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Farmers' Quality Assessment of Their Crops and Its Impact on Commercialization Behavior

A Field Experiment in Ethiopia

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ABSTRACT

Adoption of quality-enhancing technologies is often driven largely by farmers' expected returns from these technologies. Without proper grades, standards, and certification systems, however, farmers may remain uncertain about the actual financial return associated with their quality-enhancing investments. This report summarizes the outcomes of a short video-based randomized training intervention on wheat quality measurement and collective marketing among 15,000 wheat farmers in Ethiopia. Our results suggest that the intervention led to significant changes in farmers' commercialization behaviors—namely, it prompted farmers to adopt behaviors geared toward assessing their wheat's quality using easily implementable test-weight measures, assessing the accuracy of the equipment used by buyers in their kebeles (scales, in particular), and contacting more than one buyer before concluding a sale. The training also led to improvements in share of output sold, price received, and collective marketing, albeit with important limitations. First, farmers who measured their wheat quality received a higher price, but only if their wheat was of higher quality. Second, farmers who found that their wheat was of higher quality were more reluctant to aggregate their wheat (that is, sell their products through local cooperatives) than those who found that their wheat was of lower quality. Lastly, the training intervention led to better use of fertilizer in the following season. Our discovery that a short training intervention can significantly change farmers' marketing and production behavior should encourage the development of further interventions aimed at enhancing farmers' adoption of improved technologies and commercialization.

Keywords: farmers' quality assessment, impact, commercialization behavior, RCT, wheat, Ethiopia

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1. INTRODUCTION

Use of basic agricultural technologies such as adequate fertilizers and seeds remains low in Africa south of the Sahara, particularly among smallholder farmers (Gollin, Parente, and Rogerson 2002; World Bank 2007). Factors that contribute to these low adoption rates include lack of access to these technologies, to information about their use, and to financial services (Jack 2011; Karlan et al. 2014). Low or uncertain market returns from investments may further contribute to the observed low adoption rates (Suri 2011). In the face of uncertain market rewards for making investments that might enhance the quality of their products, for instance, smallholder farmers have few incentives to adopt quality-enhancing agricultural practices and technologies. Such scenarios may arise when local spot markets do not price-discriminate between higher-quality and lower-quality products, when farmers' organizations or cooperatives aggregate and sell products in a way that ignores their quality differentials, and when contractual arrangements with agro-processors rest on weakly observable quality standards.

Certain quality attributes are more directly observable than others. The presence of foreign materials, varietal mixtures, and traces of pests or spoilage are visually observable by both parties in an exchange, and price can be negotiated based on these readily observable factors. Detection of other attributes requires use of measurement tools that are typically controlled—and potentially manipulated—by buyers. These tools include scales to measure weight, as well as more sophisticated tools to assess moisture, protein content, or flour extraction rates. For these quality attributes, small-scale producers have no choice but to trust that the buyers' equipment accurately reports the quality of their product, even though measurement errors may be too costly to eliminate entirely and the losses to producers from exploitation of (deliberate) inaccuracies can be sizable (Barzel 1982).

Quality-enhancing investments include activities ranging from seed selection and purchase, fertilizer choice and application, and crop management practices, to proper harvesting, threshing, winnowing, and storage of outputs. Given the costs associated with these activities, farmers may invest in them only if they trust that the quality enhancements they generate will be duly rewarded. In other words, the investment costs must be less than the projected benefits to warrant undertaking such activities (Suri 2011). For instance, farmers may decide not to clean their products if the cleaning costs will exceed the expected market premium for clean grains. The decision is more complex for those quality attributes that are not directly observable by farmers. Absent third-party certification, farmers must trust that local traders, contractors, or cooperatives will properly reward them for producing higher-quality crops, even though they lack a means to verify these types of quality attributes.

Third-party certification systems exist for a wide variety of high-value crops, such as coffee, cocoa, milk, and fruits and vegetables, to cost-effectively safeguard against potential errors in weighing and assessing commodity attributes. To warrant the development of such systems, the measurement costs incurred by the parties to the transaction should be expected to exceed those under joint maximization (Barzel 1982). One also finds such systems for grains, although their use is typically limited to large transactions. Third-party certification systems rarely, if ever, exist for the types of small transactions that account for the bulk of individual smallholder farmers' revenues. Absent such a system, incentives to invest in quality-enhancing technologies are limited; that is, if all farmers are treated alike regardless of differences in the quality of their produce, they will eventually adjust their practices to the lowest common denominator (Eluned and Hill 1994). In turn, the lower-quality domestic output may strongly constrain efforts to limit reliance on grain imports, a strategy currently embraced by a number of governments in Africa south of the Sahara.

In the present study, we assess the effect of reducing farmers' uncertainty regarding the unobservable quality attributes of their wheat on their marketing behavior, level of commercialization, and investment in quality-enhancing agricultural technologies. The intervention applied in this study was training farmers to evaluate their wheat flour extraction rate (flour yield) through a costless and relatively accurate means. We also trained farmers to assess the accuracy of scales used by local traders, contractors, and cooperatives. Lastly, we examined the effectiveness of further training on the potential benefits of collective commercialization through farmer groups and local cooperatives.

Our experiment took the form of a cluster-randomized controlled trial in 121 kebeles[1] in high-potential wheat-producing zones in the Oromia and Amhara regions of Ethiopia. Forty randomly selected kebeles served as the control group. In another 44 kebeles, farmers were trained to perform quality measurement and weighing-scale assessment. Farmers from the remaining 37 kebeles were trained in quality assessment, scale assessment, and the potential benefits offered by collective marketing. Overall, more than 15,000 farmers were trained: 57 percent were trained in wheat quality measurement and scale accuracy assessment, and 43 percent received that training plus education on the potential advantages of collective marketing. In the training sessions, participants viewed videos that featured local farmers explaining how to measure flour extraction rates and/or describing their experience with collective marketing. The videos were screened and the ensuing discussions mediated by trained facilitators using the preexisting group structure in the villages (that is, development groups).[2] The screenings were held once per development group at a central location, usually at a farmers' training center. As part of the experiment, the study collected and analyzed baseline and follow-up information from a sample of 1,184 households in the 121 selected kebeles.

The results indicate a positive and significant change in marketing behaviors among households that took part in the training sessions. The training significantly increased the measurement of wheat quality (test-weight) and the frequency with which sellers cross-checked the accuracy of the buyer's weighing scale before concluding sales transactions. The results also show significant increases in the share of the farmers' wheat that was sold and the use of modern fertilizers in the following season. In the study, we independently measured farmers' wheat quality at baseline and further disaggregated the results based on the initial quality. In general, producers of higher-quality wheat ended up selling less of their wheat through the local cooperatives and more wheat to traders, postponed their wheat sales until later in the year, and obtained significantly higher prices per kilogram sold. These results support our initial prediction that enhancing farmers' knowledge of the quality of their products should increase their uptake of improved technology and positively reward those farmers who were able to produce higher-quality crops.

These results contribute to the empirical literature on producers' responses to market incentives. 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 are seldom able to exploit spatial arbitrage opportunities, but instead often rely on intermediaries (Fafchamps and Vargas-Hill 2008). Empirical evidence suggests that in these contexts, price information from distant markets rarely translates into improved prices and higher revenues for farmers (for example, Aker 2010; Aker and Fafchamps 2015; Futch and McIntosh 2009; Goyal 2010; Muto and Yamano 2009). Only when farmers are able to select the destination markets for their products does the evidence point to positive price premiums for their output (for example, Jensen 2007). Notably, the majority of farmers do not have this kind of leverage.

In most cases, changes in local market conditions are likely to be the most relevant factor influencing market incentives for technology adoption. In a recent study in Senegal, for instance, Bernard et al. (2016) showed how the introduction of third-party certification of quality in remote onion markets led to a significant increase in farmers' uptake of readily available improved fertilizers. In a different setting, Saenger et al. (2013) found that Vietnamese farmers invested in enhanced quality of milk through a contractual relationship following the introduction of third-party quality inspections. While the third-party inspections did not find evidence that the previous inspections by the contractors were biased, farmers had anticipated this outcome and feared that it would reduce the expected gains from their

[1] A *kebele* is the lowest-level administrative unit in Ethiopia.

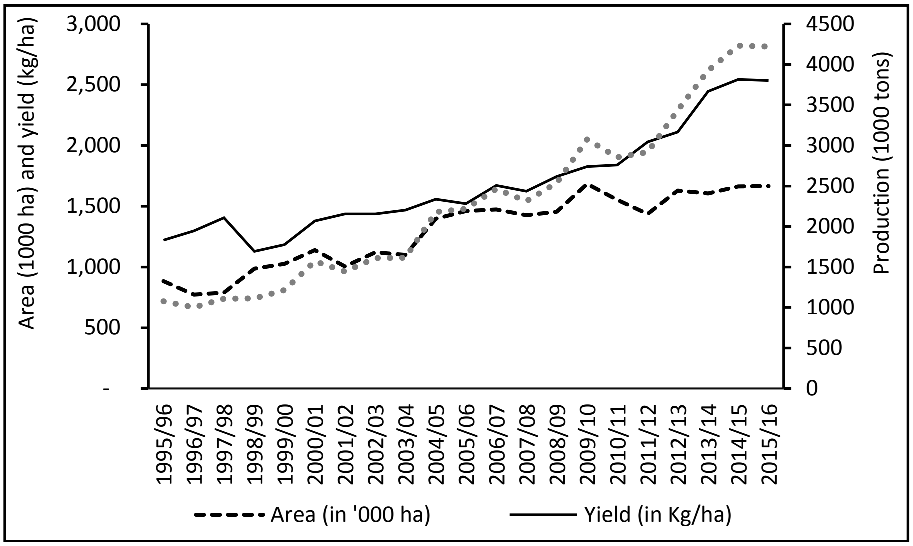
[2] A *development group* is an informal administrative structure within a village, which includes approximately 25 to 30 farm households. It is routinely used as a forum to discuss local development agendas, including new agricultural technologies and practices.

quality-enhancing investments. In a more descriptive paper on India, Fafchamps, Vargas-Hill, and Minten (2008) argued that imperfect measurement of a product's quality correlates with lower investments in quality attributes by farmers. The present study adds to this emerging literature, highlighting how farmers' own knowledge of unobservable product quality can affect their commercialization choices and the prices they obtain for their products.

2. WHEAT IN ETHIOPIA

Wheat is one of Ethiopia's main staple crops in terms of both production and consumption. Based on its role in the population's caloric intake, wheat is the second most important food in the country, behind maize (FAO 2016). Wheat is grown primarily in the highlands of Ethiopia, and the two main wheat-producing regions (Oromia and Amhara) account for approximately 85 percent of national wheat production (CSA 2013). Even though wheat is typically grown by smallholder farmers in Ethiopia, the country is the largest wheat producer in Africa south of the Sahara by a sizable margin. Wheat production during the 2015/2016 *meher* [3] season was 4.1 million metric tons and has been growing significantly over time (rising by an average annual growth of 7.1 percent over the last two decades) due to both area expansion and yield improvements (Figure 2.1).

Figure 2.1 Wheat production, area cultivated, and yields (1995/1996–2015/2016, Ethiopia)



Source: Central Statistical Agency (1995/1996–2015/2016).

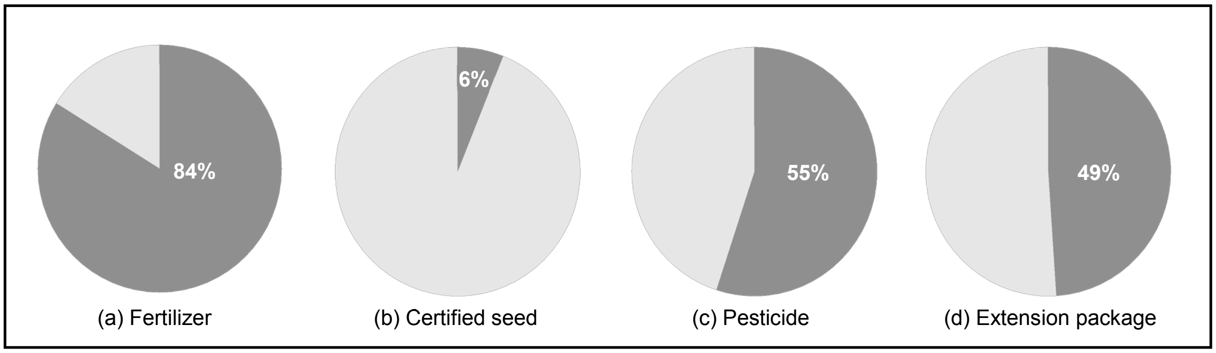
In terms of area, wheat is the fourth most widely grown crop in Ethiopia, after tef, maize, and sorghum. Today, approximately 1.7 million hectares of land are devoted to wheat crops—a significant increase from the less than 1 million hectares planted in wheat in 1996, representing an annual growth rate of 3.2 percent (Figure 2.1). In addition, the country has increased its wheat yield by approximately 3.7 percent per year over the last two decades: Current wheat yields are roughly double the average wheat yields 20 years ago, implying that more than half of the growth in production since 1996 can be attributed to yield growth. The rate of growth has been especially high in recent years: Since 2005, yield has increased more than 5.2 percent per year. Nevertheless, compared to the yields attained by other major producers in Africa (for example, Egypt, South Africa, and Kenya), Ethiopian wheat yields are low, indicating considerable potential for improvement.

Various constraints combine to explain the wheat yield gaps in Ethiopia. Use of modern production-enhancing inputs, such as fertilizers and improved seeds, among wheat farmers in Ethiopia is reportedly low. National statistics on fertilizer use indicate that a significant portion of the wheat-producing area is enhanced with fertilizer (Figure 2.2), and the application of fertilizer on wheat plots is relatively intensive (150 kilograms per hectare, which is still less than the recommended rate) compared to the use of fertilizer with other cereal crops. However, only 6 percent of the wheat-growing area is

[3] Meher is the long (main) rainy and production season in Ethiopia.

covered by certified seed, defined as seed purchased from the Ministry of Agriculture, a cooperative, a seed company, or another source of varietally pure seed. Thus, on average, wheat farmers purchase improved seed roughly every 17 years. Moreover, the country has a long way to go to close the yield gaps that have emanated from farmers' limited use of other chemicals (for example, pesticides and herbicides) and application of best agronomic practices that are promoted by the extension system (Figure 2.2).

Figure 2.2 Share of wheat area covered by modern inputs and practices (2015/2016)



Source: Central Statistical Agency (2015/2016).

Despite the rapid growth in wheat production over the last decade, shares of marketed surplus supplies of wheat are consistently low in Ethiopia. The 2015/2016 Agricultural Sample Survey reports that only 20.8 percent of Ethiopia's wheat output was sold, indicating that most wheat in the country is not marketed; instead, it is retained by farmers and used for own consumption, seed, and possibly other uses. A recent study by Minot et al. (2015) found considerable variation in the share of wheat sold across farmers' households: The majority of wheat growers do not appear to sell any of their wheat output, and only 10 percent of wheat growers sell more than half of their wheat.

Irrespective of the limited growth or lack of growth in marketed surplus, wheat processing is thriving in Ethiopia, following the trend set by the healthy domestic demand for wheat products—a demand that is predicted to grow in the future. Large-scale flour mills and pasta producers are emerging in increasing numbers, though their milling capacity is estimated to be half the capacity of the existing small-scale hammer mills (Bernard and Eppenstein 2015; Minot et al. 2015). These large-scale wheat processors rely heavily on imported wheat; the share of wheat they source locally is negligible. This reality reflects troublesome aspects of the Ethiopian wheat market that prevent smallholders from exploiting processors' growing demand for wheat, with wheat subsidies being one of the major constraints.

Ethiopia relies heavily on imports to meet its growing wheat processing and consumption needs; indeed, the country's wheat imports have increased by more than 5 percent per year, on average, over the last two decades. In recent years, the absolute level of wheat imports has emerged as a key concern for the country. Most of these imports are commercial in nature, supplying subsidized wheat to selected mills. The subsidy, which is reportedly quite costly, has a negative effect on domestic producers by lowering the price of wheat and thereby discouraging investment in quality-enhancing inputs. Recent estimates indicate that the cost of the wheat import subsidy to the Ethiopian government and farmers is eight times greater than the benefits that accrue to Ethiopian consumers (Minot et al. 2015).

The country's poor rural infrastructure (limited transport network, lack of market information, and so on) is widely cited as a factor that has constrained farmers' willingness to participate in Ethiopia's wheat market. For instance, a recent study on the wheat value chain in Ethiopia by Minot et al. (2015) indicated that transportation represents the main marketing cost and that transport fees are not proportional to distance, owing to the Ethiopian roads' poor state of repair, a lack of all-weather feeder roads, and a shortage of transportation in rural areas.

The lack of market institutions is another factor that negatively affects farmers' incentives to participate in the wheat market. Despite the efficiency and equity benefits it would provide, a system of grades and standards has not been developed for local-level wheat markets in Ethiopia. Smallholder wheat farmers and their trading partners rely heavily on physical inspection of grain when bargaining over prices, even though the main quality parameters are often unobservable (for example, protein, moisture, and hectoliter mass). Ultimately, the lack of widely recognized quality grades and standards and units of measurement considerably increases the costs of market transactions. For instance, such gaps create the need at many stages for brokers (whose tasks include checking the grain quality—using parameters known only to themselves—and determining the market-clearing price on behalf of either the buyer or the seller) and result in a long and complex wheat marketing chain (Gabre-Madhin and Goggin 2005). Moreover, the lack of grades and accompanying incentives discourages farmers from investing in quality-enhancing technologies. The present study aims to address information and technical constraints regarding grades and standards, which represent a valuable incentive to the production of quality agricultural products.

3. EMPIRICAL SETUP

The Intervention and Study Sites

In our study, we assessed the effects of a randomized training intervention related to wheat quality measurement and/or collective marketing on smallholders' marketing behaviors, levels of commercialization, and use of modern inputs. The treatments consisted of two types of training.

The first type focused on teaching and motivating farmers to measure hectoliter mass (test-weight)—an important quality metric that indicates the flour yield for bread wheat—through locally available instruments. Test-weight is a measure of the density of a known volume of wheat grain; it is used as an overall indicator of grain quality and potential flour yield. To determine a specific weight, a fixed volume of wheat is weighed, and these measurements are then converted into units of kilograms per hectoliter or pounds per bushel. Low test-weights may indicate grains that are poorly filled, shriveled, very large, or slightly curved, or those containing a large quantity of foreign matter (for example, dust or chaff). Wheat with a low test-weight generally results in a low flour extraction rate. High test-weights indicate that the grain is well filled or free from admixtures and equates to a higher flour yield. In general, the test-weight can be affected by varietal choice, growing conditions (for example, field choice, timely planting and harvest, and application of adequate nitrogen fertilizer), and proper cleaning and drying (Mallory et al. 2012). The first intervention also educated wheat farmers about the benefits of producing better wheat (for example, premium prices and ease of finding a buyer) and knowing the quality of their wheat (for example, better bargaining power), as well as about farming practices that can improve the quality of wheat (for example, plot selection, row planting, a reduced seeding rate, and nitrogen application).

The second training intervention educated farmers on the potential benefits of collective marketing and the ingredients necessary for it to be effective (for example, trust, networking, and adequate institutional support). The video shown to farmers in this intervention also informed them about the possible challenges associated with collective marketing as well as the experiences of and actions taken by existing marketing groups in their locality to overcome these challenges.

In addition to receiving these two video-based types of training, farmers were taught to assess the precision of a buyer's weighing scale, as a means to address the suspected uncompetitive behaviors of traders during measurement—for example, use of a rigged set of scales while buying farmers' products. This instruction involved weighing each participant and providing him or her with the result. This value could then be used as a reference weight when farmers sold their wheat; in other words, farmers could weigh themselves on the trader's scale to assess the reliability of that scale.

The training was provided to wheat farmers in four high-potential wheat-producing zones of the Oromia and Amhara regions: the Arsi, Bale, North Shewa, and East Gojjam zones. These four zones are the major wheat producers in Ethiopia, accounting for approximately 29 percent of the total national cultivated wheat area and 32 percent of total wheat production in the 2014/2015 *meher* season (CSA 2015). The video screening covered a total of 11 woredas and 81 kebeles in these zones, excluding the 40 control kebeles. As shown in Table 3.1, the intervention trained more than 15,000 wheat farmers, of whom 57 percent were trained primarily on wheat quality measurement and 43 percent on both wheat quality measurement and the potential benefits of collective marketing (that is, the second treatment arm included additional video-based training on collective marketing as well as the training on quality measurement). Both treatment groups received training on means to verify traders' weighing scales.

Table 3.1 Number of wheat farmers attending video screenings, by treatment arms

Treatment	Number of kebeles	Number of wheat farmers who attended the video screening
Training on:		
Wheat quality measurement and buyer's weighing scale verification	44	8,751
Wheat quality measurement, collective marketing, and buyer's weighing scale verification	37	6,543
Total	81	15,294

Source: Authors' compilation.

The experiment used video-based training following Digital Green's methodology.[4] The research team produced two participatory videos—one on wheat quality measurement and the other on the potential benefits of collective commercialization—featuring local farmers. Local farmers were included in these videos because they were expected to be more persuasive and would promote homophily—that is, people's tendency to receive, accept, internalize, and materialize information better from those whom they recognize as similar to them. We relied on preexisting group structures that are routinely used for public agricultural extension activities in Ethiopia (that is, development groups) to disseminate the videos. The videos were disseminated through human mediation using facilitators hired and trained by the research team. The chosen videos were screened once per development group at a central location, typically the local farmer training center.

Besides its key advantage of delivering a consistent message to farmers with low levels of literacy and numeracy, the use of videos (along with the existing group structure) made the intervention cost-effective. Initial estimates indicate that the intervention cost only about $3 per farmer (Table A.1). This is equivalent to the amount that farmers can retain from proper weight measurement (due to the training). The estimated training costs become even lower if we consider only the variable costs, since the costs associated with the video production and acquisition of Pico projectors to show the videos become trivial as the coverage increases. In other words, the fixed costs of video production and projectors progressively decrease and make the approach more cost-effective as the number of trained farmers increases.

Experimental Design, Sampling, and Timing

As indicated above, the experiment was conducted in 121 kebeles that were selected from 11 high-potential wheat-producing woredas in the highlands of the Amhara and Oromia regions. In each woreda, kebeles were randomly grouped into three study groups (Table 3.2):

- Treatment group 1: wheat quality measurement training group
- Treatment group 2: quality measurement and collective marketing training group
- Control group: no video screened

[4] Digital Green (www.digitalgreen.org) is a nonprofit organization that works to integrate innovative technology with global development efforts to improve human well-being. It promotes the use of videos that are of the community, by the community, and for the community, in an effort to accelerate the adoption of new technologies.

Table 3.2 Experimental design and sample distribution

Variable	Quality measurement training	Quality measurement and collective marketing training	Control group	Total
Number of kebeles	44	37	40	121
Total number of sampled households	452	412	320	1,184
Quality treatment samples	290	—	—	290
Quality and collective marketing treatment samples	—	250	—	250
Spillover samples	162	162	—	324
Control samples	—	—	320	320

Source: Authors' computation based on data from wheat growers' survey, 2016.

We randomly allocated the kebeles in both treatment groups into three treatment-intensity variations: (1) kebeles where only one randomly selected village was treated, (2) kebeles where half of the villages were randomly selected to be treated, and (3) kebeles where all the villages were treated. This was done with the aim of measuring both spillover (diffusion) effects and potential response by local market agents.

As part of the experiment, the study collected baseline and follow-up information from randomly selected individuals in the sample kebeles. The baseline data were collected right before the intervention and served as a pre-intervention benchmark with which to compare the impact of the two training interventions. These data included information on the last production and marketing season prior to the intervention. In addition, the baseline was designed to provide up-to-date information on a wide range of topics related to wheat farmers' production and marketing behavior in Ethiopia.

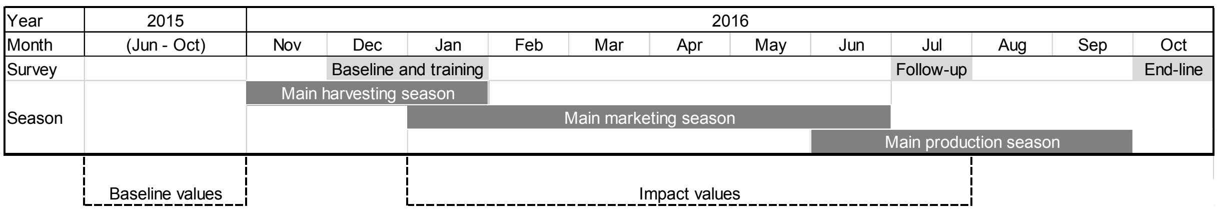
The sample households were selected using a two-stage stratified random sampling. In the first stage, 9 to 15 kebeles were selected from the 11 woredas based on their wheat production potential and randomly assigned to treatment and control groups. In the second stage, 8 or 12 farm households were randomly selected from each of the 121 kebeles using a household list maintained by the kebele administration office. As shown in Table 3.2, in kebeles where either one village or half of the villages were treated, half of the sample was drawn from untreated villages in the treatment kebele. In total, the baseline sample included 1,184 households, of which 290 attended wheat quality measurement training, 250 attended both wheat quality measurement and collective commercialization training, and 324 resided in untreated villages within the treatment kebeles ("spillover households"). The remaining 320 households were considered the control group (Table 3.2). For all groups, the head of the household or the spouse, in the absence of the head of the household, was interviewed at home. At the end of the interview, households in the treatment villages were informed about a video screening session on wheat production and marketing in their locality to be held later that same day or on the following day.

Both the implementation of the training interventions and the baseline data collection were carried out from mid-January to late February 2016. The follow-up survey was conducted five or six months later, in July 2016, after the marketing season was completed. Although our focus was on commercialization, we were also able to collect information on planting and input use (actual and estimated) during the following season since the wheat sowing was completed in most of the study areas during the follow-up survey.[5] The attrition rate in the follow-up survey was low: 0.8 percent, with 0.3 percent of the households refusing to take part in the survey and 0.5 percent being unavailable in their kebele or village during the survey period. These households were dropped from the sample in the impact analysis.

[5] In Ethiopia, the wheat planting period is between late May and early July; the main commercialization or marketing period is from late December to July. See the Famine Early Warning Systems Network (FEWS NET) and the Food and Agriculture Organization of the United Nations' Global Information and Early Warning System on Food and Agriculture (GIEWS) for details on Ethiopia's seasonal calendar.

As indicated in Figure 3.1, we originally planned to conduct a final survey by October 2016 to collect information on potential changes in production (farming practices) behaviors, and we planned to improve the data quality for marketing indicators by averaging responses from the follow-up and end-line surveys of the same period. Ultimately, we instead decided to use the follow-up survey for impact evaluation for three main reasons: (1) The follow-up data provided a complete picture of farmers' marketing activities during the main commercialization season, which was the focus of our study; (2) the follow-up data collection gathered information on the main farming activities (that is, land preparation, planting, and input use) that the intervention aimed to influence; and (3) October was not a good time to carry out a survey due to field conditions in the country.

Figure 3.1 Experiment and survey timing and wheat seasonal calendar



Source: Famine Early Warning Systems Network (FEWSNET 2013), Global Information and Early Warning System on Food and Agriculture (GIEWS 2016), and consultation with experts.

Experimental Integrity

We first assessed the extent to which the random allocation of treatment across kebeles generated comparable samples of households at baseline. For this purpose, we ran a series of balancing tests on our outcome variables and on the household- and kebele-level covariates. The balancing tests for the outcome variables indicated that there was no statistically significant difference between the study groups on any of the outcome variables, except in the case of share of wheat sold collectively or through cooperatives, which appeared to be higher in the spillover group than in the quality and collective marketing group at baseline (Table 3.3). Clearly, the observed difference was not due to access, as the treatment groups were comparable in terms of both the availability of cooperatives in the locality and the share of sample farmers who were members of a cooperative (Tables 3.4 and 3.5). We assume that the sample farmers in the spillover group were more committed when it comes to patronage or use of cooperative services.

The balancing tests on household covariates between the study groups are reported in Table 3.4. The results show that the groups were balanced at baseline in terms of age, education, and gender of the household head; household size; landholding size; livestock ownership; membership in cooperatives; and remoteness of the kebele where the household resides. Households in the study groups other than the quality measurement group tended to be more likely to own a television, but this difference affected a very small proportion of the sample—only 1 percent of these households reported owning a television. The main imbalance we found is related to use of hired labor for wheat production: Households in the control group had hired more person-days of labor for wheat production, compared to households in the other three study groups, for the *meher* season preceding the training intervention.

Table 3.3 Balancing tests on outcome variables

Variables	Quality training (*n* = 290)	Quality and commercialization training (*n* = 250)	Spillover households (*n* = 324)	Control households (*n* = 320)	*F*-test 1 *p*-value	*F*-test 2 *p*-value
Assess wheat quality (1 = yes)	0.84	0.84	0.83	0.86	0.616	0.603
Sold wheat collectively (1 = yes)	0.09	0.06	0.12	0.07	0.343	0.118
Cross-check buyer's scale (1 = yes)	0.63	0.60	0.61	0.61	0.958	0.987
Contacted more than one buyer (1 = yes)	0.80	0.82	0.84	0.81	0.427	0.592
Sold later than last year (1 = yes)	0.61	0.61	0.67	0.59	0.142	0.145
Wheat sold (share, %)	39.0	37.4	37.6	37.0	0.794	0.981
Wheat sales price (average, birr/kg)	8.2	8.5	8.3	8.2	0.894	0.345
Share sold through co-ops (%)	9.0	5.8	11.1	7.2	0.476	**0.096**
NPS rate (kg/ha)	162.7	164.2	171.5	135.1	0.228	0.228
Urea rate (kg/ha)	109.6	122.1	112.1	107.0	0.957	0.757
Wheat seeding rate (kg/ha)	237.7	238.8	231.7	230.4	0.542	0.600

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: NPS = nitrogen + phosphorus + sulfur. F-test 1 tests that quality = spillover = control = 0; F-test 2 tests quality and commercialization = spillover = control = 0. Spillover households include sample households that are untreated within the treatment kebeles. Bold indicates a statistically significance difference in means between sample households that received wheat quality measurement training (and/or collective commercialization training) and spillover and control households.

Table 3.4 Balancing tests on control variables

Variables	Quality training (*n* = 290)	Quality and commerciali-zation training (*n* = 250)	Spillover households (*n* = 324)	Control households (*n* = 320)	*F*-test 1 *p*-value	*F*-test 2 *p*-value
Age of household head (completed years)	46.2	46.2	45.4	45.7	0.827	0.832
Education (1 = read and write)	0.70	0.66	0.69	0.68	0.882	0.826
Household size (number)	5.8	5.7	6.1	6.1	0.481	0.167
Gender of household head (1 = male)	0.9	0.9	0.9	0.9	0.610	0.621
TV ownership (1 = yes)	0.0	0.1	0.1	0.1	**0.032**	0.810
Landholding (1 = >2 ha)	0.40	0.50	0.46	0.48	0.461	0.707
Livestock ownership (TLU)	8.2	8.5	8.5	8.7	0.768	0.954
Hired labor (total, in person-days)	2.6	3.0	2.7	4.5	**0.018**	**0.035**
Cooperative member (1 = yes)	0.70	0.75	0.70	0.72	0.937	0.492
Wheat quality (log, gm)	6.8	6.8	6.8	6.8	0.355	0.476
Kebele's distance to woreda center (km)	15.7	16.5	17.3	12.2	0.202	0.255

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: TLU = tropical livestock units. F-test 1 tests that quality = spillover = control = 0; F-test 2 tests quality and commercialization = spillover = control = 0. Spillover households include sample households that are untreated within the treatment kebeles. Bold indicates a statistically significance difference in means between sample households that received wheat quality measurement training (and/or collective commercialization training) and spillover and control households.

Table 3.5 reports balancing tests on a variety of kebele-level variables between the three study groups, since spillover households were found within the two treatment groups. No significant differences were found across groups of kebeles in terms of agriculture and wheat production potential, access to roads, access to markets, access to information, number of farm households, and shocks that affected wheat production in the 2015/2016 *meher* season.

Overall, the balancing tests suggest that our study used a well-executed and randomized sampling frame. The remaining differences are accounted for in the later analysis by controlling for the corresponding covariates.

Table 3.5 Balancing tests on kebele characteristics

Variables	Quality training kebeles (*n* = 43)	Quality and collective marketing training kebeles (*n* = 38)	Control kebeles (*n* = 40)	*F*-test *p*-value
Kebele's agricultural and wheat production potential				
Size of agricultural land cultivated in 2015/2016 *meher* (ha)	1,805.6	1,726.2	2,096.5	0.243
Share of wheat area in the kebele (%)	48.6	46.3	52.7	0.387
Percentage of farmer's cultivated wheat (%)	71.3	77.6	73.5	0.553
Kebele's access to roads				
Connected by paved/tar road (1 = yes)	0.57	0.71	0.67	0.407
Connected by asphalt road (1 = yes)	0.07	0.08	0.22	0.126
Kebele's access to markets				
Regular market in the kebele (1 = yes)	0.27	0.26	0.37	0.525
Agricultural trader/dealer in the kebele (1 = yes)	0.64	0.70	0.71	0.828
Agricultural cooperatives in the kebele (1 = yes)	0.93	0.84	0.92	0.433
Formal source of credit in the kebele (1 = yes)	0.78	0.89	0.74	0.166
Kebele's access to information				
Percentage of households owned mobile (%)	63.4	67.2	65.8	0.771
Farmer training center in the kebele (1 = yes)	0.97	0.97	100.0	0.367
Number of development agents in the kebele	3.3	3.1	3.0	0.576
Number of farm households in the kebele	1,018.7	1,022.0	1,177.5	0.682
Kebele's distance to woreda/district center (km)	15.7	16.8	12.1	0.213
Shock that affected wheat production in 2015/2016 *meher* (1 = yes)	0.76	0.81	0.71	0.636

Source: Authors' computation based on data from wheat growers' survey, 2016.

Compliance

We assessed compliance—the extent to which targeted households effectively participated in the experiment according to the design—for both treatment groups at two levels: (1) effective participation in the video screening sessions (first-level compliance) and (2) implementation of the practices promoted by the training (second-level compliance).

Table 3.6 reports the compliance levels for the wheat quality measurement training. The results indicate very high first-level compliance: More than 90 percent of the sample of invited households attended the video screening sessions to which they were assigned. By comparison, 11 percent of the spillover households (not initially invited to attend the screenings) participated, as well as 1 percent of the households in the control group. We further assessed whether farmers who attended the screening fully understood the main messages in the video as part of first-level compliance. As shown in Table 3.6, the vast majority of households were able to recall the main content of the video five or six months after the screening.

Table 3.6 Compliance level for wheat quality measurement training

Variable	Treatment group: Quality measurement (*n* = 288)	Quality measurement and collective marketing (*n* = 247)	Spillover households (*n* = 321)	Control households (*n* = 319)
Watched video on wheat quality measurement (%, yes)	92.0	90.7	10.9	0.9
Among those who attended screening: Video taught about … (%, yes)				
Benefits of producing good-quality wheat	99.6	100.0	100.0	100.0
Knowing the quality of wheat	99.6	99.6	100.0	100.0
How to measure wheat flour yield	98.9	98.7	97.1	100.0
Farming practices to improve quality	89.4	95.1	97.1	100.0
Among those who attended screening: Measured quality (flour yield) of wheat before sale (%, yes)	15.3	13.8	3.7	2.2
Among those who did: In what way did measuring quality (flour yield) help you? (%, yes)				
Easily find a buyer	27.3	29.4	8.3	14.3
Negotiate for better price	45.5	35.3	50.0	42.9
Easily aggregate with other farmers	2.3	2.9	16.8	0.0
Better choose varieties for next season	20.5	32.4	25.0	28.6
It didn't help	4.6	0.0	0.0	14.3
Among those who did not: Reason for not measuring the quality (flour yield) of wheat (%, yes)				
Don't have the equipment	71.3	72.3	54.4	46.5
The measurement is difficult	10.7	8.5	7.1	8.3
I don't think knowing the quality helps	10.7	11.7	10.0	7.4
I don't know how to measure	7.4	7.5	28.5	37.8

Source: Authors' computation based on data from wheat growers' survey, 2016.

By comparison, we found a relatively low rate of second-level compliance (application or implementation of the trainings). Only about 15 percent of the households that took part in the video screening effectively measured the quality of their wheat before taking it to market. Limited access to equipment (a measurement scale) was mentioned as a major reason for the lower second-level compliance rate. Those farmers who measured their wheat quality indicated that knowing the potential flour yield of their wheat enabled them to negotiate for a better price. Ease of finding buyers and information on varietal choices for the following season were also mentioned as benefits of the quality measurement exercise (Table 3.6).

Table 3.7 reports the compliance levels for the wheat quality measurement and collective marketing training. The results indicate that the vast majority of the invited households (77 percent) attended the screenings assigned to them by the study design. Those who participated in the screening were able to recall the content of the video training during the follow-up survey. Notably, approximately 44 percent of the quality measurement study group attended a training session that also included content related to collective marketing (they were not expected to receive this education, based on the study design). Likewise, a few households from the spillover and control groups attended the screening. From field observation, participation in the collective marketing training by the quality measurement treatment group was less likely; thus, we suspect that the results related to unintended training reflect data collection errors. For instance, data collectors may have posed the survey question generally—"Did the household participate in video training?"—without specifying the content of the training.

Table 3.7 Compliance level for wheat quality measurement and collective marketing training

	Treatment group			
Variable	Quality measurement (*n* = 288)	Quality measurement and collective marketing (*n* = 247)	Spillover households (*n* = 321)	Control households (*n* = 319)
Watched video on collective marketing (%, yes)	44.4	76.5	5.0	0.6
Video teaching on … (%, yes)				
Benefits of collective marketing	99.2	99.5	100.0	50.0
Challenges in collective marketing	90.6	90.5	100.0	50.0
Mechanisms to improve collective marketing	85.1	90.5	100.0	100.0
Among those who attended screening: Sold wheat collectively or through cooperatives (%, yes)	27.1	29.6	26.5	25.4
Among those who attended screening: In what way did collective marketing help you? (%, yes)				
Better price	57.7	57.5	55.3	55.6
Second payment	28.2	30.1	31.8	33.3
Save time	11.5	8.2	7.1	4.9
Able to sell to long-distance buyers	0.0	0.0	1.2	2.5
Provided reliable market outlet	2.6	4.1	4.7	3.7
Among those who did not: Reason for not selling collectively or through cooperatives (%, yes)				
Co-op starts purchasing later	23.3	19.5	17.4	15.1
Co-op shop open for limited days/hours	13.3	14.4	9.3	8.8
Co-op offers the same price for wheat of different qualities	5.7	5.8	7.6	3.8
Co-op offers low price compared to other markets	13.8	10.9	17.0	11.3
Co-op delays payment	1.9	6.3	8.1	7.6
I am not a member of a co-op / collective marketing group	10.5	10.3	10.2	16.4
I don't know the benefit of collective marketing	6.2	1.2	8.5	6.3
Other reason(s)	25.2	31.6	22.0	30.7

Source: Authors' computation based on data from wheat growers' survey, 2016.

As with the quality measurement results, we found a low level of compliance in terms of applying the practices taught in the collective marketing training. Only 30 percent of participant households were able to sell their wheat collectively or through cooperatives, which was the main focus of the training for the second treatment group. Moreover, since collective marketing is not a new marketing practice (unlike quality measurement), a comparable number of households from the spillover and control groups reported selling their wheat collectively. Interestingly, the reasons that limited collective marketing were related to either the farmers' cooperatives or marketing groups. The cooperatives either started purchasing wheat later in the season, were open for only a limited number of days and hours, or offered a lower or the same price for wheat of different qualities (Table 3.7).

Empirical Strategy

We assessed the effect of the intervention—that is, farmers' participation in training sessions—on a set of outcome indicators using the following estimation strategy:

$$Y_{ik} = \alpha + \beta_1 Q_{ik} + \beta_2 C_{ik} + \beta_3 S_{ik} + Z'_{ik}\tau + \epsilon_{ik}, \quad (1)$$

where Y_{ik} represents our outcome variables (for example, testing wheat quality, price received, share of wheat marketed, share of wheat marketed collectively or through cooperatives, and use of modern inputs); Q represents the quality measurement treatment group; *C* represents the collective marketing and quality measurement treatment group; *S* represents the spillover household group; Z'_{ik} is a vector of household- and kebele-level characteristics, which accounts for household- and kebele-level variables that lack balance (that is, households' television ownership and use of hired labor for wheat production) and/or variables that are unlikely to change over time and are likely to influence the outcome. ϵ_{ik} is a composite error term.

We accounted for the fact that households within kebeles may exhibit more similarities than households across kebeles through the following decomposition:

$$\epsilon_{ik} = \mu_k + \varepsilon_{ik}, \quad (2)$$

where μ_k is a kebele-level error that we account for by clustering the obtained standard errors at the kebele level, and ε_{ik} is an individual mean-zero error term. The primary null hypotheses to be tested are whether β_1, β_2, and β_3—the conditional differences in outcome variables between the various treatment groups and the control group—are null or significantly different from zero.

The treatments were implemented with different intensities across kebeles. Thus, we also estimated the extended model to understand whether variations in treatment intensity had different effects on our variables of interest:

$$Y_{ik} = \alpha + \beta_1 Q_{ik} + \beta_2 C_{ik} + \beta_3 S_{ik} + \gamma I_k + Z'_{ik}\tau + \epsilon_{ik}, \quad (3)$$

where I_k measures the treatment intensity in a given kebele (that is, the percentage share of villages covered by the training within the kebele).

Some of the individual characteristics of households are likely to affect their marketing capacity and commercialization behavior and may result in differential benefits from the training. We assessed the potential impact of such heterogeneity across subgroups. We added the interaction terms of the treatment dummies to the demanded variables on Equation (3) to measure the heterogeneity of the impact. The subgroup analysis included estimations of the impact by intensity of treatment, landholding size, education, remoteness, wheat grain quality at baseline, and membership in agricultural cooperatives.

4. RESULTS AND DISCUSSIONS

Impact on Marketing Behavior

The training interventions covered a large number of wheat farmers across the high-potential wheat-producing zones of Ethiopia. The farmers were free to implement the knowledge, techniques, and practices they learned from the training sessions related to wheat marketing (that is, testing the flour yield or test-weight, selling wheat collectively, cross-checking the buyer's scale, and contacting as many buyers as possible before selling their wheat). In this section, we estimate the probability that a given household implemented these marketing practices based on the treatment group to which it was assigned.

The results presented in Table 4.1 show a strong positive impact of the intervention on farmers' behavior related to measuring the potential flour yield of their wheat before they took it to the market. Specifically, the training on wheat quality and collective marketing increased farmers' measurement of wheat quality (test-weight) by 12 to 13 percentage points. By comparison, only 2 percent of the farmers implemented such quality assessments of their grain in the control group. Thus, the intervention led to a six fold increase in this practice among farmers who received the training. We did not find any direct effect of the intervention on spillover households, nor did we find that treatment intensity at the kebele level affected these results. This result is unsurprising given the short period of the study—too short to allow for widespread diffusion of the educational content—and the technical nature of the message.

In the second part of Table 4.1 (columns 3 to 8), we assess whether the direct effects mentioned above are somewhat specific to various categories of farmers, by testing treatment allocation with the variable specified at the top of each column. The quality measurement training increased wheat quality testing by 5 to 8 percentage points more among farmers who have relatively large farms and who are able to read and write, respectively, over and beyond the effect we observed among small farmers and illiterate farmers. The training increased the probability of quality assessment by 10 and 8 percentage points for small farmers and illiterate farmers, respectively. These results are plausible, since relatively better-educated farmers can more easily understand the measurement techniques and wealthier farmers can have better access to measurement equipment—weighing scales, in particular (most of the other equipment is commonly available in any rural household).

Table 4.2 reports the results related to collective marketing behavior. The data in this table show whether farmers sold wheat in a collective operation or through agricultural cooperatives over the 2015/2016 marketing season. The training had a positive but limited (statistically insignificant) direct effect on aggregation behavior. However, the results from the heterogeneity estimation show strong and informative variations according to farm size, quality of wheat produced, and farmer's literacy level. Training on quality measurement increased the practice of wheat collective marketing and use of cooperatives for marketing by approximately 16 percentage points among farmers who manage more than 2 hectares of agricultural land. While the training on collective marketing increased wheat sales through cooperatives, the trend was weaker among farmers with higher wheat quality—that is, farmers who received the training and had high-quality wheat were less likely to aggregate their wheat when selling it than their counterparts who received the training and had lower-quality wheat. An increase in wheat quality (test-weight) tended to decrease collective marketing behavior by approximately 20 percent. In other words, the direct effect of the commercialization training on collective marketing was decreased by 20 percent for households with good-quality wheat.

Table 4.1 Impact on marketing behavior: Tested quality (flour yield) of wheat before sale

	Dependent variable: Tested wheat quality (flour yield) (0/1)							
			Impact heterogeneity [by]					
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	0.131***	0.128***	0.163***	0.131***	0.129***	0.0949**	0.0760**	0.121**
	(0.0242)	(0.0298)	(0.0488)	(0.0373)	(0.0392)	(0.0419)	(0.0375)	(0.0473)
Commercialization training (0/1)	0.124***	0.122***	0.120***	0.0954**	0.136***	0.160***	0.128***	0.172***
	(0.0228)	(0.0280)	(0.0406)	(0.0367)	(0.0373)	(0.0405)	(0.0402)	(0.0586)
Spillover households (0/1)	0.0191	0.0171	0.00241	0.00314	0.0146	0.0229	0.0501**	0.0124
	(0.0151)	(0.0177)	(0.0164)	(0.0218)	(0.0172)	(0.0280)	(0.0230)	(0.0246)
Intensity (1 = ≥50% of the kebele)		0.00413	0.0342*	0.00519	0.00454	–0.00137	0.00475	0.00563
		(0.0225)	(0.0176)	(0.0225)	(0.0224)	(0.0223)	(0.0224)	(0.0225)
Quality ×			–0.0757	–0.0103	–0.00213	0.0794	0.0741*	0.00912
			(0.0544)	(0.0485)	(0.0449)	(0.0491)	(0.0420)	(0.0486)
Commercialization ×			–0.0277	0.0528	–0.0278	–0.0681	–0.00950	–0.0671
			(0.0501)	(0.0455)	(0.0430)	(0.0482)	(0.0455)	(0.0613)
Spillover ×				0.0297	0.00690	–0.00686	–0.0479*	0.00690
				(0.0273)	(0.0268)	(0.0314)	(0.0274)	(0.0297)
Constant	–0.0380	–0.0385	–0.0461	–0.0320	–0.0424	–0.0399	–0.0498	–0.0449
	(0.0441)	(0.0442)	(0.0439)	(0.0435)	(0.0454)	(0.0428)	(0.0439)	(0.0467)
Control mean	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
Observations	1,173	1,173	1,173	1,173	1,173	1,173	1,173	1,173
R-squared	0.114	0.115	0.117	0.116	0.115	0.122	0.120	0.117

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Table 4.2 Impact on marketing behavior: Sold wheat collectively or through cooperatives

	Dependent variable: Sold wheat collectively (0/1)							
			Impact heterogeneity [by]					
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	0.0201	0.0502	0.0139	–0.0193	0.0632	0.0556	0.0434	0.0807
	(0.0553)	(0.0537)	(0.0639)	(0.0613)	(0.0668)	(0.0700)	(0.0726)	(0.0552)
Commercialization training (0/1)	–0.0159	0.0498	0.0130	0.0282	0.155**	0.0365	0.116	0.0374
	(0.0581)	(0.0622)	(0.0828)	(0.0726)	(0.0757)	(0.0746)	(0.0920)	(0.0554)
Spillover households (0/1)	–0.0492	0.0285	0.0646	–0.0291	0.0958	0.0309	0.135**	0.0488
	(0.0514)	(0.0484)	(0.0524)	(0.0591)	(0.0596)	(0.0660)	(0.0651)	(0.0506)
Intensity (1 = ≥50% of the kebele)		–0.0359	–0.109*	–0.0374	–0.0360	–0.0346	–0.0364	–0.0371
		(0.0475)	(0.0624)	(0.0466)	(0.0474)	(0.0470)	(0.0476)	(0.0480)
Quality ×			0.122	0.158**	–0.0176	–0.0138	0.00771	–0.0418
			(0.0905)	(0.0736)	(0.0780)	(0.0919)	(0.0814)	(0.0636)
Commercialization ×			0.130	0.0497	–0.198**	0.0241	–0.0989	0.0163
			(0.101)	(0.0736)	(0.0798)	(0.107)	(0.0897)	(0.0757)
Spillover ×				0.125	–0.128*	–0.00617	–0.156**	–0.0282
				(0.0774)	(0.0683)	(0.0890)	(0.0773)	(0.0716)
Constant	0.0608	0.0768	0.0878	0.117	0.0175	0.0787	0.0283	0.0660
	(0.111)	(0.0913)	(0.0904)	(0.0960)	(0.0914)	(0.0968)	(0.0945)	(0.0923)
Control mean	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254
Observations	801	1,173	1,173	1,173	1,173	1,173	1,173	1,173
R-squared	0.136	0.109	0.112	0.114	0.117	0.109	0.114	0.110

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

From our field observation, the low tendency to aggregate among households with good-quality wheat can be partly explained by the pricing policy of the farmer's cooperatives. The vast majority of cooperatives in the study area did not offer different prices based on grain quality. Obviously, farmers will be less likely to sell through cooperatives when they discover that their wheat is of good quality, because they can negotiate with traders for a better price, although quality rewards are reportedly marginal in the local Ethiopian markets. The same is true for households with a literate head as opposed to an illiterate head: The former are more likely to sell their products individually, rather than through a collective or cooperative. We also found evidence of some diffusion effects on spillover households, particularly for those with lower-quality grain and lower educational levels.

Enabling wheat farmers to receive fair value for the quantity of wheat they marketed was one goal of the intervention. The aim was to address farmers' perceived mistrust of agricultural traders' weighing scales and the adverse consequences of this mistrust for incentives geared toward increasing market participation. Table 4.3 reports data on whether farmers who participated in the training sessions made use of their own body weight as a reference to check the accuracy or precision of buyers' weighing scales. The results in the second row of the table clearly show that the intervention increased weight verification by approximately 12 to 20 percentage points. In other words, farmers who participated in the quality measurement and collective marketing training, which included the measurement of their own body weight, were able to validate their buyers' weighing scales using their own body weight as a reference. Strikingly, the descriptive results indicate that among the 60 percent of the sample households that checked the accuracy of the trader's weighing scale, 67 percent came across a scale that underestimated the weight of their wheat. The average underestimation amount was approximately 3 kilograms. Given that those farmers who encountered a biased scale sold approximately 18 quintals of wheat, on average, potential losses due to a biased scale is estimated at more than half a quintal per marketing season.

Table 4.3 Impact on marketing behavior: Cross-checked buyer's weighing scale

	Dependent variable: Cross-checked buyer's weighing scale (0/1)								
			Impact heterogeneity [by]						
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	0.0370	0.0546	0.107*	0.0425	0.0693	0.0671	–0.0477	0.104
	(0.0422)	(0.0461)	(0.0544)	(0.0543)	(0.0661)	(0.0592)	(0.0771)	(0.0724)
Commercialization training (0/1)	0.123***	0.138***	0.123**	0.152***	0.198***	0.0954	0.203***	0.158*
	(0.0377)	(0.0433)	(0.0531)	(0.0494)	(0.0614)	(0.0664)	(0.0685)	(0.0812)
Spillover households (0/1)	0.0614*	0.0729*	0.0579	0.0241	0.140**	0.0203	0.0961	0.0818
	(0.0362)	(0.0406)	(0.0461)	(0.0533)	(0.0538)	(0.0590)	(0.0652)	(0.0733)
Intensity (1 = ≥50% of the kebele)		–0.0238	0.00707	–0.0244	–0.0247	–0.0180	–0.0229	–0.0245
		(0.0319)	(0.0531)	(0.0315)	(0.0316)	(0.0332)	(0.0318)	(0.0315)
Quality ×			–0.100	0.0246	–0.0216	–0.0376	0.145	–0.0686
			(0.0897)	(0.0788)	(0.0886)	(0.0861)	(0.0910)	(0.0786)
Commercialization ×			–0.00619	–0.0250	–0.110	0.0803	–0.0985	–0.0260
			(0.0766)	(0.0723)	(0.0860)	(0.0805)	(0.0808)	(0.0862)
Spillover ×				0.106	–0.132*	0.102	–0.0347	–0.0116
				(0.0720)	(0.0758)	(0.0773)	(0.0781)	(0.0817)
Constant	0.405***	0.408***	0.397***	0.425***	0.362***	0.422***	0.386***	0.391***
	(0.0870)	(0.0869)	(0.0876)	(0.0880)	(0.0891)	(0.0879)	(0.0888)	(0.0967)
Control mean	0.552	0.552	0.552	0.552	0.552	0.552	0.552	0.552
Observations	1,173	1,173	1,173	1,173	1,173	1,173	1,173	1,173
R-squared	0.153	0.154	0.155	0.156	0.157	0.157	0.160	0.154

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Compared to the control group, nearly twice as many farmers who received the training investigated the accuracy of their buyers' scales. The results for spillover households showed a positive and significant effect on buyer's scale accuracy verification by untreated households in the treatment kebeles. This outcome can be explained by the simplicity of the scale-checking technique, which is readily imitated, as opposed to the more complex quality measurement and collective marketing training material. We did not find strong or clear evidence of heterogeneous effects of the treatments on the scale-verification behavior according to farmers' characteristics, although there were some indications that the collective commercialization training had a more pronounced effect on buyer's scale verification among farmers with small farms, with relatively low-quality grain, and with an illiterate head of household.

Overall, the results on underestimation of grain weight by traders add to the emerging empirical evidence on the frequent untrustworthiness of the operation of traditional agricultural markets in developing countries. For instance, recent studies in Ethiopia and India clearly show that traditional traders often cheat consumers or buyers on unobservable quality attributes and limit the amount of information made available about those characteristics (Fafchamps et al. 2008; Minten et al. 2017).

Table 4.4 presents our results on the question of whether the training interventions led wheat farmers to seek out more potential buyers so as to compare or cross-check prices and other transaction terms and conditions. The wheat quality measurement training did not affect the number of buyers with whom farmers talked before selling their wheat. This outcome is understandable given that the content of the training focused primarily on techniques for measuring wheat quality (test-weight) and their benefits. Nonetheless, we found evidence that the commercialization or collective marketing training led farmers to explore the availability of more buyers than their counterparts in the control group did. Specifically, the training increased farmers' marketing capacity by 4 to 9 percentage points, as measured by the number of buyers whom they contacted before selling their wheat.

The data for specific categories of farmers show only limited impact of the variations in contact with buyers, although the parameters are not statistically significant. Specifically, after receiving the training intervention, farmers with relatively small farm size, those with low grain quality, and those who resided in less remote kebeles tended to contact more buyers before selling their wheat.

Table 4.5 provides the results on whether farmers postponed wheat sales after participating in the various treatment groups. We found limited direct evidence for this effect, although an increase of 7 percentage points was noted in terms of the farmers who received the commercialization training and reported later sales. However, this factor's estimated impact varied by grain quality, remoteness, and literacy of the household head. Farmers in the quality training group tended to report earlier sales, but a 16 percentage point difference was noted for those farmers with high-quality wheat—that is, 16 percent more of the latter group delayed their sales to a later period compared to their counterparts with lower-quality grain. Being in a remote kebele was associated with delaying wheat sales to a later period among farmers who participated in the quality measurement training (17 percent) and the collective commercialization training (25 percent) (Table 4.5). Although the results were statistically insignificant, farmers who could read and write and participated in the commercialization and wheat quality training reportedly sold their wheat later in the marketing season than in the previous year, an effect attributed to the interventions.

Table 4.4 Impact on marketing behavior: Contacted more than one wheat buyer

	Dependent variable: Contacted more than one wheat buyer (0/1)								
			Impact heterogeneity [by]						
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	–0.00234	0.00682	0.00684	0.0344	0.0219	0.0472	–0.0329	0.0434
	(0.0254)	(0.0331)	(0.0411)	(0.0415)	(0.0514)	(0.0384)	(0.0487)	(0.0616)
Commercialization training (0/1)	0.0443*	0.0520*	0.0509*	0.0858**	0.0831*	0.0788**	0.0498	0.0644
	(0.0225)	(0.0265)	(0.0291)	(0.0351)	(0.0458)	(0.0337)	(0.0432)	(0.0545)
Spillover households (0/1)	0.0192	0.0252	0.0258	0.0727**	0.0887**	0.0555	0.0468	0.0418
	(0.0267)	(0.0288)	(0.0292)	(0.0362)	(0.0445)	(0.0355)	(0.0425)	(0.0579)
Intensity (1 = ≥50% of the kebele)		–0.0123	–0.0136	–0.0127	–0.0137	–0.0124	–0.0118	–0.0130
		(0.0253)	(0.0397)	(0.0251)	(0.0251)	(0.0254)	(0.0252)	(0.0255)
Quality ×			0.00121	–0.0570	–0.0230	–0.0818	0.0564	–0.0506
			(0.0556)	(0.0465)	(0.0587)	(0.0499)	(0.0556)	(0.0663)
Commercialization ×			0.00298	–0.0710	–0.0539	–0.0538	0.00302	–0.0168
			(0.0440)	(0.0429)	(0.0551)	(0.0438)	(0.0543)	(0.0583)
Spillover ×				–0.103**	–0.128**	–0.0612	–0.0312	–0.0227
				(0.0467)	(0.0569)	(0.0498)	(0.0514)	(0.0641)
Constant	0.801***	0.802***	0.803***	0.776***	0.768***	0.779***	0.796***	0.787***
	(0.0658)	(0.0666)	(0.0667)	(0.0677)	(0.0723)	(0.0674)	(0.0631)	(0.0725)
Control mean	0.899	0.899	0.899	0.899	0.899	0.899	0.899	0.899
Observations	1,173	1,173	1,173	1,173	1,173	1,173	1,173	1,173
R-squared	0.031	0.032	0.032	0.036	0.039	0.034	0.034	0.033

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Table 4.5 Impact on marketing behavior: Sold wheat later than in previous marketing season

	Dependent variable: Sold wheat later than in last year (0/1)							
			Impact heterogeneity [by]					
Variable	ITT	ITT	Treatment intensity	Farm size	Wheat quality	Remoteness	Education	Membership in co-ops
Quality training (0/1)	0.00597	–0.0223	–0.0577	–0.0188	–0.109**	–0.113*	–0.0749	–0.0802
	(0.0398)	(0.0492)	(0.0743)	(0.0623)	(0.0514)	(0.0668)	(0.0787)	(0.0787)
Commercialization training (0/1)	0.0752**	0.0512	0.0666	0.0119	–0.0175	–0.0777	–0.0143	0.0415
	(0.0376)	(0.0449)	(0.0567)	(0.0622)	(0.0583)	(0.0546)	(0.0745)	(0.0830)
Spillover households (0/1)	0.0172	–0.00107	0.00675	–0.0363	–0.0843	–0.162***	–0.0512	–0.0152
	(0.0422)	(0.0406)	(0.0452)	(0.0555)	(0.0565)	(0.0574)	(0.0845)	(0.0770)
Intensity (1 = ≥50% of the kebele)		0.0377	0.0215	0.0388	0.0359	0.0438	0.0390	0.0396
		(0.0344)	(0.0650)	(0.0343)	(0.0349)	(0.0321)	(0.0345)	(0.0343)
Quality ×			0.0628	–0.0161	0.167**	0.168**	0.0745	0.0777
			(0.108)	(0.0861)	(0.0777)	(0.0773)	(0.0843)	(0.0899)
Commercialization ×			–0.00789	0.0786	0.131	0.253***	0.0954	0.0124
			(0.0855)	(0.0887)	(0.0820)	(0.0721)	(0.0878)	(0.0857)
Spillover ×				0.0737	0.164*	0.326***	0.0718	0.0178
				(0.0793)	(0.0865)	(0.0809)	(0.1000)	(0.0871)
Constant	0.588***	0.583***	0.589***	0.597***	0.655***	0.661***	0.617***	0.601***
	(0.0975)	(0.0986)	(0.0999)	(0.100)	(0.100)	(0.100)	(0.103)	(0.105)
Control mean	0.538	0.538	0.538	0.538	0.538	0.538	0.538	0.538
Observations	1,062	1,062	1,062	1,062	1,062	1,062	1,062	1,062
R-squared	0.138	0.139	0.140	0.141	0.144	0.153	0.140	0.140

Source: Authors' computation based on data from wheat growers' survey, 2016.

Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Impact on Commercialization Level

We next assess the effects of the training interventions on the farmers' commercialization level. Specifically, we estimate the relative effect of each type of training on the share of wheat marketed, the selling price for the wheat (that is, the price received), and the share of wheat marketed collectively or through agricultural cooperatives.

Table 4.6 reports the estimated impact of the interventions on the share of wheat marketed, defined as the proportion of wheat sold by the household relative to the total quantity of wheat the household produced in the 2015/2016 *meher* season. The results indicate that the quality measurement training increased the share of wheat marketed by 5 percent as compared to the control group's mean of 33 percent of total wheat sold. We also found a positive impact on share of wheat sales among the participants who received both quality measurement and collective marketing training, although this effect was not statistically significant. The results presented in Table 4.6 also show strong evidence of a positive spillover effect—namely, farmers within the treatment kebeles who did not receive any training tended to sell 5 to 6 percent more of their wheat than those in the control group. In the quality training group, most of the effects on wheat share sold were clustered among those farmers with higher-quality wheat and those who resided in relatively remote kebeles. Recognizing the potential value of their crop, these farmers may have been encouraged to sell more wheat, for additional money, while retaining less quality grains for home consumption.

Table 4.6 Impact on commercialization: Share of wheat sold

	Dependent variable: Share of wheat sold (%)								
			Impact heterogeneity [by]						
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	3.786*	3.690	1.472	2.739	2.564	1.355	5.660*	2.218
	(1.992)	(2.300)	(2.689)	(2.678)	(3.046)	(3.196)	(3.013)	(3.545)
Commercialization training (0/1)	2.485	2.404	3.307	3.188	–0.101	0.00436	1.597	1.872
	(1.978)	(2.003)	(2.135)	(2.682)	(2.846)	(3.171)	(3.297)	(2.849)
Spillover households (0/1)	4.462**	4.399**	4.904**	3.708	3.836	3.408	5.558*	5.124
	(1.826)	(1.960)	(1.990)	(2.420)	(2.825)	(2.947)	(3.171)	(3.223)
Intensity (1 = ≥50% of the kebele)		0.129	–0.914	0.0713	0.0684	0.175	0.109	0.146
		(1.554)	(2.007)	(1.532)	(1.550)	(1.570)	(1.557)	(1.557)
Quality ×			3.977	2.286	2.132	4.650	–2.822	2.058
			(2.794)	(2.880)	(3.441)	(3.992)	(2.959)	(3.519)
Commercialization ×			–0.379	–1.488	4.862	4.674	1.264	0.702
			(2.666)	(3.291)	(3.653)	(3.903)	(3.638)	(3.112)
Spillover ×				1.528	0.843	1.941	–1.672	–1.045
				(2.859)	(3.345)	(3.651)	(3.298)	(3.676)
Constant	29.63***	29.61***	30.04***	30.03***	30.92***	31.12***	29.42***	29.78***
	(4.169)	(4.172)	(4.130)	(4.341)	(4.582)	(4.581)	(4.178)	(4.224)
Control mean	33.12	33.12	33.12	33.12	33.12	33.12	33.12	33.12
Observations	1,172	1,172	1,172	1,172	1,172	1,172	1,172	1,172
R-squared	0.223	0.223	0.224	0.224	0.225	0.225	0.224	0.224

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Enabling farmers to bargain for a price better aligned with the quality of their wheat grain was one of the main objectives of the training interventions. While the training increased the measurement of wheat flour yield among farmers in the study groups, it did not have a direct effect on the average wheat price received (Table 4.7). This outcome was not totally unexpected: One cannot expect the action of measuring the wheat's quality to result in a higher price unless the wheat is actually found to be a better-quality product. This relationship was corroborated by the estimated impact associated with the grain quality and the specific treatments. The coefficients show that farmers who participated in the quality measurement training and had relatively good-quality wheat obtained higher prices, on average, as compared to those in the control group. Specifically, the training interventions increased the price received by 7 to 17 percent among farmers with higher-quality wheat compared to the price decrease observed for farmers with relatively lower-quality wheat who received the training. In other words, the training increased the price received by 0.5 to 1.3 birr per kilogram (50 to 130 birr per quintal) for treatment-recipient farmers with high-quality grain. Conversely, farmers with relatively poor-quality wheat tended to receive 1.4 to 1.7 birr less per kilogram, even if they participated in the quality measurement training. Moreover, the results indicate that most of the effect on price was realized by those farmers who were able to read and write and who were not affiliated with cooperatives.

Table 4.7 Impact on commercialization: Wheat sales price

	Dependent variable: Wheat sales price (birr/kg)								
			Impact heterogeneity [by]						
Variable	ITT	ITT	Treatment intensity	Farm size	Wheat quality	Remoteness	Education	Membership in co-ops
Quality training (0/1)	–0.0136	–0.0155	0.00485	0.00205	–0.230*	0.0265	–0.235	0.228
	(0.0790)	(0.104)	(0.160)	(0.127)	(0.130)	(0.118)	(0.166)	(0.152)
Commercialization training (0/1)	–0.0586	–0.0602	–0.0740	–0.134	–0.195*	–0.0198	–0.261*	0.0805
	(0.0734)	(0.0868)	(0.0999)	(0.109)	(0.109)	(0.118)	(0.152)	(0.141)
Spillover households (0/1)	–0.0383	–0.0396	–0.0409	–0.0683	–0.225*	0.0393	–0.260	–0.0193
	(0.0768)	(0.0811)	(0.0776)	(0.107)	(0.116)	(0.0987)	(0.177)	(0.0995)
Intensity (1 = ≥50% of the kebele)		0.00256	0.00514	0.00461	–0.00312	0.000422	0.00622	–0.00297
		(0.0698)	(0.103)	(0.0700)	(0.0707)	(0.0718)	(0.0689)	(0.0685)
Quality ×			–0.0295	–0.0497	0.404***	–0.0808	0.310*	–0.325**
			(0.185)	(0.152)	(0.149)	(0.160)	(0.171)	(0.156)
Commercialization ×			0.0200	0.152	0.257*	–0.0813	0.287*	-0.183
			(0.144)	(0.149)	(0.140)	(0.152)	(0.171)	(0.153)
Spillover ×				0.0586	0.362**	–0.165	0.314	–0.0217
				(0.131)	(0.147)	(0.160)	(0.199)	(0.126)
Constant	7.624***	7.623***	7.620***	7.634***	7.775***	7.591***	7.729***	7.544***
	(0.239)	(0.239)	(0.237)	(0.247)	(0.242)	(0.233)	(0.242)	(0.238)
Control mean	7.59	7.59	7.59	7.59	7.59	7.59	7.59	7.59
Observations	995	995	995	995	995	995	995	995
R-squared	0.349	0.349	0.349	0.350	0.356	0.350	0.353	0.352

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Although the results were not statistically significant, the control farmers received marginally higher prices, on average. This finding suggests that in the control kebeles, farmers received an average price that did not discriminate by quality level. In contrast, in the treatment kebeles, the intervention resulted in price differentials based on quality (that is, a significantly lower price for low-quality grain, and vice versa) that decreased the average price, since the proportion of farmers with relatively lower-quality wheat was larger among the treatment population.

In addition to the two most common indicators of commercialization level (that is, output price and marketed surplus), our study examined whether the training interventions encouraged farmers to sell their wheat collectively so as to benefit from economies of scale and bargaining opportunities in marketing (Table 4.8). The results identified a sizable increase in the share of wheat marketed through cooperatives (4 percent), although the direct-impact effects were statistically insignificant. Furthermore, the results in this area were informative with respect to the quality of wheat grain produced by households and the level of aggregation. The share of relatively high-quality wheat that was marketed collectively or through cooperatives declined by approximately 2 percent, whereas the share of lower-quality wheat that was sold through such cooperatives increased by 9 to 14 percent. In other words, the direct effect of the training interventions on collective marketing was strong and relatively higher among farmers with relatively low-quality wheat. This outcome may reflect the reality that most of the wheat marketing cooperatives we observed as part of the study aggregated farmers' grain irrespective of its quality and followed a "one price" policy—a factor that obviously discourages aggregation by farmers with higher-quality grain.

Table 4.8 Impact on commercialization: Share of wheat sold collectively or through cooperatives

	Dependent variable: Share of wheat sold collectively (%)								
			Impact heterogeneity [by]						
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	1.247	2.925	3.410	0.320	8.644*	5.611	–2.562	7.037*
	(3.213)	(3.872)	(5.164)	(4.494)	(5.175)	(4.780)	(5.156)	(3.758)
Commercialization training (0/1)	3.821	5.165	1.690	4.098	13.55**	0.462	6.646	7.890**
	(3.733)	(4.428)	(5.660)	(4.946)	(5.265)	(5.122)	(6.031)	(3.823)
Spillover households (0/1)	–0.945	0.156	1.959	–0.0896	5.484	–1.970	2.948	1.954
	(3.082)	(3.383)	(3.748)	(4.493)	(4.346)	(3.847)	(4.978)	(3.652)
Intensity (1 = ≥50% of the kebele)		–2.250	–5.877	–2.247	–1.907	–1.574	–2.226	–2.351
		(3.051)	(4.119)	(3.032)	(3.038)	(2.928)	(3.019)	(3.101)
Quality ×			3.015	5.827	–10.94*	–7.062	7.832	–5.480
			(7.481)	(4.735)	(5.668)	(6.311)	(5.631)	(4.909)
Commercialization ×			9.242	2.191	–15.79**	8.501	–2.261	–3.555
			(6.562)	(6.076)	(6.068)	(7.304)	(6.586)	(5.610)
Spillover ×				0.505	–10.27**	3.913	–3.989	–2.352
				(5.451)	(5.012)	(6.472)	(5.953)	(5.180)

Table 4.9 Continued

	Dependent variable: Share of wheat sold collectively (%)		Impact heterogeneity [by]					
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Constant	10.81*	11.09*	11.46*	11.97*	5.485	11.50*	10.15	9.205
	(6.416)	(6.511)	(6.519)	(6.683)	(6.898)	(6.577)	(6.794)	(6.724)
Control mean	14.56	14.56	14.56	14.56	14.56	14.56	14.56	14.56
Observations	1,011	1,011	1,011	1,011	1,011	1,011	1,011	1,011
R-squared	0.136	0.137	0.140	0.139	0.145	0.144	0.141	0.138

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

Impact on Use of Modern Inputs

We next assess whether the training intervention led to changes in farmers' production behavior, since the use of modern inputs and practices is reportedly associated with quality (Table A.3). Specifically, we assess whether farmers changed their production practices in a way that could increase the unobservable quality of their product. These practices may include the use of modern inputs such as fertilizer and improved seeds at the recommended rates of application—techniques in which farmers are routinely trained through the existing extension system.

The results presented in Table 4.9 show the impact of the interventions on the use of NPS (nitrogen + phosphorus + sulfur) fertilizer by treatment-recipient households; this type of fertilizer was recently introduced in Ethiopia as a substitute for DAP (diammonium phosphate) fertilizer. The results indicate that the training interventions led to sizable and statistically significant increases in the use of NPS fertilizer for the cultivation of wheat in both study groups relative to the control group. Notably, farmers in the wheat quality measurement training group showed an 11 to 21 percent increase in their use of NPS fertilizer per hectare. Nonetheless, the application intensity remained less than the average rate recommended by the extension system. The results also suggest that a positive and statistically significant spillover in NPS fertilizer use occurred: NPS fertilizer use increased 13 to 18 percent among the sample farmers in untreated villages in the treatment kebeles as compared to the farmers in the control group.

Table 4.10 Impact on input use: Use of fertilizer (NPS)

Variable	Dependent variable: Use of NPS fertilizer (log kg/ha)							
			Impact heterogeneity [by]					
	ITT	ITT	Treatment intensity	Farm size	Wheat quality	Remoteness	Education	Membership in co-ops
Quality training (0/1)	0.111**	0.143***	0.120*	0.141**	0.135*	0.151**	0.207***	0.138
	(0.0448)	(0.0527)	(0.0649)	(0.0634)	(0.0688)	(0.0731)	(0.0616)	(0.0841)
Commercialization training (0/1)	0.0574	0.0840	0.0826	0.0845	0.138**	0.147**	0.0904	0.152*
	(0.0609)	(0.0551)	(0.0520)	(0.0620)	(0.0624)	(0.0735)	(0.0688)	(0.0825)
Spillover households (0/1)	0.129***	0.150***	0.161***	0.135**	0.158***	0.182***	0.171***	0.0930
	(0.0414)	(0.0450)	(0.0439)	(0.0590)	(0.0587)	(0.0640)	(0.0634)	(0.0841)
Intensity (1 = ≥50% of the kebele)		–0.0420	–0.0636	–0.0420	–0.0421	-0.0470	–0.0426	–0.0383
		(0.0432)	(0.0517)	(0.0434)	(0.0430)	(0.0444)	(0.0435)	(0.0430)
Quality ×			0.0517	0.00252	0.0182	-0.00190	–0.0961	0.00396
			(0.0781)	(0.0804)	(0.0817)	(0.0969)	(0.0722)	(0.0910)
Commercialization ×			0.0239	–0.000657	–0.0993	–0.119	–0.00950	–0.0897
			(0.104)	(0.0867)	(0.105)	(0.126)	(0.107)	(0.101)
Spillover ×				0.0335	-0.00783	–0.0612	–0.0327	0.0733
				(0.0839)	(0.0727)	(0.0932)	(0.0780)	(0.0925)
Constant	5.183***	5.190***	5.194***	5.195***	5.172***	5.168***	5.180***	5.196***
	(0.103)	(0.104)	(0.103)	(0.105)	(0.0973)	(0.111)	(0.101)	(0.111)
Control mean	150.2	150.2	150.2	150.2	150.2	150.2	150.2	150.2
Observations	993	993	993	993	993	993	993	993
R-squared	0.456	0.456	0.457	0.456	0.458	0.458	0.457	0.458

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. NPS = nitrogen + phosphorus + sulfur. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 meher season; and the kebele's remoteness.

Although the results were insignificant, the estimated impact varied by location and cooperative membership. Farmers who resided in relatively less-remote kebeles and members of a cooperative tended to use more NPS fertilizer as a result of the intervention—an outcome that can be explained by better access to fertilizer supplies. NPS fertilizer is typically available from cooperatives, and these organizations are mostly found in more-developed locations or kebeles (Bernard et al. 2010).

The same estimates are reported in Table 4.10, regarding the use of urea fertilizer. We did not find a meaningful increase in the use of urea in response to the treatments that farmers received. This outcome could be due to the fact the farmers in Ethiopia tend to apply one of the fertilizers or nutrients, mostly DAP (or its substitute, NPS) (Kefyalew 2010). Even so, we found evidence of a large and significant increase in the use of urea fertilizer among farmers in the quality measurement training group and in high-intensity kebeles (that is, kebeles where the training covered more than 50 percent of the villages). Specifically, the training on wheat quality measurement increased the use of urea fertilizer by 20 percent among treatment-recipient farmers in high-intensity kebeles. Also, for the same reason that they used more NPS fertilizer, farmers who resided in relatively less-remote kebeles tended to use more urea fertilizer than their counterparts in more-remote kebeles.

Table 4.11 Impact on input use: Use of fertilizer (urea)

	Dependent variable: Use of urea fertilizer (log kg/ha)								
			Impact heterogeneity [by]						
Variable	ITT	ITT	Treatment intensity	Farm size	Wheat quality	Remoteness	Education	Membership in co-ops
Quality training (0/1)	0.0273	–0.00976	–0.0944	0.0177	–0.0828	–0.00198	0.00693	0.101
	(0.0586)	(0.0656)	(0.0691)	(0.0809)	(0.0783)	(0.0858)	(0.0802)	(0.127)
Commercialization training (0/1)	–0.0247	–0.0566	–0.0694	–0.0682	–0.0974	0.0524	–0.0995	–0.0903
	(0.0543)	(0.0673)	(0.0890)	(0.0884)	(0.0888)	(0.0807)	(0.0644)	(0.160)
Spillover households (0/1)	–0.0528	–0.0760	–0.0343	–0.113	–0.0658	–0.0617	–0.0453	–0.242
	(0.0533)	(0.0587)	(0.0633)	(0.0770)	(0.0770)	(0.0878)	(0.0724)	(0.168)
Intensity (1 = ≥50% of the kebele)		0.0493	–0.0383	0.0487	0.0445	0.0434	0.0481	0.0445
		(0.0569)	(0.0813)	(0.0565)	(0.0578)	(0.0565)	(0.0573)	(0.0568)
Quality ×			0.200*	–0.0717	0.148	0.00252	–0.0235	–0.131
			(0.116)	(0.100)	(0.110)	(0.127)	(0.0971)	(0.138)
Commercialization ×			0.106	0.0240	0.0917	–0.198*	0.0697	0.0456
			(0.117)	(0.114)	(0.101)	(0.112)	(0.0962)	(0.161)
Spillover ×				0.0820	–0.0215	–0.0225	–0.0438	0.216
				(0.108)	(0.116)	(0.115)	(0.106)	(0.178)
Constant	4.215***	4.205***	4.223***	4.212***	4.232***	4.165***	4.204***	4.246***
	(0.178)	(0.178)	(0.175)	(0.180)	(0.187)	(0.188)	(0.178)	(0.165)
Control mean	90.74	90.74	90.74	90.74	90.74	90.74	90.74	90.74
Observations	891	891	891	891	891	891	891	891
R-squared	0.475	0.476	0.477	0.477	0.477	0.478	0.476	0.480

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 *meher* season; and the kebele's remoteness.

In addition to using fertilizer, wheat farmers are encouraged to sow seeds at the rate recommended by the extension system, since the seeding rate affects the flour yield and other quality parameters. Traditionally, wheat farmers in Ethiopia have sown large amounts of seeds for reasons related to weed control or to compensate for a poor plant emergence or seed germination rate, which is common when seeds are broadly applied. The results presented in Table 4.11 indicate almost no direct effect on the seeding rates for either the treatment or spillover households, except for a 4 percent increase in the seeding rate among the collective marketing training group (an unintended effect). Nevertheless, the results were quite informative in two cases: (1) The treatment-recipient farmers in high-intensity kebeles where the quality measurement training was conducted reduced their seeding rate by approximately 12 percent and (2) the farmers who produced relatively high-quality wheat during the *meher* season preceding the training intervention reduced their seeding rate by approximately 8 percent as a result of the intervention. We also found evidence that wheat farmers who resided in remote kebeles tended to sow more seeds than their counterparts in less-remote kebeles.

Table 4.12 Impact on wheat seeding rate

	Dependent variable: Wheat seeding rate (log kg/ha)							
			Impact heterogeneity [by]					
Variable	**ITT**	**ITT**	**Treatment intensity**	**Farm size**	**Wheat quality**	**Remoteness**	**Education**	**Membership in co-ops**
Quality training (0/1)	0.0246	0.0339	0.0974	0.0312	0.0519	–0.0125	0.0112	0.0377
	(0.0262)	(0.0398)	(0.0589)	(0.0472)	(0.0458)	(0.0465)	(0.0501)	(0.0625)
Commercialization training (0/1)	0.0431*	0.0510*	0.0342	0.0160	0.0931**	–0.00210	0.00073 8	0.0385
	(0.0258)	(0.0304)	(0.0332)	(0.0377)	(0.0395)	(0.0432)	(0.0464)	(0.0546)
Spillover households (0/1)	0.0372	0.0433	0.0237	0.0213	0.0857**	0.0289	0.0678	0.0349
	(0.0252)	(0.0302)	(0.0316)	(0.0354)	(0.0362)	(0.0406)	(0.0464)	(0.0581)
Intensity (1 = ≥50% of the kebele)		–0.0125	0.0276	–0.0113	–0.0127	–0.0113	–0.0119	–0.0129
		(0.0306)	(0.0379)	(0.0305)	(0.0305)	(0.0316)	(0.0307)	(0.0310)
Quality ×			–0.125**	–0.000307	–0.0315	0.0913*	0.0325	–0.00537
			(0.0568)	(0.0535)	(0.0420)	(0.0539)	(0.0453)	(0.0563)
Commercialization ×			–0.0136	0.0706	–0.0787*	0.102*	0.0761	0.0168
			(0.0487)	(0.0482)	(0.0463)	(0.0546)	(0.0521)	(0.0588)
Spillover ×				0.0465	–0.0833**	0.0274	–0.0348	0.0116
				(0.0488)	(0.0414)	(0.0539)	(0.0481)	(0.0567)
Constant	5.448***	5.449***	5.436***	5.461***	5.417***	5.480***	5.453***	5.454***
	(0.0551)	(0.0568)	(0.0561)	(0.0588)	(0.0593)	(0.0590)	(0.0565)	(0.0586)
Control mean	229.1	229.1	229.1	229.1	229.1	229.1	229.1	229.1
Observations	1,160	1,160	1,160	1,160	1,160	1,160	1,160	1,160
R-squared	0.308	0.308	0.312	0.310	0.311	0.312	0.311	0.308

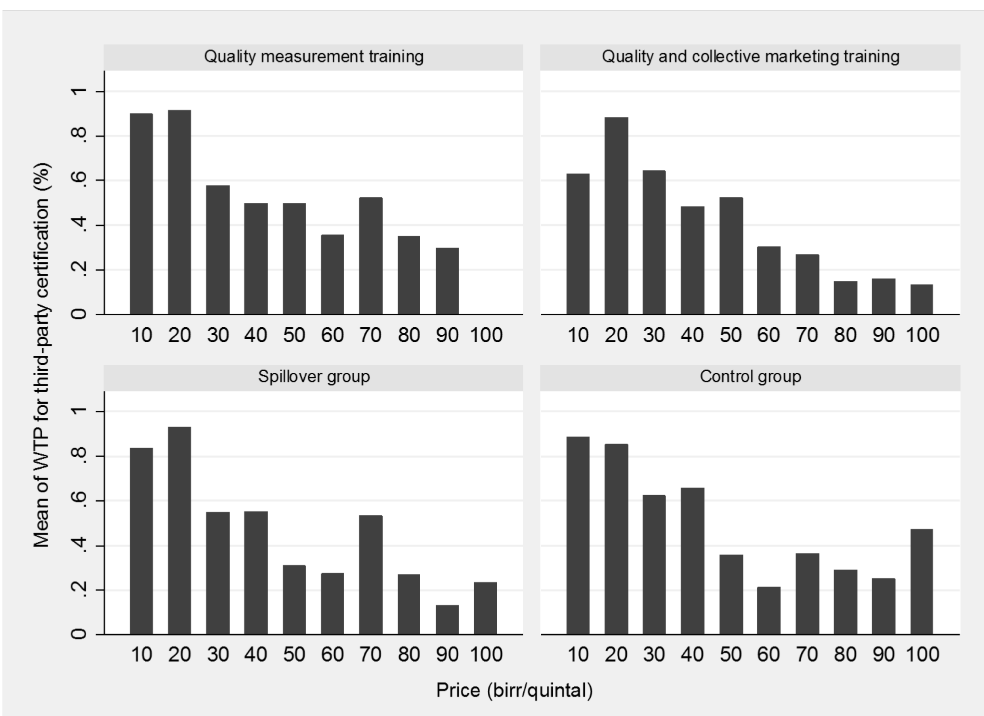
Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: ITT refers to intent-to-treat estimation. Standard errors clustered at the kebele level appear in parentheses. *** p < .01, ** p < .05, * p < .1. All estimates include woreda/district fixed effects as well as controls for age, gender, and education of the household head; household size; farm size; livestock ownership (in tropical livestock units [TLU]); television ownership; use of hired labor for wheat production; membership in agricultural cooperatives; quality of wheat (test-weight) produced by the household during the 2015/2016 meher season; and the kebele's remoteness.

5. DEMAND FOR THIRD-PARTY CERTIFICATION

We also investigated farmers' demand for third-party certification of their wheat production. This demand was assessed by following a willingness-to-pay approach. The willingness-to-pay module began by describing the components of third-party certification (that is, grading, weighing, and labeling) and the process (for example, farmers get their product back and can then sell it anywhere or to any buyer they prefer). Farmers were asked whether they would be willing to pay *x* birr per quintal for a service that would weigh their product, assess its quality, and label it accordingly before the farmers took the wheat to potential buyers by themselves. The variable *x* was randomly varied across farmers, from 10 birr per quintal to 100 birr per quintal (as a base reference, the price for a quintal of wheat is approximately 1,000 birr, such that the proposed certification prices amounted to 1 to 10 percent of the selling price expected by farmers). Although the randomization of the proposed price across households was found to be reasonable, given the use of more than 30 schoolmate computers, the sample size for each price was not large enough for inference (Table A.2). Figures 5.1 and 5.2 report the percentage of farmers who would be willing to buy such a service at each price offered.

In Figure 5.1, we report the findings from this willingness-to-pay experiment at baseline. We discovered that a large proportion of farmers (approximately 80 percent) would be willing to buy such a service if it were priced at 10 or 20 birr. The proportion became smaller as the proposed price of the service increased. No clear differences were found among the various treatment groups. These results point to an existing demand for micro-level certification services, although farmers seem mostly unwilling to purchase such services if they are priced at 8 to 10 percent of the market value of their products. For those farmers who were willing to pay the random proposed price, the average price for which the service was deemed acceptable was 37.7 birr per quintal (approximately 3.8 percent of the selling price expected by farmers).

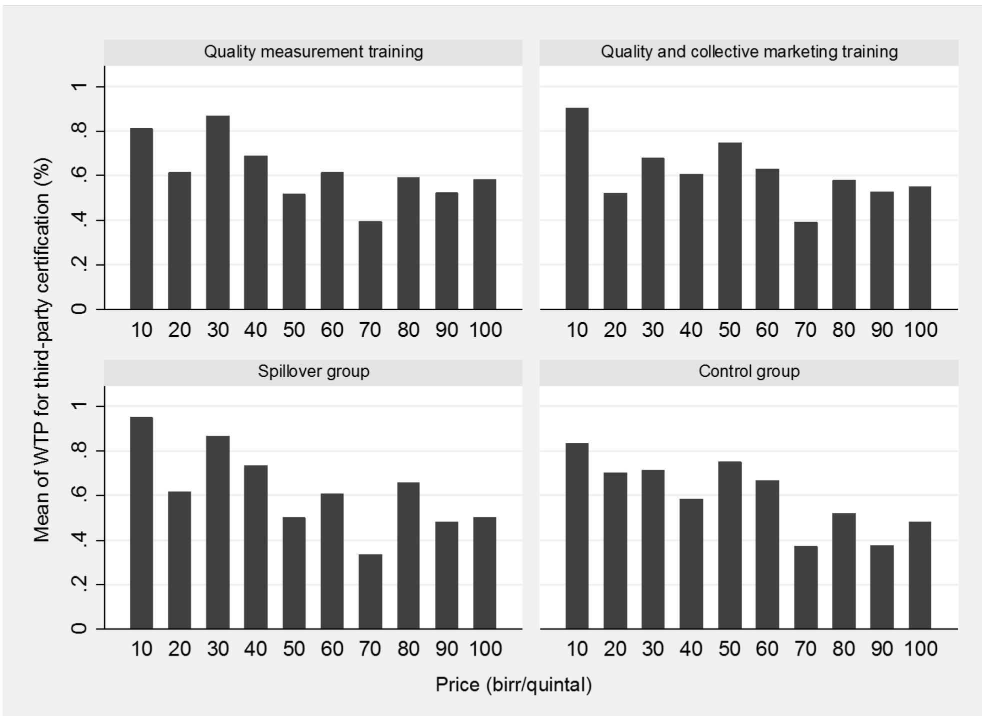
Figure 5.1 Willingness to pay for third-party quality certification, at baseline



Source: Authors' computation based on data from wheat growers' survey, 2016.

In Figure 5.2, we report the same estimates, but this time measured at follow-up. We found an increased willingness to pay a higher price for the service among all groups at this point in the study. This increase was particularly significant among the two treatment groups whose members received quality training (upper panel). In those groups, more than 50 percent of the farmers were willing to purchase third-party certification services for their wheat, at a price amounting to as much as 10 percent of the value of their output. The average price that these farmers were willing to pay increased by approximately 9 birr per quintal compared to the baseline estimate; specifically, farmers were willing to pay 46.1 birr per quintal, on average.

Figure 5.2 Willingness to pay for third-party quality certification, at follow-up



Source: Authors' computation based on data from wheat growers' survey, 2016.

6. CONCLUSIONS

This paper presents a first set of results related to a one-hour video-based training intervention (that is, approximately 30 minutes per session) among wheat farmers in Ethiopia. The intervention primarily aimed to equip farmers with the means to assess the unobservable quality of their wheat, and in particular the flour extraction rate. For some farmers, it also provided a sense of the potential economies of scale available through collective commercialization.

While just an initial set of data, the results point to several important patterns. First, the video training intervention was able to reach a large number of farmers at a relatively low cost. Second, these interventions were well accepted by farmers, leading to significant changes in their marketing-related behaviors—namely, assessing the quality of their wheat using easily implemented test-weight measures, assessing the accuracy of the equipment used by the buyers in their kebeles (scales, in particular), and contacting several buyers before concluding sales transactions.

We also found positive evidence that the training led to enhanced collective marketing, albeit with an important qualification. Farmers who found that their wheat was of higher quality were more reluctant to sell their products through local cooperatives than those who found that their wheat was of lower quality. Most cooperatives in Ethiopia do not offer their members differential pricing according to the quality of their grain. Thus, farmers with higher-quality wheat may be reluctant to aggregate their products with others of potentially lower quality in the cooperative. For these farmers with higher-quality wheat, we found that the intervention had a positive impact on the price that they received for their wheat output.

Lastly, we found evidence that farmers changed some of their production behavior in a way that can enhance some of the unobservable quality attributes of their product. In particular, we found that the short videos shown during the training led to significant increases in the use of NPS, a fertilizer whose use is currently promoted by the agricultural extension system in Ethiopia.

Overall, the study highlights the importance of the functioning of local markets in triggering technology adoption by farmers. In particular, it shows that uncertainty about quality assessments at the time of sales transactions may be a strong disincentive for farmers to invest in quality-enhancing technologies. Our study intervened on only one side of the exchange—that is, farmers' increased knowledge of the value of their product. We did not intervene on the other side, which would have involved training local aggregators (traders or cooperatives, for instance) on quality recognition. Thus, we did not fully address all issues related to bargaining based on quality assessments. More broadly, while grades and standards exist in food markets in Africa south of the Sahara, they tend to be applied only at higher levels of aggregation (for example, a truckload) upon reaching a major consumption or export market. Our results suggest that implementation of lower-level ("micro-level") certification could facilitate the type of food crop aggregation that is often advocated for the region. A more general intervention that we are seeking to pilot in the short run is local, micro-level third-party certification schemes. Evidence from the current study shows that farmers would likely be willing to pay for such services, owing to their low level of trust in the current marketing systems.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 Estimated cost of intervention

Cost items	Amount (in USD)
Video production	1,500.00
Video facilitators training	2,467.40
Video facilitators salary	28,538.70
Pico projectors	9,576.00
Miscellaneous expenses	2,073.60
Total cost	44,155.80
Number of trained farmers	[15,294]
Cost of intervention per farmer	2.90

Source: Authors' computation based on data from wheat growers' survey, 2016.

Table A.2 Frequency of random values generated for willingness to pay for third-party certification

Random value	Frequency at baseline (%)	Frequency at follow-up (%)
100 birr	5.41	8.6
90 birr	11.74	8.43
80 birr	8.19	10.47
70 birr	6.17	9.36
60 birr	12.5	8.09
50 birr	8.45	9.11
40 birr	10.73	11.91
30 birr	14.7	9.62
20 birr	9.21	9.53
10 birr	12.92	14.89
Observations	1,184	1,175

Source: Authors' computation based on data from wheat growers' survey, 2016.

Table A.3 Determinants of wheat quality (test-weight)

Variables	Test-weight (kg/hL)			
	(1)	(2)	(3)	(4)
Inputs				
Urea (kg/ha)	0.00523***	0.00461**	0.00374*	0.00357*
	(0.00199)	(0.00209)	(0.00204)	(0.00204)
NPS (kg/ha)	0.00127	0.00183	0.00144	0.00134
	(0.00177)	(0.00178)	(0.00172)	(0.00173)
Seed rate (kg/ha)	–0.00343*	–0.00334*	–0.00328*	–0.00316*
	(0.00196)	(0.00197)	(0.00191)	(0.00190)
Seed type (certified = 1)	–0.405	–0.329	–0.375	–0.388
	(0.313)	(0.317)	(0.321)	(0.323)
Weeding frequency	0.132	0.143	0.128	0.126
	(0.104)	(0.104)	(0.0943)	(0.0930)
Plot characteristics				
Soil type				
Black soil		0.907**	0.911**	0.945**
		(0.390)	(0.379)	(0.381)
Gray/sandy soil		0.680	0.842*	0.918**
		(0.451)	(0.454)	(0.452)
Plot slope				
Medium		–0.432	–0.484*	–0.487*
		(0.282)	(0.271)	(0.271)
Steeper		–0.106	–0.0151	–0.0183
		(0.460)	(0.450)	(0.440)
Own plot		0.178	0.282	0.243
		(0.230)	(0.221)	(0.214)
Grain characteristics				
Cleanness			1.937***	1.934***
			(0.304)	(0.302)
Varietal mix			–0.00540	0.0252
			(0.723)	(0.718)
Moisture			–0.770	–0.719
			(0.692)	(0.700)
Household characteristics				
Age of household head				0.00389
				(0.0110)
Gender of household head				–0.915
				(0.608)
Education of household head				0.0656*
				(0.0384)
Household size				0.0636
				(0.0628)
Constant	86.68***	86.45***	86.64***	86.84***
	(0.868)	(0.831)	(1.042)	(1.286)
Observations	2,741	2,596	2,596	2,596
R-squared	0.327	0.329	0.356	0.359

Source: Authors' computation based on data from wheat growers' survey, 2016.
Note: NPS = nitrogen + phosphorus + sulfur. Robust standard errors clustered at the kebele level in parentheses. *** p < .01, ** p < .05, * p < .1. Red soil is a reference category for soil type. Flat is a reference category for plot slope. The estimation accounted for woreda-level fixed effects.

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