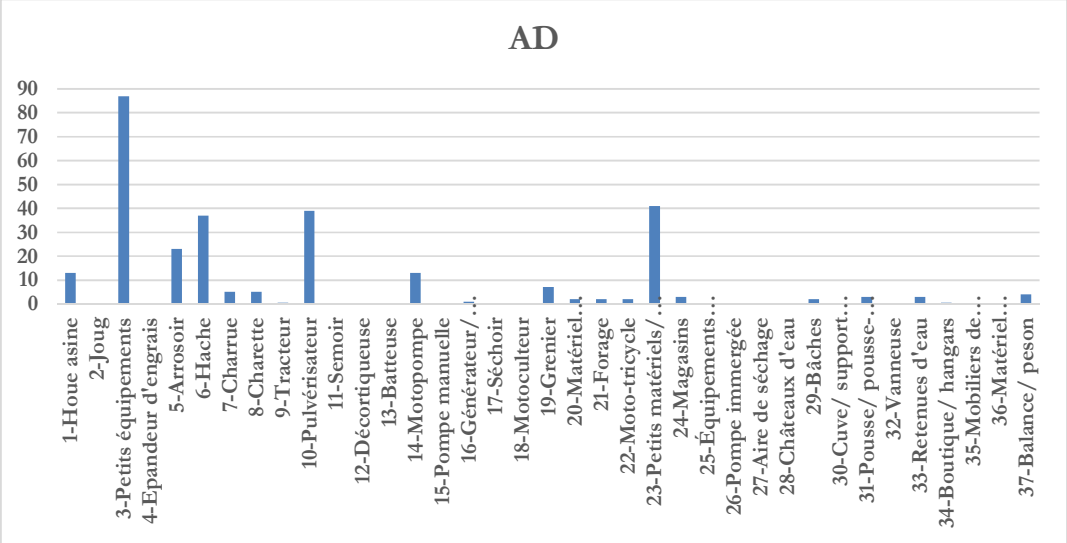
Figure 9. Providers of services (%)



5.5.5 Access to material and equipment

Figure 10 below displays information related to the possession of 37 agricultural materials and equipment across the two regions. Entrepreneurs have a limited possession of advanced agricultural equipment. Figure 11 reports the use of equipment and materials and confirms the limited use of advanced agricultural equipment - although there is a slight improvement.

Figure 10. Possession of materials and equipment (%), AD and MC



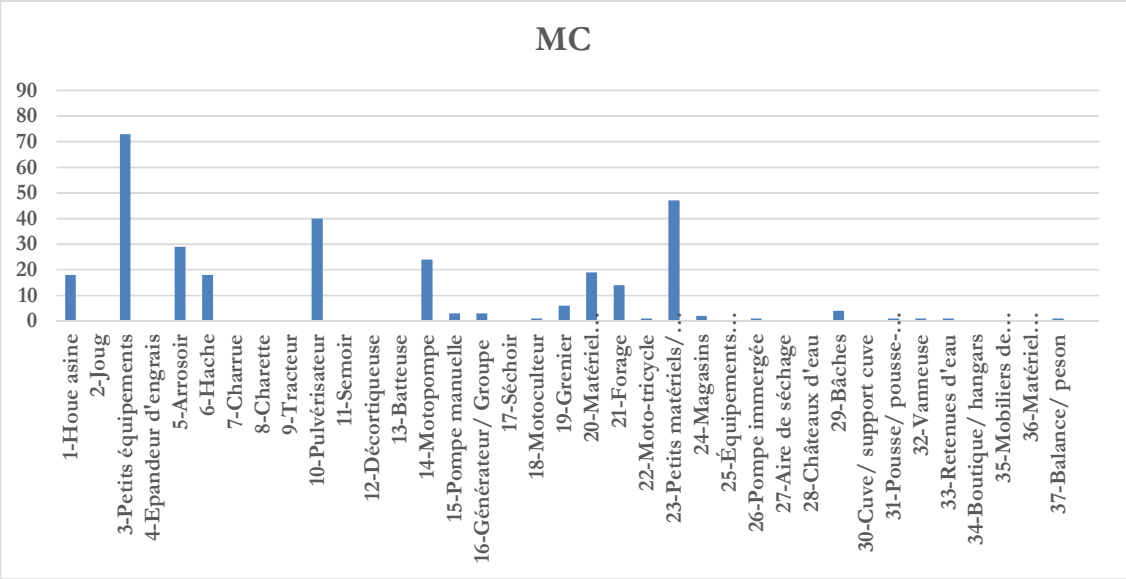
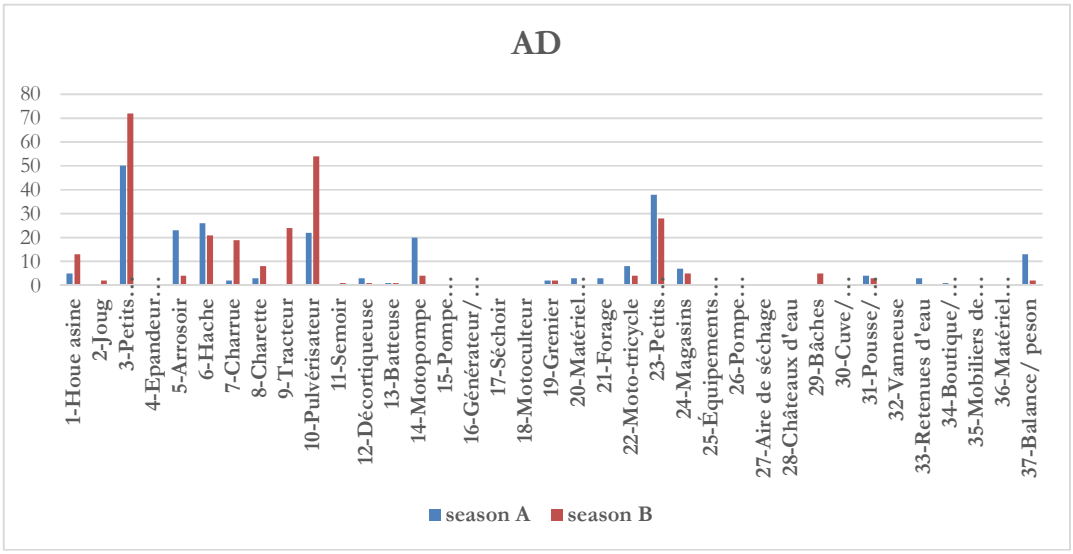
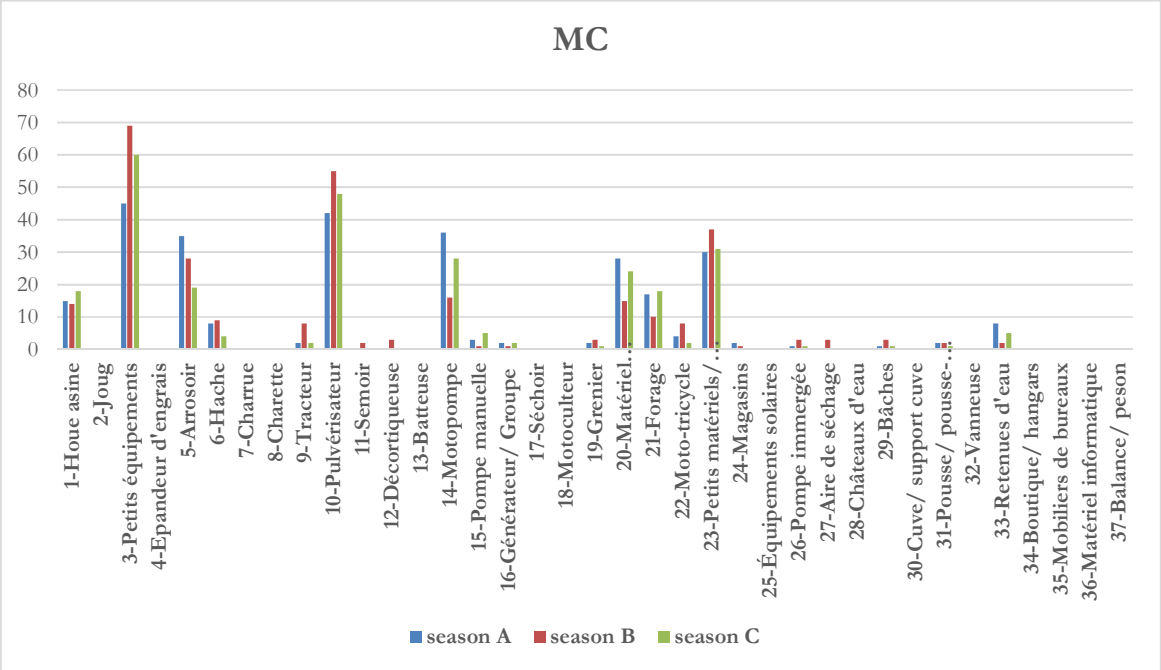


Figure 11. Use of materials and equipment (%), AD and MC





5.6 Performance indicators

We present overall sample averages, along with average values of the indicators by plot, season, and crop. We limit ourselves at this stage at a descriptive presentations postponing any further analysis until a deeper check and a more detailed examination of the data can be performed at a more disaggregated level.

5.6.1 Average performance indicators

Table 26 below presents average performance indicators and shows that there is a large heterogeneity of performance across the sample. Note that we restrict the sample to include only producers that completed all the modules on costs and post-harvest production necessary for the calculation of the performance indicators. For cashews, we relax such a restriction since cashew plants grow differently than rice and vegetables and not all the cost modules are pertinent for cashew production (i.e. seed module).

Table 26. Average performance indicators

Performance indicators	N. of obs	Mean	Std. Dev.
Yield	862	3,945	6,571
Gross margin	862	1,732,702	3,207,576
Added value	862	1,398,574	2,869,484
Profit	862	1,392,737	2,867,009
Gain	862	1,277,072	2,853,375
Production cost	862	187	212
Financing capacity	862	1,279,009	2,853,482
Margin	862	131	254
Threshold	862	4,236	8,809
Threshold kg/ha	862	1,995	3,454

5.6.2 Performance indicators by crop

We start by focusing on yields (kg/ha) and presenting benchmarks by crops and commune for Benin, which are available for the following vegetable types: cabbage, crin-crin, okra, onion, pepper, and tomato. The source of these benchmarks is the Ministry of Agriculture, Livestock, and Fisheries (MAEP). Data refer to the 2015-2016 period.

Table 27. Yields by crop, Benchmark values

	2015-2016 BENCHMARK VALUES						
COMMUNES	**Rice**	**Cabbage**	**Crin-Crin**	**Okra**	**Onion**	**Pepper**	**Tomato**
BOUKOUMBE	3,479	16,000		5,095	12,000	2,565	6,000
COBLY	823		9,000	2,390		1,474	4,800
KEROU	2,233	8,000	9,000	2,488		3,678	9,747
KOUANDE	2,750	7,000	9,000	5,250	5,800	7,500	6,000
MATERI	2,785			4,904		1,800	6,175
NATITINGOU	2,541	16,000	16,871	4,386		1,874	5,500
PEHOUNCO	3,246	8,000	9,500	2,800	11,335	2,000	4,500
TANGUIETE	2,301	12,000	16,870	4,449	11,600	1,888	5,500
TOUCOUNTOUNA	3,567		9,500	2,390	4,500	2,938	4,700
BASSILA	2,672	7,500	9,000	3,762	8,000	1,205	18,493
COPARGO	2,800			6,500	15,000	5,000	12,000
DJOUGOU	1,165	27,000	9,000	3,000	5,000	800	11,000
OUAKE	1,991	16,000	16,871	4,759		2,000	5,848
ATACORA-DONGA							
Min	**823**	**7,000**	**9,000**	**2,390**	**4,500**	**800**	**4,500**
Max	**3,567**	**27,000**	**16,871**	**6,500**	**15,000**	**7,500**	**18,493**
ATHIEME	1,983	10,000	8,000	1,812		747	4,047
BOPA	2,016			2,399		742	7,230
COME	4,460	10,520	4,320	3,367	8,729	1,556	13,297
GRAND-POPO	2,500		3,750	3,352	20,347	1,898	17,048
HOUEYOGBE	1,946	3,250	2,538	3,405		652	5,974
LOKOSSA	3,823	14,803	6,643	1,009		695	3,373
APLAHOUE	2,119		1,099	1,908		655	7,662
DJAKOTOMEY	2,238	15,000		2,044		702	7,209
DOGBO	2,709		11,605	3,858		2,964	8,952
KLOUEKANME	2,826		3,000	1,929		848	8,296
LALO	3,459	20,000	3,720	2,463	6,000	628	8,356
TOVIKLIN	2,500		1,142	1,117	9,000	2,905	5,441
MONO-COUFFO							
Min	**1,946**	**3,250**	**1,099**	**1,009**	**6,000**	**628**	**3,373**
Max	**4,460**	**20,000**	**11,605**	**3,858**	**20,347**	**2,964**	**17,048**

Then we compare these benchmarks to our sample averages by crop, region, and season for yields, production costs, and margins. It is useful to notice that our yield sample averages are always included in the benchmark ranges. In the appendix, we add distribution plots for all the indicators presented.

Table 28. Yields, Production Costs, and Margins by crop, region, and season

	Yield S1	**Yield S2**	**Yield S3**	**Prod cost S1**	**Prod cost S2**	**Prod cost S3**	**Margin S1**	**Margin S2**	**Margin S3**
Cashews									
AD Region	443			238			262		
Rice	**4,325**	**1,892**	**3,349**	**100**	**173**	**241**	**21**	**-15**	**82**

AD Region	.	1,907	.	.	165	.	.	-22	.
MC Region	4,325	1,807	3,349	100	223	241	21	29	82
Cabbage	**16,542**	**36,420**	**24,654**	**101**	**52**	**241**	**95**	**56**	**-132**
AD Region	9,578	5,336	.	122	57	.	88	74	.
MC Region	26,989	50,407	24,654	69	49	241	106	48	-132
Crin-crin	**15,694**	**19,787**	**27,630**	**103**	**47**	**93**	**157**	**36**	**64**
AD Region	7,652	1,729	.	90	179	.	49	-52	.
MC Region	16,721	20,657	27,630	105	41	93	171	40	64
Okra	**5,314**	**4,335**	**3,070**	**88**	**123**	**118**	**143**	**53**	**58**
AD Region	3,816	1,577	.	127	376	.	180	-47	.
MC Region	6,288	5,039	3,070	63	58	118	118	79	58
Onion	**10,839**	**5,766**	**8,187**	**91**	**271**	**387**	**101**	**-57**	**13**
AD Region	6,724	4,296	.	75	140	.	136	108	.
MC Region	20,098	6,174	8,187	128	307	387	22	-103	13
Chilli pepper	**8,982**	**9,003**	**11,130**	**209**	**138**	**105**	**191**	**102**	**219**
AD Region	2,333	2,204	.	217	115	.	273	408	.
MC Region	9,444	9,156	11,130	208	139	105	185	95	219
Pepper	**15,275**	**13,626**	**13,746**	**200**	**120**	**113**	**359**	**82**	**88**
AD Region	8,856	4,799	.	229	125	.	356	118	.
MC Region	20,013	14,765	13,746	179	120	113	361	77	88
Tomato	**24,862**	**23,049**	**25,989**	**76**	**61**	**59**	**154**	**16**	**17**
AD Region	9,770	7,463	.	95	188	.	114	18	.
MC Region	30,130	24,703	25,989	69	48	59	168	16	17

Furthermore, in order to draw clear correlations between agricultural performance and key characteristics, such as plot size, type of plot (i.e., individual plot vs. shared or common plot), farmer's gender, region, and season, we run simple statistical models (OLS regressions) with commune dummies for a series of performance indicators calculated separately by crop. Regression results based on data at the plot/ season level are shown below in Table 29. Regarding the definition of season, season 1 refers to the hard season, season 2 to the main rainy season, and season 3 to the small rain season characteristic of the MC region; hence, we consider season 2 as our base category. Notice that the indicators for Gross Margin, Added Value, Gain, and Profit are normalized by quantity and that we present results separately for the above-defined indicator of Production Cost and a Production Cost indicator that does not take into account the value of household labour. Note also that for common plots, we include only the observation of the president of the producer organization (OP) to ensure we are not duplicating information.

Table 29. Main correlates of Agricultural Performance, Indicators by crop

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cashew	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	-23.87***	10.70***	11.35***	10.09***	23.67***	-12.53*	0.993	22.97***
	(6.503)	(2.909)	(3.239)	(3.307)	(6.928)	(6.632)	(2.859)	(6.937)
Farmer is male	-332.8	33.44	39.50	34.40	-35.44	69.40**	-0.415	-35.36
	(214.7)	(38.79)	(33.44)	(35.06)	(33.59)	(27.59)	(17.56)	(32.87)
Common plot	753.0***	-81.86**	-27.73	-14.85	180.3**	-268.0**	-74.72**	185.1**
	(68.48)	(38.36)	(28.11)	(30.69)	(88.09)	(113.5)	(33.77)	(88.11)
Shared plot	8.781	16.27	22.35	26.02	35.40	-24.03	-14.67	35.14
	(53.90)	(35.06)	(30.90)	(32.53)	(107.3)	(131.8)	(20.95)	(107.3)
Constant	712.7***	502.1***	448.9***	461.5***	363.5***	135.4***	37.80	367.8***
	(210.2)	(42.02)	(45.54)	(45.61)	(61.30)	(49.53)	(23.40)	(60.48)

Observations	234	234	234	234	234	234	234	234
R-squared	0.149	0.180	0.252	0.233	0.243	0.112	0.115	0.236

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rice	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	66.02	6.541*	5.767	4.879	29.35***	-21.90**	1.532	33.65***
	(88.64)	(3.607)	(6.001)	(6.292)	(9.596)	(9.885)	(6.109)	(10.07)
Farmer is male	426.4**	-3.402	7.293	8.834	17.94	-24.11	-13.98	18.87
	(188.3)	(9.647)	(14.61)	(15.19)	(21.64)	(17.93)	(11.06)	(22.32)
Common plot	28.47	-76.76***	34.27	22.21	28.22	-96.46*	-86.98***	46.53
	(350.6)	(17.56)	(46.21)	(36.93)	(56.93)	(49.42)	(24.36)	(58.56)
Shared plot	236.8	15.65	7.035	4.696	13.85	10.85	19.62*	12.30
	(174.6)	(9.899)	(12.61)	(12.45)	(16.39)	(16.71)	(10.11)	(17.19)
MC region	-1,576	230.2***	156.3	179.7*	682.9***	-412.4**	74.12	720.9***
	(1,454)	(61.96)	(99.18)	(103.1)	(155.1)	(161.8)	(101.5)	(162.7)
Season 1	6,342***	-59.64	-21.31	-21.55	120.4	-193.0**	-53.73	157.1
	(1,984)	(49.21)	(72.18)	(72.45)	(97.78)	(78.79)	(45.01)	(98.78)
Season 3	4,292**	-7.160	47.12	47.13	112.9**	-115.3**	-51.43**	142.7***
	(1,908)	(10.93)	(32.68)	(32.78)	(55.34)	(52.01)	(24.94)	(50.73)
Constant	2,420	28.58	-39.64	-60.43	-649.0***	686.2***	117.4	-765.9***
	(1,719)	(72.67)	(117.0)	(121.9)	(183.7)	(191.3)	(119.8)	(192.7)
Observations	330	330	330	330	330	330	330	330
R-squared	0.331	0.613	0.331	0.327	0.324	0.450	0.580	0.343

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cabbage	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	-4,892***	-47.41***	-130.1***	-129.9***	-148.2***	145.2***	126.9***	-148.7***
	(1,158)	(12.06)	(31.18)	(31.11)	(35.67)	(35.52)	(30.76)	(35.78)
Farmer is male	36,874	-31.41	-34.86	-36.73	-2.225	-13.34	21.16	-4.956
	(35,751)	(33.55)	(57.45)	(57.16)	(77.94)	(64.07)	(42.88)	(77.57)
Common plot	14,525**	-21.69	43.86	45.35	61.49	-110.9	-94.71	61.49
	(5,464)	(48.21)	(98.14)	(97.25)	(109.8)	(93.81)	(80.81)	(109.9)
Shared plot	-25,763***	-312.4***	-862.5***	-860.6***	-988.7***	985.2***	857.2***	-993.4***
	(4,936)	(29.07)	(80.23)	(79.91)	(92.90)	(98.16)	(84.54)	(93.11)
Season 1	-1,200	11.53	-7.919	-9.323	-11.12	33.26	31.46	-11.95
	(3,634)	(34.05)	(69.43)	(69.93)	(78.82)	(77.05)	(67.75)	(79.13)
Season 3	-10,673	-168.7	-382.8	-382.9	-426.6	406.7	363.0	-429.3
	(8,635)	(131.9)	(332.4)	(331.8)	(376.7)	(388.1)	(343.2)	(378.8)
Constant	-23,835	445.7***	542.1***	545.1***	527.6***	-147.5	-165.0	528.9***
	(34,324)	(69.55)	(147.6)	(147.7)	(172.6)	(163.5)	(139.0)	(173.0)
Observations	62	62	62	62	62	62	62	62
R-squared	0.665	0.775	0.661	0.659	0.630	0.605	0.590	0.627

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crin-crin	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	4,297	9.181	9.833	9.848	7.661	-0.864	-3.052	6.708
	(3,334)	(7.181)	(7.438)	(7.433)	(7.382)	(7.601)	(6.660)	(7.602)
Farmer is male	-9,841	-11.00	19.37	19.27	20.43	-36.32	-35.16	23.08
	(19,081)	(18.23)	(29.44)	(29.43)	(30.22)	(30.74)	(29.16)	(31.61)
Common plot	17,111	8.524	-31.03	-31.26	-16.43	23.41	38.24	-16.76
	(24,015)	(19.17)	(37.42)	(37.41)	(37.25)	(41.53)	(41.04)	(39.40)
Shared plot	-329.9	-32.40	-48.61	-48.59	-39.33	-0.0354	9.219	-36.35
	(11,783)	(51.84)	(44.77)	(44.79)	(47.07)	(58.69)	(47.11)	(49.26)
MC region	-41,727	242.7***	188.6**	189.4**	146.5*	98.48	55.61	104.0
	(53,792)	(33.15)	(81.75)	(81.67)	(82.68)	(93.38)	(91.48)	(87.38)

Season 1	4,251	167.0***	135.4***	134.9***	135.0***	21.76	21.87	132.6***
	(5,537)	(17.15)	(26.43)	(26.36)	(26.05)	(24.71)	(24.26)	(26.35)
Season 3	21,689	12.22	-1.000	-1.247	-12.69	37.32	25.87	-15.46
	(20,704)	(20.29)	(21.75)	(21.73)	(23.70)	(23.73)	(18.72)	(24.68)
Constant	1,079	-33.12	-53.49***	-53.58***	-52.25***	64.04***	65.36***	-61.27***
	(13,195)	(20.04)	(19.58)	(19.59)	(18.38)	(20.83)	(19.00)	(18.65)
Observations	151	151	151	151	151	151	151	151
R-squared	0.121	0.532	0.358	0.359	0.377	0.323	0.270	0.362

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Okra	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	-130.0	17.88	19.87	20.04	11.75	6.926	-1.360	13.85
	(260.4)	(24.34)	(23.05)	(22.92)	(28.35)	(12.59)	(4.733)	(27.56)
Farmer is male	-341.8	35.30	13.67	13.40	18.82	36.71	42.13**	11.01
	(1,044)	(31.67)	(31.40)	(31.26)	(38.02)	(28.94)	(20.79)	(39.08)
Common plot	1,240	-43.50	-33.04	-33.39	9.043	-51.99	-9.558	7.141
	(1,633)	(46.60)	(42.90)	(42.68)	(43.59)	(42.50)	(41.46)	(43.06)
Shared plot	1,751	-217.9**	-172.0*	-170.4*	-236.0	-3.130	-68.66***	-199.9
	(1,271)	(98.77)	(88.81)	(88.05)	(180.8)	(124.9)	(20.83)	(171.3)
MC region	2,321	-131.3	-209.9**	-209.4**	-195.5*	54.02	67.92	-129.2
	(2,683)	(102.6)	(91.62)	(91.69)	(97.12)	(108.1)	(99.23)	(82.87)
Season 1	335.5	130.7***	111.7***	110.7***	136.5***	-6.391	19.38	122.6***
	(743.0)	(41.74)	(33.79)	(33.62)	(36.85)	(33.31)	(24.27)	(37.24)
Season 3	-632.8	9.494	-25.28	-25.81	-24.29	41.60	43.12**	-32.91
	(752.8)	(28.39)	(21.88)	(21.60)	(30.20)	(25.85)	(18.44)	(27.94)
Constant	2,931***	182.3**	191.3**	191.2**	149.9**	32.14	-9.204	78.75**
	(929.1)	(83.94)	(74.64)	(74.71)	(71.65)	(24.57)	(19.16)	(30.74)
Observations	111	111	111	111	111	111	111	111
R-squared	0.280	0.472	0.494	0.494	0.445	0.244	0.283	0.420

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Onion	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	1,160	-39.21**	-20.93	-19.35	-15.27	-46.27**	-42.19*	-16.19
	(913.0)	(18.46)	(13.80)	(13.57)	(13.50)	(20.60)	(20.60)	(12.60)
Farmer is male	1,276	31.87	2.973	6.101	16.16	58.12	68.18	20.09
	(849.9)	(57.27)	(67.95)	(68.61)	(72.44)	(69.91)	(71.87)	(73.08)
Common plot	-7,195	145.8**	192.5***	188.1***	166.9***	24.46	3.192	-45.83
	(4,281)	(64.65)	(59.00)	(58.64)	(58.27)	(83.05)	(84.17)	(56.54)
Shared plot	-244.1	72.48	86.34	90.54	92.99	-10.83	-8.374	90.71
	(1,368)	(50.55)	(57.71)	(57.91)	(59.46)	(55.66)	(56.76)	(59.63)
MC region	-6,070***	-867.0***	-3,314***	-3,313***	-3,887***	3,903***	3,329***	-3,884***
	(1,520)	(93.42)	(96.41)	(96.51)	(93.28)	(46.71)	(46.99)	(93.52)
Season 1	846.2	30.53	59.53	58.70	66.14	-57.48	-50.03	68.52
	(1,485)	(37.03)	(43.46)	(43.56)	(41.05)	(47.63)	(48.78)	(40.29)
Season 3	1,634	210.2**	178.5*	174.9*	175.7*	56.26	57.02	174.3*
	(1,472)	(86.53)	(88.20)	(87.97)	(88.18)	(57.65)	(60.37)	(88.83)
Constant	2,586	-5.216	-62.67	-70.37	-97.66	98.70	71.40	-101.0
	(3,663)	(113.0)	(128.6)	(129.1)	(137.6)	(146.0)	(148.9)	(138.1)
Observations	77	77	77	77	77	77	77	77
R-squared	0.711	0.350	0.797	0.796	0.838	0.868	0.833	0.837

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chilli-pepper	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	-954.1*	10.60	1.218	1.182	1.727	10.42	10.96	1.115
	(514.2)	(12.86)	(16.54)	(16.53)	(17.29)	(14.78)	(13.51)	(17.46)

Farmer is male	-1,978	26.92	34.02	33.98	16.36	16.04	-1.584	14.25
	(2,002)	(41.76)	(46.44)	(46.43)	(46.73)	(35.40)	(29.60)	(47.50)
Common plot	1,123	152.0	164.4	164.3	174.4	-12.72	-2.628	165.2
	(2,440)	(108.5)	(109.7)	(109.7)	(112.5)	(48.58)	(41.18)	(115.5)
Shared plot	3,439**	-836.1***	-700.0**	-690.9**	-762.8**	-118.2*	-190.2***	-763.4**
	(1,461)	(313.7)	(272.1)	(269.7)	(358.4)	(68.70)	(37.34)	(358.3)
MC region	-2,119	364.5***	360.7***	360.2***	91.87	262.9***	-5.446	90.44
	(2,200)	(58.76)	(67.76)	(68.00)	(70.45)	(41.63)	(37.38)	(68.54)
Season 1	-995.3	80.15	62.13	61.63	72.44	8.517	19.32	71.08
	(2,191)	(58.89)	(67.94)	(68.17)	(70.74)	(41.75)	(37.42)	(68.83)
Season 3	307.7	41.28	54.69	54.69	64.57	-25.21	-15.33	67.05
	(2,219)	(73.01)	(76.11)	(76.12)	(77.91)	(34.00)	(26.86)	(77.59)
Constant	5,712**	57.90	55.69	56.24	51.01	32.61	27.38	54.62
	(2,465)	(65.63)	(73.57)	(73.77)	(77.07)	(49.12)	(42.64)	(75.49)
Observations	175	175	175	175	175	175	175	175
R-squared	0.154	0.252	0.207	0.205	0.179	0.177	0.210	0.173

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pepper	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	-2,653**	2.550	-13.10	-12.51	-18.36	24.95	19.10*	-19.97
	(1,042)	(14.42)	(16.89)	(16.76)	(20.59)	(15.54)	(11.29)	(19.41)
Farmer is male	-7,548	32.07	-8.384	-11.36	-4.812	63.91	70.46*	-9.492
	(6,634)	(34.42)	(37.80)	(37.92)	(45.62)	(44.37)	(36.48)	(45.92)
Common plot	8,476	21.60	68.92	68.81	93.52	-81.42**	-56.70*	99.59*
	(9,683)	(54.72)	(55.36)	(55.32)	(57.16)	(36.59)	(31.97)	(57.11)
Shared plot	-5,748*	-46.88	-191.5*	-190.0*	-295.3**	303.8**	198.5*	-300.1**
	(3,225)	(43.40)	(112.8)	(112.5)	(129.4)	(138.9)	(115.7)	(130.1)
MC region	-3,615	84.91	-36.28	-33.54	-61.16	214.7	187.1*	-277.7
	(7,079)	(97.24)	(155.8)	(159.4)	(181.8)	(130.0)	(105.5)	(185.1)
Season 1	1,694	297.1***	275.8***	273.2***	277.4***	27.24	31.48	270.4***
	(4,226)	(60.93)	(65.61)	(65.19)	(67.93)	(45.42)	(40.01)	(66.70)
Season 3	-2,872	-43.32	0.794	5.222	7.919	-58.48	-55.78	6.935
	(3,560)	(37.61)	(55.51)	(56.66)	(62.59)	(69.73)	(64.65)	(62.64)
Constant	7,964	500.2***	383.7**	380.8**	332.2*	194.6	146.0	333.3*
	(10,253)	(107.8)	(166.1)	(169.8)	(187.7)	(129.7)	(110.2)	(191.8)
Observations	188	188	188	188	188	188	188	188
R-squared	0.093	0.435	0.379	0.376	0.347	0.248	0.214	0.330

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tomato	Yield	Gross Margin	Added Value	Gain	Profit	Production Cost	Product. Cost (no HH labor)	Margin
Plot surface	75.88	13.31	10.88	10.81	12.77	2.564	4.589	11.28
	(1,263)	(14.14)	(14.22)	(14.19)	(13.36)	(3.936)	(2.819)	(12.14)
Farmer is male	2,937	-22.69*	-23.53*	-24.34*	-24.74*	5.188	4.514	-24.07*
	(4,282)	(11.44)	(12.36)	(12.49)	(13.99)	(9.416)	(7.042)	(14.18)
Common plot	12,588	-9.221	-0.440	-0.762	25.68	-38.75***	-12.81	29.99
	(9,217)	(18.08)	(17.91)	(17.86)	(22.50)	(12.14)	(8.211)	(21.87)
Shared plot	-1,237	-52.71	-54.85	-55.50	-7.562	-51.04	-3.137	-2.994
	(4,101)	(41.03)	(36.55)	(36.58)	(45.44)	(50.70)	(17.01)	(43.81)
MC region	-14,487	-67.12	-18.34	-17.68	-23.87	-49.38	-55.04***	-5.474
	(9,474)	(44.44)	(37.65)	(37.80)	(48.93)	(40.71)	(20.56)	(48.54)
Season 1	2,594	174.6***	161.0***	160.8***	163.5***	10.23	12.25	159.7***
	(3,241)	(27.26)	(26.69)	(26.72)	(27.88)	(16.98)	(11.94)	(27.59)
Season 3	-311.8	0.493	-3.951	-3.912	-9.270	12.36	6.941	-9.799
	(4,396)	(14.78)	(14.11)	(14.08)	(15.06)	(10.44)	(6.719)	(14.41)
Constant	-354.3	30.19	-9.477	-8.707	-55.43	106.9**	60.92***	-74.54
	(4,722)	(52.43)	(46.62)	(46.82)	(53.64)	(42.78)	(22.77)	(52.75)
Observations	345	345	345	345	345	345	345	345
R-squared	0.232	0.413	0.368	0.362	0.338	0.142	0.100	0.328

Plot size

Table 29 shows that the correlation between cultivated land size and yield is statistically significant and negative for many crops including cashew, cabbage, and pepper (chilli/long and round). This result implies that smallholder farmers are more productive than large farmers (the inverse farm size-productivity relationship). It can also reflect the fact that farmers rely primarily on extending land size to increase the quantity produced and that adoption of new technology is limited in the short term. These results may be related to limited used of inputs such as fertilizer, constraints to credit access, and labour markets (e.g. Ali and Deininger, 2015; Carletto,et al., 2013[23]).

Bigger land size significantly reduces the production cost of cashew, rice, and onion. This could be capturing an economies of scale effect. As a result, farmers with larger land endowments display better performance in terms of value added, gross margin, gain, profit, and margin for these crops, even though the results are strongly statistically significant only for cashew.

Gender

Yield is higher on men's plots rather than women's plots, but the result is statistical significant only for rice. Compared to female farmers, male farmers generally have better access to financial and human resources (especially family labour which is the dominant source of labour among the producers in our sample) to conduct their farming operations. Costs are higher for men in the production of cashew, okra, and pepper. Other performance indicators do not show significant gender differences, except in the case of tomato production where men seem to perform poorly.

Type of plot

Compared to having an individual plot, having a common plot and managing it collectively affects positively and significantly yields, but the results is statistically significant only for cashew and cabbage. This is in line with evidence presented by Mekonnen and Dorfman (2017)[24]. Indeed, the collective management of a farm can allow farmers to share resources and knowledge (synergy and learning effects of labour sharing) and thereby increase farm productivity. On the contrary, when farmers hold a shared plot, i.e. a common plot shared in pieces where each farmer works separately on his/her own piece, performance in terms of yield, margin, value added, and profit is significantly lower for cabbage, okra, chilli-pepper, and pepper. This may be due to the fact some crops are more labour intensive than others.

Region

We find heterogeneous performance across the two regions, after having controlled for commune fixed effects. For instance, the performance of the MC region is significantly better for the crin-crin and pepper crops, whereas the reverse holds true for okra and onion.

23 D. A. Ali and K. Deininger (2015). Is There a Farm Size–Productivity Relationship in African Agriculture? Evidence from Rwanda. *Land Economics* 1(91): 317-343. C. Carletto, S. Savastano, and A. Zezza (2013). Fact or Artifact: The impact of measurement errors on the farm size–productivity relationship. *Journal of Development Economics* 103: 254-261

24 D. Mekonnen and J. Dorfman (2017). Synergy and Learning Effects of Informal Labor-Sharing Arrangements. *World Development* 99: 1-14.

Season

Seasons also seem to play an important role in crop performance. Rice yield is higher during season 1 and season 3 compared to season 2. Other performance indicators for crin-crin, okra, pepper and tomato are better in season 1. This result likely reflects the fact that excess supply in season 2 pushes prices down.

5.6.3 Production Costs

Finally, we conclude the description of our baseline data by analysing the production costs, considering only shared and individual plots. In the next page, Figure 12 shows the components of production costs separately by crop, region, and season – where season 1 is reported as C.S., season 2 as S.P. or G.S.P. and season 3 as P.S.P. In order of presentation, such cost components include expenses incurred for soil preparation, seeds, and fertilizers, other expenses, family and paid labour costs, fixed costs, financial expenses, and asset amortization costs. Specifically, we focus on seeds and labour costs as they clearly represents the main cost components.

Seeds

Expenses on seeds, often along with expenses on fertilizers, are one of the higher cost components for vegetables: in the AD region for crin-crin and in the MC region for okra, onion, and tomato.

Labor

Across all crops, labor and, in particular, family labor represents the highest cost component. This is the case for cashews, rice, crin-crin, as well as cabbage, okra, and chilli-pepper in the AD region. It is also interesting to notice the seasonal variation in cost shares. Farmers seem more likely to invest more on their plots and hire paid labor during season 1 when market prices are higher; this is especially true for chilli-pepper and in the MC region for rice, cabbage, crin-crin, okra, onion, pepper, and tomato.

6 | Conclusion

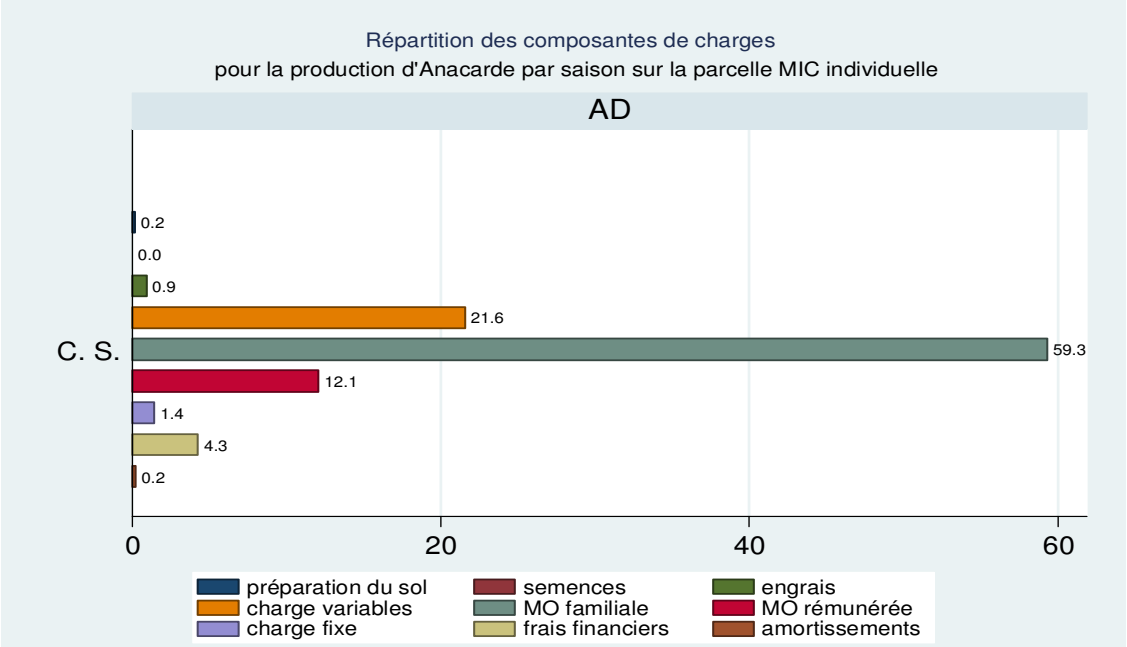
The objective of this study was twofold. First, we aim to design randomized evaluation of the PROFI project of the BTC which provides financial and technical support to agricultural entrepreneurs in Benin. Second, we aim to collect detailed baseline data allowing to better understand the performance as well as the issues facing the entrepreneurs under-studies.

The research team successfully estbalished a collaboration with BTC-Benin and followed up the development of the project step by step. First, we analyze the selection process of beneficiaries with the objective to understand the take up rate of the project. Second, taking into account the local constraints from discussions with BTC, we employ a phase-in evaluation approach where organizations are randomly assigned to either the treatment group or the control group. During phase 1, entrepreneurs in both groups receive non-financial help (with priority given to the treatment group), while only the treatment group receives the requested materials and equipment. During phase

2, the control group receives the requested materials and equipment as well. Third, we designed a comprehensive questionnaire covering several topics across different modules to identify a series of indicators across the treatment and control groups. The baseline survey was implemented in collaboration with BTC-Benin in December 2016-February 2017. Midline and endline information on the same indicators will be collected in 2018 and 2019. This framework provides the opportunity to answer a number of policy-related questions such as: what is the additionality of the support to agricultural entrepreneurs? What is the impact of agricultural investments on farm incomes? And other welfare indicators such as access to credit or inputs markets? What are the economic returns to well drilling and other types of irrigation improvements? What types of inputs and practices are required for agricultural productivity in a developing country? What determines the use of the subsidised equipment and material across cooperative members? To which extent does this BTC program improve the welfare of vulnerable people in Benin?

Figure 12. Production Costs by crop

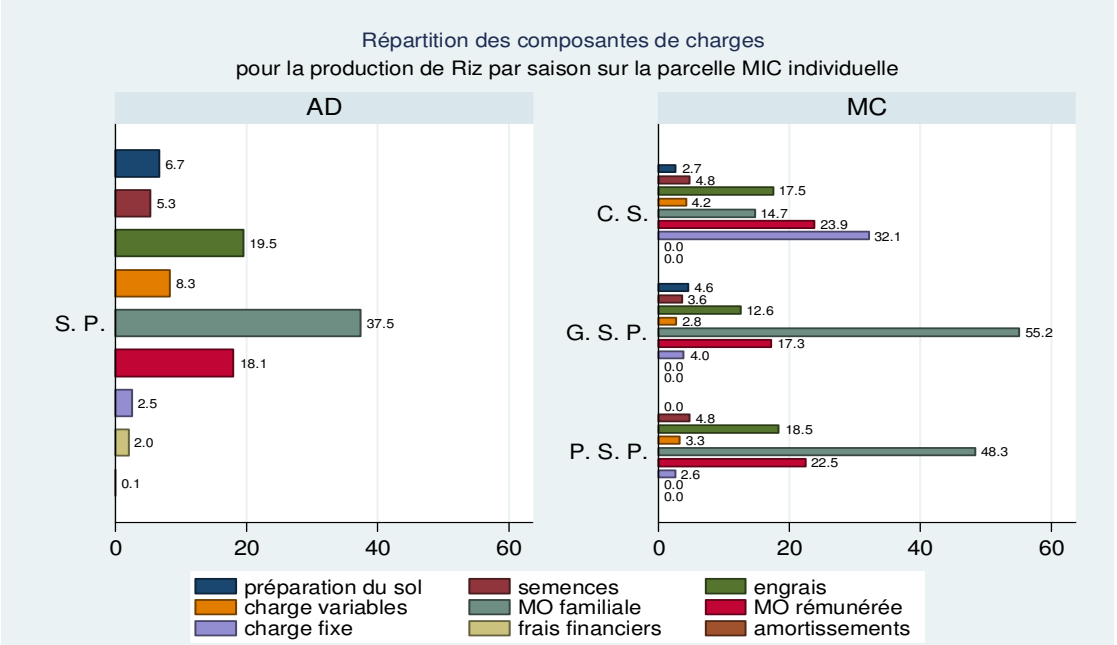
1. Cashews



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

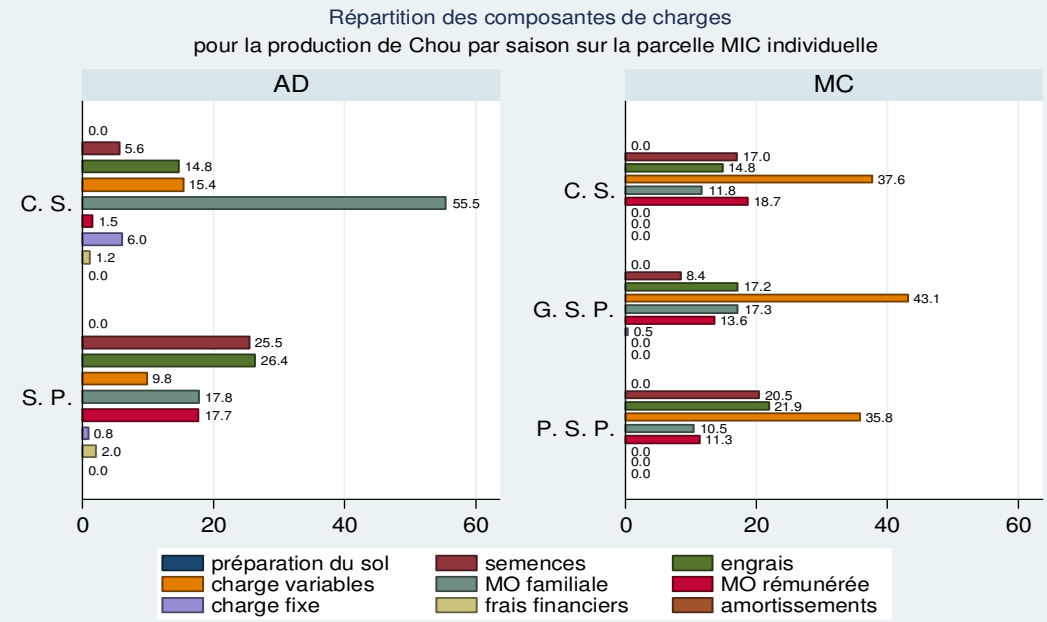
2. Rice



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

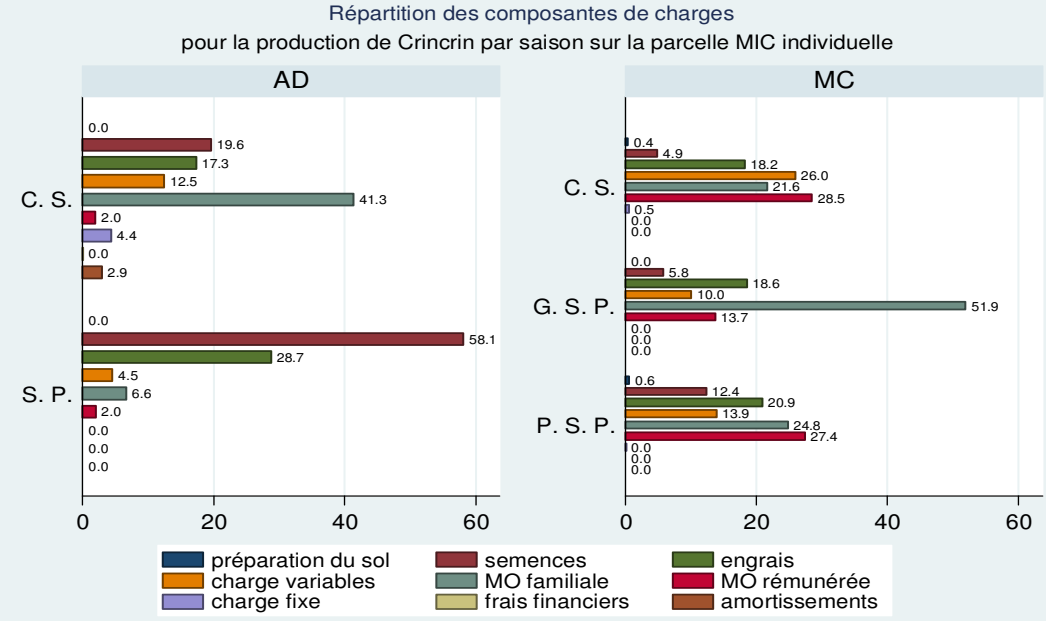
3. Cabbage



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

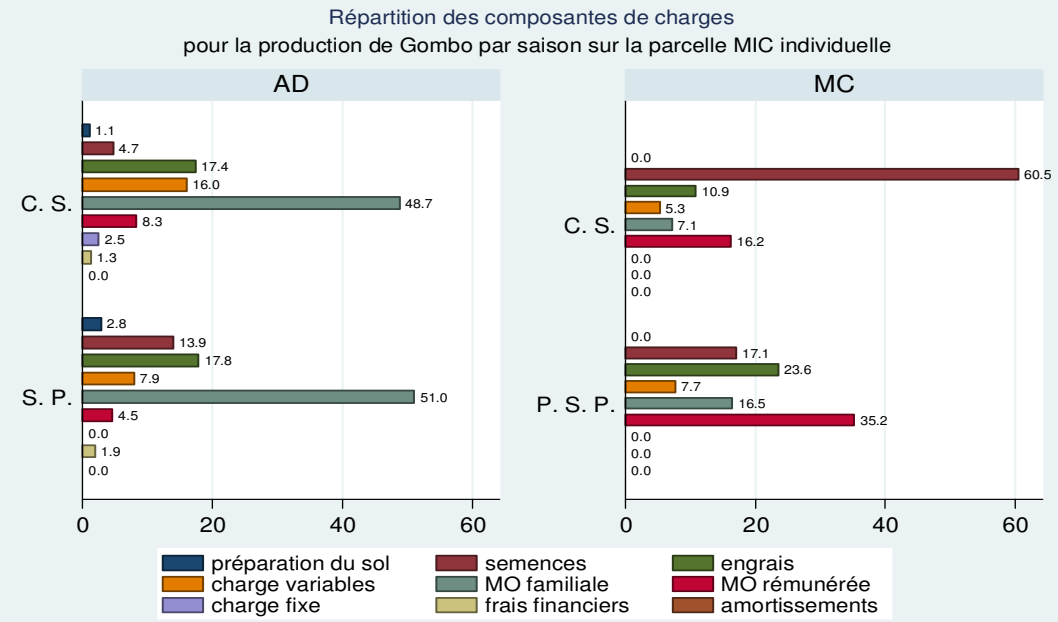
4. Crin-crin



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

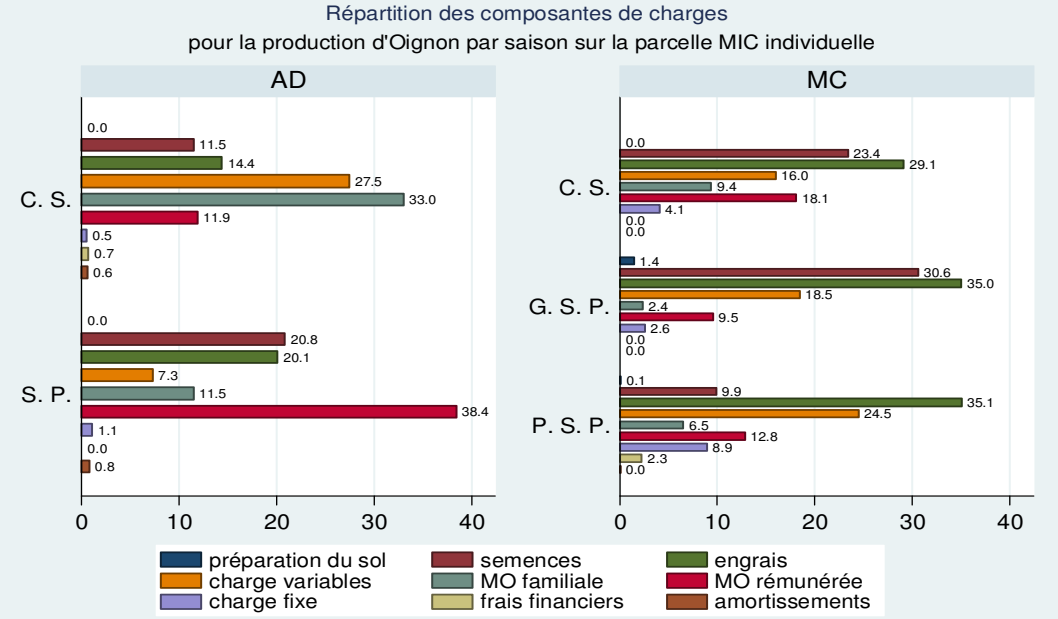
5. Okra



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

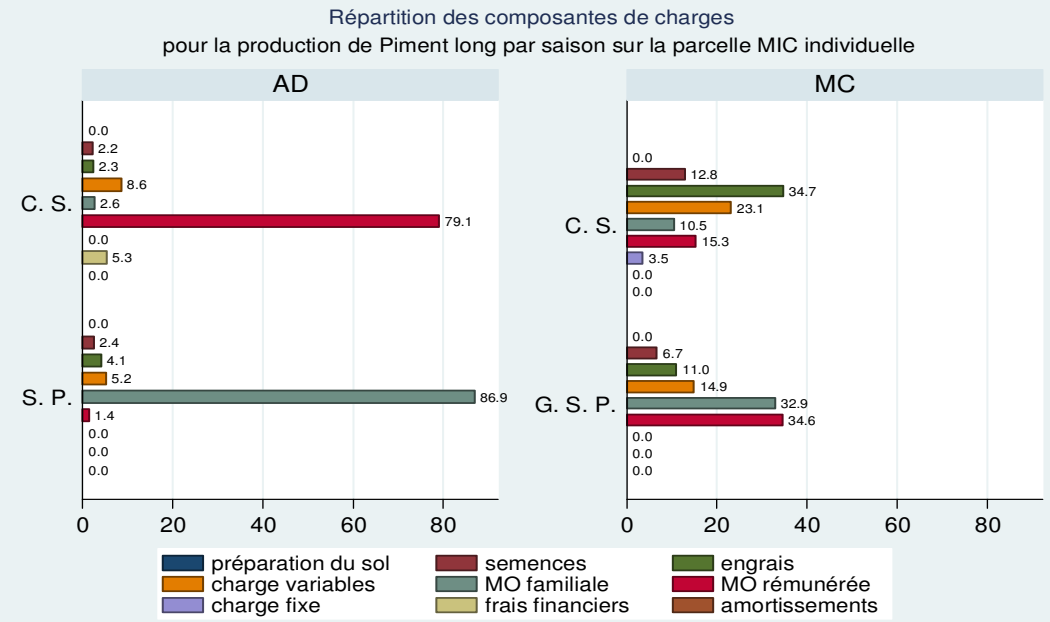
6. Onion



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

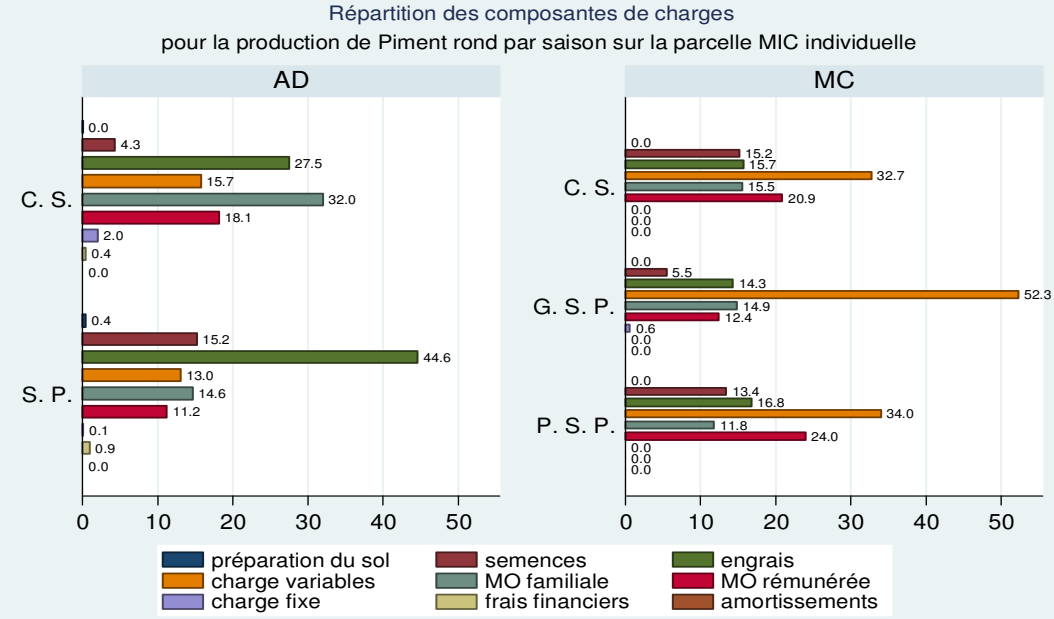
7. Chilli-pepper



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

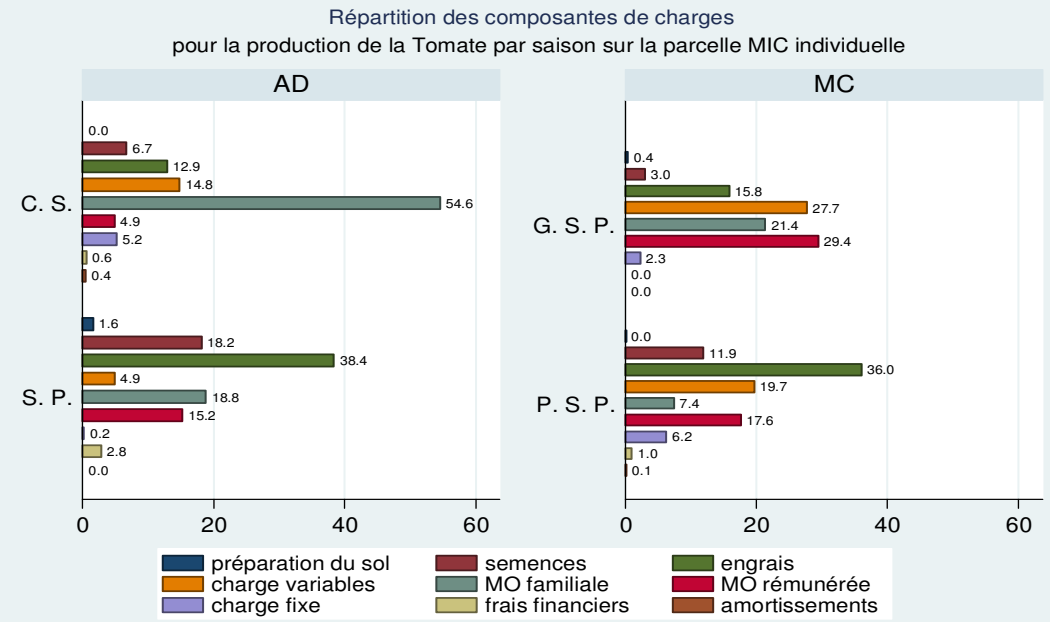
8. Pepper



Source: Baseline PROFI 2016; ACROPOLIS

Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

9. Tomato



Source: Baseline PROFI 2016; ACROPOLIS

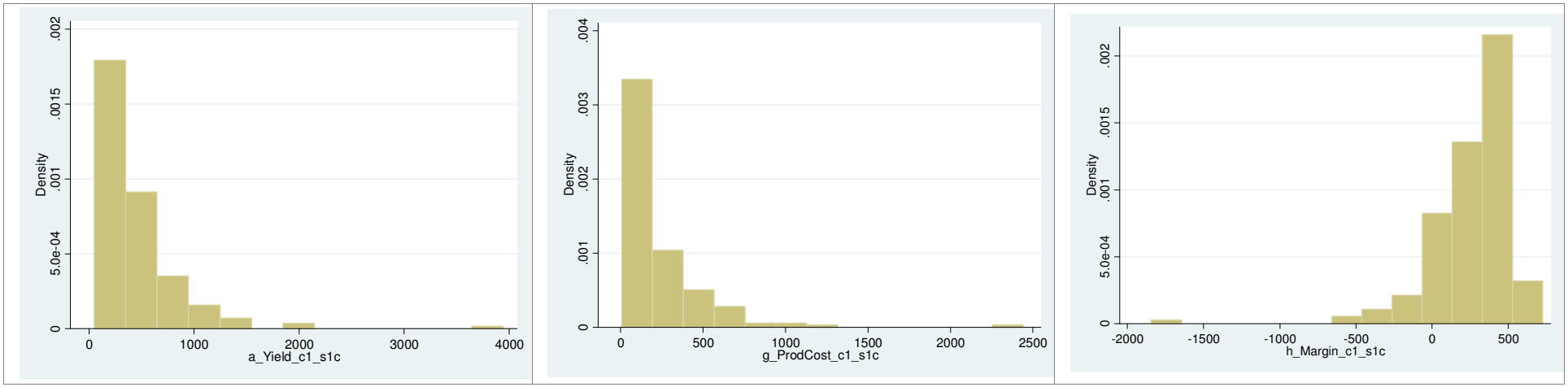
Notes: C.S.=Contre saison; S.P.=Saison de pluie; G.S.P.=Grande saison de pluie; P.S.P.=Petite saison de pluie; MO= Main d'oeuvre

Appendix

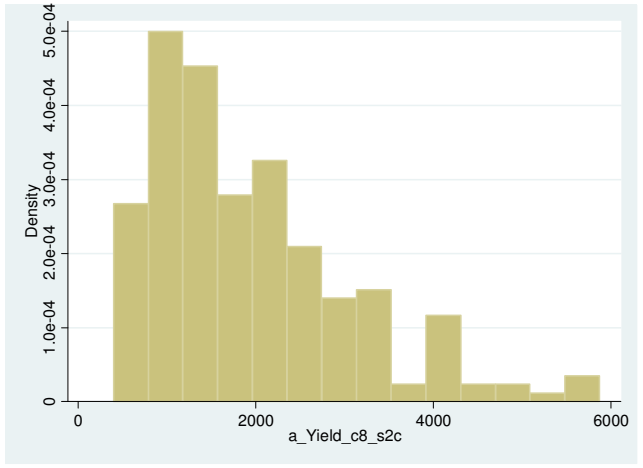
Appendix 1: Distributions of key performance indicators

APPENDIX 1.

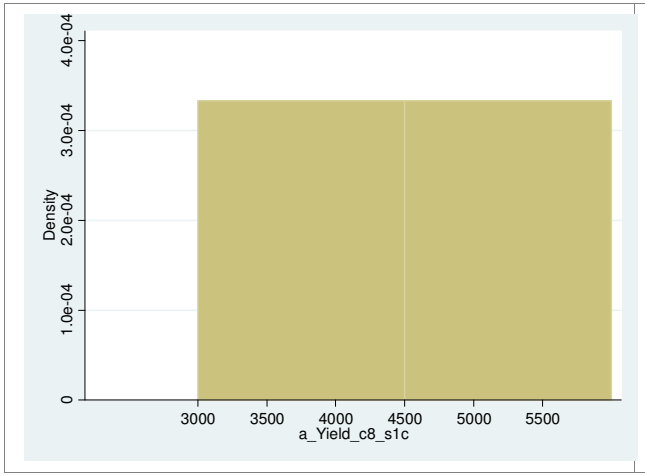
Cashews AD Region – Yield, Production Cost, and Margin for Season 1

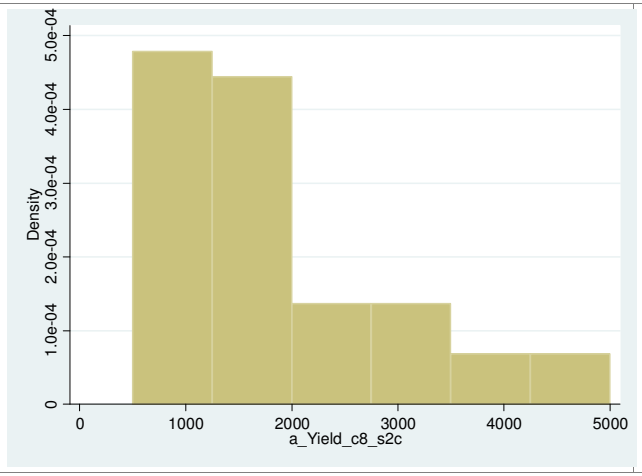


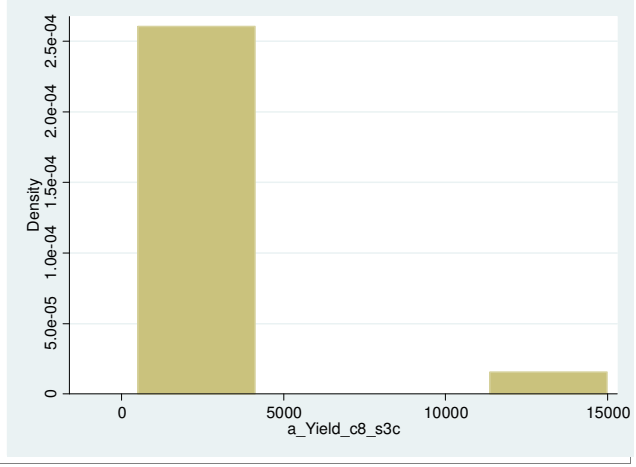
Rice AD Region – Yield for Season 2



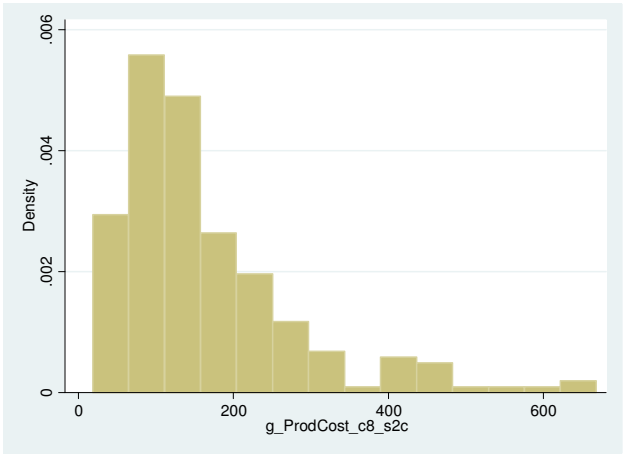
Rice MC Region – Yield for Seasons 1-3



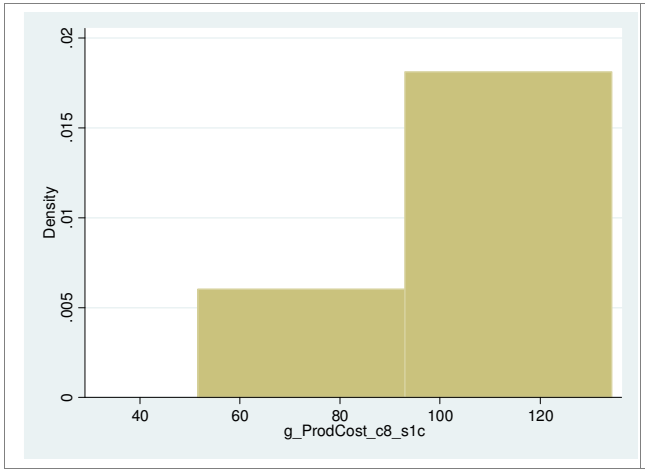


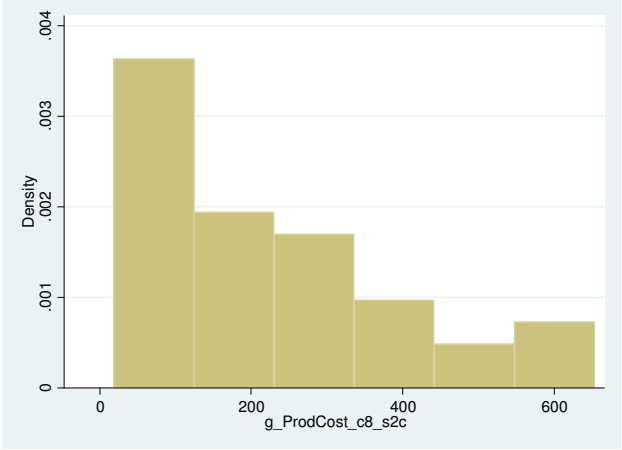


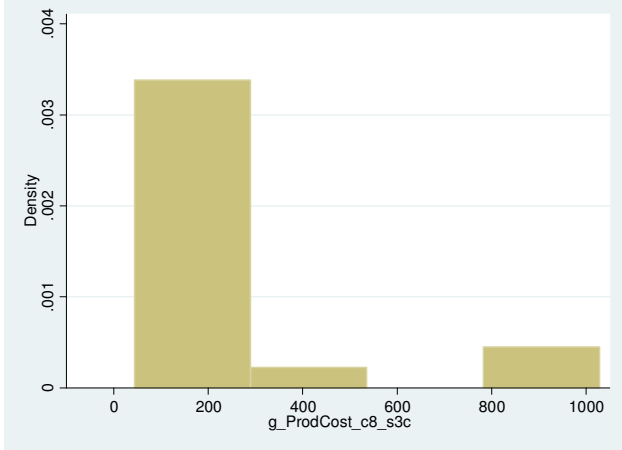
Rice AD Region – Production Cost for Season 2



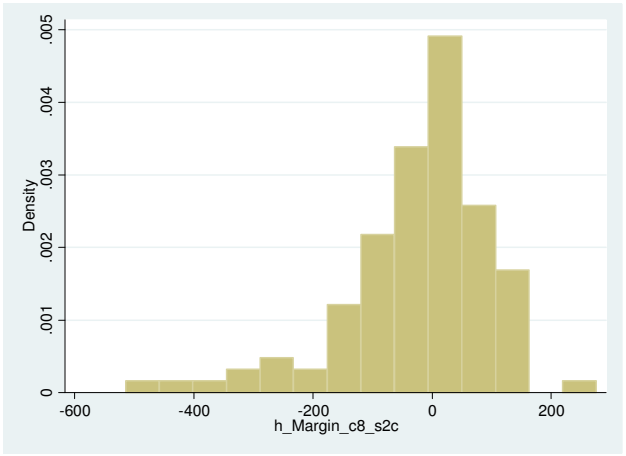
Rice MC Region – Production Cost for Seasons 1-3



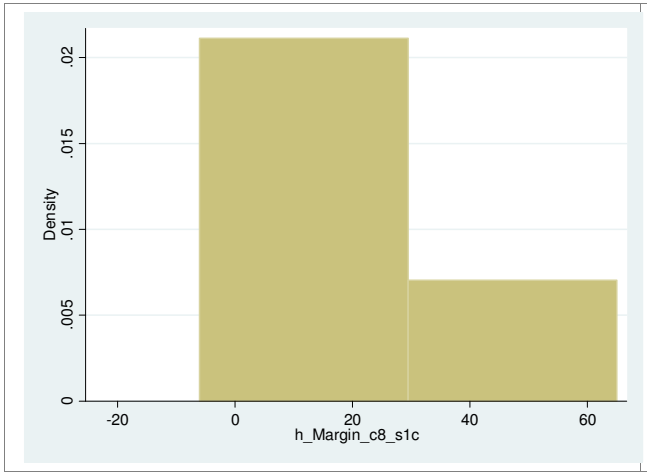


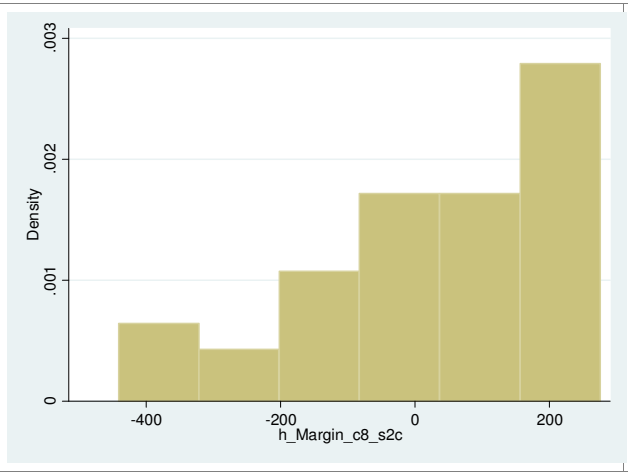


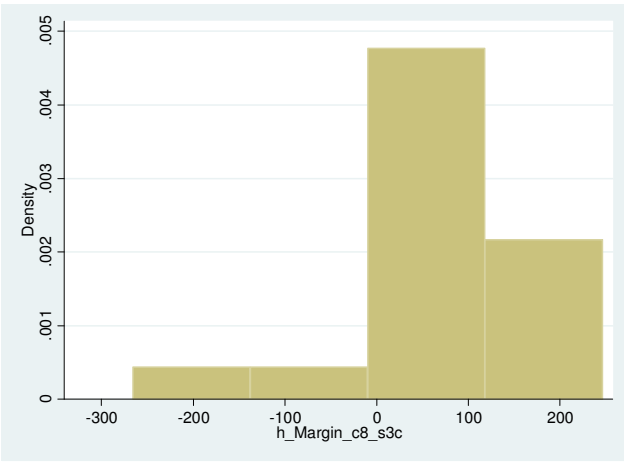
Rice AD Region – Margin for Season 2



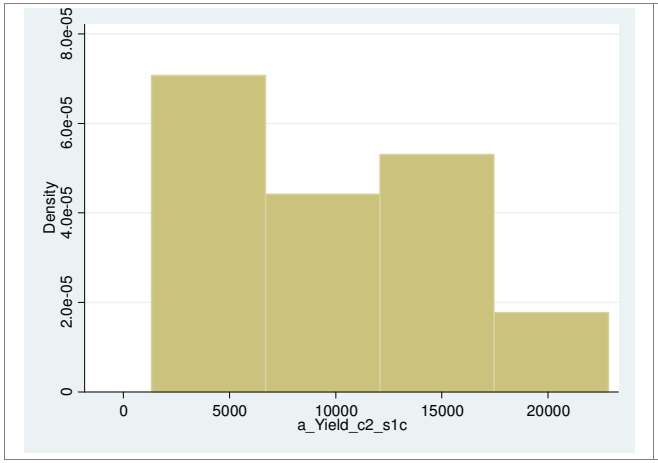
Rice MC Region – Margin for Seasons 1-3

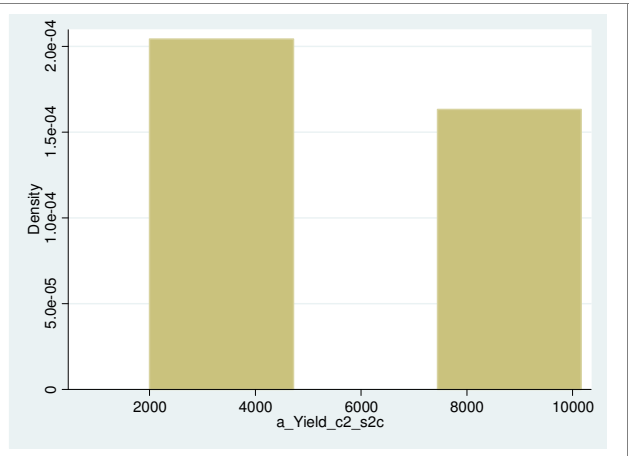




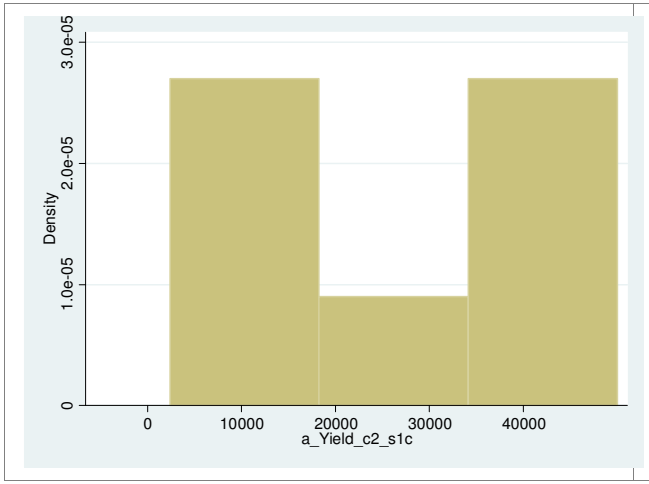


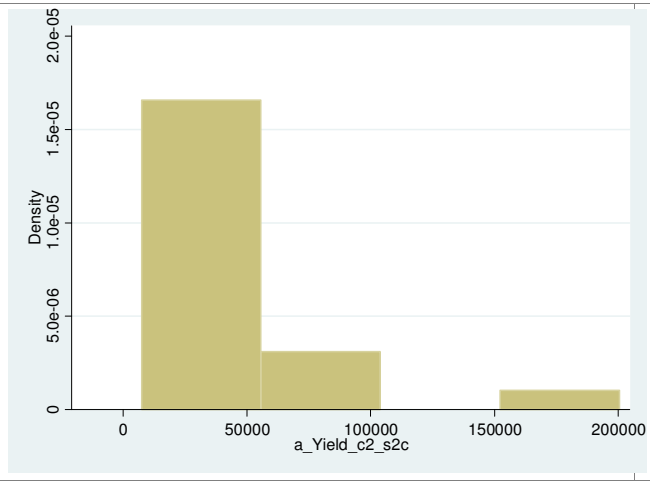
Cabbage AD Region – Yield for Seasons 1-2

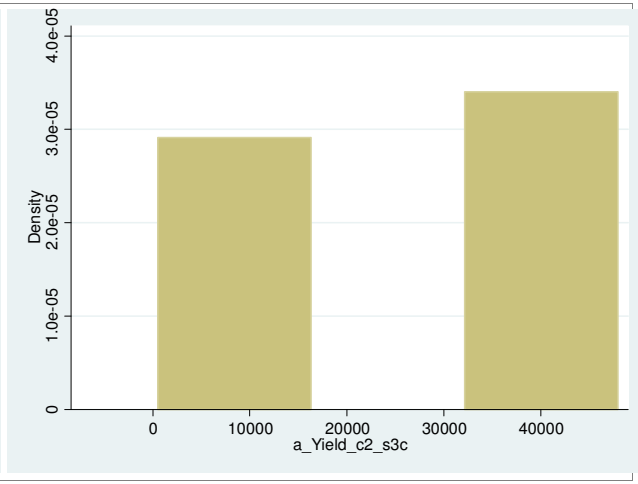




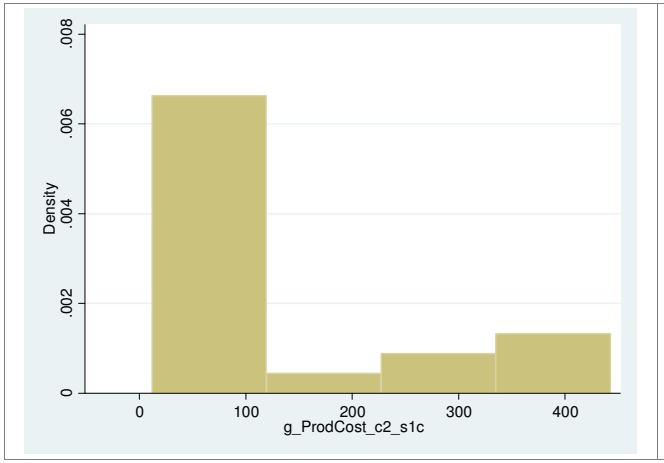
Cabbage MC Region – Yield for Seasons 1-3

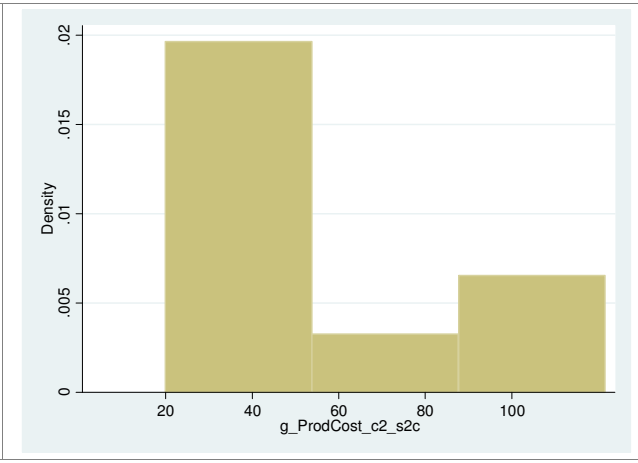




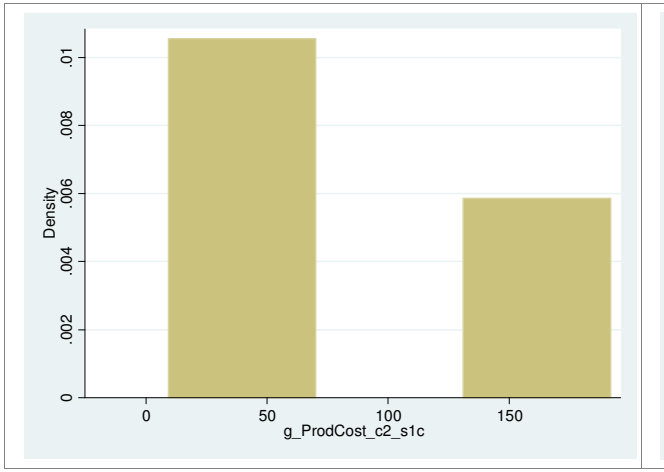


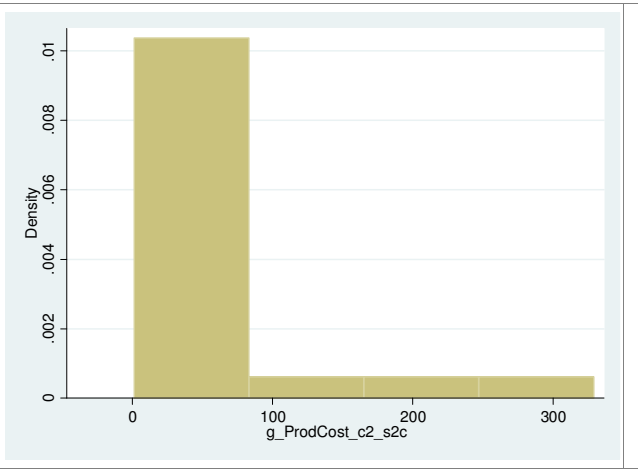
Cabbage AD Region – Production Cost for Seasons 1-2

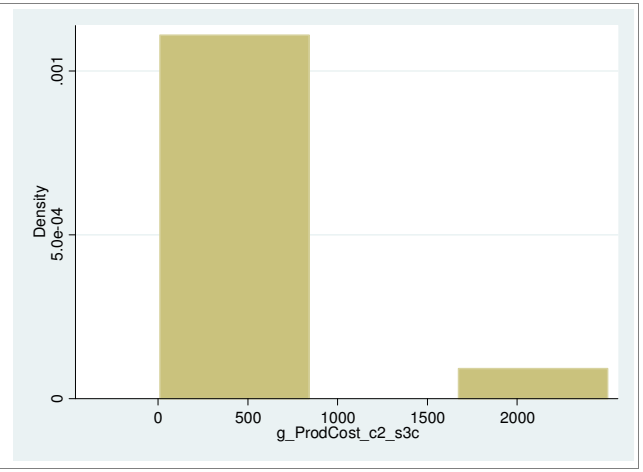




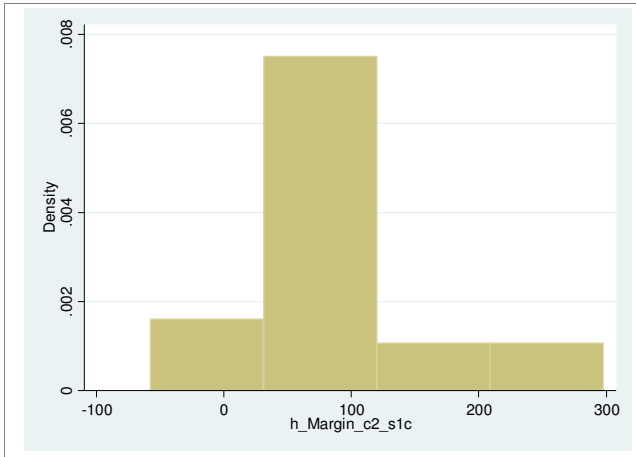
Cabbage MC Region – Production Cost for Seasons 1-3

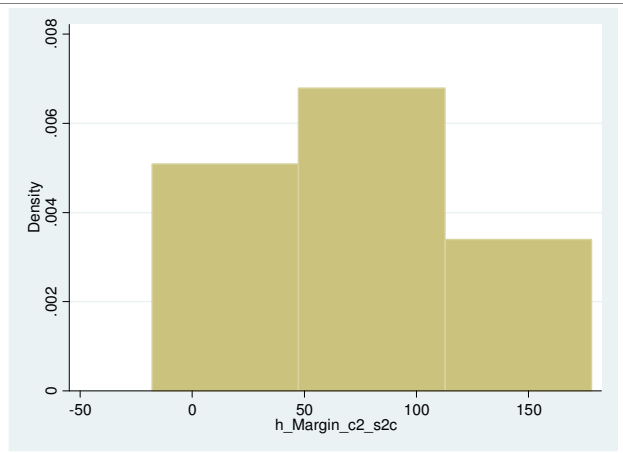




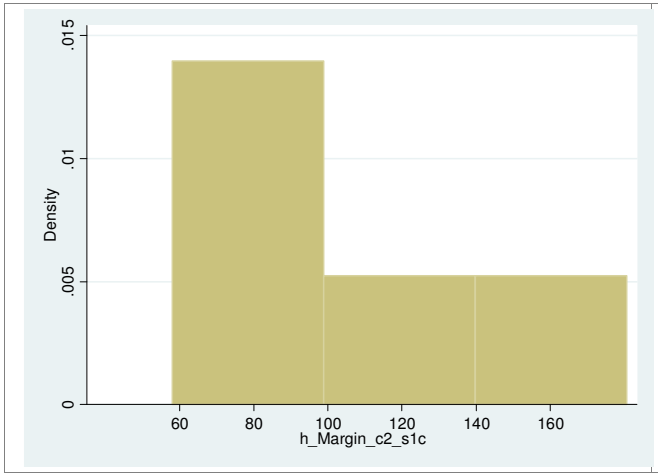


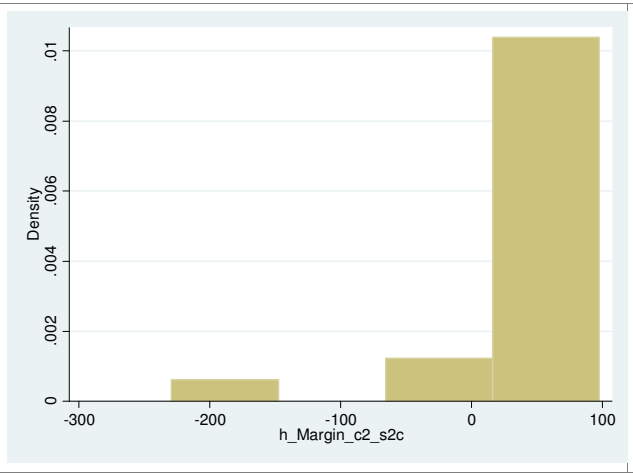
Cabbage AD Region – Margin for Seasons 1-2

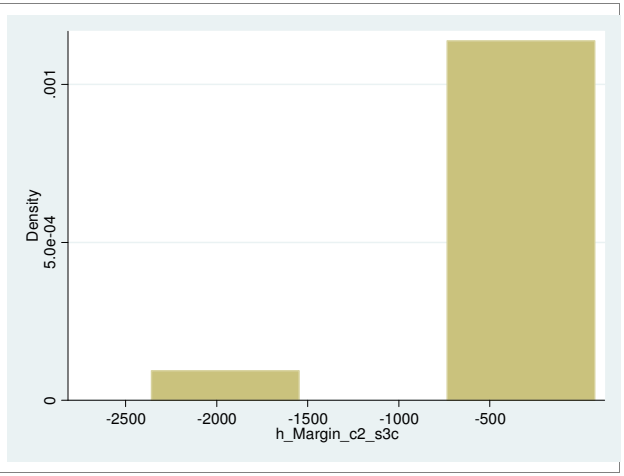




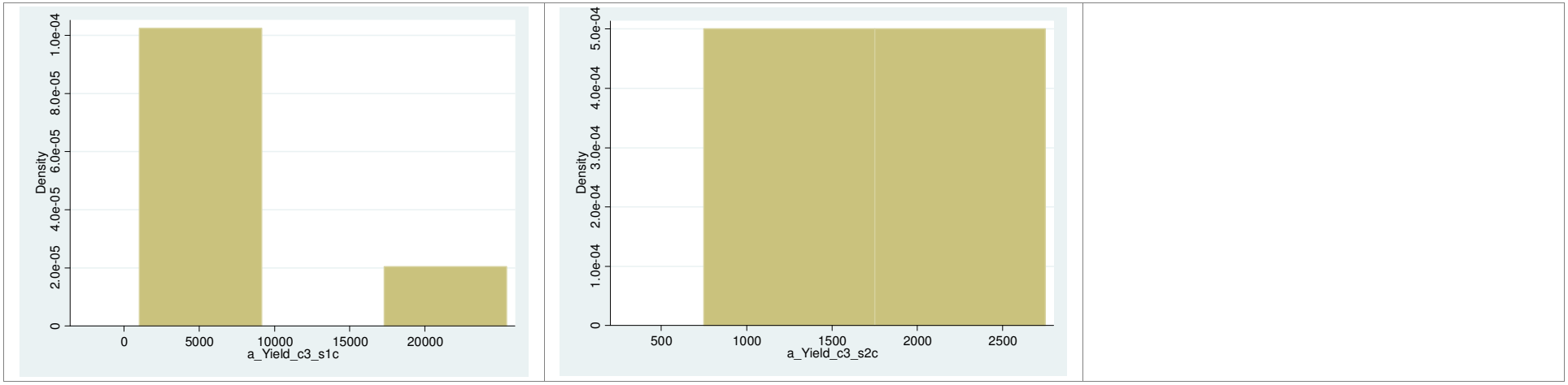
Cabbage MC Region – Margin for Seasons 1-3



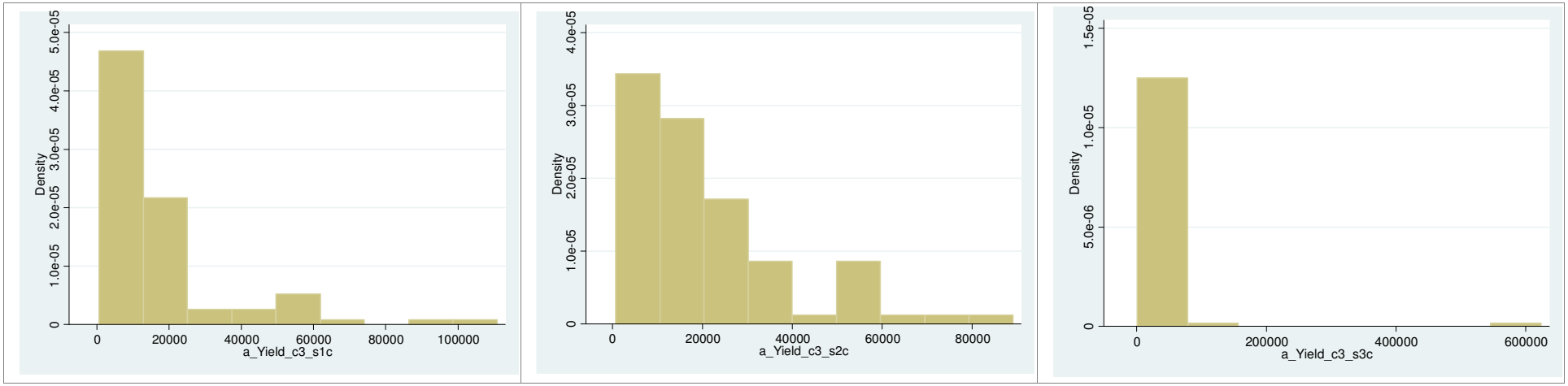




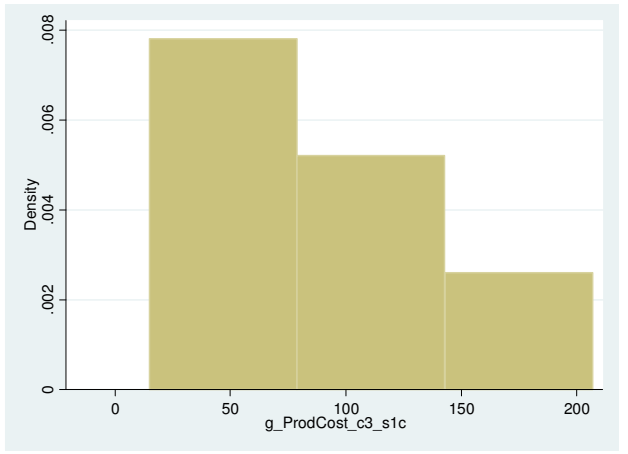
Crin-crin AD Region – Yield for Seasons 1-2

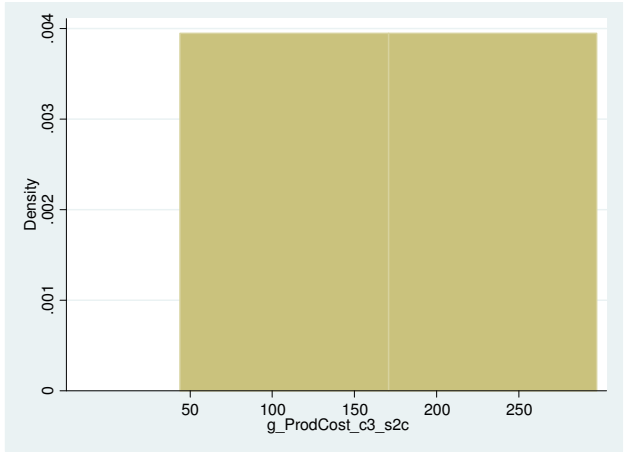


Crin-crin MC Region – Yield for Seasons 1-3

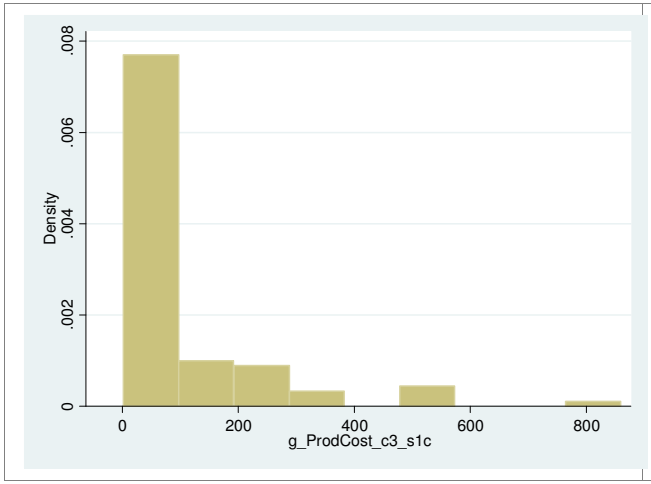


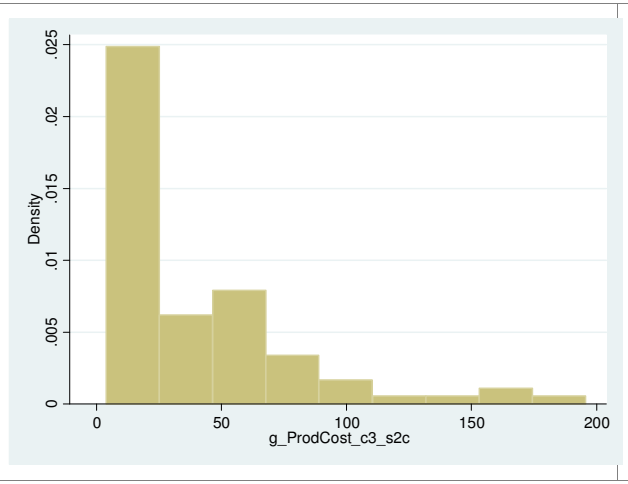
Crin-crin AD Region – Production Cost for Seasons 1-2

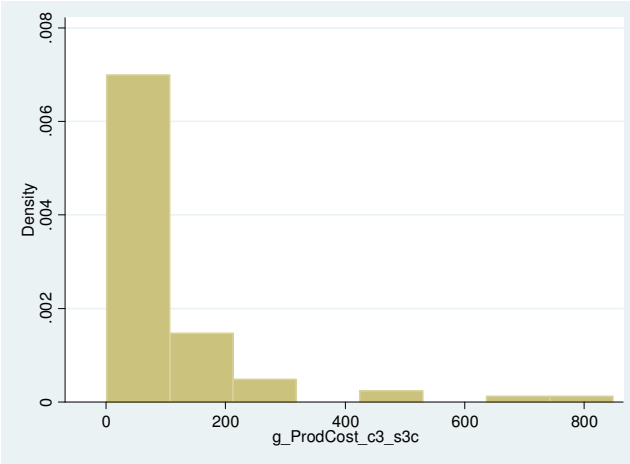




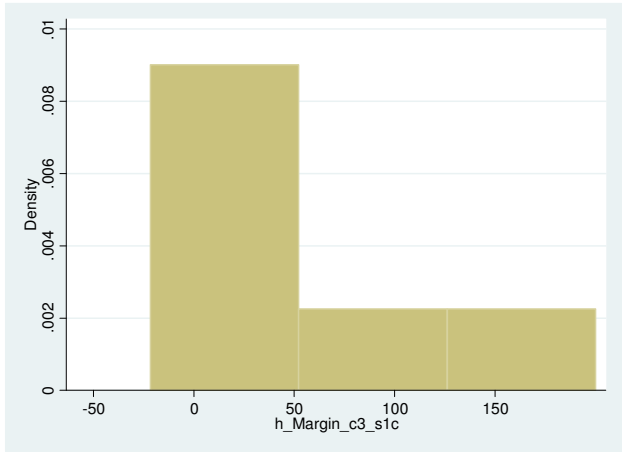
Crin-crin MC Region – Production Cost for Seasons 1-3

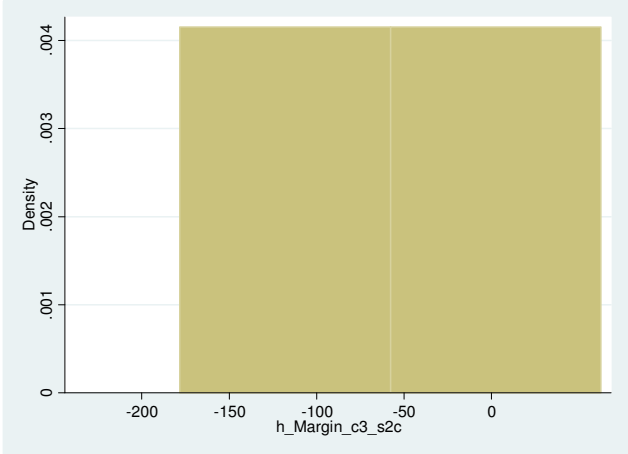




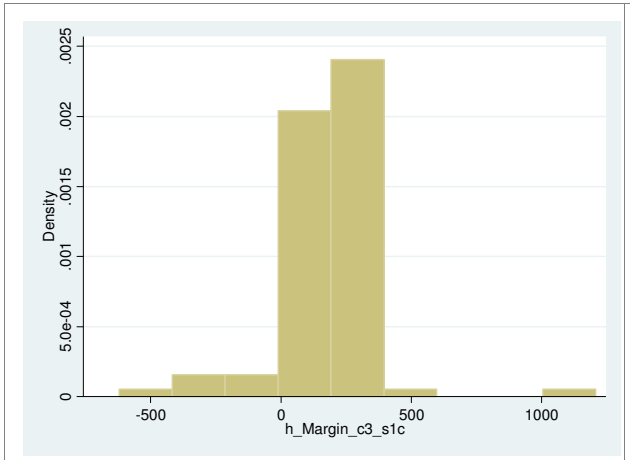


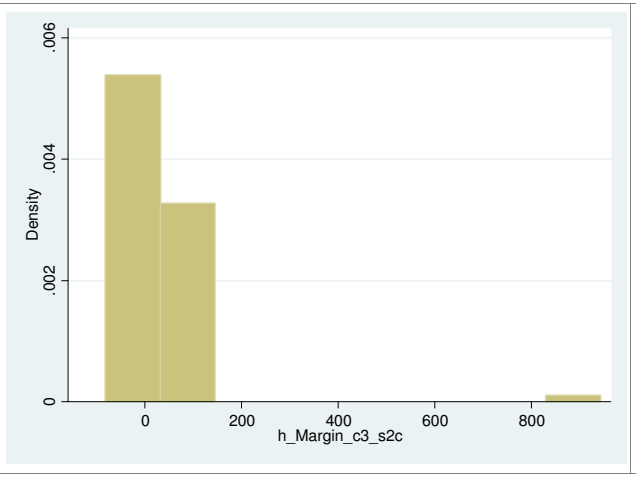
Crin-crin AD Region – Margin for Seasons 1-2

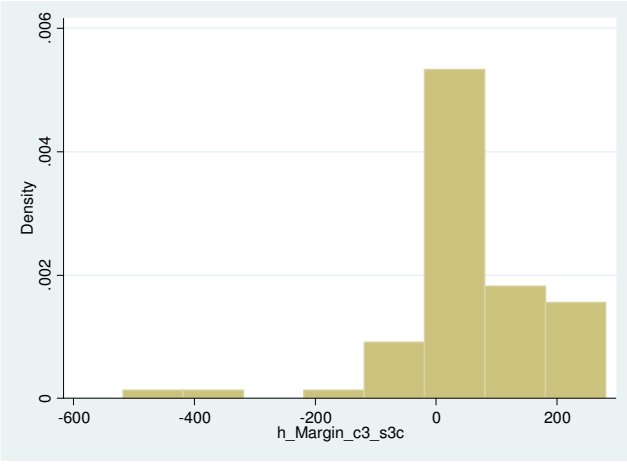




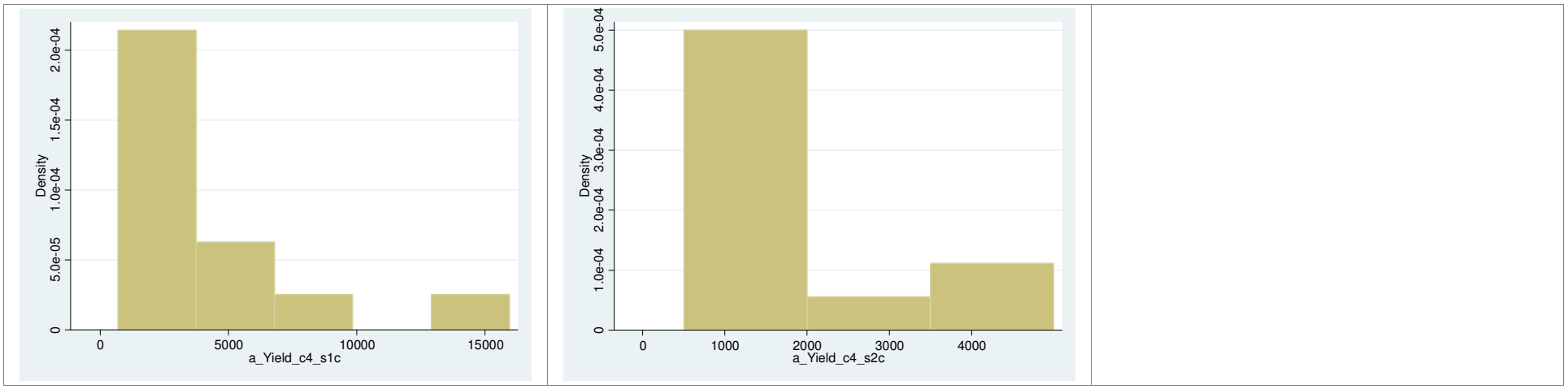
Crin-crin MC Region – Margin for Seasons 1-3



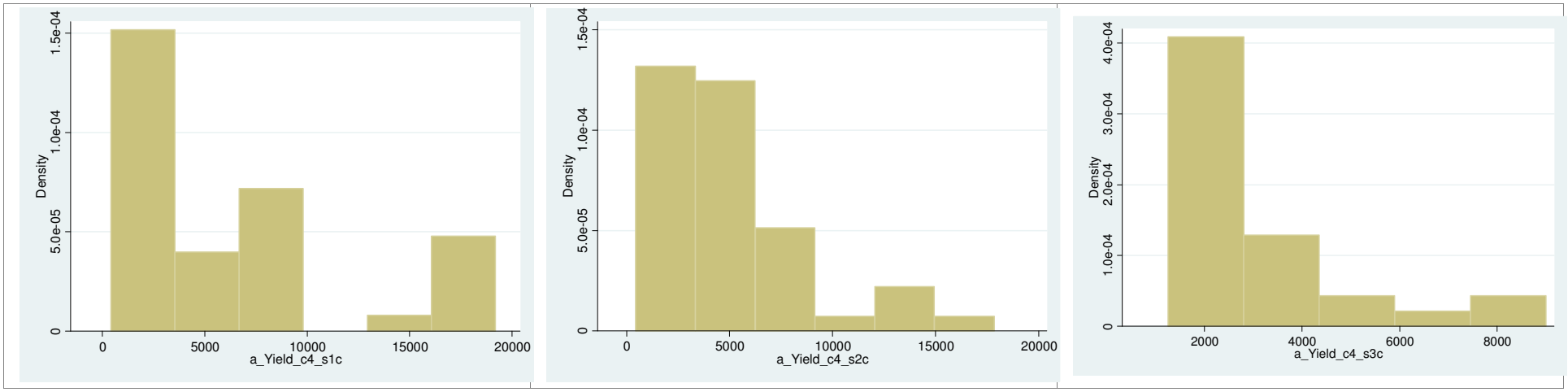




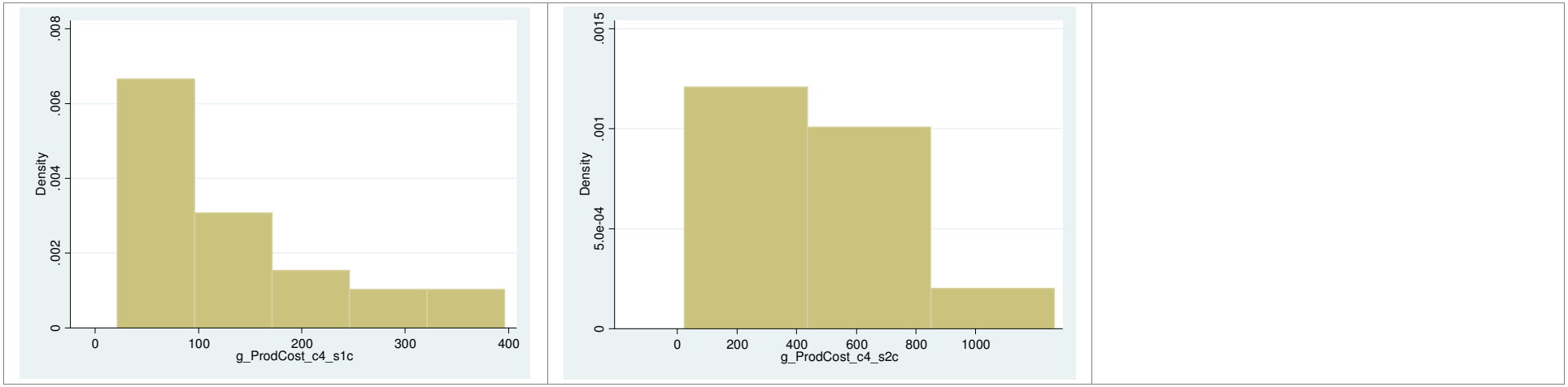
Okra AD Region – Yield for Seasons 1-2



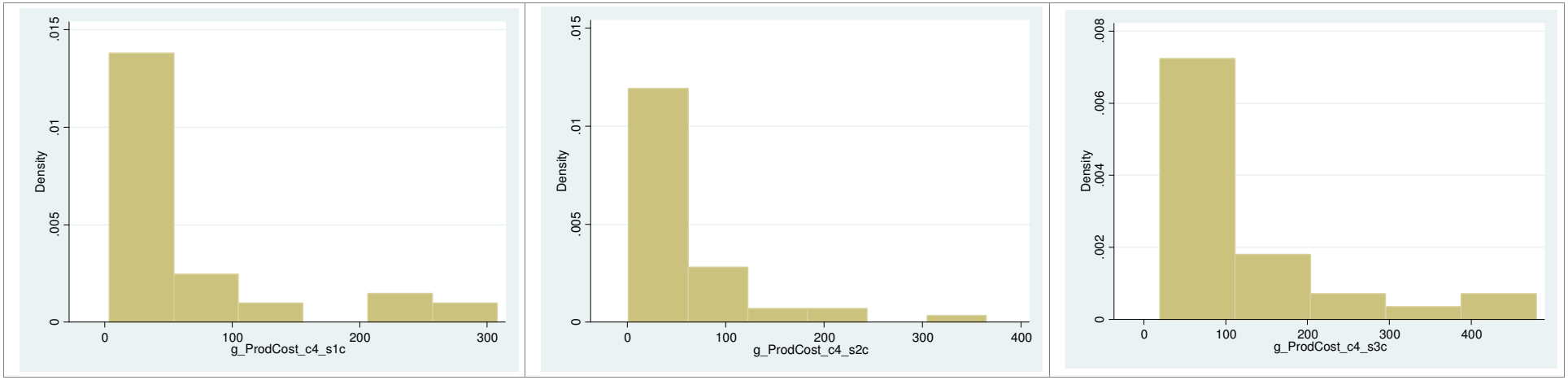
Okra MC Region – Yield for Seasons 1-3



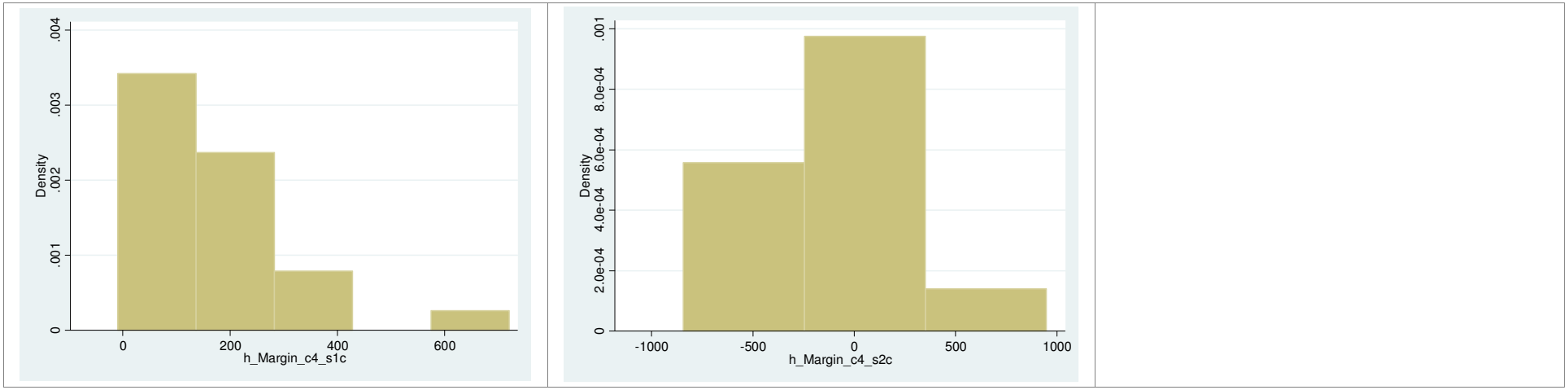
Okra AD Region – Production Cost for Seasons 1-2



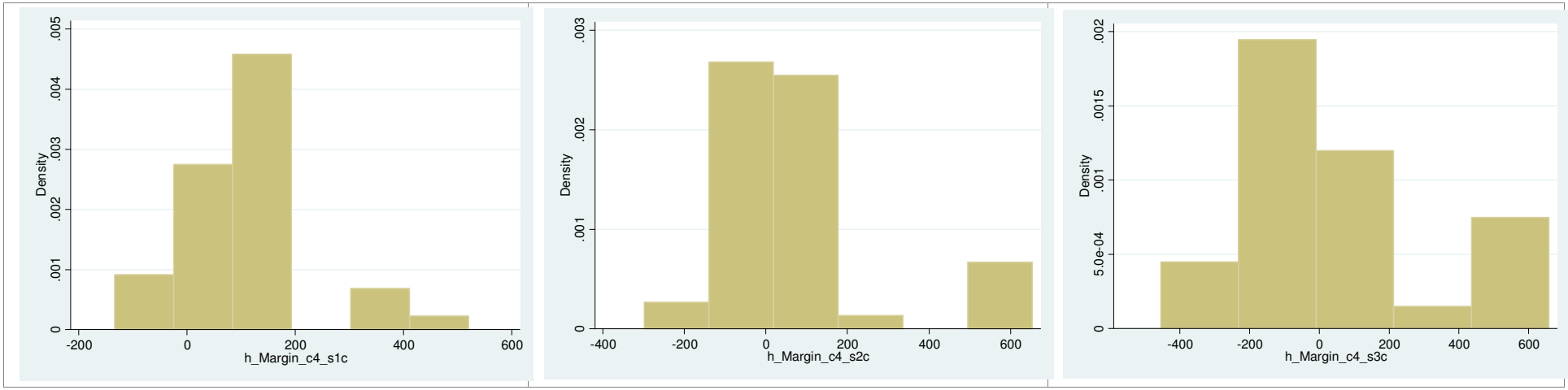
Okra MC Region – Production Cost for Seasons 1-3



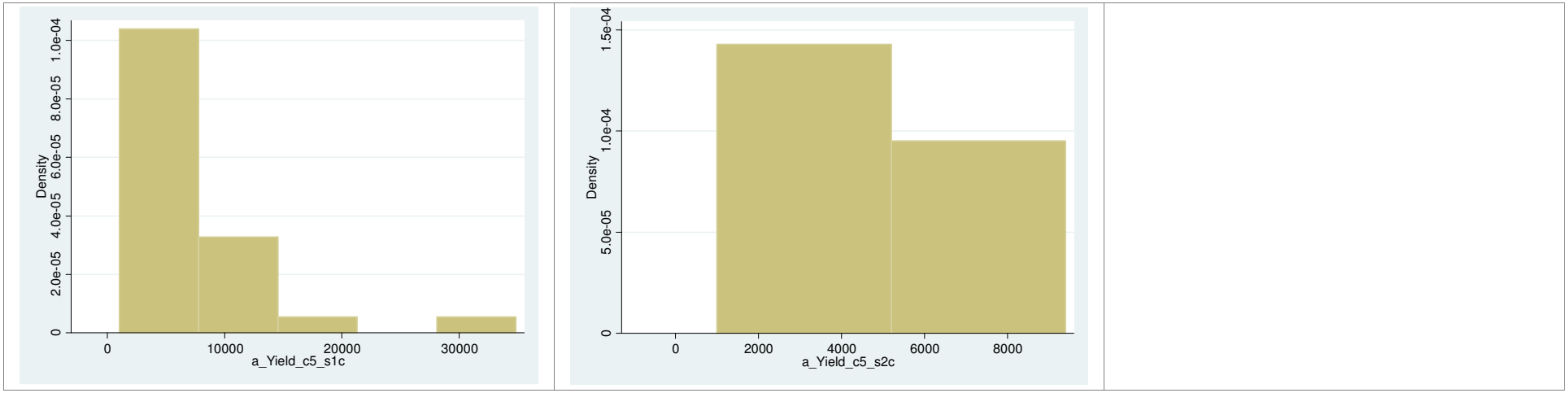
Okra AD Region – Margin for Seasons 1-2



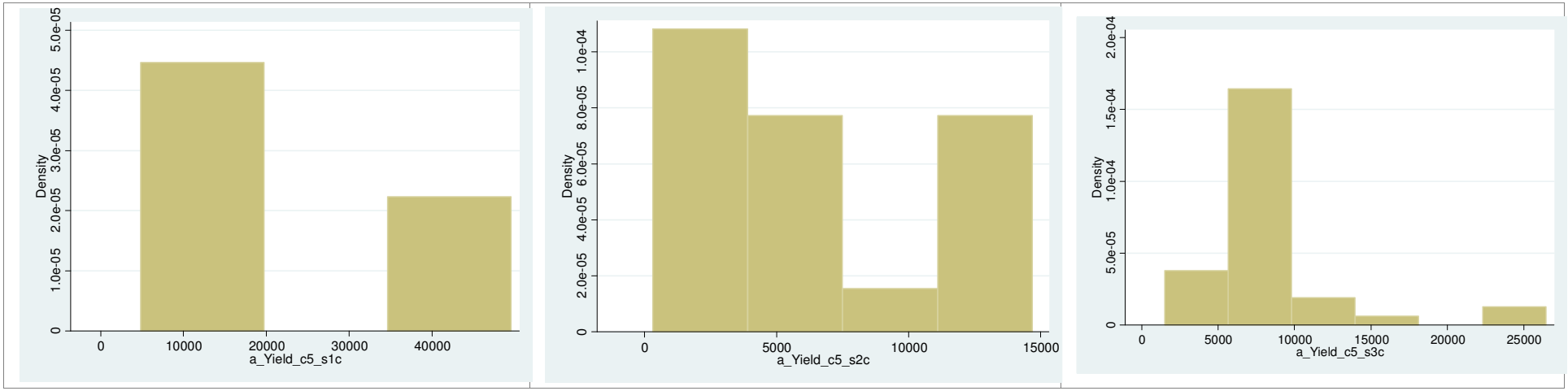
Okra MC Region – Margin for Seasons 1-3



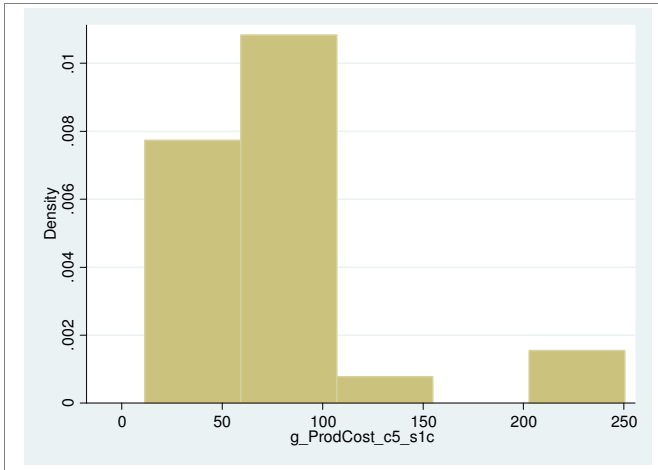
Onion AD Region – Yield for Seasons 1-2

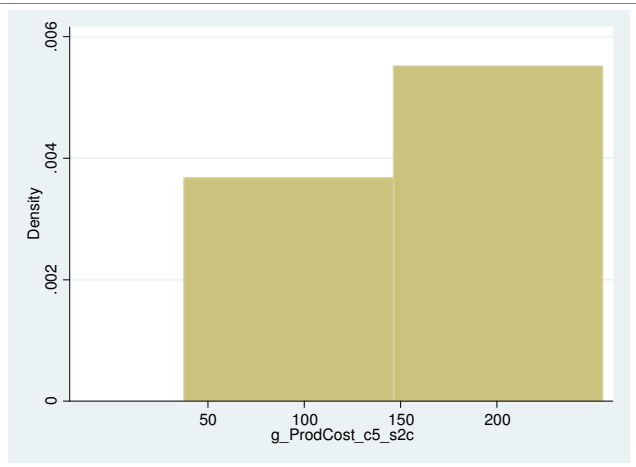


Onion MC Region – Yield for Seasons 1-3

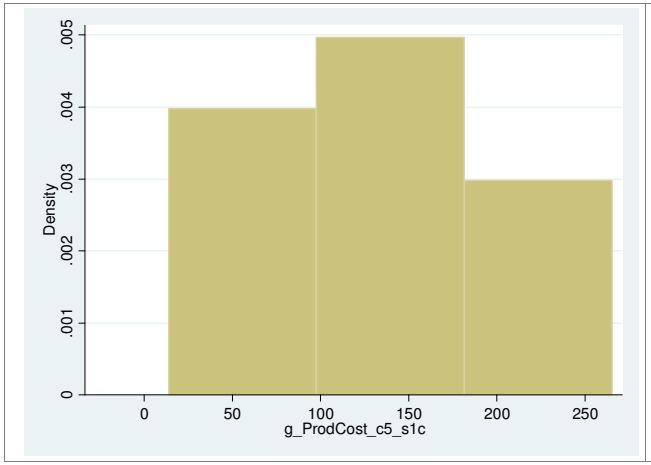


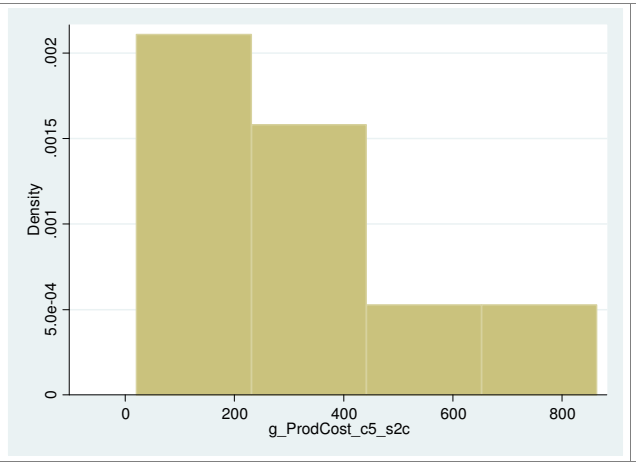
Onion AD Region – Production Cost for Seasons 1-2

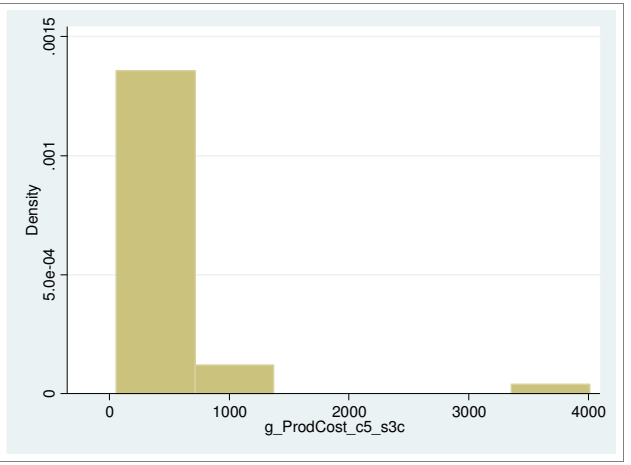




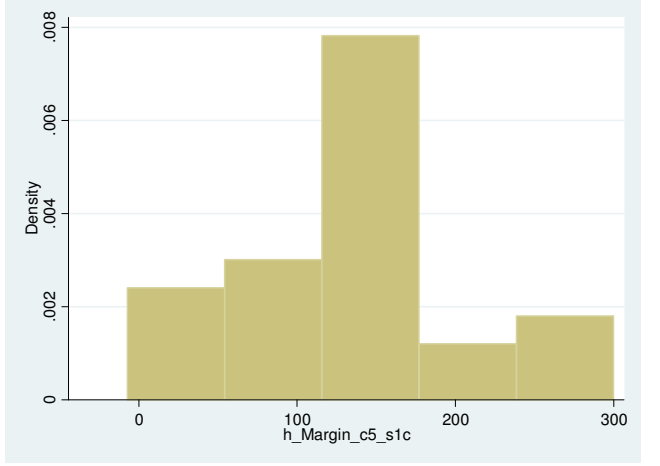
Onion MC Region – Production Cost for Seasons 1-3

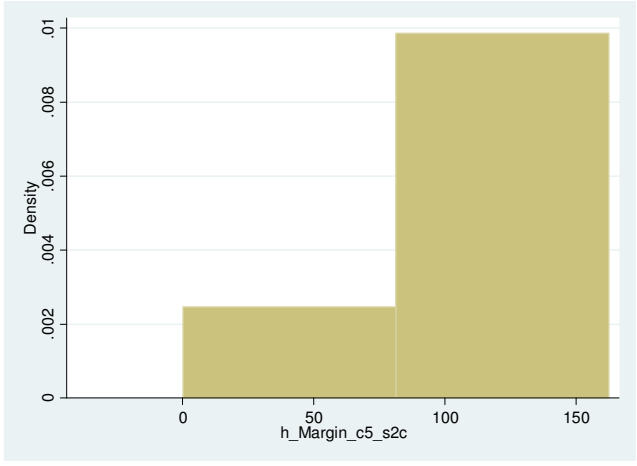




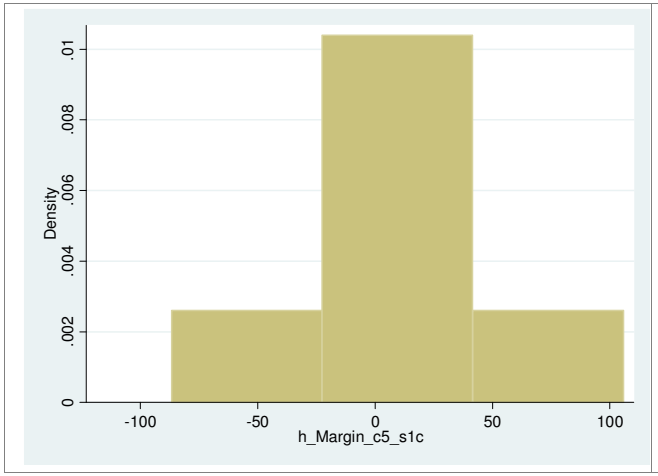


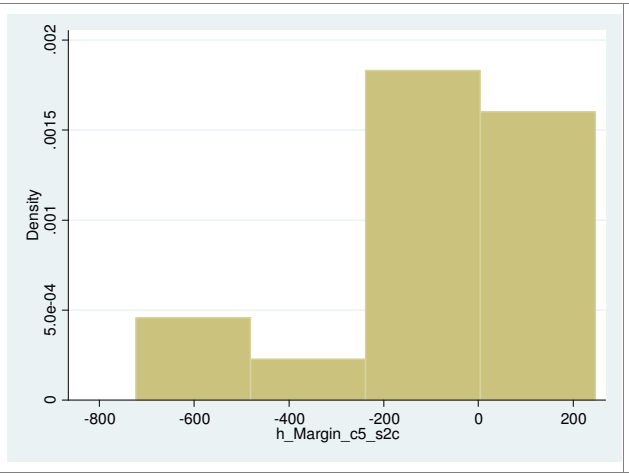
Onion AD Region – Margin for Seasons 1-2

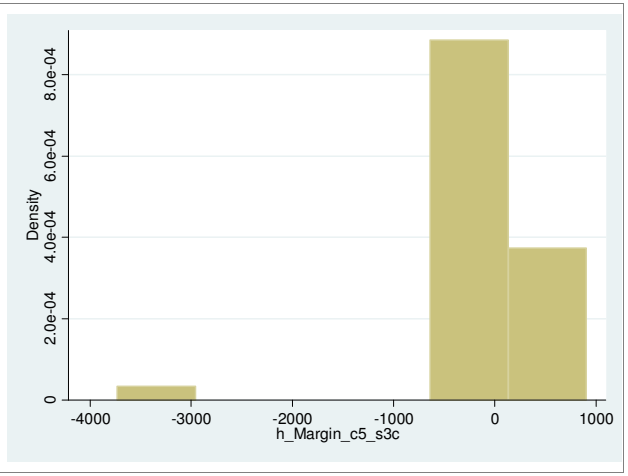




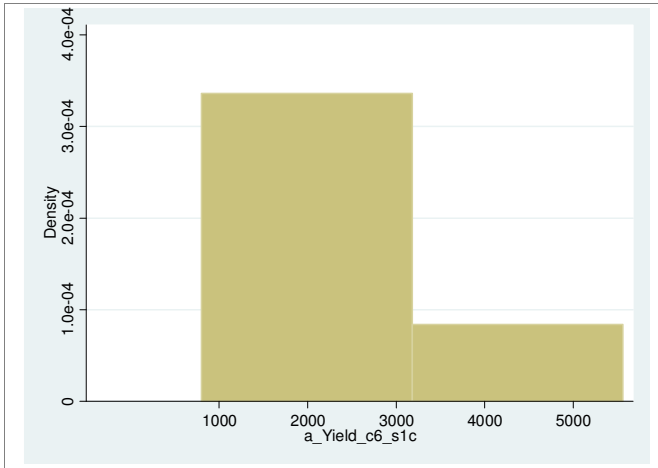
Onion MC Region – Margin for Seasons 1-3

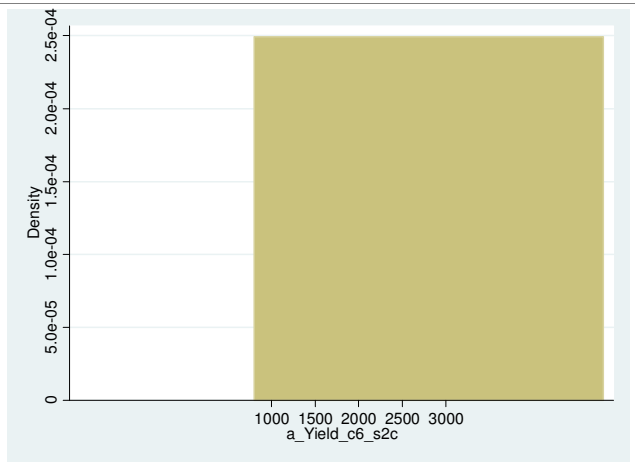




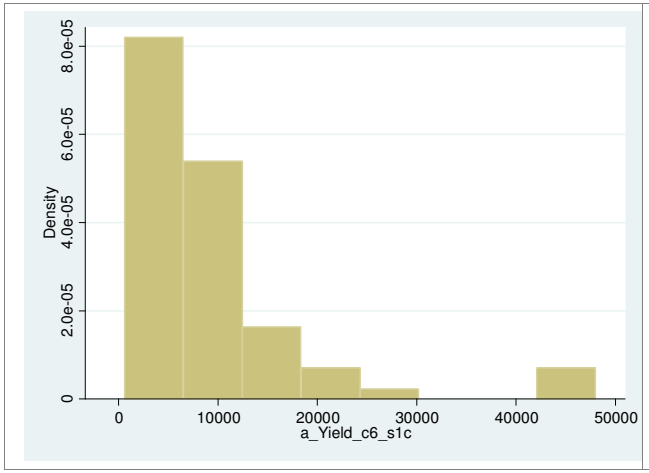


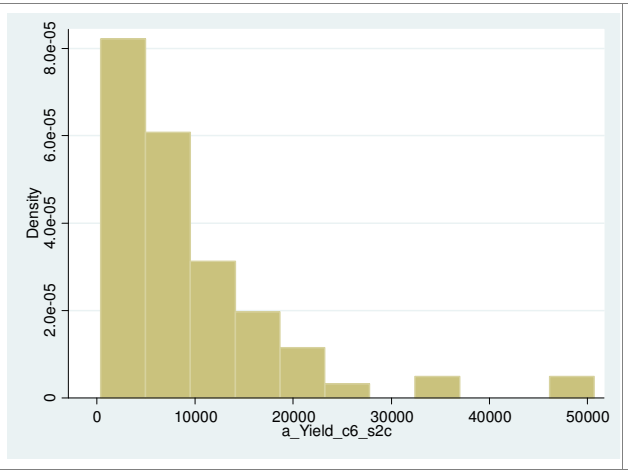
Chili pepper AD Region – Yield for Seasons 1-2

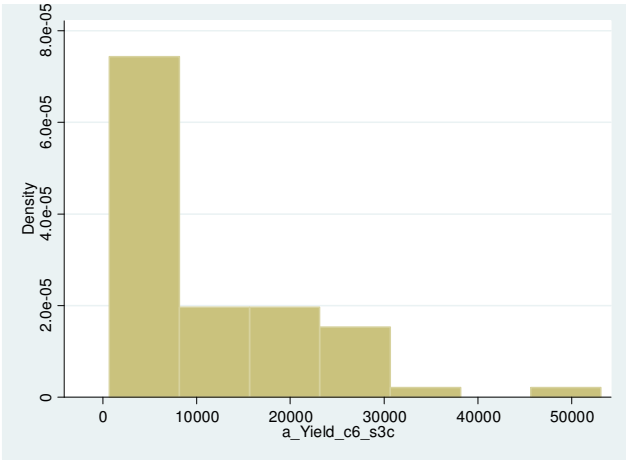




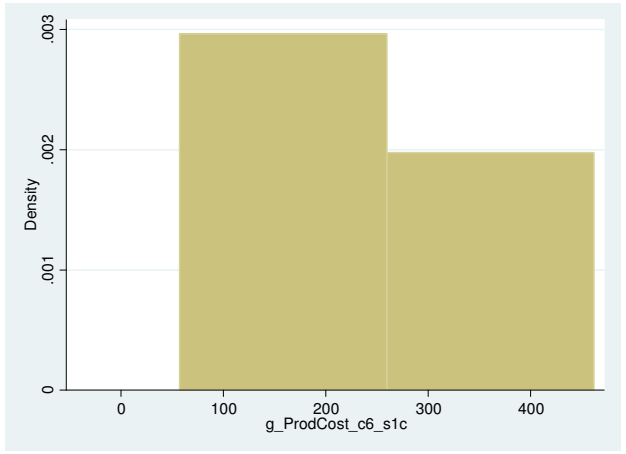
Chili pepper MC Region – Yield for Seasons 1-3

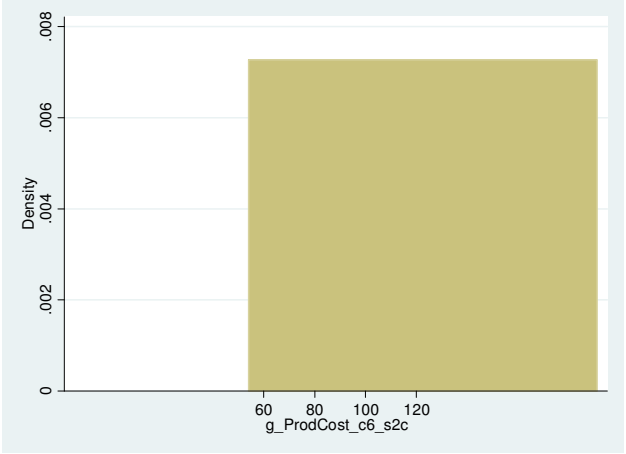




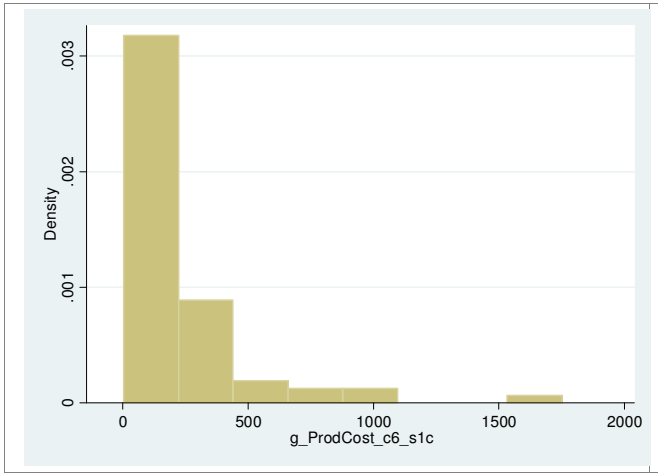


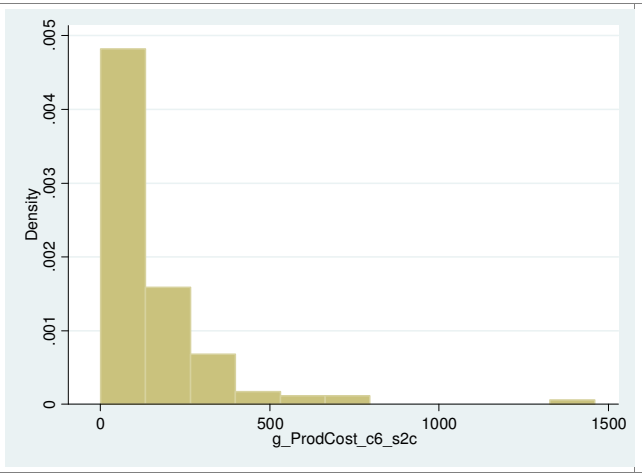
Chili pepper AD Region – Production Cost for Seasons 1-2

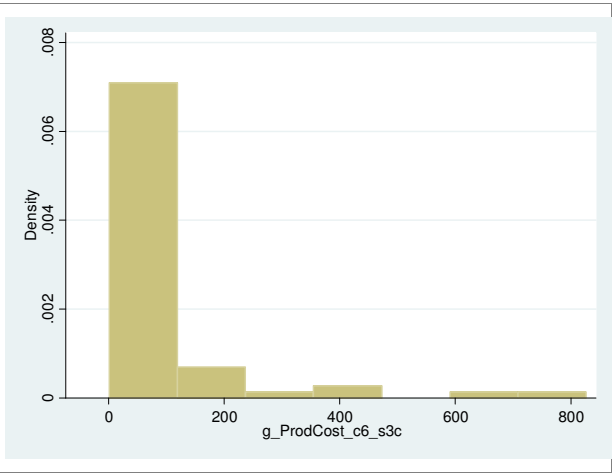




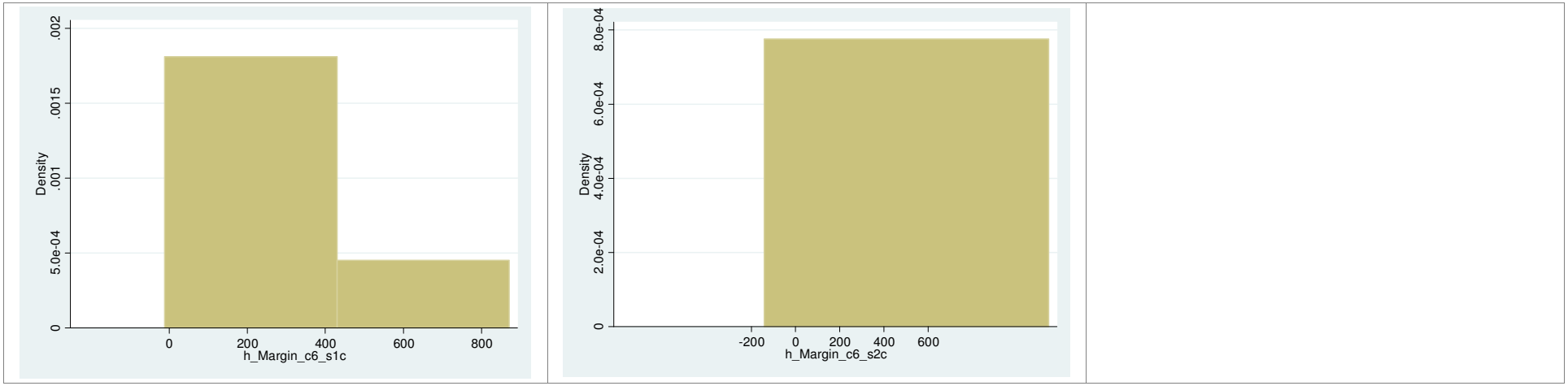
Chili pepper MC Region – Production Cost for Seasons 1-3



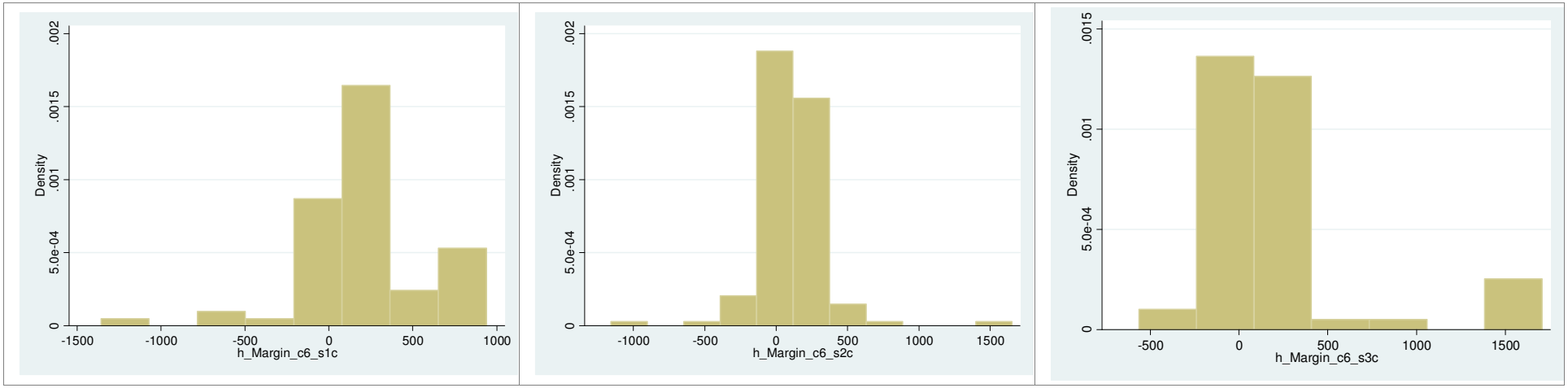




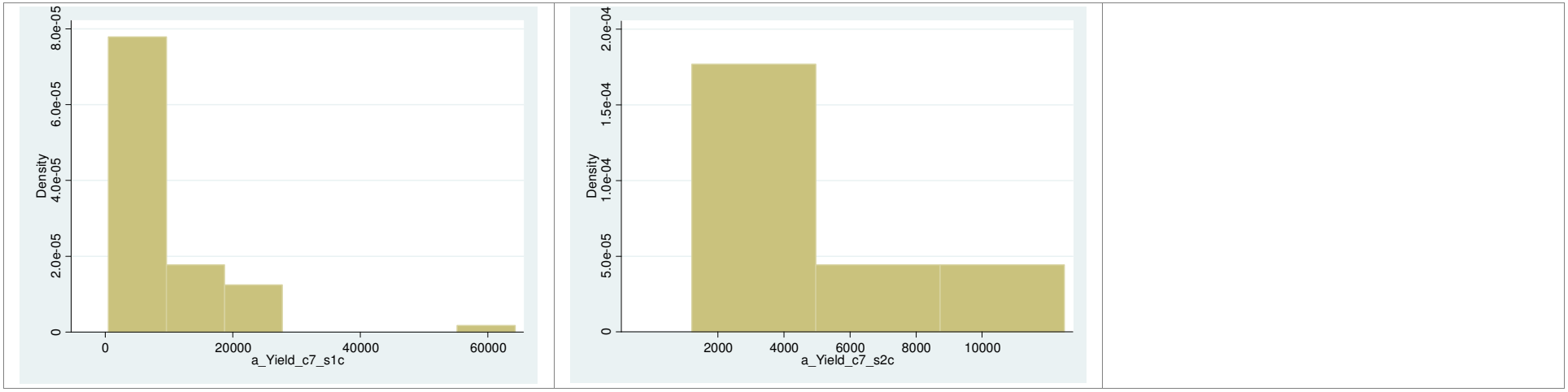
Chili pepper AD Region – Margin for Seasons 1-2



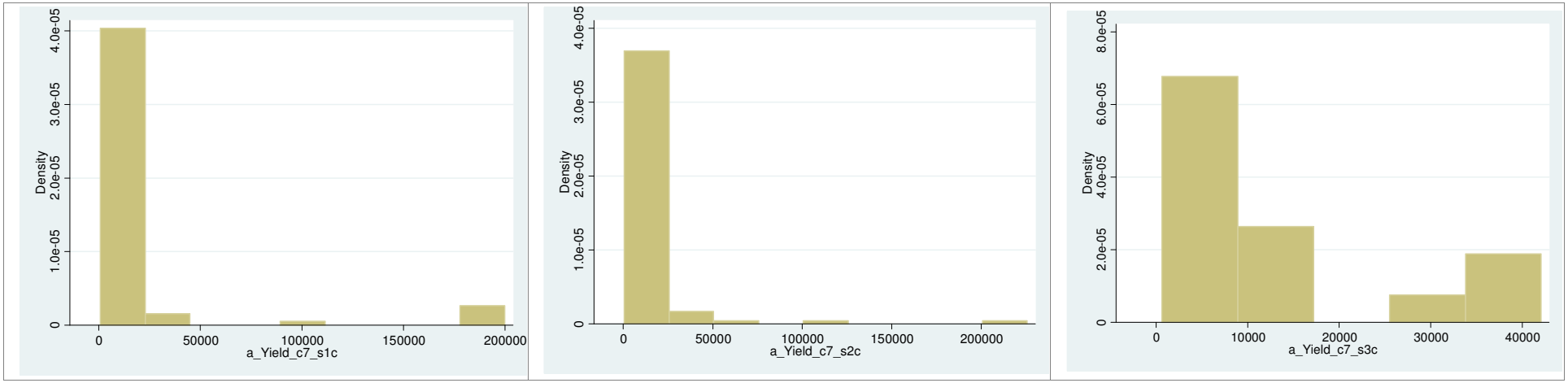
Chili pepper MC Region – Margin for Seasons 1-3



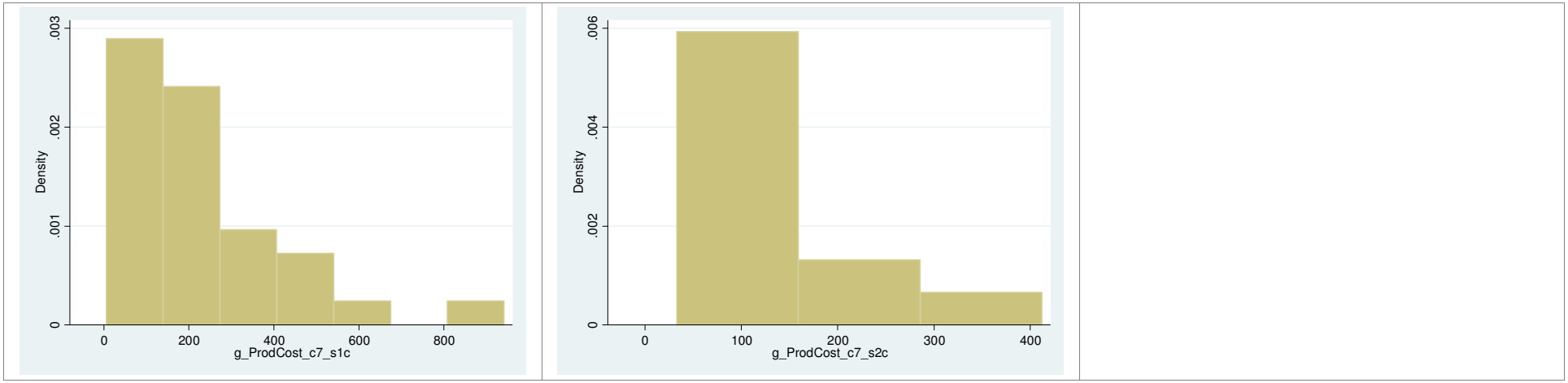
Pepper AD Region – Yield for Seasons 1-2



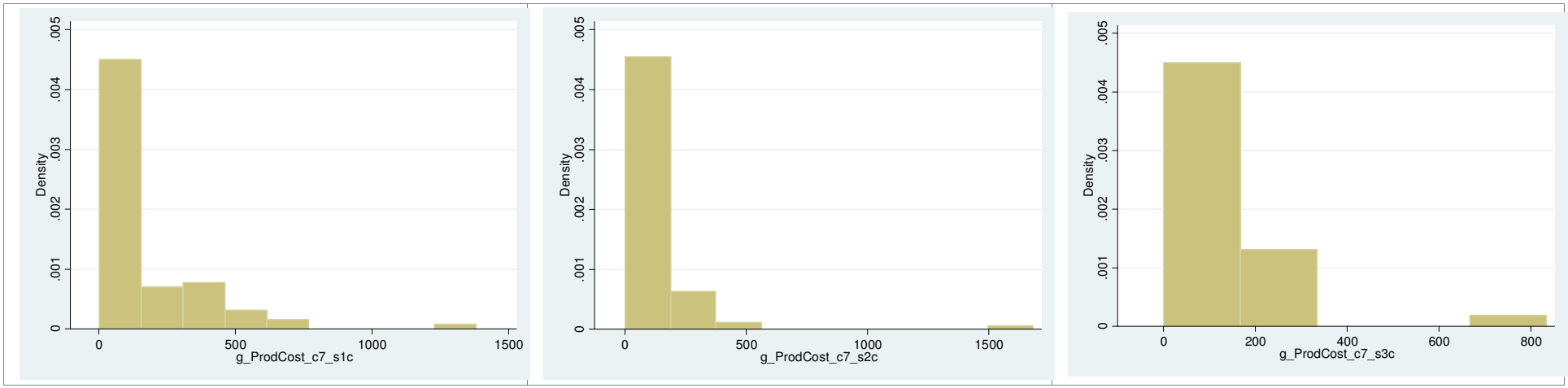
Pepper MC Region – Yield for Seasons 1-3



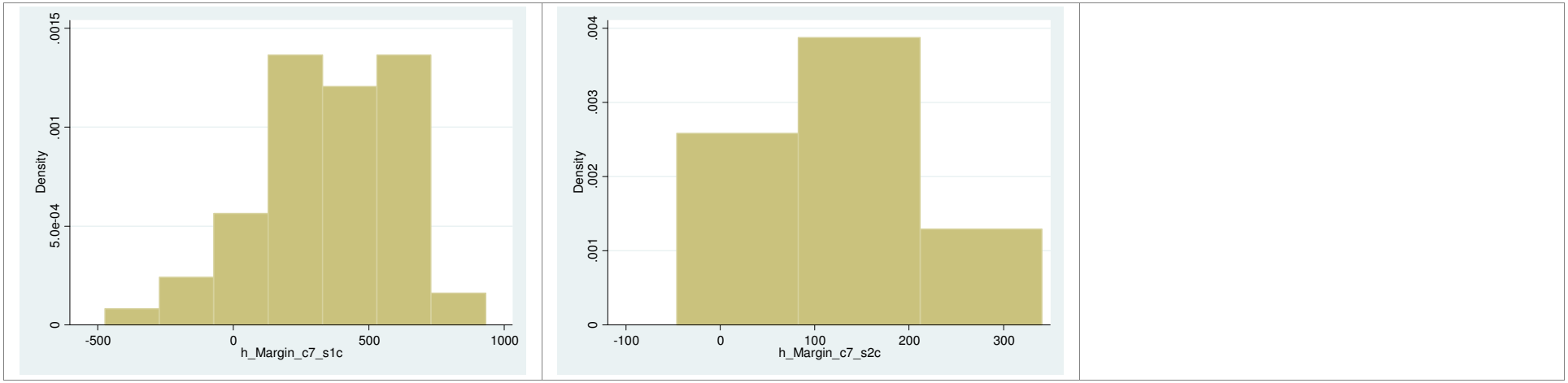
Pepper AD Region – Production Cost for Seasons 1-2



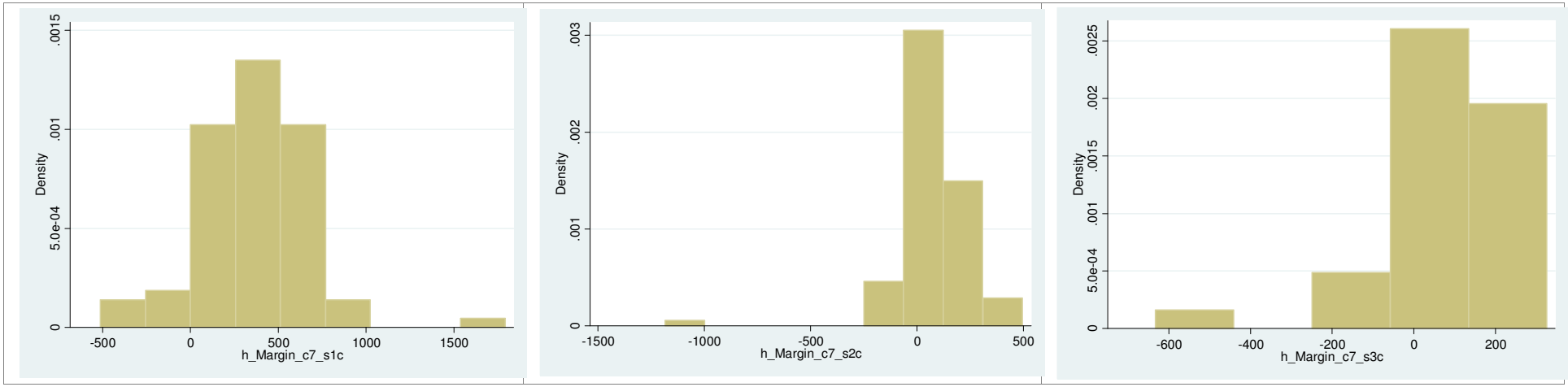
Pepper MC Region – Production Cost for Seasons 1-3



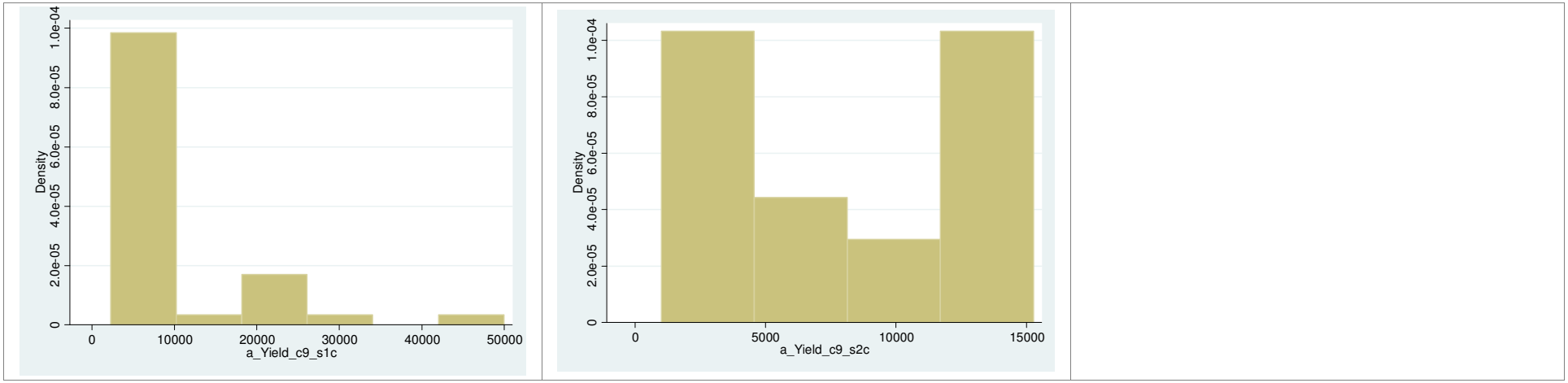
Pepper AD Region – Margin for Seasons 1-2



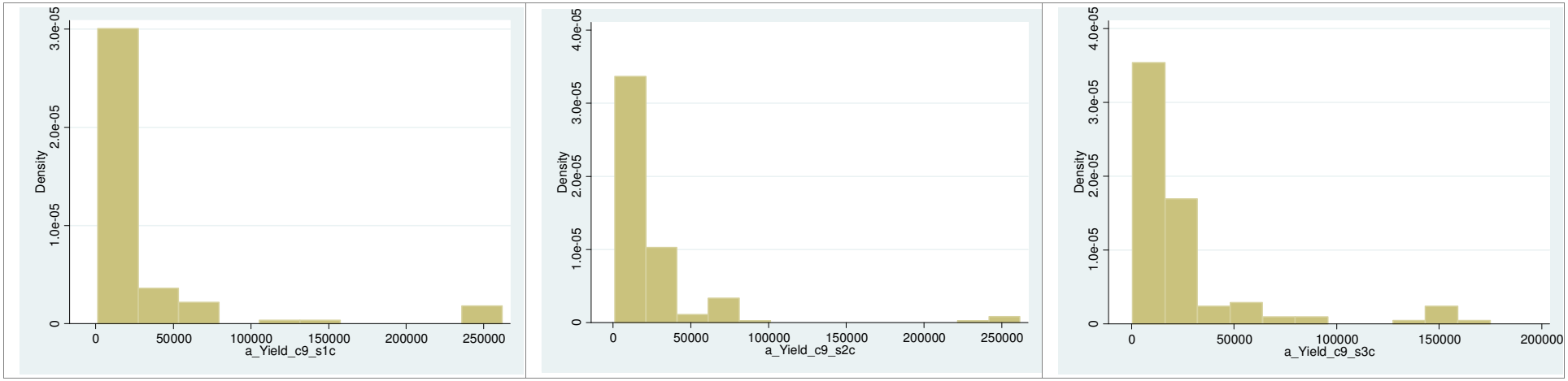
Pepper MC Region – Margin for Seasons 1-3



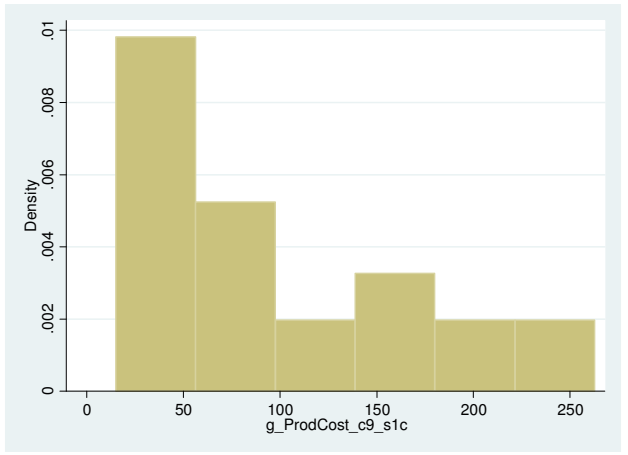
Tomato AD Region – Yield for Seasons 1-2

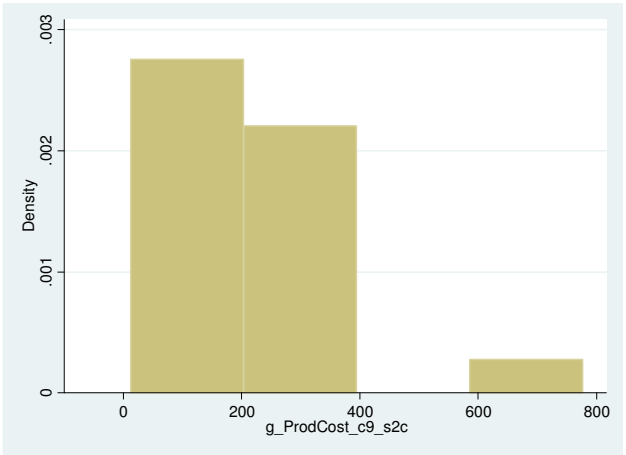


Tomato MC Region – Yield for Seasons 1-3

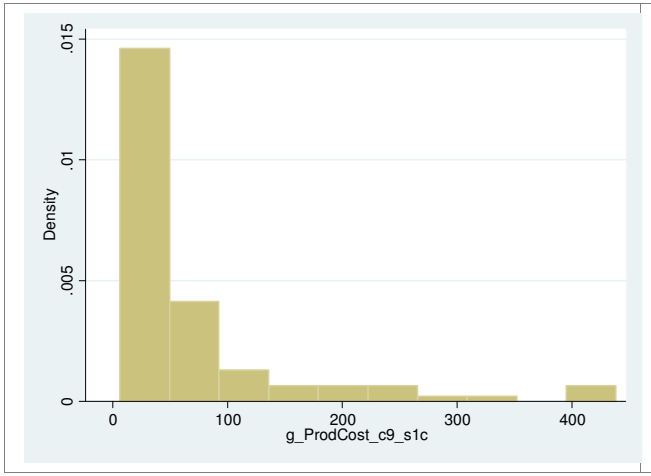


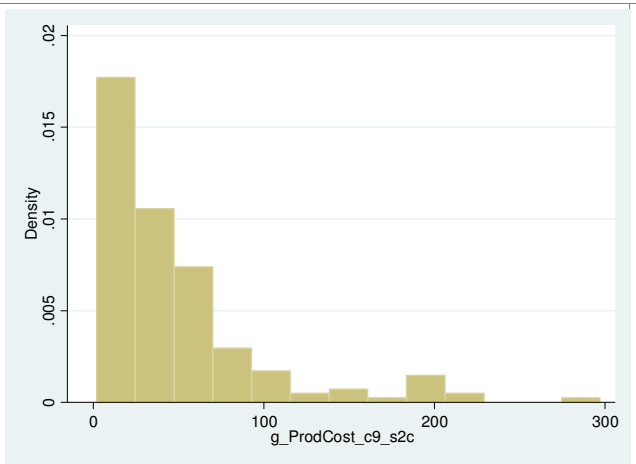
Tomato AD Region – Production Cost for Seasons 1-2

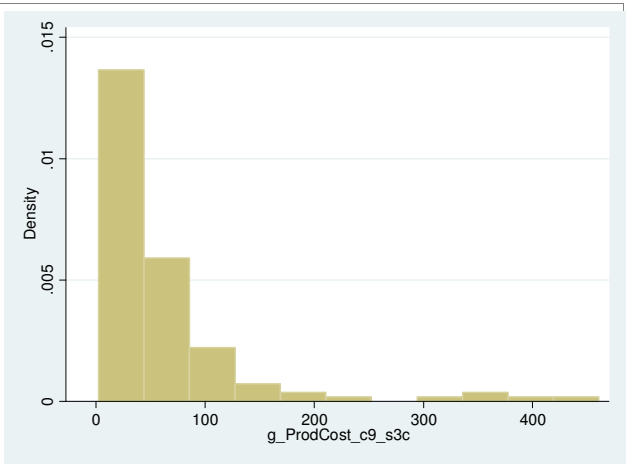




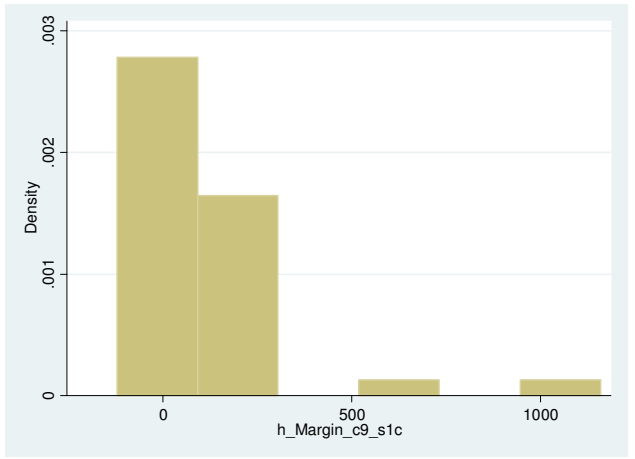
Tomato MC Region – Production Cost for Seasons 1-3

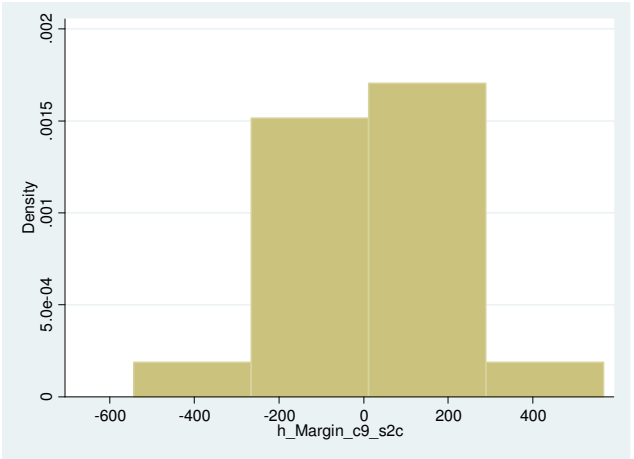






Tomato AD Region – Margin for Seasons 1-2





Tomato MC Region – Margin for Seasons 1-3