Expected Product Market Reforms and Technology Adoption by Senegalese Onion Producers

Tanguy Bernard, Alain de Janvry, Samba Mbaye, and Elisabeth Sadoulet

We assess the responsiveness of Senegalese onion producers to their knowledge of expected changes in product market conditions, whereby onions would no longer be sold based on volume but rather on weight and with labeling certifying quality. A village-level randomized information campaign on the upcoming introduction of these reforms induced significant investments by farmers into quality-enhancing inputs. Delays in the actual introduction of scales enabled us to rigorously identify positive price effects from these investments. Our results point to the importance of farmers' expectations regarding the improved functioning of product markets in triggering technology adoption.

Key words: Agricultural technology, product market, quality, Sub-Saharan Africa.

JEL codes: O13, Q12, Q13.

The use of basic agricultural technologies such as chemical fertilizers and improved seeds remains low in Sub-Saharan Africa, particularly among smallholder farmers (World Bank 2007). A lack of access to these technologies, to information about how to use them, and to financial services all contribute to these low adoption rates (Jack 2011; Karlan et al. 2014). Farmers can be further discouraged by low prices for their products. Insufficient roads and communication infrastructures create high transaction costs, whereby farmers mostly participate in shallow local markets with limited rewards to investments in quality or yields (Foster and Rosenzweig 2010; Suri 2011).

This paper provides evidence that small changes in such market settings can lead to important production responses by farmers. We rely on a field setting in northern Senegal where scales were not available for onions to be weighed when sold at local collection points.[1] Local consignment agents (*coaxers*) and authorities argued that these markets were so distant from large consumer markets that the use of scales would discourage traders (*banabanas*) from traveling the distance and thereby reduce market opportunities for farmers. Thus, onions were sold based on loosely-assessed forty kilogram bags, with preference given to overfilled ones. Farmers reacted to this perverse incentive by using urea-based fertilizer, which produced larger though lower-quality (i.e., fast-deteriorating due to their high water content) onions that carry a lower value on consumer markets.

In late 2013, local authorities decided to introduce scales and quality labeling in the 2014 season. To assess how this change in market conditions may affect farmers' production behavior, we designed an information campaign ahead of the 2014 season, randomly targeted to half of the villages in the vicinity of these markets, and related to the upcoming introduction of scales and labels. In this information campaign, farmers

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[1] Such scales exist in most onion markets in other parts of the country, including at collection points, wholesale markets, and consumer markets.

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were told that for all producers willing to use this service, each bag would be duly weighed, and a sample inspected for quality. Quality grades ranging from 1 (best) to 3 (worst) would then be assigned to each bag, based on the proportion of good-/medium-/low-quality onions found in the sampled bag. The service would be free of charge. At the end of the season, we collected production data from each producer, irrespective of treatment group, who used the scale at the time of commercialization. We find that farmers from villages targeted by the information campaign were nine percentage points less likely to have used urea and twenty-seven percentage points more likely to have used a weight- and quality-enhancing fertilizer (a 10%-10%-20% mixture of nitrogen, phosphorus, potassium, i.e., 10-10-20) compared to the control group. Farmers were also seven percentage points (p-value=0.12) more likely to have sorted their onions before taking them to the collection point, a costly measure to enhance quality. Using data from each batch of onions that went through the weighing and quality certification system, we find that bags originating from villages where information had been provided were sixteen percentage points more likely to be of higher quality than those from control villages.

To identify an effect on prices, we rely on a naturally-occurring time discontinuity. Local authorities did not grant final formal permission for the scales to operate until a rather unforeseen date, late in the season.[2] Until then, scale operators could measure weight and quality but were not allowed to reveal this information on a label attached to each bag of onions weighed. We collected price information on all transactions involving bags that had been weighed and inspected for quality and found that the information campaign had no effect on the price per kilogram in the days before labeling was introduced. The price of onions from the targeted villages, however, increased by 9% in the very first days following labeling. This effect may relate to traders being better able to sort through quality and hence better reward higher-quality onions from treatment villages. This increase may also reflect increased bargaining power by farmers who produced higher quality onions. With imperfect attendance at meetings in treatment villages and information spillovers to control villages, these results are likely conservative.

Information about, and availability of, inputs is not a significant constraint to technology adoption in our study setting. The area has long been the focus of agricultural extension activities, and access to inputs is facilitated by a relatively dense network of private retailers. Liquidity constraints are also unlikely to explain the low adoption of improved fertilizers. While more expensive, the added cost of 10-10-20 is negligible compared to the overall cost of onion cultivation. Price information is fairly widely available in the area, with close to 60% of the farmers reporting that they already know market prices per kilogram on the main wholesale and consumer markets before taking their onions to collection points. Lastly, our study setting is one where producers from nearby villages bring their onions to collection points that are located on a fully-functional national road leading to all main consumer markets—even if they are several hours away. Our results, however, suggest that even under these conditions, a lack of information about the specificity of products transacted on markets can be a strong impediment to technology adoption. Farmers' awareness of an upcoming small change in the functioning of these markets led to a rapid response, inducing the delivery of higher-quality onions sold at better prices for producers.

These results contribute to an emerging body of empirical literature on producers' response to changes in market conditions by further highlighting the importance of locally-specific market conditions. Recent improvements in communication technologies have, for instance, enabled farmers to more easily access timely information on product prices in consumer markets. In the presence of high transport costs however, farmers may not be able to exploit spatial arbitrage opportunities and instead often rely on intermediaries (Fafchamps and Vargas-Hill 2005). Empirical evidence suggests that in these contexts, price information on distant markets rarely translates into improved price and income for farmers (e.g., Futch and

[2] Specifically, a council gathering local representatives of the state and the Ministry of Agriculture was to be held to formally grant permission, and four representatives were to be present. The meeting was initially planned for mid-February, but was postponed three times, several weeks each time, as one or more of these representatives had to travel for work or personal reasons (to attend funerals). At the time, we suspected that the council was being lobbied by some local *coaxers* not to grant the authorization for scales, although we have no formal evidence to support it.

McIntosh 2009; Muto and Yamano 2009; Aker 2010; Goyal 2010; Aker and Fafchamps 2015). Only when producers are able to select destination markets does the evidence point to positive price premiums for their output (e.g., Jensen 2007).

Local arrangements between producers and intermediaries determine the extent to which price incentives are transmitted to farmers (e.g., Osborne 2005; Fafchamps and Vargas-Hill 2008; Porteous 2016; Dillon and Dambros 2016). Casaburi and Reed (2014), for instance, show that in settings of interlinked contracts between producers and intermediaries, higher-quality requirements on destination markets lead to higher availability of loans from intermediaries to producers. In another paper, Casaburi, Glennerster, and Suri (2014) study the effect of rural road rehabilitation in Sierra Leone and find differential price transmission from intermediaries to farmers depending on remoteness and the extent of local surpluses. Our paper adds to this literature by studying specific market arrangements in a different—yet relatively common—setting of local assembly markets. In particular, we show that under a given set of information and transportation infrastructures, farmers' awareness of relatively small changes in the functioning of these local markets can induce important production responses.

Our results point to the importance of farmers' expectations regarding the effective assessment of their products' quality. In a different setting, Saenger et al. (2013) find that Vietnamese farmers invested in enhanced quality of milk in a contractual relationship upon the introduction of third-party quality inspection. While the third-party inspection did not find evidence that previous inspections by the contractor were biased, farmers were expecting this to be possible, which would reduce their expected gains in quality-enhancing investments. In a more descriptive paper on India, Fafchamps, Vargas-Hill, and Minten (2008) show that the imperfect measurement of a product's quality correlates with lower investments in quality attributes by farmers. To support their result, these authors develop a model showing that growers' incentive to engage in quality-enhancing investments decreases as the cost of quality inspection increases. Positive inspection costs lead to the under-provision of quality, up to a point when inspection costs are sufficiently high that no quality premium is provided and no farmer uses quality-enhancing technology. Our results further support these findings: farmers who knew in advance that their products would be graded by an external entity invested more in quality-enhancing technology. The grading service was introduced free of charge, thereby decreasing the expected inspection cost of onions, though this took the form of sometimes lengthy discussions with intermediaries regarding the quality of their onions.

The remainder of this article is organized as follows. The next section provides background information about the production and sale of onions in our study area, the Senegal River Valley in northern Senegal. The following section details our study design, including the various interventions, identification strategies, and data collected. Next, we present results on technology adoption by farmers, while the subsequent section focuses on market outcomes. The final section concludes with an epilogue on the sustainability of the market reforms.

Study Setting

Context

Onions are used basically daily in every Senegalese kitchen. For years, the estimated 150,000 tons consumed annually were supplied mostly by imports from the Netherlands. However, every year since the early 2000s, the Senegalese government has attempted to create incentives for the local production of onions. The first attempt was a seven-month ban on onion imports (from February to August), followed by the development of new irrigation schemes, input subsidies, and technical support from national and regional extension agencies such as the Institut Sénégalais de Recherche Agricole (ISRA) and the Société Nationale d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal (SAED). In the Senegal River Valley, onions now compete with tomatoes as the second-most important crop for acreage, after rice.

The Podor department, where our study takes place, is several hundred kilometers distant from the main consumer markets in Dakar, Touba, and Saint-Louis (see figure 1). There, onion production covered 350 hectares in 1990 and 3,500 hectares a decade later. Onion is mostly cultivated on irrigated perimeters, with a cycle ranging from seventy-five to ninety days from transplantation to harvest, depending on varieties, inputs used, and temperature. In our data, farmers started planting onions as early as October 4,

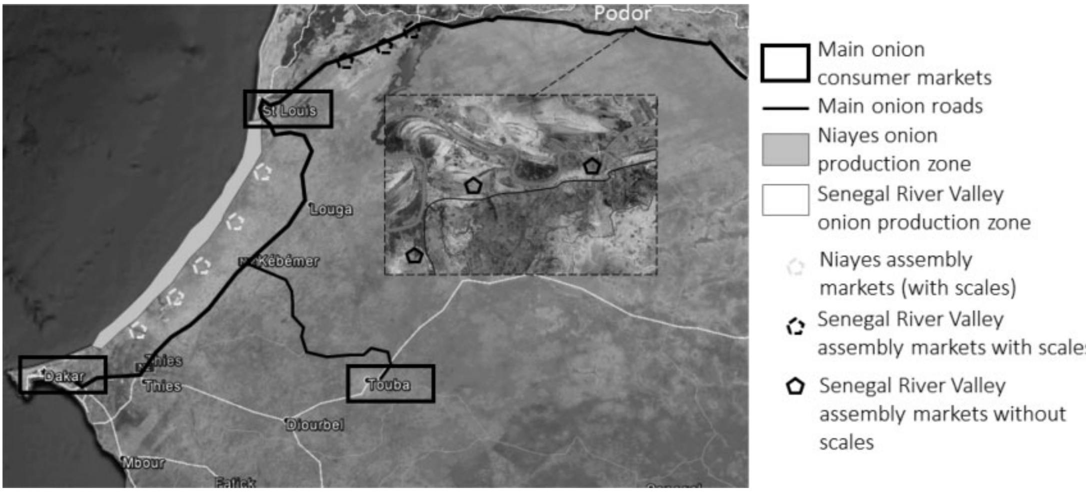

Figure 1. Study zone

Source: Direction de l'Horticulture, Ministry of Agriculture.

2013. While relatively straightforward to cultivate, onion size depends on planting density and type of fertilizers used for top-dressing, which in turn affects quality. In particular, the SAED (the main extension agency in the Senegal River Valley) recommends four applications of fertilizers: at transplanting time and twenty, forty, and sixty days after transplanting. The type of fertilizer recommended includes organic fertilizer or urea jointly, with a cover of 10-10-20 (nitrogen, phosphorus, potassium) chemical fertilizer. Overall, the per-hectare recommendation is of 100kg of urea and 200kg of 10-10-20 fertilizer. Studies have found, however, that farmers make excessive use of urea in order to increase yields. In contrast, potassium, which is a key element for producing higher quality and lower perishability, is largely underapplied (Duteurtre, Faye, and Dièye 2010).

While onion production receives important support from the SAED, all actors agree that commercialization remains a major constraint contributing to reduced benefits for farmers. Spatial arbitrage opportunities are limited for farmers due to high transportation costs.[3] Time arbitrage opportunities are also scarce due to the high perishability of onions produced locally and a lack of storage facilities. Once harvested, onions would need to be sold within the next one or two days to avoid deterioration.[4] To facilitate exchanges between producers and buyers, commercialization largely rests on the use of consignment agents (*coaxers*) who sell on behalf of producers to itinerant traders (*banabanas*), generally without assuming property of the product. *Coaxers* are residents of local village communities who have accurate information on the availability of mature onions among local farmers. Historically, *coaxers* would bring *banabanas* to farmers' fields for farm-gate transactions. With the increase in local production, *banabanas* have increasingly been using large trucks with little possibility of reaching remote farmers' fields. Instead, 60% to 70% of all transactions occur at local collection points, where farmers leave their onions on consignment with *coaxers*, who are remunerated a flat fee per each (presumed) forty-kilogram bag upon sale of the onions to *banabanas*. Most farmers complain that prices are highly volatile depending on daily levels of supply and demand (figure 2), that quality is not recognized, that *coaxers* are not providing enough effort (with eventual suspicions of cheating in reporting prices to farmers), and that the market power of *banabanas* is a source of graft and rent extraction from producers. Although farm-gate commercialization is preferred by the majority of farmers, most are

[3] The transportation cost of onions from our study zone to the main consumer outlets in Dakar or Touba reached XOF 450 to XOF 500 per 40kg bag (roughly equivalent to USD 1 at the time)—a gross 10% of the sale price at collection points.

[4] Data from the 2013 commercialization season suggests that over 90% of the onions were sold within three days after they were brought to the collection point. By then, the quality of 10% had deteriorated, with an overall 30% of bags containing a significant amount of rotten onions.

Figure 2. Evolution of daily mean prices at three Podor collection points in the 2013 season, price per estimated 40 kilogram bag

Source: Price data collected by authors in the 2013 onion commercialization season (one year prior to the current study).
Note: Apr = April.

forced to bring their onions to collection points where the probability of selling quickly is higher—a point of importance with produce that rapidly degrades once harvested.

Transactions in wholesale and retail markets (mainly in Dakar, Touba, and Saint-Louis) are organized around criteria of origin, variety, quality, and weight. This is also the case at collection points in production zones closer to wholesale and consumer markets, where each transaction is duly weighed and inspected for quality. Only in the department of Podor are transactions based on fuzzier assessments. While most onions are of the same variety, there were traditionally no scales to assess the actual weight of each bag. Informal weight assessment was part of the negotiation process between *coaxers* and traders, with farmers overfilling their bags in expectation of higher prices and more rapid sales. In our data, the average weight of bags was 42.7 kilograms before the introduction of scales, with close to 90% of the bags weighing more than forty kilograms. Producers have long complained about the absence of scales, but *coaxers* argued that introducing scales would reduce visits by traders in such distant markets, implicitly acknowledging that traders benefited from a system without scales.[5]

Intervention and Data

In late 2013, Podor's local authorities decided to introduce scales at local collection points, provided by the local onion producer association, the Association des Producteurs d'Oignons de la Vallée du Fleuve (APOV). Supported by an external development intervention, the scales were to be operational at the beginning of the 2014 commercialization season. In collaboration with SAED, we organized training sessions for the thirty-four villages in the area from which farmers had brought onions to the three collection points in the previous year. The training focused on quality-enhancing technologies and practices in the cultivation of onions, including optimal fertilizer use for quality onions. In each village, the training was announced publicly several days in advance, and all farmers were invited to attend. Although the region is characterized by relatively high access to extension services provided by SAED, this training ensured that all producers in the area had a similar level of information about how to produce high-quality onions.

In late January 2014, we randomly chose half of these villages for a follow-up information campaign, whereby we informed onion producers about the upcoming introduction of scales at the three local collection points. Given our small sample size, villages were first grouped in quintiles based on the

[5] While this issue is beyond the scope of this paper, as the epilogue to the paper indicates, the concern about continued servicing of these distant markets by traders was indeed legitimate.

number of onion producers who had participated in the training campaign (a proxy for the total number of producers in the village). In each quintile, half of the villages were allocated treatment status (a public meeting was organized to provide producers with information about the upcoming system of weight and quality labeling), and the other half were kept as controls. As before, meetings were announced several days in advance and all local producers were invited to attend. Producers in this treatment group were told that at each of the three collection points, scales would be installed early in the season and operated by external agents from the local University Gaston Berger (UGB). These agents would also assess the quality of onions brought to collection points based on the share of good-/medium-/low-quality onions in each bag. Specifically, scales operators would be trained to assess the quality of onions based on their size, compactness, and rate of deterioration. Bags would then be labeled with information about weight and quality. *Coaxers* would still be in charge of sales to traders. This village-level random variation in access to information about the upcoming scales constitutes our main source of variation, enabling us to assess how farmers' production decisions vary in response to reforms in the market on which they are selling their onions. As described above, fertilizer applications occur throughout the growth cycle of onions—recommended at transplanting time, and twenty, forty, and sixty days afterwards. With the earliest planting time being October 4 and the latest being February 29, the information campaign differentially affected farmers. Some received the information when all fertilizer rounds had likely been implemented and for them the information campaign could only affect their decision to sort their onions before taking them to market. For other farmers, the information came when some of the fertilizer applications remained to be done, and for some before planting time.[6]

By February 2014, eight scales were purchased and placed at the collection points, with operators hired and trained by UGB. For the scales to effectively start operating, however, a formal decision by the head of the local administration needed to be made in a meeting that gathered representatives of farmers and *coaxers*. The meeting was postponed several times until late April 2014, well into the commercialization season. It was then decided that scales would operate but that farmers and *coaxers* would be free to use them or not.

On May 2, UGB agents started operating the scales and assessing the quality of bags, with a separate group of enumerators collecting information about weight, quality, and price obtained for each transaction.[7] For their first ten days of operation, the scale operators merely provided the weighing and quality assessment service to farmers upon arrival at the market with their onions to be sold. Starting on the eleventh day (May 12, 2014), each onion bag that went through a scale was duly labeled with a tag reporting its weight and its (externally assessed) quality. Here, discontinuity in the effective implementation of the market reforms enabled us to assess how changes in production strategies by farmers were effectively rewarded through better prices. By the end of May, the season was essentially over and data collection on markets stopped.

Our final sample includes 533 transactions that occurred during May 2014 at the three collection points of Podor; the transactions went through the weighting and quality-assessment system. For 75% of these transactions, onions originated from villages targeted by the randomized information campaign of January 2014. As shown in figure 3, this imbalance does not seem to vary significantly during the time period considered, particularly before and after the introduction of labels on the weighed bags. It is clear, however, that the number of transactions drastically decreases in the second half of May as the season comes to an end.

[6] Because not all farmers could adjust their fertilizer applications, our results give a lower bound to the information treatment.

[7] Every bag was weighed. Regarding quality assessment, every fifth bag of a batch of onion bags brought by a producer was emptied and each onion allocated to one of three piles: good, medium, and low quality. If the pile of good quality onions represented over 80% of the total, the whole bag was classified as high quality. If it represented less than 80% but the piles of good and medium quality onions together represented over 80% of the total, the bag was classified as medium quality. If together, these two piles represented less than 80% of the total, the bag was classified as low quality. The next four bags were classified with the same quality label as the sampled one.

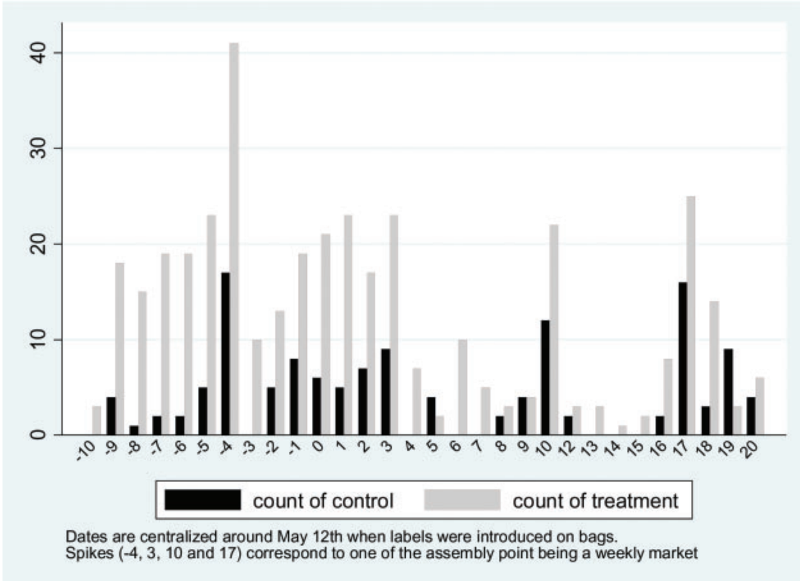

Figure 3. Number of transactions recorded per treatment arm during May

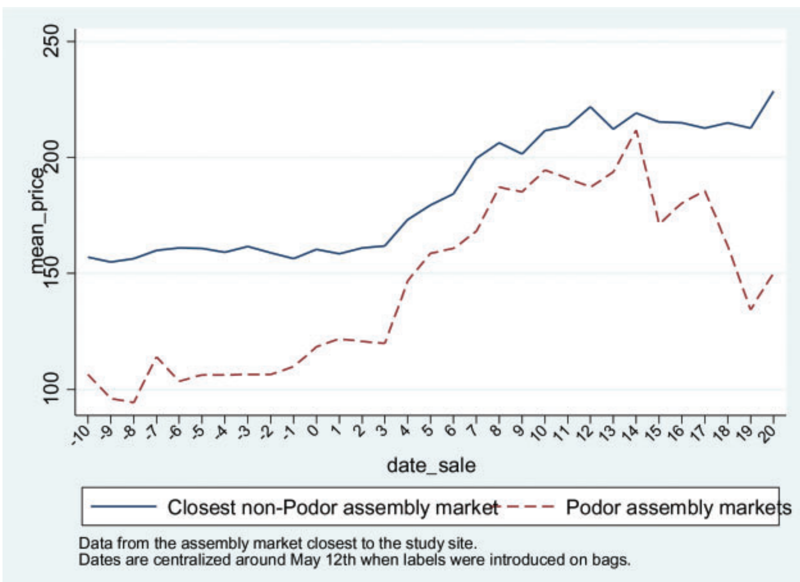

Figure 4. End-of-season evolution of prices, price per kilogram of onion

Note: Data are from the collection point closest to the study site. Dates are centered around May 12, when labels were introduced on bags.

Figure 4 further illustrates the particularly high instability of prices toward the end of the commercialization season in the Senegal River Valley. We report the evolution of prices at the closest collection point to our study sites, the closest one where scales were already operating in previous seasons. This market is more than fifty kilometers away from Podor, on the main road toward major wholesale and retail markets. There, scales had been operating for several years such that the price level is unlikely to have been affected by the introduction of scales at the Podor collection points. If

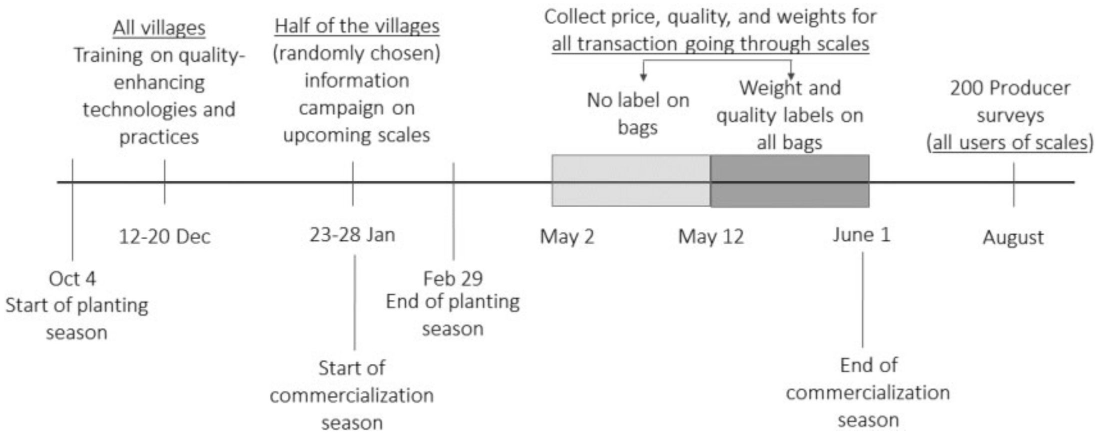

Figure 5. Study timeline

Note: Dec = December; Jan = January. Period is October 2013 to August 2014. There is a three-month growing season between planting and harvesting.

anything, figure 4 suggests the likely sharp natural rise in prices at the Podor collection points, even without the introduction of scales.

In August 2014, we visited all 200 farmers who had sold their onions on the market during May and used the weighing and labeling system in place.[8] Information collected covered issues related to planting, fertilizer, irrigation, and post-harvest sorting, along with the recalled dates of these operations. Our sample covered only farmers and *coaxers* who effectively chose that their onions be weighed and quality assessed. Figure 5 summarizes the timeline for the various treatment and data collection efforts, along with their corresponding duration of coverage.

Experimental Integrity

This section reports on implementation of the information campaign and validates experimental design. At the village level, table 1 reports on producers' knowledge of the scales and labels intervention. By the time we conducted the survey (August 2014, i.e., well after the end of the season), virtually everyone knew about the introduction of scales and labels in both targeted and non-targeted villages. Yet one finds clear differences in the sources of this information and the timing when it was made available to farmers in the treatment and control villages. In treatment villages, 53% of respondents report learning about the scales and labels through the information campaign, which occurred at the end of January. This is confirmed by a similar proportion (51%) reporting that they learned about the change in January.[9]

A large fraction of producers in treatment villages only learned about the introduction of scales later in the year—in April and May in particular—either from relatives or *coaxers*, or upon taking their onions to the market. In effect, while all villagers were invited to attend the meeting of the information campaign, attendance was only partial. More surprising, however, is the fact that information did not rapidly spread to non-attendees within the same village; 18% of the farmers in non-targeted villages learned about the introduction of scales and labels through the campaign. Because the meeting was announced several days in advance, farmers from these villages may have heard about it and decided to attend in neighboring targeted villages. The vast majority of farmers from these villages, however, learned about upcoming scales and labels through other means, and 42% only found out about it upon delivering their onions to markets.

Compliance with our randomized design is thus imperfect, with a thirty-five percentage-

[8] For about 25% of the recorded transactions, onions were owned by *coaxers* themselves—most of them having purchased these onions from farmers at the farm gate. As they did not specifically engage in production, we did not survey these *coaxers*.

[9] The slight discrepancy between the two numbers is due to individuals not precisely remembering the day of the campaign, which occurred in late January.

Table 1. Access to Information about the Introduction of Scales, by Treatment and Control Villages

Information	Control Villages	Treatment Villages	Difference: p-value
Percentage who know about introduction of scales	97.44	98.75	t-test: .548
Percentage who learned about it through			
Information campaign	18.42	53.46	
Friends/relatives	23.68	11.32	
Coaxer	15.79	13.21	
On delivery	42.11	20.75	
Other	0.00	1.26	KS-test: .001
Percentage who learned about it in the month of			
January	21.05	50.94	
February	13.16	3.14	
March	5.26	2.52	
April	47.37	32.70	
May	13.16	9.43	
Does not know	0.00	0.63	KS-test: .008
Percentage who changed production behavior since learned about scales	23.08	78.80	t-test: .000
n	39	161	

Note: KS-test: Kolmogorov-Smirnov test of equality of distribution. T-test: Student test for equality of proportions.

point difference in rate of access through the information campaign between treatment and control group farmers. In return, farmers from control villages were twenty-one percentage points more likely to have only learnt about the introduction of scales and labels upon delivering their onions to the market. Yet we find important differences in farmers' reported changes in production behavior upon learning about these market changes. According to farmers themselves, less than 25% of farmers in control villages changed their production decisions in response to this information, compared to 79% in treatment villages.[10] Thus, and despite imperfect compliance in attendance rates, the information campaign had a significantly higher effect on producers' behavior in treatment than in control villages. Among those who changed, 48% revised their use of fertilizers (often referred to as "moving out of urea"), 13% say they used better irrigation, 2% say they used better seeds, and 52% say that they sorted their onions better. Those who received the information late in the season are more likely to have only improved their sorting of onions, while those who accessed the information campaign in January are more likely to have also changed their choice of fertilizer.

Next, we assess the similarity of farmers' characteristics and production choices before the information campaign. Planting-related decisions are unlikely to be affected by the information campaign, as most planting occurs from November to January and the information related to scales and labels only came at the end of January (in our data, 95% of the plots were planted before the date of the information campaign). As reported in table 2, we do not find significant differences between treatment and control villages related to the number of plots, total area planted with onions, or date of planting. We further assess whether farmers from treatment and control villages started with the same initial level of knowledge about onion production. The extension campaign reached only about one in three farmers in both treatment and control villages. Asked about key aspects of this training, farmers in treatment and control villages gave similar answers on average, with the exception of whether one should harvest onions with or without their leaves. Last, we find that a large proportion of farmers in both treatment and control villages have a good idea of onion prices in Dakar before they bring their own to the

[10] Only 18% of the farmers in control villages learned of the scales and labels through the campaign, while 25% changed their production decisions; this suggests that information also circulated through other channels. This is also the case in treatment villages where 53% of farmers were informed through the campaign, while 79% changed their production or sorting behavior.

Table 2. Tests of Balance, Household Level

	n	Mean Treatment	Mean Control	Difference: p value
Total number of bags harvested	200	177.97	146.12	.56
Total area cultivated in onions (hectares)	198	0.67	0.58	.58
Number of plots cultivated in onions	200	1.51	1.52	.99
Respondent attended training on quality	199	0.33	0.29	.67
Respondent's knowledge about means to enhance onion quality				
- One should use herbicides	165	1.00	0.98	.12
- One should harvest with leaves	200	0.54	0.84	.00
- Kilograms of base fertilizer to use per hectare	175	206.76	205.07	.85
- Number of days after planting to start irrigation	200	17.23	16.44	.54
- Number of weeks after planting for first fertilizer application	199	20.03	19.74	.82
- Recommended number of fertilizer applications	200	3.08	3.22	.43
- Number of days before harvest for last irrigation	200	20.00	19.07	.53
- One should use mostly urea as fertilizer (percentage)	200	5.13	3.73	.71
- One should use mostly 10-10-20 as fertilizer (percentage)	200	30.77	34.78	.55
- One should use mostly 9-23-30 as fertilizer (percentage)	200	51.28	46.58	.57
Respondent generally knows prices in consumer markets (percentage)	200	0.54	0.65	.23

local collection points. Overall, we do not find evidence of systematic differences between producers in treatment and control villages in pre-treatment behavior, or in characteristics that are unlikely to be affected by treatment.

Information and Producers' Behavior

As shown in table 1, 79% of the farmers in treatment villages reported that knowing about the upcoming introduction of scales and labels affected their production decisions. In most cases, these behavioral changes related to the type of fertilizer used and whether they would sort their onions before bringing them to the collection points. This section further explores the magnitude of these effects. We rely on ordinary least squares–based Intention-To-Treat (ITT) estimates, where the dependent variable is regressed on village-level treatment allocation. Our reliance on ITT estimates instead of an Average Treatment on the Treated (ATT) estimate is motivated by our limited ability to assess when farmers were affected by the information in their production process, given that many farmers cultivate several plots planted at different times, and many heard about the scales and labels through other means. Using an ITT estimate as opposed to an ATT is also made necessary by the possibility of selection bias should the non-uptakers systematically differ from the uptakers of the intervention.

Because the treatment is allocated at the village level, standard errors are correspondingly clustered at this level. Specifically, we report two separate estimations of standard errors. Our main specification relies on standard Huber-White heteroskedastic-consistent clustering of standard errors at the village level. Bertrand, Duflo, and Mullainathan (2004) show, however, that this clustering approach still leads to downward-biased estimates of standard errors for samples with relatively few clusters (less than thirty). Given our relatively small sample (thirty-one

Table 3. Mean of Dependent Variables in Control Group

	Mean	Standard Deviation
Date planted	December 16, 2013	27 days
Date ready to harvest	April 2, 2014	24 days
Use urea (0/1)	0.95	0.22
Kilograms of urea per hectare	218.01	145.56
Use 10-10-20 (0/1)	0.28	0.45
Kilograms of 10-10-20 per hectare	43.34	96.15
Use 9-23-30 (0/1)	0.64	0.48
Kilograms of 9-23-30 per hectare	211.87	268.41
Sorted onions	0.92	0.26

clusters), we also compute more conservative randomized inference-based estimates of standard errors as robustness checks of our results. For this, we randomly switch the treatment allocation across clusters to estimate the distribution of parameter estimates across placebo allocations of treatment across clusters. We use this distribution to produce a one-sided test of hypothesis by locating the value of our true parameter estimate within the distribution of all possible ones. This approach—equivalent to a Fisher exact test—usually relies on the computation of parameter estimates for all possible allocation of treatment across groups. In our case, however, there are over 300 million such possibilities across our thirty-one clusters. Instead, in each estimation we use a set of 1,000 resampling of treatment allocations to produce our test. The P-value results of these tests for key parameters of interest are provided below each concerned table; all of them confirm the results obtained using the Huber-White clustering of standard errors.

The data in this section exclusively rely on the August 2014 survey of the 200 farmers who transacted on the three collection points in May, and whose onions were weighed with the scales.

In table 3 we first report the means and standard deviations of the variables used later in this section for the control group. Accordingly, we find that the average planting date lies far ahead of the information campaign. In our sample, 95% of the fields were planted before January 23, thus limiting the scope for any impact of the information campaign on production decisions. On average, onions were ready to be harvested by April 2, 2014. Onions do not need to be harvested right away, however, and can stay in the field for an additional one to three weeks without much damage. The deterioration rate accelerates quickly once the onion has been picked from the field. Still, with the average onion plot being harvested in mid-April, the effective introduction of labels on May 12 did miss most of the season's production.

Table 3 further indicates the high levels of fertilizer application. In effect, we did not survey a single producer who had not used at least one type of fertilizer in his or her onion field. Urea is by far the most commonly used, followed by 9-23-30. The use of 10-10-20 (nitrogen, phosphorous, potassium) fertilizer, which is the number one recommendation by SAED for top-dressing, is comparatively very low in terms of both occurrence and volume (extensive and intensive margins). Lastly, a very high proportion of farmers reported sorting their onion harvests before bringing them to the local collection points. Accordingly, for 92% of the transactions originating from farmers in the control group, onions had been sorted before being brought to the consignment agent. Clearly, however, this binary variable could mask important heterogeneity in the extent of sorting.

In tables 4, 5, and 6, we report estimates of the impact of living in a village chosen to receive information about the upcoming scales and labels in late January 2014. We first assess whether farmers revised their planting plans. Table 2 shows we did not find that farmers from these villages differed in terms of the number and size of plots allocated to onion production. Table 4 indicates we do not uncover further evidence that information affected decisions about when to plant fields, nor when to harvest.

In contrast, table 5 reports a significant effect of the information campaign on fertilizer use: two-thirds of fertilizer applications in control villages occurred after the date of the information campaign. Overall, fertilizer applications were more likely to be affected by treatment than were planting decisions. We find that treatment is associated with a nine percentage-point decrease in the likelihood that a household used urea as a fertilizer, although we do not find a clear effect on the quantity of urea used. In contrast, our results show a large increase in the likelihood of using 10-10-20 fertilizer. Farmers in treatment villages are twenty-seven percentage points more likely to have used such fertilizer (a nearly 100% increase from the control group), and there was a 116-kilogram per hectare increase in the quantity used of this fertilizer (a more than 250% increase). We do not find any meaningful effect of the information campaign on the use of 9-23-30 fertilizer. This result on the shift in fertilizer use from urea (good for yields) to 10-10-20 (good for quality) is a major indication of the channel through which quality response has been achieved.

Lastly, table 6 reports estimates of the extent to which farmers affected the timing of their sales and increased their sorting of onions before bringing them to collection points. We find no evidence that the month of sales is different for farmers in treatment and control villages. Regarding sorting, we found that the initial level is very high to begin with, likely due to a broad assessment of what sorting entailed. While the initial objective was to capture whether farmers gathered good-, medium-, and low-quality onions into separate bags, it is likely that this question was understood by farmers as asking whether they merely removed overly-rotten onions and foreign matter from the bags. As discussed above, 52% of the farmers indicated having improved their sorting of onions in response to information on scales and labeling facilities at the markets. The transaction-level data used in table 6 is unlikely to fully capture these improvements. Nevertheless, table 6 suggests a positive increase in the sorting of onions among farmers in treatment villages. Importantly, this effect is limited to May, when scales and labeling were effectively operating. In effect, farmers typically call up their *coaxers* before bringing their onions to market. Those informed about the upcoming scales may have asked whether the scales were in place, and only if so did they engage in further sorting of their onions. Without this information, or without higher-quality

Table 4. Effect of Information Campaign on Planting and Harvesting Time, Plot Level

	Date Planted	Date Harvested
Treatment village	6.706	3.598
	(4.296)	(4.079)
Constant	December 16, 2013	April 2, 2014
	(3.558)***	(3.566)***
R^2	.01	.00
n	303	303

Note: Standard errors are clustered at the village level. Asterisks indicate the following: ***= $p < .01$.

Table 5. Effect of Information on Overall Fertilizer Use, Household Level

	1 Use urea (0/1)	2 Kilograms of urea per hectare	3 Use 10-10-20 (0/1)	4 Kilograms of 10-10-20 per hectare	5 Use 9-23-30 (0/1)	6 Kilograms of 9-23-30 per hectare
Treatment village	–0.092	45.217	0.271	116.431	–0.014	–0.649
	(0.051)*	(63.187)	(0.118)**	(27.871)***	(0.074)	(50.059)
Constant	0.949	218.012	0.282	43.344	0.641	211.870
	(0.033)***	(28.845)***	(0.102)**	(18.404)**	(0.069)***	(41.403)***
R^2	.01	.00	.05	.05	.00	.00
n	200	198	200	198	200	198
Mean of control group	0.95	218.01	0.28	43.34	0.64	211.87

Note: Standard errors are clustered at the village level. Asterisks indicate the following: *= $p < .1$, **= $p < .05$, and ***= $p < .01$. Randomized inference-based p-values for one-sided test: column 1, Treatment village=0.10; column 2, Treatment village=0.62; column 3, Treatment village=0.01; column 4, Treatment village=0.00; column 5, Treatment village=0.39; column 6, Treatment village=0.48.

Table 6. Effect of Information on Sorting of Onions, Transaction Level

	Month when the transaction occurred	Producer reports having sorted onions before sales		
	1	2	3	4
Treatment village	0.003	0.028	0.026	0.009
	(0.109)	(0.049)	(0.048)	(0.076)
Transaction occurred in May			0.047	0.032
			(0.020)**	(0.033)
Treatment village × transaction occurred in May				0.076
				(0.049)
Constant	4.466	0.925	0.901	0.864
	(0.104)***	(0.047)***	(0.046)***	(0.066)***
R^2	0.00	.00	.01	.04
N	602	602	602	602

Note: Standard errors are clustered at the village level. Asterisks indicate the following: **= $p < .05$, ***= $p < .01$. Randomized inference-based p-values for one-sided test: column 1, Treatment village=0.20; column 2, Treatment village=0.22; column 3, Treatment Village x Transaction Occurred in May =0.04.

onions derived from the enhanced use of appropriate fertilizer, farmers in control villages had a lower incentive to increase sorting of their onions in May 2014.

Overall, results in this section point to a rapid and meaningful reaction of farmers to the information they received about the usage of scales and quality labeling at local collection points. Despite a relatively small sample size and a one-time-only information campaign, we find clear evidence that farmers changed their production behavior in response to incentives to produce better quality onions by using dedicated fertilizer, and by sorting onions. These results are reinforced by the fact that impact is not observed for decisions that could not be affected by the campaign (planting time), or when scales were not yet active (sorting).

Information and Market Outcomes

The treatment-induced changes in producer behavior are mainly driven by changes in the type and quantity of fertilizer used. Increased use of 10-10-20 and decreased use of urea are expected to generate higher-quality, denser, heavier-per-volume, though less voluminous onions. We assess the extent to which changes in producers' behavior translate into higher prices for their produce. We rely on data collected at the scale and transaction level at the three collection points. Each transaction was matched with the producer's village of origin, which enables us to assess the effect the information campaign has on market outcomes. Results are reported in table 7.

We first assess whether onions brought to collection points by producers from treatment villages were of higher quality than those originating from control villages. Scale operators were trained by SAED to measure onion quality by emptying one in every five bags, separating the bag's content into high- and low-quality onions, and assessing the respective proportions within the bag.[11] If the proportion of high-quality onions surpassed an established threshold, the bag was deemed of good quality, as were the next four bags from the same producer. If not, it was assessed of low quality, as were the next four bags. This exogenous quality measurement, independent from ongoing negotiations between producers, *coaxers*, and traders, enables us to trace producers' decisions on the quality of their onions in the market. Results in the first column indicate a sixteen percentage-point higher chance of onions' being of good quality if originating from a treatment village (from a level of 8% in the control villages). Thus, there is a clear effect of farmers' production decisions on the quality of their onions. Results in the second column show that once labels have been introduced, 43% (though not significant) of the treatment effect is accounted for by the effect of labeling.

[11] Although the UGB agents were trained (by SAED) to evaluate three levels of quality, only two (medium and low) were reported in the data. In what follows, we use this distinction as a binary variable indicating whether the bags were of higher or lower quality.

Table 7. Market-Level Impact of the Information Campaign

	Good Quality (full sample) 1	Good Quality (full sample) 2	Price (full sample) 3	Price]–8,0[days 4	Price]–4,+4[days 5	Price]–2,+2[days 6	Price]–8,+8[days 7
Treatment village	0.164	0.110	6.509	–1.399	–4.172	–3.936	–4.831
	(0.056)***	(0.069)	(5.181)	(3.572)	(3.837)	(3.387)	(2.469)*
Treatment village × labels introduced		0.082			10.643	10.438	6.827
		(0.055)			(4.492)**	(4.603)**	(3.100)**
Treatment village × placebo date for label introduction				–2.145			
				(4.064)			
Constant	–0.254	–0.179	77.376	97.905	99.102	37.346	140.054
	(0.094)**	(0.115)	(7.307)***	(7.286)***	(39.455)**	(84.079)	(3.717)***
R^2	.12	.12	.61	.08	.15	.14	.49
n	543	543	533	223	165	123	320
Mean of control group	0.08	0.08	141.51	106.77	114.02	113.9	114.94

Note: Standard errors are clustered at the village level. All estimates include market dummies, date, and date^2 terms. Asterisks indicate the following: *$p = < .1$, ** = $p < .05$, and *** = $p < .01$. Randomized inference-based p-values for one-sided test: column 1, Treatment village=0.03; column 2, Treatment Village x Labels Introduced =0.17; column 3, Treatment Village =0.13; column 4, Treatment Village × Placebo date for label introduction=0.73; column 5, Treatment Village × Labels Introduced=0.00; column 6, Treatment Village × Labels Introduced=0.01; column 7, Treatment Village × Labels Introduced=0.01. Data contain 543 measurements of quality (columns 1 and 2), but only 533 for price paid (column 3). Discrepancy with column 3 is because we are missing information on price for ten transactions (quality was assessed for all bags going through the scales, but prices were obtained by tracking down these bags for later transactions on the market).

This likely comes from additional sorting once scales and labels were in place.

In the third column, we assess the extent to which such quality increases translated into price increases over the entire month of May.[12] With the naturally-occurring variation in prices in the second half of the month (cf. figure 4), we control for the transaction's date with linear and quadratic terms. We do not find a clear effect of the information campaign on prices received by producers throughout the period.

Although they began operations on May 2, scale agents did not start labeling bags with weight and quality information until May 12. Until then, traders did not access weight and quality measures, and onions were sold by the bag as done in the previous season. If, as believed by producers, scales would make quality-enhancing investments more remunerative, one should observe these effects after labels were properly introduced. We test for this effect in columns 4 to 7 with a difference-in-differences approach where the interacted term between the use of labels and being from a treatment village shows the effect on price of introducing scales and labels at the collection points, inclusive of producers' behavioral responses to these changes.

In column 4, we verify that there was no premium for the higher quality of onions from treatment markets ahead of the introduction of labels. We do this with a test of parallel trends over the period before the introduction of labels. Taking as a placebo the label introduction date in the middle of the period (day 4), we do not find any evidence of differentially evolving price trends for onions in treatment and control villages.

In columns 5 to 7, we assess the price effect of duly introduced labels on May 12. In column 5, a bandwidth of +/– four days from May 12 yields the minimum mean square error and is thus considered optimal. We test for the robustness of these results with half and double bandwidths in columns 6 and 7, respectively. We find clear evidence of the combined effect of labeling and the information campaign on prices received. In the four days following the introduction of labels, farmers from treatment villages received an average extra XOF 10.6 for each kilogram of onion. This corresponds to a 9% increase from the overall per-kilogram price.

[12] We analyze the reduced-form effect of treatment on price. In table 9 we will explicitly relate the effect on price to the effect on quality.

Table 8. Test of Recognition of Externally-Assessed and *Banabana*-Assessed Quality

	Onions Are Evaluated as Good Quality by University Gaston Berger Agents	
Excluded: High quality as assessed by *banabanas*		
Medium quality	–0.177	–0.037
	(0.051)**	(0.112)
Low quality	–0.320	–0.096
	(0.065)***	(0.119)
Transaction occurred after introduction of labels ×		
medium quality		–0.177
		(0.122)
Low quality		–0.333
		(0.121)***
Constant	0.111	–0.040
	(0.091)	(0.142)
R^2	.16	.18
n	476	476

Note: Standard errors are clustered at the village level. All estimates include market dummies, date, and date^2 terms. Asterisks indicate the following: **= $p < .05$, and ***= $p < .01$.

The same results hold when considering a smaller bandwidth in column 6. Results are, however, lower in magnitude in column 7, when the bandwidth considered runs from –8 to + 8 days around May 12. These results suggest that quality premiums are lower toward the end of the season when the growing scarcity of supply becomes the main driver of prices.

We further verify that the external assessment of quality as reported in labeling, that is, classifying bags into three categories from best to worst, corresponds to what wholesale agents are looking for in their transactions. In table 8, we correlate the external quality indicator with *banabanas*' own quality assessments of the same bags. Results show that label categories have strong predictive power of *banabanas*' own quality assessment, with categories 2 and 3 in *banabanas*' assessment scoring increasingly lower on UGB agents' quality assessment. As column 2 suggests, this correspondence in quality assessment is fully conveyed by the introduction of labels. We further verify the relationship between externally assessed quality and price and the role that labels have in transmitting this information. In table 9, we see that externally-assessed quality is positively correlated with price, further providing an upper bound estimate of the impact of the information campaign. As column 2 shows, this price effect is mainly the result of the introduction of labels.

Costs and Benefits

With onions of potentially smaller size, it is unclear whether the XOF ten-premium-per-kilogram measured in table 7 is sufficient to cover the cost of investing in the technology. In this section, we compute an average cost-benefit analysis. We have individual producer information on hectares planted, number of bags produced, and quantity of fertilizer used. However, we only have information on weight per bag and price received for the subset of transactions that took place after the scales were put into place, and on input price at the market level. We thus combine these data to compute an estimated average difference in revenues per hectare between farmers in treatment and control groups.

The (subsidized) price of urea in the area is XOF 167 per kilogram, while each kilogram of 10-10-20 fertilizer costs XOF 200—a 19% difference. However, the unsubsidized price of urea in the region is XOF 240 per kilogram, which is 20% higher than the cost of 10-10-20. In the following estimates, we assume that all farmers have access to the subsidized price and discuss the implication of subsidies at the end of the section. Using results from column 4 in table 5, this represents a XOF 4,408 increase in production cost per hectare.

The increase in quality may come at the cost of a lower overall quantity being harvested. Our survey setting did not allow for the

Table 9. Impact on Price of Externally Assessed Quality and Role of Labels

Variable	Price per Kilogram	
	1	2
Good quality	23.415	4.775
	(7.341)***	(2.786)*
Labels introduced × Good quality		27.763
		(7.965)***
Constant	85.785	90.726
	(4.089)***	(4.237)***
R^2	.65	.67
n	533	533

Note: Standard errors are clustered at the village level. Asterisks indicate the following: *= $p < .1$, and ***= $p < .01$. All estimates include market dummies, date, and date^2 terms. Randomized inference-based p-values for one-sided test: column 1, Good quality=0.00; column 2, Post-treatment Date × Good quality =0.00.

Table 10. Impact of Information on Weight of Bags

Variable	Kilograms per Bag 1	Kilograms per Bag 2
Good quality	0.804	
	(0.411)*	
Treatment village		0.688
		(0.524)
Constant	42.544	42.190
	(0.236)***	(0.445)***
R^2	.02	.02
n	536	536

Note: Standard errors are clustered at the village level. Asterisks indicate the following: *= $p < .1$, and ***= $p < .01$. Randomized inference-based p-values for one-sided test: column 1, Good quality=0.06; column 2, Treatment village=0.13.

weighing of farmers' total harvest, nor could we measure the volume of each bag. Although these bags are standard, farmers decide whether to overfill them or not. From casual observations, we did not observe that bags of onions from treatment villages—of higher quality on average—were less filled than bags from control villages. Furthermore, with a fixed price per bag and payment by kilogram, farmers in treatment villages had no incentive to decrease their filling of bags. Thus, we hypothesize a homogeneous volume of bags between treatment and control villages.

Using information collected on markets, we estimate (see table 10) the relationship between quality and weight (column 1) and the impact of the information campaign on the weight of each bag (column 2). Results are consistent with agronomic predictions in that bags of higher-quality onions weigh more than bags of lower-quality onions. The magnitude is, however, relatively small: bags of forty-two kilograms on average for the lower-quality type are only 0.86 kilograms heavier when filled with onions of better quality (a mere 2% difference in weight). Results in column 2 are consistent in sign and magnitude, with bags from treatment villages weighing slightly more than those coming from control villages, although the coefficient is less precisely estimated.

Turning to production levels, we assess (see table 11) the changes induced by the information campaign on the quantity of onions harvested per hectare at the plot level, relying on recall data from farmers (measured in number of bags). Our results show no overall effect of the information campaign on farmers' overall harvest (columns 1 and 2) or yields per hectare (columns 3, 4, and 5). This result in itself contradicts a common belief held by farmers in the area: that changing from urea to 10-10-20 fertilizer would lead to large declines in volumes harvested.

Assuming that other production costs are constant across treatment and control villages (we did not find an impact on the number of irrigation rounds per plot), one may use the above numbers to assess the overall impact of the information campaign on farmers' onion revenues. The average farmer produced 239 bags of onions per hectare in both control and treatment villages. The average bag in control villages weighed 42.2 kilograms, resulting in a total harvest of $239 \times 42.2 = 10{,}086$ kilograms per hectare in the control group, and $239 \times (42.2 + 0.68) = 10{,}248$ kilograms per hectare in the treatment group. Farmers in treatment villages invested XOF 4,408 more per hectare in 10-10-20 fertilizer than did those in control villages, that is, $4{,}408/10{,}248 =$ XOF 0.43 per kilogram harvested. When selling in markets with operating scales, onions from treatment villages were priced XOF 10.6 higher than those from control villages for which the average price was XOF 115 per kilogram at the time the scales were introduced.

Overall, the difference in revenues per hectare between farmers in treatment and control groups is given by $10{,}248 \times (114 + 10.6 - 0.42) - 10{,}086 \times 114 =$ XOF $122{,}793$ (a 10.7% increase in income per hectare compared to the control group), although there is

Table 11. Impact of Information Campaign on Volumes Harvested

	Number of Bags Harvested 1	Number of Bags Harvested 2	Bags per Hectare 3	Bags per Hectare 4	Bags per Hectare 5
Treatment village	–31.224	–15.449	22.651	26.858	28.38
	(54.268)	(45.033)	(27.01)	(26.363)	(26.096)
Constant	177.974	161.414	239.159	212.307	215.368
	(49.873)***	(60.967)**	(22.983)***	(43.650)***	(42.030)***
n	199	199	302	302	302
Mean control group	177.97	177.97	239.16	239.16	239.16
Month fixed effects	No	Yes	No	Yes	Yes
Household fixed effects			No	No	Yes

Note: Standard errors are clustered at the village level. Asterisks indicate the following: **= $p < .05$, and ***= $p < .01$. Randomized inference-based p-values for one-sided test: column 1, Treatment village=0.26; column 2, Treatment village=0.38; colunm 3, Treatment village=0.24; colunm 4, Treatment village=0.21; column 5, Treatment village=0.21.

a likely smaller increase in benefits per hectare once the costs of other inputs are subtracted.

Four caveats are worth mentioning with respect to these calculations. First, we implicitly assume that the price premium received upon the introduction of labels would have been the same had the scales been introduced earlier. Anecdotal evidence, however, suggests that, given the low supply, the end-of-season-price premium for quality output tends to be lower than at the height of the season when supply is abundant. We therefore hypothesize that the price premium would likely have been higher had the labeling been authorized earlier. Second, farmers may have changed other production practices in response to their change in fertilizer use. While we did not find changes in irrigation cycles or area planted, we are unable to account for other potential changes that could affect production costs. Third, the price premium obtained in the previous sections could have been different had all farmers been aware of the introduction of scales. Such local general equilibrium effects have long been discussed in the literature related to shallow agricultural markets as a potential explanation for the limited uptake of yield-increasing technologies (e.g., Foster and Rosenzweig 2010). Finally, because the quality premiums are unknown *ex ante*, risk aversion will dampen technology adoption regardless of net returns.

Selection Issues

Our sample of transactions (and producers undertaking these transactions) is not representative of the overall population selling onions at the collection points considered. A significant number of producers did not use the scales to weigh and eventually label their onions, and are therefore not recorded in our dataset. Anecdotal evidence suggests that, upon being offered the opportunity of using a scale and labeling, producers with lower-quality onions decided to sell directly to *banabanas* on a volume basis. Furthermore, a number of consignment agents boycotted the use of scales for all the onions they were responsible for selling on behalf of farmers.

If true, this self-selection issue implies that our analysis compares farmers producing the best-quality onions in villages targeted by the information campaign to the best-quality producers in control villages. Using the list of 2,430 producers who sold their onions at collection points in the 2013 season, we find that 10% of the farmers in treatment villages used a scale and labeling in the next season, while 2% of the farmers in control villages did so.[13] If anything, this selection suggests that part of the recorded producers from treatment villages would have produced lower-quality onions than those from control villages, had they not had access to the information campaign. A comparison of recorded producers between treatment and control groups would thus produce a downward bias on our estimate of prices obtained on the markets.

[13] The scales were introduced late in the season, so most farmers sold at collection points before the scales had been installed.

Table 12. Issues of Selection, Using Previous Year's Data

	Used Scale in 2014 Season				
	1	2	3	4	5
Number of bags sold in 2013 (,000)	–0.077	–0.029		–0.056	0.205
	(0.037)**	(0.035)		(0.124)	(0.187)
Price per bag sold in 2013 (,000)	0.005	0.008		–0.008	–0.018
	(0.007)	(0.008)		(0.005)	(0.010)
Sorted onions before sale in 2013	0.024	0.026		–0.017	–0.020
	(0.018)	(0.017)		(0.027)	(0.037)
Treatment village			0.082	–0.014	–0.054
			(0.035)**	(0.041)	(0.048)
Treatment village × number of bags sold in 2013 (,000)				–0.024	–0.242
				(0.130)	(0.195)
Sorted onions before sale in 2013				0.056	0.058
				(0.033)*	(0.041)
Price per bag sold in 2013 (,000)				0.016	0.029
				(0.010)	(0.016)*
Constant	0.055	0.100	0.022	0.065	0.139
	(0.026)***	(0.060)	(0.012)*	(0.025)**	(0.066)***
N	2,429	2,429	2,430	2,429	2,429
Coaxer fixed effects	No	Yes	No	No	Yes

Note: Standard errors are clustered at the village level. Asterisks indicate the following: *= $p < .1$, and ***= $p < .01$. Randomized inference-based p-values for one-sided test: column 1, Number of bags sold in 2013 (000)=0.09; column 3, Treatment village=0.08; column 4, Sorted Onions before Sale in 2013=0.20; column 5, Treatment village x Price per Bag Sold in 2013 (000)=1,000.

We assess the extent to which selection issues may bias our results using data from the previous campaign on the same markets—a campaign wherein no scales were introduced on the market. At the same time, we recorded basic characteristics of transactions from farmers selling at collection points, including the number of bags sold in a given transaction, the price obtained, whether the producer had sorted his or her onions for quality, as well as his or her phone number. Telephone numbers were also recorded in the dataset used in this paper, enabling a matching of our sample of producers with the larger sample of producers who sold on the market in the previous year. This enabled us to compare the characteristics of producers using the scales and labeling when they became available to the characteristics of those who decided not to use them.

Our results are presented in table 12. We do not find any clear evidence of selection in column 1 or in column 2 upon adding *coaxer* fixed effects. If anything, results suggest that those who sold more onions at collection points in 2013 were less likely to have used the scales in the following season. *Coaxer* fixed effects (not reported here) are in large part highly significant, further suggesting that the choice of using scales was in fact largely decided by *coaxers*, some of whom simply decided to boycott the scheme. While most interviewed producers indicated that they felt free to change *coaxers* if they were dissatisfied with their services, our data indicate that 80% of producers had relied on the same *coaxer* to sell their onions in the previous four seasons. Furthermore, in 40% of the cases, producers and *coaxers* have family ties and in 26% of the cases they live in the same village. Thus, relational contracts between producers and *coaxers* likely contribute to explaining the fact that most producers followed their *coaxers*' suggestion of using the grading system or not. Results in column 3 indicate an overrepresentation of treatment producers in our sample as compared to controls, although we did not uncover clear evidence that this selection is based on the farmer characteristics that we rely upon here. This is seen in columns 4 and 5, where marginally significant relationships using standard clustering of standard errors are clearly rejected based on randomized inference estimates.

Epilogue

Scales and quality labeling were introduced in 2014 at the Podor onion collection points to make those engaging in transactions better informed about quantities and qualities, and transactions more transparent. We used a field experiment to assess producers' responses to quality recognition in market transactions. Results show that this created significant gains for producers as weighing and labeling induced higher quality that was rewarded by higher prices. Producers responded to quality recognition by using more quality-enhancing, instead of volume-enhancing, fertilizers, and by engaging in more onion sorting to grade bags by quality level. Higher prices with no declines in yields led to significant income gains for farmers. This suggests that African smallholder farmers can respond to price incentives by adjusting both their production and marketing practices.

With these positive results creating efficiency and equity gains, it should come as a surprise that the process of weighing and labeling was abandoned in the subsequent cropping season. Understanding why this happened requires assessing the political economy of relationships between the four categories of agents involved in the onion value chain: producers, *coaxers*, *banabanas*, and local development agencies. A survey of opinions revealed the following responses to the experiment.

Producers indicated strong appreciation for the initiative. Weighing was seen as important to them because they knew that there was extensive cheating by *banabanas*, with presumed 40-kilogram bags needing to be overfilled to be sold and reaching, on average, an extra un-remunerated 7%. Quality recognition was also important to them as a source of additional revenue, especially through labeling endorsed by third-party verification, in this case the UGB team overseeing the labeling process.

Coaxers were divided about the issue due to fears of free-riding creating advantages for some at the expense of others. The *coaxers*' main objective is to rapidly sell to *banabanas* the onion bags on consignment with them. Further, *coaxers'* also aim to deter *banabanas* from exercising their fallback options, namely, buying at the farm-gate instead of the collection point, shifting their purchases to other collection points, or buying from *coaxers* who do not use scales. As is typical of a prisoner's dilemma situation, each of them has more to gain from defaulting until a regulatory authority imposes the new system on all *coaxers*. A survey of opinions thus found some *coaxers* agreeing with the system and others categorically rejecting it.

Banabanas are the ones with market power in these distant markets, and they are the main losers due to greater market transparency; they voiced nearly unanimous opposition to the system. *Banabanas* were able to exercise enough pressure on *coaxers* and regional authorities to make sure that the system would be discontinued and not universally extended to all collection points.

Local development agencies have been shown to be effective in delivering technical assistance to farmers. These agencies were able to gather farmers and work with their local organizations to offer training in quality response and storage. They were, however, not able to intervene in the regulation of local markets or the imposition of new rules to coordinate agents on behalf of the collective good. This may in part be due to the fact that national markets remain highly unstable with erratic government interventions in import policies that undermine price expectations on local markets; it may also be due to a lack of political representation of farmers' interests that the local agencies could use to press for policy reforms.

In the end, we see that market reforms which make participants better-informed and transactions more transparent can be effective at inducing technology adoption by smallholder farmers, but they need effective regulatory power to be implemented. In spite of this temporary setback in our study area, using scales is prevalent on onion markets throughout the country, as shown in figure 1. The experimental introduction of scales and labeling where they were not yet present has allowed us to show that they create large gains for farmers. We can thus expect that it is only a matter of time for scales and labeling to be introduced in more distant markets such as those in our study area.

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