

Adoption of Improved Seeds, Evidence from DRC

Tanguy Bernard, Sylvie Lambert, Karen Macours, Margaux Vinez

▶ **To cite this version:**

Tanguy Bernard, Sylvie Lambert, Karen Macours, Margaux Vinez. Adoption of Improved Seeds, Evidence from DRC. 2019. halshs-02422695v2

HAL Id: halshs-02422695
https://shs.hal.science/halshs-02422695v2

Preprint submitted on 10 Jan 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

PARIS SCHOOL OF ECONOMICS
ECOLE D'ECONOMIE DE PARIS

WORKING PAPER N° 2019 – 72

Adoption of Improved Seeds, Evidence from DRC

Tanguy Bernard
Sylvie Lambert
Karen Macours
Margaux Vinez

JEL Codes:
Keywords: agricultural policies, technology adoption, input subsidies, Sub-Saharan Africa, Democratic Republic of Congo

Funded by a French government subsidy managed by the ANR under the framework of the Investissements d'avenir programme reference ANR-17-EURE-001

Adoption of Improved Seeds, Evidence from DRC.

Tanguy Bernard[*], Sylvie Lambert[†], Karen Macours[‡], Margaux Vinez[§]

December 27, 2019

Abstract

Agricultural input subsidies are often considered key instruments to increase adoption of new technologies in developing countries. Using unique experimental data from Equateur province in DRC, we document the effectiveness of such interventions in increasing households adoption of modern seed varieties (MVs). High subsidy levels increase adoption, in particular when other access constraints were also relieved. Demand is highly price sensitive, but demand curves do not display strong discontinuity at low prices. We find very limited spillover effects on adoption by non-voucher recipients. Adoption persists to some extent in the season that follows voucher distribution.

Key words: agricultural policies, technology adoption, input subsidies, Sub-Saharan Africa, Democratic Republic of Congo

[*]GREThA - Université de Bordeaux International Food Policy Research Institute
[†]Paris School of Economics, INRA
[‡]Paris School of Economics, INRA
[§]World Bank

1 Introduction

Approximately 75% of the population in sub-Saharan Africa remains dependent on agriculture for its livelihoods. Increasing productivity and income for smallholder farmers is therefore one of the highest development priorities, and is often seen as a cornerstone in the fight against poverty and hunger. One of the oft cited causes for this low agricultural productivity is the underutilization of technologies that are deemed profitable but that farmers are not adopting. While modern input use has increased in the last decade, it still varies widely between and within countries (Christiaensen, 2017). A large literature is dedicated to understanding the causes of this underutilization, underlining behavioral constraints and market imperfections, with important implications for the justification and design of input subsidy programs (see World Bank, ed (2007), Jack (2013), de Janvry et al. (2017) for reviews).

This paper draws on a randomized control trial conducted in the Democratic Republic of Congo to provide empirical evidence on the role of subsidies to prompt adoption of improved seeds. In 60 randomly selected villages, households were randomly chosen to receive vouchers to buy improved seeds at a subsidized price for five of the main staple crops. Vouchers were distributed before the planting season to either a man or a woman in each household, with price reductions of 30, 60, 90 or 100%. The vouchers could be redeemed (within 3 months) at the offices of local seed-multipliers, at prices fixed by the Ministry of Agriculture. In addition, in a randomly selected,subsample of 35 villages, a truck delivered seeds directly in the village a few days after the voucher distribution, so households could redeem their voucher. The truck delivery spared households the travel cost but left little time to gather cash. In addition, trucks provided an opportunity to buy groundnuts (a legume) and/or cereals, while seed multipliers offered mostly cereals in their local offices. This last difference between villages with and without truck delivery was unintended. To test for spillovers in technology adoption and general equilibrium effects, we introduced random variation in the proportion of households in a village receiving vouchers (20, 45 or 70%).

The different experimental variations were designed to test different constraints to adoption, to estimate price elasticities and to estimate diffusion of the improved seeds. The subsidies effectively induced large variation in the adoption of improved seeds in the agricultural season following the intervention and one year later, with impacts being larger for higher levels of subsidy, and when access costs were lifted. While households were more likely to use their vouchers in villages with truck delivery, those with low levels of subsidy bought smaller quantities of seeds compared to households in villages without truck delivery.

This paper presents some background facts on agriculture in Equateur, describes the experimental design and data and presents results of the subsidies on adoption of improved seeds.

2 Context and Data

2.1 Background: DRC and the Equateur Province

With 2.345 billion square kilometers, the Democratic republic of Congo is the second largest country in sub-Saharan Africa. In 2012, 71% of the population of 67 million estimated inhabitants lived under the poverty line, and three quarters of them in rural areas. DRC is also home to the second largest tropical forest in the world, and holds 80 million hectares of arable land (Herdeschee et al., 2012). Rainfall patterns allow for two annual rain-fed cropping activities covering a variety of crops (Season A with planting starting in March, and Season B with planting starting in August). Subsistence farming occupies 60% of the active population, and generates 40% of GDP. During the Zairianisation in the 1970's,[1] the agricultural sector was dislocated and large scale investments in agriculture were discouraged. Infrastructures then collapsed during the Congo Wars (1996-2003), and inadequate infrastructure for the transport of agricultural products limits commercialization. Although agricultural production started to recover between 2006 and 2010, yields and aggregate production remain very low.

Agricultural productivity is particularly low in Equateur province in DRC, a remote region with very extensive slash-and-burn agriculture, high levels of food insecurity and extreme poverty, and arguably severe constraints to economic development in other sectors.[2] While historically plantation agriculture played an important role in the development of the province, many plantations are currently abandoned, and households rely mostly on subsistence smallholder agriculture through shifting cultivation of staples, as well as gathering of forest products, fishing and hunting.[3,4] While agricultural potential is believed to be large, road density is very low, commercialization is hampered by long distances from farm to market, and most farmers don't have access to improved varieties or technologies. Traditional slash and burn clearing methods are used, and the only capital inputs used are generally hand held tools. Farmers traditionally purchase "seeds" from the food market or exchange it with neighbors.

To strengthen the agricultural sector in the province of Equateur, the Ministry of Agriculture started implementing the Agricultural Rehabilitation and Recovery Support Project (PARRSA: Projet d'Appui à la Réhabilitation et à la Relance du Secteur Agricole) in 2011 with the support of the World Bank. PARRSA works in 9 territories in the three northern

[1] "Zairianisation" is a nationalist political process launched in 1973 by president Mobutu, by which, among other changes, agricultural businesses that belonged to foreigners were transferred to citizens of the DRC. In many cases, the new owners did not continue to farm the land they received and many plantations were abandoned.

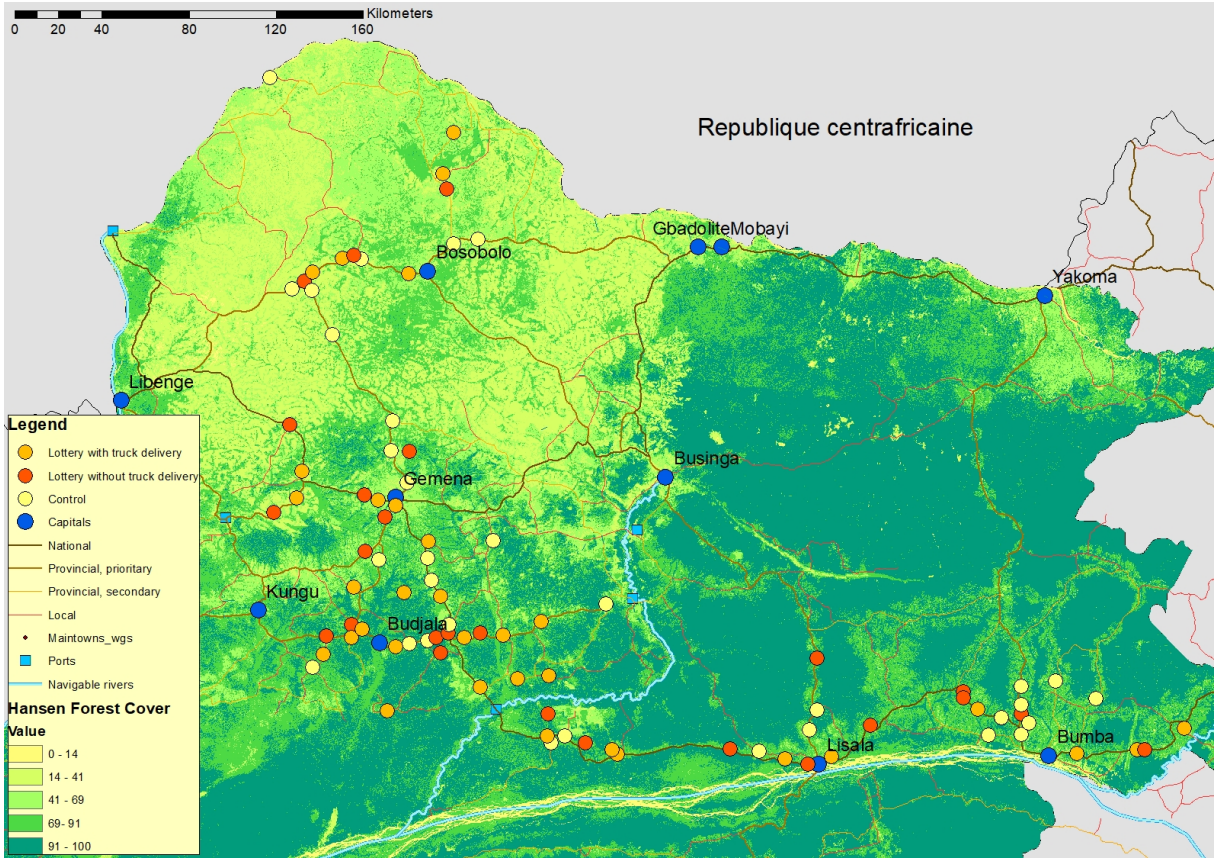
[2] An administrative reform recently changed the administrative divisions. What was until 2015 the province of Equateur is now divided in five smaller provinces.

[3] Plantations: palm oil, coffee, cotton, hevea, cocoa

[4] Staples: maize, rice, groundnuts, cassava, soya, niebe, yam, plantain

districts of the Equateur Province.[5] The intervention area comprises roughly 150.000 square kilometers, and is at the heart of the Congo Bassin Forest. It is characterized by a large heterogeneity in access to land both between and within villages: while some villages are located near the forest border, others are located further away and access to natural resources varies widely (See Figure 1).

Figure 1 – Map of forest cover and villages localisation in the project area



2.2 Evaluation design

The Agricultural Rehabilitation and Recovery Support Project aims at improving agricultural productivity in the region through a variety of mechanisms (see appendix A for details). We focus this paper on a one-time seed price subsidy program implemented in February-March 2013. Seed vouchers provided subsidized access to seeds of improved varieties of maize, rice, groundnut, and soya, or stems of an improved variety of cassava. The varieties were selected

[5]Territories: Bosobolo, Budjala, Bumba, Gemena, Kungu, Lisala, Mobayi Mbongo, and Yakoma. Districts: Nord Ubangi, Sud Ubangi, and Mongala.

mainly for their high yield and/or short cycle characteristics and for their resistance to a very widespread disease (mozaique) in the case of cassava.

A set of 92 villages was selected for possible targeting of seed subsidies based on their relative accessibility by truck. The 92 villages are a subset of villages selected for a larger, orthogonal extension experiment. The 92 villages were stratified based on size (below or above median size), remoteness (a subjective indicator of accessibility), and treatment status of the PARRSA extension intervention (see appendix A for details on the larger study). Respecting this stratification, 32 villages were randomly selected as control villages for the seed vouchers, and 60 for distribution of seed vouchers.

The PARRSA team then distributed seed vouchers offering price reductions in the 60 treatment villages, through public lotteries organized in each of them. Starting from census data collected at baseline, randomly selected households received vouchers offering either 30, 60, 90 or 100% reduction on a maximum of 10 kg of any mix of the cereal or legume seeds on offer (or equivalent amounts of cassava stems). The voucher was given to the man (the household head) or his wife based on a second level random draw. For polygamous households, and if the voucher was to be given to a woman, an additional random draw determined which of the wives would receive it.[6]

Among the 60 villages, 35 were randomly selected to be visited by a truck with seeds of the seed-multipliers in the days following the voucher distribution, effectively removing a potential access constraint. Voucher recipients in the remaining 25 villages, as well as households of the 35 truck villages that did not redeem their voucher when the truck passed their village, could redeem their vouchers and buy seeds at the offices of the seed-multipliers, commonly located in the local town. Reaching the offices of the seed-multipliers typically required several hours (and up to several days) of travel.[7] The potentially more limited supply of different types of seeds (and in particular the limited supply of groundnut seeds in the offices) further affects access in this experimental variation.

The share of households receiving vouchers in each village was also experimentally varied in order to assess potential spillovers and general equilibrium effects. In one third of treatment villages, 70% of households received a voucher (high density), in another third 45% of households received vouchers (medium density) and in the last third only 20% received vouchers (low density). In each treatment village, equal shares of 30%, 60%, 90% and 100% subsidy vouchers were distributed. Across the 60 villages a total of 4394 vouchers was distributed.

[6]The full price for the improved seeds was 690 Congolese Francs (FC) per kg of Maize and Rice, and 920 FC for groundnuts. During the same season, the averages prices of traditional seeds on the local market were respectively 544, 292 and 768 FC, while they reached 511, 350 and 864 FC for seeds labelled as "improved" and bought on the local market.

[7]Travel is in fact very slow in this region, where virtually no asphalted road currently exist, and households mostly walk or rely on bicycle and sometimes motorbike for transportation.

Careful administrative records were kept documenting the names, gender and subsidy levels of all beneficiaries.

2.3 Data

A baseline survey was administered between March 2012 and July 2012. In each village, a group of 4 to 5 people was selected to answer a community level questionnaire and establish the village census. The group was composed of knowledgeable people in the village, including the village chief, the director of the school, the director of the health center, and other notables, depending on availability. The same group of people was asked about basic characteristics of 20 households from the village randomly picked in the census list. For those 20 households, we hence have baseline proxy information on variables related to agriculture, demographics, and participation in producer organizations.

A first follow-up was conducted between November and December 2013, i.e. after the agricultural season following the lotteries (see the timeline in section A.3 in the Appendix). Sample selection for the follow-up survey was done based on the initial census and the administrative data from the public lotteries. In particular, in each of the treatment villages, we randomly sampled 2 beneficiaries, a man and a women, for each level of subsidy (including zero, that is households who did not receive a voucher). An additional man or woman was added for both the 0 and 100% subsidy levels to maximize power. This gives a first group of 12 households, for whom we collected detailed information about agricultural production in the season after voucher distribution, in addition to information on take-up, perceptions and social networks. Given that the voucher distribution was random, these 12 households can be compared to 12 randomly drawn households in the control. In all villages, the samples were stratified on baseline membership in producer organizations, on having leadership positions in the village, and on polygamy. For the second follow-up survey, the same 12 households were surveyed again between June and July 2014 (Follow-up wave 2014). In this survey round, special effort was done to obtain an exhaustive list of plots, resulting in an large increase of the number of plots reported.

In this paper we concentrate on the sample of households who were sampled to be surveyed both in 2013 and 2014. [8,9,10]

[8] Almost all households who where sample to be surveyed in 2013 were sampled to be surveyed in 2014 as well, but an additional stratified random sample of households was added to the sample in A 2014.

[9] Attrition is limited in both survey rounds with data on adoption missing for 6 and 2% of households in 2013 and 2014, respectively.

[10] Results obtained using the balanced panel or considering the full sample each year are similar to those presented here and are available with the authors.

2.4 Empirical Specification

The basic OLS specification is a simple difference model estimating the intent to treat (ITT) impacts of receiving a price subsidy for improved seeds, allowing for differences between villages with and without truck delivery. All regressions control for the stratification variables, including indicator variables for the extension intervention.[11] In those cases where there are missing values for the covariates, we include the village sample mean. Standard errors are clustered at the village level. As we only have 92 villages, and as we introduce multiple experimental variations at the village level, we test for the robustness of our findings using randomization inference. Following (Young, 2017), we simultaneously also test for the joint significance of the different coefficients in each equation, and across all equations in a table using a Wald omnibus test. The omnibus test tests for statistical significance of all the regressions in each table through randomization inference. We each time show the maximum P-value and the random P-value. Complete results are shown in the Appendix D (Tables 8 to 11), and referred to in the text when relevant.

[11] As the extension intervention was randomized over a much larger set of villages, it is not the prime focus of this paper. Appendix C discusses the impact estimates and interaction effects with the extension intervention

3 Experimental Variation in Take-up and Adoption of Improved Seeds

This section shows how subsidies impacted adoption of improved seeds in the short term. The vouchers provided a subsidy to buy improved seeds from specific seed-multipliers, and involved co-financing from the beneficiaries (cash and/or travel costs, except for subsidies of 100% in villages with a truck delivery). We start by presenting some descriptive statistics about voucher utilization.

3.1 Voucher utilization and quantities bought

We draw on the administrative data collected during the voucher distribution, and the records of seed sales (obtained both for sales from the trucks (delivery) and at the seed-multipliers offices). Each voucher indicated the name and identifier of the household that received it, and details about the sale were registered each time a voucher was used (including identity of the buyer, identifier of the voucher, and quantities of seeds bought).

The administrative data shows that vouchers were very successful in convincing households to get seeds, and that voucher take-up is higher for higher subsidy levels. In the sample of interest for this paper (1098 households[12]), 533 households received a voucher, and 294 (55%) redeemed it to buy seeds either directly from a truck or from seed-multipliers. In villages with truck delivery, the rate of use of vouchers was very high. Only 9 out of the 103 households did not use their 100% voucher (probably because they were absent on the day the truck came), and 77% of the 90% vouchers used it as well. This figure drops to 56 and 48% for 60 and 30% vouchers respectively, but remains relatively high. As expected, voucher use is lower in villages where households had to cover travel costs, but remains high. In those villages, only close to 46% of households used their 100% vouchers. 40% for 90% vouchers, 22% for 60% vouchers, and 14% for 30% vouchers. There are no big differences in take-up in villages where a higher proportion of households received vouchers. In villages without truck delivery, it is slightly stronger for higher share of households treated: 36% of voucher recipients used their voucher in villages were 70% of households were given one, 37% in villages were 45% received one, and 22% in villages were 20% of households received one. In villages with a truck delivery, around 70% of voucher recipients used their vouchers irrespective of the percentage of households who received one. Overall, these take-up rates suggest demand is highly sensitive to price but there appear not to be strong non-linearities in the demand curves. Corresponding tables are available in Appendix, section E, Tables 12

[12]Due to the size of the village, the target sample was 11 instead of 12 households in one of the villages, and 7 in another

- 15. [13]

We focus on groundnuts, rice and maize as the vast majority of sales occurred for these three crops. For our main sample of interest, in villages with a truck delivery, among those who redeemed their voucher, 72% bought groundnuts, 37% bought rice, and 28% bought maize. In villages without a truck delivery, 41% bought rice, 25% bought maize, and 23% bought groundnuts. If a relatively large share of households who redeemed a voucher used it to buy soya in village with no truck delivery (29%), virtually none did so in truck villages. The difference between villages with and without truck delivery is largely supply driven, as groundnuts were not always available at the seed-multipliers offices.

In terms of quantities of seeds obtained, households from villages without truck delivery who decided to use their voucher bought an average of 9.6 kilograms of seeds regardless of the level of the subsidy. When a truck delivery took place after the lottery, however, households with lower levels of subsidies (30 and 60%) only bought an average of 5.4 kilograms while households with high subsidies (90 and 100) bought close to 10 kilograms on average. Our interpretation of these differences is that they may reflect both selection and liquidity constraints. There may have been a stronger selection of less-poor or more motivated households buying in the villages without truck delivery (not only did they need to have cash, but also they had to travel to the offices of the seed-multipliers). In villages benefiting from truck delivery, stronger liquidity constraints likely played a role. The truck came to the village only a few days after the lottery, so in those villages households who wanted to buy seeds from the truck had less time to gather money. They also had the option to go buy later in the offices if they covered their travel costs, but seldom used this option.

When differentiating by crops, we find that households in villages without truck bought very small quantities of groundnuts compared to households who received a voucher and benefitted from a truck delivery of seeds: 0.3 kg on average (and 1.4 kg for those who used their voucher), compared to 2.5 kg for trucks (and 4.6 kg on average for those who used their voucher). Differences are much smaller for maize and rice. Those who used their voucher bought on average 3.1 kg of rice without truck, compared to 2.5 with truck. For maize, households with vouchers without truck bought on average 1.9 kg compared to 1.2 kg in truck villages. The quantities of improved seeds bought by households are critical in analyzing the impact of the subsidies on sustained adoption and other input use since they determine the area that can be sown, as well as the quantities harvested and possibly re-used the next season. [14]

[13] Doing the same exercise on the full sample of 4394 vouchers for the sample of all households living in the 92 villages of the experiment, give similar results. See tables 16 - 19

[14] Keeping quantities constant, the areas sown also differs between crops, as agronomists calculations suggest that 10 kg of seeds would have been appropriate for planting .5 hectares of maize, .17 hectares of rice and .1 hectares of groundnut, leading to expected production of 1000 kg of maize, 500 kg of rice, and 100 kg of groundnuts. Keeping seeds from one year to the next is always a challenge, and to the extent it is harder to keep some seeds when quantities are lower, these numbers suggest that it may have been harder to sustain

To sum up, the different experimental variations created variation in take-up of improved seeds in a number of ways. Randomly receiving a voucher had a positive impact on improved seed purchases in 2013. The different subsidy levels resulted in experimentally-induced differences in take-up and quantities. Households randomly assigned to the "truck" treatment used their vouchers more, but when they did they bought smaller quantities of seeds. The "truck" treatment is associated with more purchase of groundnuts. While the experimental variation in prices, densities, and access led to the anticipated differences in take-up and quantities, the differences in crop selection were not necessarily fully anticipated when designing the experiment, and might well have been driven by a difference in supply.

3.2 Adoption just after the intervention, season A 2013

Because voucher use and use of improved seeds are likely endogenous to household characteristics, we look at the impact of the exogeneously determined treatment status on adoption (defined as the use of improved seeds on one of the household plots). We look successively at the two years following the voucher distribution, focusing on "spring" planting, the main season for agricultural production (season A), since some farmers don't cultivate in the second season). Our estimates are thus Intent-to-Treat ones, where the reported effect is that of being given a voucher. All estimates presented in this paper include controls for a set of strata dummies.

Tables 1 to 4 present the results, with each Table showing the impact of the different variations in the interventions on seed adoption in the first season after voucher distribution (column 1), and one year after the voucher distribution (column 2). Column 3 shows the persistence of adoption by looking at the probability to use improved seeds in both years. Finally, they also show spillover effects on households who did not receive a voucher in treated villages. We first discuss all results for season A 2013, and then those for A 2014.

Strong impact on adoption, stronger in truck villages

The voucher treatment had a clear positive impact on adoption, and a stronger impact when associated with a truck delivery. Table 1 first reports the results without differentiating by subsidy level. In the absence of any demand side intervention, adoption of improved seeds in season A 2013 is rather low: only 9% of the households surveyed in the villages where no lottery took place report using improved seeds. In A 2013, adoption of improved seeds is 17.3 percentage points higher for households who received a voucher but no truck delivery (significant at the 1% level) compared to households in control villages. The impact of the voucher distribution is much larger in the villages where a truck delivery followed the distribution of vouchers in the village: in those villages, adoption among voucher recipients

adoption for groundnuts, especially considering that groundnuts can be eaten directly without preparation.

is 42.9 percentage points higher (significant at the 1% level) than in control villages. Finally, Table 5 of the Appendix B further shows that vouchers in truck villages had a strong impact on the probability to cultivating groundnuts in 2013 compared to control villages.

Sensitivity to price

Table 2 shows results differentiated by levels of subsidies, separately for villages with and without truck delivery, and separating households who did not receive a voucher in treated villages. Table 3 presents results grouping low levels of subsidy (30 and 60%) and high levels of subsidy (90 and 100%) together. As expected, higher levels of subsidy have a higher impact on adoption. The first column of Table 2 shows that adoption is very sensitive to price: lower prices are associated with higher adoption rates. This result is consistent with similar findings in the health literature (see Cohen et al. (2015); Dupas (2014); Tarozzi et al. (2014)) adoption is much stronger with higher levels of subsidies indicating strong liquidity constraints, but there is no strong drop off between 90% and 100 subsidy [15] If anything, the results may indicate a non-linearity between 60 and 90% in the absence of truck delivery.

For households in villages with lotteries but no truck delivery, price reductions of 30 and 60% have a small positive but non significant impact on adoption compared to control villages. When the price is close to zero (90% reduction) or at zero (100% reduction) however, adoption is higher by 25 percentage points (significant at the 1% level) and reaches 34%. The difference between lower and higher subsidy levels is significant, as evidenced by the P-values of the test of the difference between coefficients for different levels of vouchers presented at the bottom of Tables 2 and 3. Moreover, adoption is stronger for all levels of subsidies for households who benefited both from a voucher distribution and a truck delivery of seeds as compared to control villages but also to villages who received only vouchers. Average adoption rates reach 33%, 40%, and 59% respectively for those who received a 30, 60 or 90% voucher, and up to 68% for households who got seeds for free. Again, the difference of impact between low level and high level subsidies is significant, while the difference between 30 and 60% on the one hand and 90 and 100% on the other hand is not significant.

Impact of the proportion of households treated

Table 4 presents the results for different proportions of targeted households in treated villages (this proportion varied randomly between 20, 45, and 70% of the households). The proportion does not have any significant impact on the probability that a household adopts in A 2013, meaning that more people from the same village receiving a voucher did not influence a household's decision to use improved seeds, for the same level of subsidy.

[15] Miguel and Kremer (2004) find that increasing price of deworming from 0 to a very small price decreases adoption from 75 to 19%.

3.3 Sustained adoption, season A 2014

Use of improved seeds in season A 2014 is still low in control villages, but higher than in A 2013, indicating an overall increase in the availability of improved seeds in the region: 19% of the households in control villages report using improved seeds in that year.[16] In treated villages, the high levels of adoption in season A 2013 may have helped farmers learn about the new technology and potentially decide to re-adopt it. Besides buying new seeds, households who bought seeds in one year can continue using them the next year if they manage to keep some from the previous harvest. If the seeds are of good quality and if farmers carefully select the seeds they keep, seeds will continue having a higher yield potential than locally available ones one or two years after the purchase. We hence test whether households who received vouchers in 2013 are using improved seeds one year later, in season A 2014, and whether in particular those who adopted in 2013 sustained their adoption in 2014. We find that the intervention had lasting effects on adoption of improved seeds.

Adoption is sustained

The evidence presented in Table 1 points to a positive impact of the subsidy remaining one year after the intervention: in villages where vouchers were distributed without truck delivery, adoption is 9.8 percentage points higher than in control villages (not significant). In villages with both a voucher distribution and a truck delivery, adoption is 14.9 percentage points higher than in control villages (significant at the 1% level). The difference between villages with and without truck delivery is smaller and is no longer significant after one year. This could be explained by a strong selection and/or the larger quantities bought by households in villages without truck delivery, inducing a higher persistence in those villages. Tables 2 and 3 show that the difference between high levels of subsidies and low levels of subsidies is smaller in 2014 than in 2013, and only significant for truck villages. The much smaller quantities bought by beneficiaries of low levels of subsidies in truck villages limit the possibility of re-using ones own seed and might explain the absence of a significant effect of the subsidy in this second season, contrary to what happens to the beneficiaries of higher subsidy levels in those same villages.

The third column in Table 1 also shows a relatively high impact on the persistence of adoption one year after the intervention. While only 5% of households in the control used improved seeds in both years, this increases to 26.7% in villages with voucher distribution and truck delivery, and to 16.1% in other voucher villages. This could be driven by households being able to either keep enough good quality seeds from their harvest to sow them again the next year, or by households who buying new seeds again one year after trying them for the first time. Comparing columns 1 and 3 shows that among those who adopted in 2013, a higher proportion kept doing so the following year among beneficiaries of non-truck villages

[16] Increased availability is possibly induced by the supply side intervention of the PARRSA project

(61%) compared to truck villages (51%). This points again toward the potential difference in selection of adopters and the observed difference in seed quantities purchased between the two arms of the treatment as potential explanatory factors. Comparing columns 2 and 3 also indicates that part of the increase in adoption in A 2014 is still driven by new households adopting.

Note that, neither in 2013 nor in 2014, there seem to be any interaction between the subsidies and the orthogonal extension intervention that was carried out by PARRSA over the period. The above results are therefore not affected when taking extension status into account (see Appendix C).

Table 4 shows that while the intensity of voucher distribution had little impact on the probability of adoption in A 2013, it does make a difference in the following year, in particular in villages with truck delivery. Column 2 shows in particular that the impact is 13 (16) percentage points lower in villages in which the percentage of households who got a voucher is 45 (70 respectively) as compared to villages where only 20% of households were treated. In other words, the probability for a given household to keep using improved seeds is enhanced when a smaller share of households in the village received a voucher. This implies that in truck villages, the difference in the number of people adopting between villages with different voucher density is smaller in 2014 than in 2013. Finally, the impact on the use of groundnuts identified in 2013 in Table 5 vanishes in 2014.

3.4 Spillovers

We find only limited evidence of spillover effects. Tables 1 to 4 suggest that the lotteries had spillover effects on adoption of improved seeds on non-voucher recipients, but only in truck villages and only in the first season. In A 2013, adoption is 11 percentage points higher for households who did not receive a voucher in village with a lottery with a truck delivery compared to households in control villages. However, this result should be taken with caution as it does not always resist randomization inference (P-value is only .11 for the corresponding coefficient in table 1, see table 8 in Appendix D). The coefficient for non-recipients in villages with vouchers without truck delivery is not significantly different from zero. We find no significant effects for households that did not receive vouchers by 2014. Hence there appear to be no longer-term spillovers on adoption in villages with lotteries, whether with or without truck delivery.

3.5 Summary

Overall, the results demonstrate that (1) there is more adoption when costs are lower: adoption in season A 2013 is very sensitive to price, and adoption is higher when the access constraint was relieved; (2) The difference in impact on adoption between the different levels of subsidy is lower in villages with truck delivery, and decreased everywhere between the first and the second year after the lotteries, in particular in villages without truck delivery; (3) for those that use the vouchers, in villages with truck delivery they buy a different mix of crops; (4) for those that use the vouchers in villages with truck delivery, the quantities of seeds bought are also less compared to treated households in villages without truck, suggesting selection and possibly motivation of households who use vouchers are different; (5) spillover effects on adoption of improved seeds by non-voucher recipients is limited, and if at all, only occurred in the first season after distribution, suggesting that improved seeds did not diffuse within the village after the first harvests; (6) the probability to adopt in the season following the voucher distribution is not influenced by the proportion of other households who received a voucher in villages without truck, meaning that in higher density villages overall more people are adopting. But the higher the share people receiving subsidies, the lower the impact on adoption in season A 2014 in villages with truck delivery.

3.6 Tables

Table 1 – Adoption of Improved Seeds Just After the Intervention and Two Seasons After the Intervention

	(1) Season A 2013	(2) Season A 2014	(3) Both seasons
Voucher x no truck	0.173***	0.098	0.111**
	(0.050)	(0.061)	(0.045)
No voucher x no truck	0.046	0.052	0.056
	(0.051)	(0.059)	(0.044)
Voucher x truck	0.429***	0.149***	0.217***
	(0.037)	(0.045)	(0.031)
No voucher x truck	0.106**	0.053	0.035
	(0.051)	(0.057)	(0.037)
Strat Vars	Yes	Yes	Yes
Observations	1034	1077	1020
Mean Control	0.09	0.19	0.05
P-v test voucher/no voucher,no truck	0.01	0.38	0.28
P-v test voucher/no voucher, truck	0.00	0.05	0.00
P-v test voucher with-without truck	0.00	0.37	0.02
P-v Test of Joint Significance	0.00	0.05	0.00

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Follow up surveys waves 2013 and 2014, panel households

Note: OLS Regression: The dependant variable is a dummy indicating whether improved seeds are used. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 2 – Adoption of Improved Seeds Just After the Intervention and Two Seasons After the Intervention, by level of subsidy

	(1) Season A 2013	(2) Season A 2014	(3) Both seasons
Voucher 30 x no truck	0.091	0.158*	0.086
	(0.073)	(0.087)	(0.060)
Voucher 60 x no truck	0.064	0.039	0.097
	(0.069)	(0.079)	(0.066)
Voucher 90 x no truck	0.248***	0.012	0.031
	(0.081)	(0.070)	(0.058)
Voucher 100 x no truck	0.254***	0.156**	0.191***
	(0.070)	(0.077)	(0.069)
Voucher 30 x truck	0.240***	0.065	0.100*
	(0.059)	(0.064)	(0.052)
Voucher 60 x truck	0.312***	0.072	0.108**
	(0.065)	(0.064)	(0.046)
Voucher 90 x truck	0.498***	0.226***	0.309***
	(0.073)	(0.068)	(0.064)
Voucher 100 x truck	0.590***	0.205***	0.308***
	(0.052)	(0.056)	(0.047)
No voucher x no truck	0.045	0.052	0.055
	(0.051)	(0.060)	(0.044)
No voucher x truck	0.105**	0.053	0.034
	(0.052)	(0.057)	(0.037)
Strat Vars	Yes	Yes	Yes
Observations	1034	1077	1020
Mean in the control	0.09	0.19	0.05
P-value Test 30-60 no truck	0.73	0.18	0.86
P-value Test 60-90 no truck	0.09	0.74	0.40
P-value Test 90-100 no truck	0.95	0.09	0.08
P-value Test 30-60 truck	0.28	0.94	0.89
P-value Test 60-90 truck	0.05	0.04	0.00
P-value Test 90-100 truck	0.27	0.78	1.00
P-value Test voucher 30-no voucher in no truck	0.53	0.22	0.65
P-value Test voucher 30-no voucher in truck	0.02	0.86	0.25
P-v Test of Joint Significance	0.00	0.02	0.00

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Follow up surveys waves 2013 and 2014, panel households

Note: OLS Regression: The dependant variable is a dummy indicating whether improved seeds are used. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies. The last rows present the P-value of the difference between coefficients for different levels of vouchers, for villages with truck and villages without truck separately.

Table 3 – Adoption of Improved Seeds Just After the Intervention and Two Seasons After the Intervention, by level of subsidy (low or high)

	(1) Season A 2013	(2) Season A 2014	(3) Both seasons
Voucher low x no truck	0.077	0.099	0.091*
	(0.059)	(0.070)	(0.054)
Voucher high x no truck	0.251***	0.097	0.126***
	(0.052)	(0.062)	(0.048)
Voucher low x truck	0.278***	0.068	0.104***
	(0.053)	(0.052)	(0.039)
Voucher high x truck	0.552***	0.213***	0.308***
	(0.046)	(0.049)	(0.038)
No voucher x no truck	0.045	0.052	0.055
	(0.051)	(0.060)	(0.044)
No voucher x truck	0.105**	0.053	0.035
	(0.051)	(0.057)	(0.037)
Strat Vars	Yes	Yes	Yes
Observations	1034	1077	1020
Mean Control	0.09	0.19	0.05
P-value test low-high no truck	0.00	0.97	0.44
P-value test low-high truck	0.00	0.00	0.00
P-value test low no truck - low truck	0.00	0.67	0.83
P-value test high no truck - high truck	0.00	0.06	0.00
P-v Test of Joint Significance	0.00	0.03	0.00

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Note: OLS Regression: The dependant variable is a dummy indicating whether improved seeds are used. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 4 – Adoption of Improved Seeds Just After the Intervention and Two Seasons After the Intervention, by density of the treatment

	(1) Season A 2013	(2) Season A 2014	(3) Both seasons
Voucher x no truck x density 20	0.141*	0.094	0.071
	(0.083)	(0.091)	(0.053)
Voucher x no truck x density 45	0.172*	0.086	0.119
	(0.091)	(0.082)	(0.083)
Voucher x no truck x density 70	0.196***	0.115	0.133*
	(0.059)	(0.102)	(0.069)
Voucher x truck x density 20	0.460***	0.244***	0.303***
	(0.055)	(0.059)	(0.039)
Voucher x truck x density 45	0.440***	0.117**	0.188***
	(0.043)	(0.048)	(0.041)
Voucher x truck x density 70	0.386***	0.085	0.158***
	(0.055)	(0.061)	(0.042)
No voucher x no truck	0.046	0.053	0.056
	(0.051)	(0.060)	(0.044)
No voucher x truck	0.106**	0.054	0.035
	(0.051)	(0.057)	(0.037)
Strat Vars	Yes	Yes	Yes
Observations	1034	1077	1020
Mean Control	0.09	0.19	0.05
P-value test 20=45=70 no truck	0.84	0.97	0.73
P-value test 20=70 truck	0.27	0.03	0.00
P-v Test of Joint Significance	0.00	0.02	0.00

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Follow up surveys waves 2013 and 2014, panel households

Note: OLS Regression: The dependant variable is a dummy indicating whether improved seeds are used. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

4 Conclusion

This paper studies the role of subsidies in facilitating adoption of improved seed varieties in Equateur Province in DRC. Randomized price subsidies - with or without lifting additional access constraints - led to large and significant increases in adoption of improved seeds, inducing more households to try these new seeds. Overall, the results show that demand is highly price elastic and that liquidity constraints are an additional hurdle. It is noteworthy that the demand curves do not display any strong discontinuity at low prices. Further, in the context of the Equateur province, access costs are a significant limit to adoption: lifting them nearly doubles the adoption rate relative to a situation where subsidies are offered but access is not facilitated. It is also remarkable that spillover effects seem non-existent: however important the share of households in the village who got facilitated access to improved seeds, we observe no diffusion of their use. Finally, results on adoption persistence suggest that both a large enough quantity of seeds purchased in the first place and a strong motivation are instrumental in fostering continued used of improved seeds for the second season.

References

Christiaensen, Luc, "Agriculture in Africa – Telling Myths from Facts: A Synthesis," *Food Policy*, February 2017, *67*, 1–11.

Cohen, Jessica, Pascaline Dupas, and Simone Schaner, "Price Subsidies, Diagnostic Tests, and Targeting of Malaria Treatment: Evidence from a Randomized Controlled Trial †," *American Economic Review*, February 2015, *105* (2), 609–645.

de Janvry, A., E. Sadoulet, and T. Suri, "Field Experiments in Developing Country Agriculture," in "Handbook of Economic Field Experiments," Vol. 2, Elsevier, 2017, pp. 427–466.

Dupas, Pascaline, "Short-Run Subsidies and Long-Run Adoption of New Health Products: Evidence From a Field Experiment," *Econometrica*, January 2014, *82* (1), 197–228.

Herdeschee, Johannes, Kai-Alexander Kaiser, and Daniel Mukoko Samba, *Resilience Dun Geant Africain: Accelerer La Croissance et Promouvoir l Emploi En Republique Democratique Du Congo, Volume I Synthese, Contexte Historique et Macroeconomique*, Kinshasa: MEDIASPAUL, 2012.

Jack, B. Kelsey, "Market Inefficiences and Adoption of Agricultural Technologies in Developing Countries," *Center for International Development*, 2013.

Miguel, Edward and Michael Kremer, "Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities," *Econometrica*, 2004, pp. 159–217.

Tarozzi, Alessandro, Aprajit Mahajan, Brian Blackburn, Dan Kopf, Lakshmi Krishnan, and Joanne Yoong, "Micro Loans, Insecticide-Treated Bednets, and Malaria: Evidence from a Randomized Controlled Trial in Orissa, India †," *American Economic Review*, July 2014, *104* (7), 1909–1941.

Tavneet, Suri and Rachel Glennerster, "Agricultural Technology and Nutrition: The Impacts of NERICA Rice in Sierra Leone.," 2017.

World Bank, ed., *World Development Report 2008: Agriculture for Development*, Washington DC: World Bank Publications, 2007. OCLC: 237205625.

Young, Alwyn, "Channelling Fisher: Randomization Tests and the Statistical Insignificance of Seemingly Significant Experimental Results," 2017.

A Details on the project and experimental design

A.1 The project : Dissemination of seeds, techniques and technologies to improve agricultural production

The Agricultural Rehabilitation and Recovery Support Project (PARRSA for its acronym in French) was implemented by the Ministry of Agriculture , starting in 2011, with the Support of the World Bank. PARRSA operates in 9 territories in the three northern districts of Equateur Province in DRC. [17] PARRSA aims to improve agricultural productivity in the region through a variety of mechanisms. Agricultural extension and advisory services in Equateur province have been virtually absent for years and the availability of high quality improved seeds is severely constrained. A first important objective of PARRSA is therefore the regeneration of the market for improved seeds. In the phase prior to the phase covered by the evaluation, the project assisted the national research institute (INERA) to resume improved seed production in the region for maize, rice, groundnut, niebe, soya and cassava and provided subsidies for the multiplication of improved seeds by selected agri-multipliers in the region. The varieties were selected mainly for their high yield characteristics and for their resistance to a very widespread disease (mozaique) in the case of cassava.

The evaluation focuses on subsequent interventions, implemented to encourage the demand for seeds, including disseminate information about the improved seeds and related techniques through demonstration plots and extension activities, as well as seed subsidies. In parallel, the project also targeted 2,500 kilometers of feeder and access roads for rehabilitation.

A.2 Experimental design

A.2.1 Presentation of the evaluation

The evaluation aims at providing experimental evidence on the impact of several interventions targeting demand constraints to the adoption of improved seed varieties and subsequent welfare gains among poor smallholders in Equator province in the DRC. We measure the impact of extension through demonstration plots, different levels and modalities of seed price subsidies in a context of extensive slash and burn agriculture and strong gender division in agricultural tasks. We introduce experimental variations that allowed targeting extension and subsidies specifically to women and hypothesize that such gender targeting could increase both the sustainability of adoption and the translation of the adoption of improved seeds in better nutrition, health and education outcomes. The evaluation specifically focuses on such welfare

[17] Territories: Bosobolo, Budjala, Bumba, Gemena, Kungu, Lisala, Mobayi Mbongo, and Yakoma. Districts: Nord Ubangi, Sud Ubangi, and Mongala.

outcomes given the high levels of poverty, malnutrition, food insecurity and child mortality in the region studied, and the importance of crop income in households income portfolio. Given the extreme difficult road access in the region studied, the interventions were stratified based on market access, and an experimental variation was introduced that eliminated transportation costs for improved seeds. To study diffusion patterns of the improved technologies we introduce experimental variation in the density of the subsidies

A.2.2 Extension services

The extension interventions was implemented by local NGOs who organized a group of farmers from a targeted village around a demonstration plot. An extension agent was in charge of the introduction of the new seeds and adapted practices, and the group works in common on the field, following the indications given by the agent. In a first set of randomly chosen villages most members of the group are men. In the second randomly chosen villages the extension agents had to organize groups around the demonstration plots with a majority of women. In both type of villages, relatively small demonstration plots were first organized by local PARRSA teams during 3 seasons (from spring 2012 to spring 2013). As of the fall of 2013, NGOs started organizing more intensive extension activities, and respect for men or women targeting was imposed as a condition in the NGOs contracts with PARRSA.

The theory of change of the extension intervention is relatively straightforward. By introducing improved seeds on demonstration plots, households in targeted villages have the opportunity to directly learn about the returns to such improved seeds. Households that participate in the works on the demonstration plots also learn about complementary practices such as row planting. And potentially, all households could get access to improved planting material resulting from the harvests on the demonstration plots, though this should be relatively limited. Overall the extension intervention is expected to increase demand for and subsequent adoption of improved seeds.

A.2.3 Lotteries and vouchers

Given the subsidies received by the supply side for seed multiplication, there was an open question of the optimal pricing of seeds for the final user. A subset of 92 villages was selected for possible targeting of seed subsidies. The PARRSA team then distributed seed vouchers in a random subsample of 60 villages, with the remaining 32 villages serving as control). Seed vouchers offering price reductions were distributed through public lotteries, organized in each of the 60 villages. Starting from census data collected at baseline, randomly selected households received vouchers offering either 30, 60, 90 or 100% reduction on a maximum of 10 kg of cereal or pulse seeds (or equivalent amounts of manioc stems). Once a households

was randomly selected, a second draw determined randomly whether the voucher was given to the man (the household head) or his wife. In case of polygamous households, and if the voucher was to be given to a woman, the third random draw determined to which of the wives the voucher was given. Among the 60 villages, 35 were in addition randomly selected to be visited by a truck with seeds of the agri-multipliers in the days or weeks following the voucher distribution, effectively removing a potential transportation constraint. Voucher recipients in the remaining 25 villages, as well as households of the 35 truck villages that did not redeem their voucher when the truck passed by their village, could redeem their vouchers and buy seeds in the offices of the seed-multipliers, located typically in the local urban centers. The share of households receiving vouchers in each village also varied in order to assess the potential spillovers and general equilibrium effects.

The different levels of subsidies and targeting allows testing the importance of liquidity and transportation constraints for the adoption of improved seeds. Indeed, we hypothesize that the initial price at which farmers get access to improved seeds can be an important obstacle in the context of Equateur, where households mainly live from subsistence agriculture and liquidity constraints are severe. The theory of change we are testing is whether initial price subsidies for a limited amount of seeds lead to more sustained adoption and higher demand on the long run, once households have had an opportunity to learn about returns from their own experimentation. In addition, given the extremely difficult road access in almost the entire region covered by the project, we also hypothesize that transportation costs may add to the existing liquidity constraints. The intervention that sends trucks to the villages was designed to test this hypothesis.

A.2.4 Experimental design : selection into the program

Identification for the extension intervention and its gender targeting was based on randomized assignment. As the extension intervention is based on demonstration plots or fields to which all villagers can have access, this intervention was randomized at the village level. The local district offices of PARRSA first selected 201 villages as potential candidates for the initial phase of the intervention. The sample size was determined by operational constraints, and reflected the number of villages PARRSA envisioned being able to attend to in a first phase. The villages are spread over the 9 territories targeted by PARRSA and cover an extensive geographical area (they belong to 154 different Groupements, a lower administrative division). Village level baseline data was collected for 201 villages, and for an additional 201 randomly selected neighboring villages. As we hypothesize important treatment heterogeneity by accessibility, the 201 candidate villages were stratified by organizing them in triplets based on similar proximity to roads and markets. In each district, a public lottery was organized in February 2012 (prior to

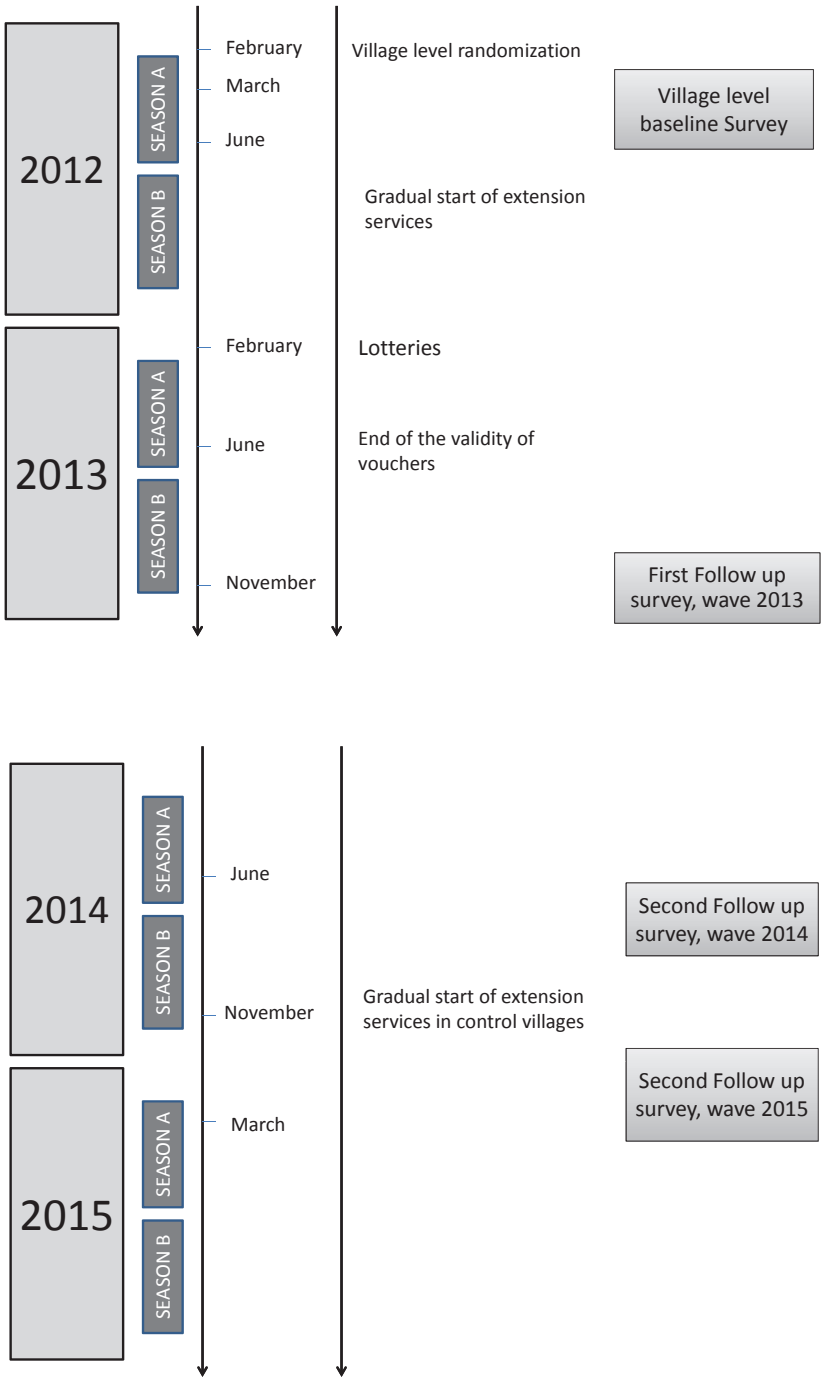
the first season of 2012). For each of the triplets, one candidate village was selected as a women treatment, one village as men treatment, and the third village as control. In the control group, no PARRSA extension activities took place until the second season of 2014.

Identification for the seed subsidy vouchers and their gender targeting was also based on random assignment. First, among the original 201 villages selected for the extension intervention, a subsample of 92 villages were purposely selected to enter the seed subsidy vouchers experiment, based on being relatively accessible by truck. The 92 villages are spread across Sud Ubangi, Mongala and North Ubangi, and across 5 (out of 9) territories in those districts. The 92 villages were stratified based on size (below or above median size), remoteness (a subjective indicator of accessibility), and treatment status of the PARRSA extension intervention (control, women treatment, men treatment). Respecting this stratification, 32 villages were randomly selected as control villages for the seed vouchers, 25 as voucher villages, and 35 as voucher and truck villages. The number of treatment villages was based on logistical and cost constraints. This randomization was done by computer, orthogonally to the extension treatment. Stratification on remoteness should allow shedding light on the mechanism underlying any potential difference between voucher and voucher+truck villages, while the stratification on size was done to analyze potential differences in diffusion patterns based on village size.

In each of the 60 voucher villages, a public lottery was organized through which subsidy vouchers for improved seeds were distributed. In 1/3 of randomly selected villages, 70% of households received a voucher through this lottery (high density), in 1/3 random villages 45% of households received vouchers (medium density) and in the last 1/3 villages only 20% received vouchers (low density). The variation in voucher density was introduced to study whether diffusion of improved seeds is a function of village level intensity of initial exposure. In each treatment village, equal amounts of 30%, 60%, 90% and 100% subsidy vouchers were distributed through the lottery, with half of them randomly assigned to the household heads, while the other half assigned to the (or a) wife of the household head. In case of polygamous households, a randomization was conducted to determine which women would receive the voucher. Across the 60 villages a total of 4344 vouchers was distributed. Given these large numbers, and the household level randomization, the design results on substantial statistical power to detect the direct impacts of receiving vouchers, differences between different levels of subsidies, and differences between men and women beneficiaries. The differences in the level of subsidies were chosen to get a better estimate of willingness to pay and advise on optimal pricing, and to test any potential non-linearities (e.g. by analyzing differences between 90 and 100% subsidy).

A.3 Timeline

Figure 2 – Timeline



A.4 Data : baseline survey, followup surveys, and sampling strategy

A baseline survey was administered between March 2012 and July 2012 in 895 villages, including the 201 villages of the experiment. In each village, a group of 4 to 5 people was selected to answer a community level questionnaire as well as indirect household surveys for 20 randomly chosen households. For those 20 households, basic household characteristics related to agriculture, demographics, and poverty are available. The group was composed of knowledgeable people in the village, including the chief of the village, the director of the school, the director of the dispensary, and other notables, depending on availability. Census data was also collected.

A first follow-up was conducted between November and December 2013, i.e. after the agricultural season directly following the lotteries. Data was collected in the 92 villages involved in the lottery experiment. For the 60 voucher treatment villages, administrative records about the beneficiaries identity and type of seed voucher received during the lotteries is also available. This administrative data was used for the sample selection of the follow-up surveys. In particular, in each of the voucher villages, we randomly drew beneficiaries, stratified by level of subsidy and gender (Male/Female; 0%, 30%/60%/90%/100%).
An additional men or women was added for 0 and 100% subsidy levels to maximize power. This gives a first group of 12 households, for whom detailed information about agricultural production in the season after voucher distribution, in addition to information on take-up, perceptions and social networks was collected. Given that the voucher distribution was random, these 12 households can be compared to 12 randomly drawn households in the control. In all villages, the samples were further stratified on baseline membership in producer organizations, on having a leadership positions in the village, and on polygamy. In addition, the same survey instrument was also implemented for the person that was the village leader at the time of the lottery.
For an additional 10 random households (1 men and 1 women for each subsidy level) a short survey was implemented on take up, perceptions and social networks. This sample again includes 2 people with leadership positions. The sampling of the first followup survey was targeted to understand take up and mechanisms leading to final outcomes, including importantly the potential to understand different diffusion mechanism through social networks, and the potential example roles of local leaders to encourage adoption by others.

For the second follow-up survey in the 92 villages, the same 12 households for whom we had detailed agricultural information in the first follow-up survey have been resurveyed. To increase power,six additional households, for whom only a short survey was implemented in 2013, were added to the sample (two each with 0, 90 and 100% subsidies (one men, one women for each household) in the voucher villages. Finally, an additional 8 households with 0 or 100% reduction (or 90% reduction when there was not enough households with 100%

voucher) were added in the voucher+truck villages. Based on qualitative field work following voucher distribution, we hypothesized that diffusion of information about the new technologies might only circulate within very narrow social circles. We therefore added to the sample by targeting a brother of the household head for the original 12 households living in the same village (maximum 10 such brothers in each village). As there can be large inequalities in access to land based on order in the sibship, we surveyed in particular the oldest brother (or a random brother in case the original household is the oldest brother). Since the households of each of those brothers were equally eligible for vouchers, they will have also been randomly exposed to different subsidy levels and gender targeting. As such, this sample will not only allow us to analyze diffusion within families, but will also allow to analyze to what extent impacts differ depending on households access to land (forest) resources. For all these households, men and women were interviewed separately, and two women were interviewed in polygamous households (In case of polygamous households with more than 2 women, the first wife and a randomly selected other wife were selected). In monogamous households with more than one adult woman with children, the spouse of the household head and the mother of the youngest child was interviewed. This sampling allows analyzing potential heterogeneity in child health, nutrition and education outcomes within households. Because of the length and complexity of the survey, we visited households twice : a first wave was conducted between June and July 2014 (Followup wave 2014), and a second wave was conducted between November 2014 and March 2015 (Followup wave 2015). [18]

[18]The second wave was originally scheduled to immediately follow the first wave, but was postponed due to an Ebola outbreak in Equateur.

B Impact on the choice of crops

Table 5 – Crops Cultivated, by Treatment

	(1) Maize	(2) Rice	(3) Groundnut
2013			
Voucher low x no truck	−0.026	−0.046	−0.020
	(0.074)	(0.100)	(0.083)
Voucher high x no truck	−0.042	−0.026	0.023
	(0.068)	(0.105)	(0.079)
Voucher low x truck	−0.074	−0.041	0.182***
	(0.065)	(0.087)	(0.069)
Voucher high x truck	−0.050	−0.042	0.199***
	(0.062)	(0.079)	(0.065)
No voucher x no truck	0.008	−0.030	−0.033
	(0.083)	(0.098)	(0.074)
No voucher x truck	−0.038	−0.115	0.064
	(0.065)	(0.081)	(0.072)
Strat Vars	Yes	Yes	Yes
Observations	1047	1047	1047
Mean Control	0.63	0.34	0.29
P-v Test of Joint Significance	0.49	0.51	0.22
2014			
Voucher low x no truck	0.082*	−0.043	−0.019
	(0.043)	(0.093)	(0.095)
Voucher high x no truck	0.010	0.005	−0.036
	(0.046)	(0.102)	(0.086)
Voucher low x truck	−0.045	−0.083	0.066
	(0.053)	(0.079)	(0.077)
Voucher high x truck	0.004	−0.067	−0.026
	(0.039)	(0.070)	(0.075)
No voucher x no truck	−0.080	−0.059	−0.084
	(0.057)	(0.100)	(0.080)
No voucher x truck	−0.031	−0.122*	−0.097
	(0.052)	(0.073)	(0.076)
Strat Vars	Yes	Yes	Yes
Observations	1079	1079	1079
Mean Control	0.86	0.30	0.51
P-v Test of Joint Significance	0.77	0.39	0.60

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Follow up surveys waves 2013 and 2014, panel households

Note: OLS regression: Dependant variables are dummies for whether household cultivate this crop, *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

C Interaction with the Extension Services Intervention

As described Appendix A, the 92 villages in this study are a subset of villages selected for a larger, orthogonal extension experiment. Since information is one of the potential contraints to adoption of improved seeds, there may be synergies with the extension experiment (Tavneet and Glennerster, 2017). We therefore present the results from the interaction between the voucher and the extension experiments in Tables 6 and 7.

Overall, we find little evidence that the interaction between extensions services and vouchers makes a difference. The is very little impact on adoption: if anything, extension slightly reduces the effect of the vouchers on adoption for high subsidies in villages without truck delivery.

Table 6 – Adoption of Improved Seeds, interaction between subsidies and extension

	(1) Season A 2013	(2) Season A 2014	(3) Both seasons
Voucher x no truck	0.276***	0.136	0.179**
	(0.076)	(0.092)	(0.077)
Voucher x no truck x extension	–0.149	–0.053	–0.096
	(0.099)	(0.122)	(0.096)
No voucher x no truck	0.018	0.007	0.010
	(0.072)	(0.086)	(0.060)
No voucher x Lottery no truck x extension	0.035	0.067	0.065
	(0.098)	(0.115)	(0.083)
Voucher x truck	0.460***	0.078	0.164***
	(0.051)	(0.064)	(0.034)
Voucher x truck x extension	–0.049	0.107	0.079
	(0.072)	(0.087)	(0.054)
No voucher x truck	0.111	0.094	0.062
	(0.081)	(0.097)	(0.055)
No Voucher x truck x extension	–0.007	–0.060	–0.039
	(0.104)	(0.120)	(0.071)
Extension	0.050	0.006	0.018
	(0.047)	(0.072)	(0.038)
Strat Vars	Yes	Yes	Yes
Observations	1034	1077	1020
Mean Control	0.09	0.19	0.05
P-v test voucher/no voucher,no truck	0.01	0.01	0.07
P-v test voucher/no voucher, truck	0.00	0.84	0.04
P-v test voucher-without truck	0.03	0.46	0.85
P-v Test of Joint Significance	0.00	0.26	0.01

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Follow up surveys waves 2013 and 2014, panel households

Note: OLS Regression: The dependant variable is a dummy indicating whether improved seeds are used. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. *Extension* is a dummy indicating whether the villages benefited from the extension intervention. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 7 – Adoption of Improved Seeds, interaction between subsidies and extension

	(1) Season A 2013	(2) Season A 2014	(3) Both seasons
Voucher low x no truck	0.152	0.104	0.140
	(0.105)	(0.116)	(0.095)
Voucher low x no truck x extension	–0.108	–0.006	–0.068
	(0.128)	(0.146)	(0.117)
Voucher high x no truck	0.380***	0.162	0.211***
	(0.072)	(0.101)	(0.079)
Voucher high x no truck x extension	–0.186*	–0.090	–0.120
	(0.100)	(0.129)	(0.099)
Voucher low x truck	0.315***	–0.022	0.042
	(0.082)	(0.072)	(0.044)
Voucher low x truck x extension	–0.058	0.136	0.091
	(0.106)	(0.099)	(0.069)
Voucher high x truck	0.568***	0.157**	0.255***
	(0.063)	(0.073)	(0.051)
Voucher high x truck x extension	–0.025	0.085	0.082
	(0.090)	(0.098)	(0.072)
No voucher x no truck	0.017	0.007	0.010
	(0.073)	(0.086)	(0.060)
No voucher x Lottery no truck x extension	0.035	0.067	0.064
	(0.099)	(0.115)	(0.083)
No voucher x truck	0.111	0.093	0.062
	(0.081)	(0.097)	(0.055)
No Voucher x truck x extension	–0.008	–0.060	–0.039
	(0.104)	(0.120)	(0.071)
Extension	0.050	0.006	0.018
	(0.047)	(0.072)	(0.038)
Strat Vars	Yes	Yes	Yes
Observations	1034	1077	1020
Mean Control	0.09	0.19	0.05
P-value test low-high no truck	0.02	0.61	0.37
P-value test low-high truck	0.01	0.01	0.00
P-value test low no truck - low truck	0.21	0.26	0.33
P-value test high no truck - high truck	0.04	0.96	0.62
P-v Test of Joint Significance	0.00	0.22	0.00

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Follow up surveys waves 2013 and 2014, panel households

Note: OLS Regression: The dependant variable is a dummy indicating whether improved seeds are used. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. *Extension* is a dummy indicating whether the villages benefited from the extension intervention. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

D Tables, Randomization Inference

Table 8 – Randomization Inference, Table 1

	randomization c P-value	randomization t P-value
1		
Adoption, Season A 2013		
Voucher x no truck	0.005	0.002
No voucher x no truck	0.52	0.394
Voucher x truck	0.001	0.001
No voucher x truck	0.114	0.057
Equation	0	0
2		
Adoption, Season A 2014		
Voucher x no truck	0.088	0.14
No voucher x no truck	0.452	0.389
Voucher x truck	0.002	0
No voucher x truck	0.413	0.394
Equation	0.014	0.021
3		
Adoption, Both Seasons		
Voucher x no truck	0.017	0.026
No voucher x no truck	0.286	0.204
Voucher x truck	0	0
No voucher x truck	0.505	0.384
Equation	0	0
	max c P-value	randomization c P-value
Omnibus test	0.001	0

Source: Follow up surveys waves 2013 and 2014, panel households

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies. The *Equation* lines present the results of the randomization tests for each equation, while the *Omnibus test* is a test of the overall experimental significance for all the regressions in the table.

Table 9 – Randomization Inference, Table 2

	randomization c P-value	randomization t P-value
1		
Adoption, Season A 2013		
Voucher 30 x no truck	0.216	0.237
Voucher 60 x no truck	0.382	0.373
Voucher 90 x no truck	0.001	0.011
Voucher 100 x no truck	0	0.002
Voucher 30 x truck	0.001	0.001
Voucher 60 x truck	0	0
Voucher 90 x truck	0	0
Voucher 100 x truck	0	0
No voucher x no truck	0.48	0.395
No voucher x truck	0	0
Equation	0	0.001
2		
Adoption, Season A 2014		
Voucher 30 x no truck	0.026	0.097
Voucher 60 x no truck	0.58	0.613
Voucher 90 x no truck	0.878	0.874
Voucher 100 x no truck	0.018	0.063
Voucher 30 x truck	0.262	0.313
Voucher 60 x truck	0.226	0.277
Voucher 90 x truck	0	0.004
Voucher 100 x truck	0	0
No voucher x no truck	0.431	0.411
No voucher x truck	0	0
Equation	0	0.161
3		
Adoption, Season A 2013		
Voucher 30 x no truck	0.133	0.173
Voucher 60 x no truck	0.087	0.159
Voucher 90 x no truck	0.596	0.602
Voucher 100 x no truck	0.002	0.02
Voucher 30 x truck	0.035	0.074
Voucher 60 x truck	0.022	0.035
Voucher 90 x truck	0	0
Voucher 100 x truck	0	0
No voucher x no truck	0.269	0.218
No voucher x truck	0.272	0.447
Equation	0	0.039
	max c P-value	randomization c P-value
Omnibus test	0	0

Source: Follow up surveys waves 2013 and 2014, panel households

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies. The *Equation* lines present the results of the randomization tests for each equation, while the *Omnibus test* is a test of the overall experimental significance for all the regressions in the table.

Table 10 – Randomization Inference, Table 3

	randomization c P-value	randomization t P-value
1		
Adoption, Season A 2013		
Voucher low x no truck	0.267	0.224
Voucher high x no truck	0.001	0.001
Voucher low x truck	0.001	0.001
Voucher high x truck	0.001	0.001
No voucher x no truck	0.519	0.382
No voucher x truck	0	0
Equation	0.001	0.001
2		
Adoption, Season A 2014		
Voucher low x no truck	0.12	0.186
Voucher high x no truck	0.092	0.127
Voucher low x truck	0.186	0.203
Voucher high x truck	0	0
No voucher x no truck	0.425	0.393
No voucher x truck	0	0
Equation	0.001	0.007
3		
Adoption, Both Seasons		
Voucher low x no truck	0.076	0.127
Voucher high x no truck	0.007	0.016
Voucher low x truck	0.014	0.025
Voucher high x truck	0	0
No voucher x no truck	0.287	0.23
No voucher x truck	1	1
Equation	0.983	0
	max c P-value	randomization c P-value
Omnibus test	0.001	0.001

Source: Follow up surveys waves 2013 and 2014, panel households

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies. The *Equation* lines present the results of the randomization tests for each equation, while the *Omnibus test* is a test of the overall experimental significance for all the regressions in the table.

Table 11 – Randomization Inference, Table 4

	randomization c P-value	randomization t P-value
1		
Adoption, Season A 2013		
Voucher x no truck x density 20	0.134	0.142
Voucher x no truck x density 45	0.056	0.12
Voucher x no truck x density 70	0.021	0.017
Voucher x truck x density 20	0.001	0.001
Voucher x truck x density 45	0.001	0.001
Voucher x truck x density 70	0	0
No voucher x no truck	0.554	0.458
No voucher x truck	0.007	0.006
Equation	0	0
2		
Adoption, Season A 2014		
Voucher x no truck x density 20	0.272	0.329
Voucher x no truck x density 45	0.308	0.351
Voucher x no truck x density 70	0.098	0.29
Voucher x truck x density 20	0.001	0.001
Voucher x truck x density 45	0.086	0.041
Voucher x truck x density 70	0.205	0.201
No voucher x no truck	0.261	0.235
No voucher x truck	0	0.001
Equation	0.001	0.06
3		
Adoption, Both Seasons		
Voucher x no truck x density 20	0.298	0.237
Voucher x no truck x density 45	0.056	0.202
Voucher x no truck x density 70	0.018	0.116
Voucher x truck x density 20	0.001	0.001
Voucher x truck x density 45	0.001	0.001
Voucher x truck x density 70	0.004	0.008
No voucher x no truck	0.181	0.134
No voucher x truck	0.999	0.999
Equation	0.983	0.001
	max c P-value	randomization c P-value
Omnibus test	0.002	0.002

Source: Follow up surveys waves 2013 and 2014, panel households

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.The *Equation* lines present the results of the randomization tests for each equation, while the *Omnibus test* is a test of the overall experimental significance for all the regressions in the table.

E Take up rates, Administrative data

E.1 Households samples in the 2013 survey

Table 12 – Take-up of Vouchers for Improved Seeds, administrative data, sample of households surveyed in 2013

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher x no truck	0.323***	0.082***	0.134***	0.070**	0.096*	0.044
	(0.063)	(0.031)	(0.043)	(0.027)	(0.051)	(0.028)
No voucher x no truck	0.012	–0.001	–0.000	0.003	0.014	0.001
	(0.013)	(0.004)	(0.013)	(0.011)	(0.013)	(0.003)
Voucher x truck	0.708***	0.200***	0.268***	0.505***	0.007	0.009
	(0.026)	(0.033)	(0.036)	(0.035)	(0.007)	(0.007)
No voucher x truck	–0.001	–0.002	0.002	0.003	0.001	0.003
	(0.005)	(0.003)	(0.012)	(0.010)	(0.004)	(0.003)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1096	1096	1096	1096	1096	1096
Mean Control	0.00	0.00	0.00	0.00	0.00	0.00
P-v test voucher/no voucher,no truck	0.00	0.01	0.00	0.01	0.07	0.13
P-v test voucher/no voucher, truck	0.00	0.00	0.00	0.00	0.42	0.37
P-v test voucher with-without truck	0.00	0.01	0.01	0.00	0.08	0.23
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.06	0.06

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for households surveyed in 2013

Note: OLS Regression: The dependant variable is a dummy indicating whether the voucher was redeemed. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 13 – Take-up of Vouchers for Improved Seeds by Detailed Subsidy Level, administrative data, sample of households surveyed in 2013

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher 30 x no truck	0.142**	0.000	0.043	0.018	0.041	0.081
	(0.063)	(0.004)	(0.030)	(0.023)	(0.043)	(0.055)
Voucher 60 x no truck	0.224***	0.061*	0.084*	0.018	0.082	0.059
	(0.071)	(0.034)	(0.046)	(0.022)	(0.056)	(0.043)
Voucher 90 x no truck	0.406***	0.122**	0.145**	0.142**	0.082	0.061
	(0.081)	(0.060)	(0.060)	(0.054)	(0.056)	(0.043)
Voucher 100 x no truck	0.458***	0.124**	0.226***	0.093**	0.154**	–0.002
	(0.075)	(0.048)	(0.072)	(0.037)	(0.066)	(0.004)
Voucher 30 x truck	0.485***	0.132***	0.110***	0.303***	0.001	–0.000
	(0.064)	(0.048)	(0.038)	(0.061)	(0.005)	(0.003)
Voucher 60 x truck	0.562***	0.095**	0.226***	0.363***	0.029	0.026
	(0.060)	(0.037)	(0.048)	(0.060)	(0.027)	(0.027)
Voucher 90 x truck	0.775***	0.225***	0.242***	0.545***	0.000	0.013
	(0.053)	(0.055)	(0.054)	(0.062)	(0.004)	(0.014)
Voucher 100 x truck	0.913***	0.301***	0.425***	0.711***	0.001	–0.000
	(0.029)	(0.052)	(0.058)	(0.049)	(0.006)	(0.003)
No voucher x no truck	0.011	–0.001	–0.001	0.003	0.013	0.001
	(0.013)	(0.003)	(0.013)	(0.011)	(0.013)	(0.003)
No voucher x truck	–0.002	–0.002	0.001	0.002	0.001	0.003
	(0.005)	(0.003)	(0.012)	(0.010)	(0.004)	(0.003)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1096	1096	1096	1096	1096	1096
Mean in the control	0.00	0.00	0.00	0.00	0.00	0.00
P-value Test 30-60 no truck	0.15	0.08	0.41	0.98	0.34	0.64
P-value Test 60-90 no truck	0.00	0.31	0.24	0.02	0.92	0.96
P-value Test 90-100 no truck	0.22	0.97	0.19	0.21	0.07	0.17
P-value Test 30-60 truck	0.31	0.43	0.03	0.39	0.31	0.33
P-value Test 60-90 truck	0.02	0.02	0.81	0.02	0.31	0.66
P-value Test 90-100 truck	0.03	0.30	0.00	0.03	0.80	0.34
P-value Test voucher 30-no voucher in no truck	0.05	0.72	0.13	0.44	0.55	0.15
P-value Test voucher 30-no voucher in truck	0.00	0.01	0.00	0.00	0.98	0.16
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.06	0.06

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for households surveyed in 2013

Note: OLS Regression: The dependant variable is a dummy indicating whether the voucher was redeemed. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies. The last rows present the P-value of the difference between coefficients for different levels of vouchers, for villages with truck and villages without truck separately.

Table 14 – Take-up of Vouchers for Improved Seeds by Subsidy Level, administrative data, sample of households surveyed in 2013

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher low x no truck	0.182***	0.030*	0.062**	0.017	0.061	0.070
	(0.061)	(0.017)	(0.031)	(0.017)	(0.045)	(0.043)
Voucher high x no truck	0.436***	0.123**	0.191***	0.112***	0.124**	0.024
	(0.075)	(0.049)	(0.060)	(0.040)	(0.059)	(0.016)
Voucher low x truck	0.524***	0.113***	0.168***	0.333***	0.015	0.014
	(0.050)	(0.036)	(0.035)	(0.049)	(0.014)	(0.014)
Voucher high x truck	0.856***	0.270***	0.349***	0.643***	0.001	0.005
	(0.026)	(0.040)	(0.050)	(0.041)	(0.005)	(0.007)
No voucher x no truck	0.011	–0.001	–0.001	0.003	0.014	0.001
	(0.013)	(0.003)	(0.013)	(0.011)	(0.013)	(0.003)
No voucher x truck	–0.002	–0.002	0.002	0.002	0.002	0.003
	(0.005)	(0.003)	(0.012)	(0.010)	(0.004)	(0.003)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1096	1096	1096	1096	1096	1096
Mean Control	0.00	0.00	0.00	0.00	0.00	0.00
P-value test low-high no truck	0.00	0.04	0.01	0.01	0.04	0.10
P-value test low-high truck	0.00	0.00	0.00	0.00	0.31	0.57
P-value test low no truck - low truck	0.00	0.04	0.02	0.00	0.31	0.23
P-value test high no truck - high truck	0.00	0.02	0.04	0.00	0.04	0.30
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.06	0.06

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for households surveyed in 2013

Note: The dependant variable is a dummy indicating whether the voucher was redeemed. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 15 – Take-up of Vouchers for Improved Seeds by Treatment Density, administrative data, sample of households surveyed in 2013

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher x no truck x density 20	0.225*	0.063	0.120	0.078	0.131	0.041
	(0.130)	(0.045)	(0.093)	(0.047)	(0.127)	(0.041)
Voucher x no truck x density 45	0.371***	0.141**	0.110*	0.065	0.013	0.082
	(0.113)	(0.060)	(0.058)	(0.057)	(0.015)	(0.076)
Voucher x no truck x density 70	0.359***	0.047	0.165**	0.070*	0.139*	0.014
	(0.085)	(0.045)	(0.063)	(0.036)	(0.083)	(0.011)
Voucher x truck x density 20	0.727***	0.226***	0.270***	0.538***	–0.001	0.000
	(0.046)	(0.049)	(0.064)	(0.053)	(0.013)	(0.005)
Voucher x truck x density 45	0.707***	0.222***	0.296***	0.495***	0.024	0.021
	(0.047)	(0.066)	(0.072)	(0.080)	(0.018)	(0.018)
Voucher x truck x density 70	0.688***	0.155***	0.242***	0.481***	–0.002	0.007
	(0.043)	(0.053)	(0.043)	(0.047)	(0.005)	(0.010)
No voucher x no truck	0.012	–0.001	–0.001	0.004	0.013	0.000
	(0.013)	(0.004)	(0.013)	(0.010)	(0.013)	(0.003)
No voucher x truck	–0.001	–0.002	0.002	0.003	0.002	0.002
	(0.005)	(0.004)	(0.012)	(0.010)	(0.004)	(0.003)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1096	1096	1096	1096	1096	1096
Mean Control	0.00	0.00	0.00	0.00	0.00	0.00
P-value test 20-45 without truck	0.39	0.30	0.93	0.86	0.34	0.65
P-value test 45-70 without truck	0.93	0.21	0.53	0.93	0.16	0.38
P-value test 20-45 with truck	0.75	0.96	0.79	0.66	0.29	0.29
P-value test 45-70 with truck	0.78	0.43	0.52	0.88	0.19	0.52
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.06	0.06

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for households surveyed in 2013

Note: OLS Regression: The dependant variable is a dummy indicating whether the voucher was redeemed. *Voucher* is a dummy for households who received voucher in treatment villages, while *No-voucher* indicate non-beneficiaries in treatment villages. *Truck* and *no-truck* variables specify the treatment arm. Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

E.2 Census of households living in the 92 villages of the experiment

Table 16 – Take-up of Vouchers for Improved Seeds, administrative data, census of households

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher x no truck	0.298***	0.060***	0.156***	0.057***	0.069**	0.016**
	(0.059)	(0.018)	(0.052)	(0.017)	(0.029)	(0.008)
No voucher x no truck	0.002	0.002	0.003	–0.003	0.000	0.001
	(0.004)	(0.002)	(0.011)	(0.007)	(0.002)	(0.001)
Voucher x truck	0.629***	0.131***	0.223***	0.484***	0.003	0.007
	(0.022)	(0.026)	(0.032)	(0.028)	(0.003)	(0.004)
No voucher x truck	0.003	0.001	0.002	0.002	–0.000	–0.000
	(0.003)	(0.001)	(0.009)	(0.006)	(0.001)	(0.001)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14265	14265	14265	14265	14265	14265
Mean Control	0.00	0.00	0.00	0.00	0.00	0.00
P-v test voucher/no voucher,no truck	0.00	0.00	0.01	0.00	0.02	0.06
P-v test voucher/no voucher, truck	0.00	0.00	0.00	0.00	0.25	0.14
P-v test voucher with-without truck	0.00	0.03	0.28	0.00	0.02	0.30
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.01	0.01

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for the census of households in 92 villages

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 17 – Take-up of Vouchers for Improved Seeds by Detailed Subsidy Level, administrative data, census of house holds

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher 30 x no truck	0.145***	0.012**	0.077*	0.029***	0.027	0.016
	(0.044)	(0.005)	(0.039)	(0.010)	(0.017)	(0.012)
Voucher 60 x no truck	0.215***	0.040**	0.107***	0.037***	0.050	0.017
	(0.053)	(0.015)	(0.039)	(0.013)	(0.030)	(0.012)
Voucher 90 x no truck	0.350***	0.074***	0.188***	0.069***	0.075**	0.011
	(0.074)	(0.026)	(0.065)	(0.026)	(0.030)	(0.007)
Voucher 100 x no truck	0.485***	0.115***	0.254***	0.092***	0.125**	0.020*
	(0.082)	(0.034)	(0.078)	(0.023)	(0.053)	(0.010)
Voucher 30 x truck	0.357***	0.063***	0.118***	0.232***	0.005	0.009
	(0.042)	(0.018)	(0.027)	(0.035)	(0.004)	(0.007)
Voucher 60 x truck	0.490***	0.068***	0.158***	0.352***	0.005	0.008
	(0.035)	(0.016)	(0.027)	(0.035)	(0.005)	(0.005)
Voucher 90 x truck	0.754***	0.147***	0.251***	0.595***	0.002	0.009
	(0.022)	(0.035)	(0.044)	(0.033)	(0.002)	(0.008)
Voucher 100 x truck	0.916***	0.247***	0.365***	0.760***	0.002	0.001
	(0.010)	(0.048)	(0.050)	(0.035)	(0.002)	(0.002)
No voucher x no truck	0.002	0.002	0.003	–0.003	0.000	0.001
	(0.004)	(0.002)	(0.011)	(0.007)	(0.002)	(0.001)
No voucher x truck	0.003	0.001	0.002	0.002	–0.000	–0.000
	(0.003)	(0.001)	(0.009)	(0.006)	(0.001)	(0.001)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14265	14265	14265	14265	14265	14265
Mean in the control	0.00	0.00	0.00	0.00	0.00	0.00
P-value Test 30-60 no truck	0.03	0.03	0.06	0.47	0.35	0.91
P-value Test 60-90 no truck	0.00	0.06	0.01	0.06	0.18	0.57
P-value Test 90-100 no truck	0.00	0.00	0.02	0.12	0.07	0.32
P-value Test 30-60 truck	0.00	0.73	0.13	0.00	0.97	0.59
P-value Test 60-90 truck	0.00	0.00	0.01	0.00	0.31	0.86
P-value Test 90-100 truck	0.00	0.00	0.00	0.00	0.68	0.34
P-value Test voucher 30-no voucher in no truck	0.00	0.05	0.08	0.00	0.14	0.22
P-value Test voucher 30-no voucher in truck	0.00	0.00	0.00	0.00	0.18	0.19
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.02	0.01

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for the census of households in 92 villages

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full se of strata dummies. The last rows present the P-value of the difference between coefficients for different levels o vouchers, for villages with truck and villages without truck separately.

Table 18 – Take-up of Vouchers for Improved Seeds by Subsidy Level, administrative data, census of households

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher low x no truck	0.180***	0.026***	0.092**	0.033***	0.038*	0.017*
	(0.045)	(0.009)	(0.038)	(0.011)	(0.021)	(0.009)
Voucher high x no truck	0.417***	0.094***	0.221***	0.081***	0.100**	0.016**
	(0.077)	(0.030)	(0.071)	(0.024)	(0.041)	(0.007)
Voucher low x truck	0.424***	0.066***	0.138***	0.292***	0.005	0.008
	(0.035)	(0.015)	(0.024)	(0.033)	(0.004)	(0.006)
Voucher high x truck	0.835***	0.197***	0.308***	0.677***	0.002	0.005
	(0.012)	(0.039)	(0.045)	(0.030)	(0.002)	(0.004)
No voucher x no truck	0.002	0.002	0.003	–0.003	0.000	0.001
	(0.004)	(0.002)	(0.011)	(0.007)	(0.002)	(0.001)
No voucher x truck	0.003	0.001	0.002	0.002	–0.000	–0.000
	(0.003)	(0.001)	(0.009)	(0.006)	(0.001)	(0.001)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14265	14265	14265	14265	14265	14265
Mean Control	0.00	0.00	0.00	0.00	0.00	0.00
P-value test low-high no truck	0.00	0.01	0.00	0.00	0.04	0.74
P-value test low-high truck	0.00	0.00	0.00	0.00	0.21	0.46
P-value test low no truck - low truck	0.00	0.03	0.31	0.00	0.12	0.43
P-value test high no truck - high truck	0.00	0.04	0.30	0.00	0.02	0.20
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.02	0.01

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for the census of households in 92 villages

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.

Table 19 – Take-up of Vouchers for Improved Seeds by Treatment Density, administrative data, census of households

	(1) All crops	(2) Maize	(3) Rice	(4) Groudnuts	(5) Soja	(6) Cassava
Voucher x no truck x density 20	0.203*	0.057	0.092	0.076**	0.083	0.028
	(0.104)	(0.035)	(0.083)	(0.033)	(0.083)	(0.027)
Voucher x no truck x density 45	0.238***	0.107***	0.073**	0.039*	0.032	0.019
	(0.084)	(0.040)	(0.035)	(0.023)	(0.029)	(0.015)
Voucher x no truck x density 70	0.367***	0.028	0.232***	0.064**	0.091*	0.011
	(0.078)	(0.020)	(0.077)	(0.025)	(0.047)	(0.009)
Voucher x truck x density 20	0.692***	0.147***	0.228***	0.545***	–0.002	0.001
	(0.031)	(0.044)	(0.065)	(0.056)	(0.004)	(0.001)
Voucher x truck x density 45	0.636***	0.191***	0.239***	0.471***	0.012	0.013
	(0.043)	(0.049)	(0.068)	(0.046)	(0.009)	(0.011)
Voucher x truck x density 70	0.609***	0.094***	0.215***	0.475***	0.001	0.005
	(0.027)	(0.031)	(0.042)	(0.041)	(0.003)	(0.005)
No voucher x no truck	0.002	0.003	0.002	–0.002	–0.000	0.001
	(0.004)	(0.002)	(0.010)	(0.007)	(0.002)	(0.001)
No voucher x truck	0.003	0.001	0.002	0.002	–0.000	–0.000
	(0.003)	(0.002)	(0.008)	(0.006)	(0.001)	(0.001)
Strat Vars	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14265	14265	14265	14265	14265	14265
Mean Control	0.00	0.00	0.00	0.00	0.00	0.00
P-value test 20-45 without truck	0.80	0.35	0.83	0.36	0.55	0.76
P-value test 45-70 without truck	0.26	0.08	0.06	0.46	0.30	0.68
P-value test 20-45 with truck	0.30	0.51	0.91	0.31	0.19	0.28
P-value test 45-70 with truck	0.60	0.10	0.76	0.94	0.22	0.49
P-v Test of Joint Significance	0.00	0.00	0.00	0.00	0.03	0.03

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Administrative data for the census of households in 92 villages

Note: Robust standard errors clustered at the household level in parentheses. All regressions control for a full set of strata dummies.