Technology Training, Buyer-Supplier Relationship, and Quality Upgrading in an Agricultural Supply Chain

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Abstract

This paper examines the impacts of technology training and buyer-supplier relationship on technology adoption and quality upgrading. We randomly varied subjects of each training group across farmer–exporter clusters—farmers, exporters, both, or none—and provided training on Good Agricultural Practices (GAP). We find that training farmers enhances technology adoption and quality upgrading. Yet, the effects are much stronger when farmers and exporters are trained together. We document a plausible mechanism to explain this finding: joint training improves buyer-supplier relationship, which facilitates contract trade between farmers and exporters. We find no effect of GAP certification eligibility on technology adoption.

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1 Introduction

Quality upgrading is imperative for producers to export to high-income markets (Verhoogen 2008) and a pathway to growth for developing economies (Hausmann, Hwang, & Rodrik 2007). Yet in many developing countries, the transition from production of low- to high-quality goods is painfully slow (Verhoogen 2021; World Bank 2007). To stimulate quality upgrading, government policies typically focus on reducing producers' costs of technology adoption and quality upgrading (a supply-side constraint) through technology training, R&D subsidies, and input subsidies. However, asymmetric information on quality between producers and downstream buyers and the resulting market friction (a demand-side constraint) may dampen the effects of supply-side interventions. For example, subsidizing farmers to produce high-quality dragon fruit may fail if buyers are unwilling to pay a price premium due to lack of trust in the product's quality. This problem may be especially severe in supply chains where quality verification (e.g., safety of food products) is difficult or costly, and when contract enforcement is weak.

This paper examines the impact of technology training and buyer-supplier relationship on technology adoption and quality upgrading through a field experiment in an agricultural supply chain in Vietnam. As the main intervention, we provide training on agricultural technologies designed to increase food safety, which is a key determinant of quality for agricultural products, yet difficult for downstream buyers to observe or verify. We experiment with farmers and exporting intermediaries (henceforth, exporters) and randomize the subjects of training groups across matched farmer-exporter clusters: farmer-only training, exporter-only training, farmer-exporter joint training, or no training, which serves as our control group. The content of the training program was developed based on Good Agricultural Practices (GAP) and was identical across all training groups. As the second intervention, we randomly offer eligibility for GAP certification to farmers in half of the clusters within each training treatment arm. The certificate can convey information about product quality to buyers, and thus being eligible for certification may incentivize farmers to adopt GAP in farm production.

The main finding is that training farmers and exporters together generates much larger effects on technology adoption and quality upgrading than when only farmers are trained. Moreover, training exporters only or certification eligibility has no significant effect on farmers' technology adoption or quality upgrading. We exploit detailed survey data on farmer knowledge, farm-gate transactions, and measures of trust between farmers and exporters obtained from a lab-in-the-field experiment to document potential mechanisms. On the one hand, training farmers increases their knowledge of GAP, relaxing a supply-side constraint to quality upgrading. On the other hand, the intensive interaction between farmers and exporters in joint training improves their mutual trust and buyer-supplier relationship, leading to more contract trade and higher incentives for farmers to upgrade quality.

As introduced in Section 2, the dragon fruit supply chain is characterized by many smallholder farmers and medium- to large-scale intermediaries specializing in export or domestic markets. Farmers and intermediaries mostly engage in spot trade at the farm gate, lacking a stable buyer-supplier relationship and contract trade is rarely used. Mostly grown as a cash crop, quality and food safety have been a major obstacle for Vietnam to exporting dragon fruit to high-price countries. Accordingly, the Vietnamese government has been encouraging agricultural producers to adopt GAP through policy interventions, such as GAP training and state-operated GAP certification programs.

Section 3 describes the experimental design and introduces our main measures of technology adoption and product quality. The experiment features a 4×2 factorial design with two randomized interventions—training and certification eligibility. We formed farmer-exporter clusters by matching randomly sampled farmer groups and exporters from the same commune. As our first intervention, we offered training on Good Agricultural Practices, which is a set of agricultural management practices designed to improve food safety and product quality (Food and Agriculture Organization 2016). Each cluster was randomly assigned to one of four training treatment arms: (1) farmer-only training, (2) exporter-only training, (3) farmer-exporter joint training, and (4) no training which serves as our control group. Within each training treatment arm, we then randomly provide certification eligibility to farmers in half of the clusters. Eligible farmers who met the requirements would be awarded a GAP certificate after the end of our study.

To increase the accuracy of the measurement of technology adoption, we hired agronomists specializing in dragon fruit to conduct field audits on each participating farmer's GAP compliance twice, 6 and 12 months after the training respectively. The product quality measure is based on a pesticide residue analysis of 18 different types of pesticides conducted by an ISO-certified laboratory. Based on the test results, we constructed a standardized quality index for dragon fruit at the farm level.

We present the empirical analysis in Section 4. First, we find that farmer-only training improves technology adoption. It increases a farmer's GAP compliance by 0.46 standard deviation, commensurate with a 6.4 percent increase in compliance relative to the control group. Second, joint training generates a significantly larger effect, increasing GAP compliance by 0.68 standard deviation (a 9.4 percent increase). Accordingly, product quality increased substantially. Farmer-only training reduces the average pesticide residue by 30 percent relative to the control group. Yet, again, farmer-exporter joint training has a significantly larger impact. Pesticide residue falls by 48 percent relative to the average level found in the control group. Third, exporter training and certification eligibility has no significant impact on technology adoption and quality upgrading. As corroborating evidence, we find that training effectively increases farmers' GAP knowledge and expenditures on crucial inputs required for adopting technology. This finding is consistent with the interpretation that our training intervention increased farmers' knowledge on GAP and induced them to upgrade their farming practices.

Do training and quality upgrading improve farmer performance at the farm gate? Studies have shown positive (often limited) training effects on farmers' profit and income (Davis et al. 2012; Fafchamps, Islam, Malek, & Pakrashi 2020). We find that 12 months after the intervention, farmers in the joint training group receive higher farm-gate prices (by 11.5 percent), revenue (by 20 percent), and profits (by 30 percent). However, there is no significant effect on farm performance in the farmer-only training group, although they improved product quality. The differential price and profitability performance of the joint training and farmer-only training groups emphasize the importance of demand-side constraint as a barrier for quality upgrading.

Section 5 provides potential explanations for the major findings. We provide suggestive evidence that improved buyer-supplier relationship may have contributed to the larger effects of joint training. A lab-in-the-field experiment shows that joint training substantially increases mutual trust between farmers and exporters, which is arguably a proxy for buyer-supplier relationship, potentially due to their intensive interaction during the training. As predicted by the model in Section 4.1, a better buyer-supplier relationship can increase contract trade and quality upgrading by reducing monitoring costs. This is confirmed using detailed survey data on contract formation and trade partners. Joint training substantially increases within-cluster trade between farmers and exporters by 31 percent (from 7 percent in the baseline). A large portion of the increase is arranged through informal contracts, which were associated with higher farm-gate price and product quality. By contrast, we find no economically or statistically significant increase in contract trade in clusters with farmer-only or exporter-only training.

Next, regarding the lack of effect of GAP certification eligibility, our data show that farmers with GAP certificates previously issued by the government do not receive higher prices at the farm-gate. This result holds regardless of whether we control for the farm's GAP compliance or product quality. A plausible explanation is that although GAP compliance is valued by intermediaries in the local dragon fruit supply chain, the government-issued GAP certificate is not considered as a credible device that can mitigate asymmetric information. As a result, providing eligibility has no impact on farmers' incentives to adopt GAP technology. This result is related to the literature on quality disclosure and certification (see Dranove &

Jin 2010, for a review). Although a number of studies suggest that the distortions caused by asymmetric information on quality may be "solved" by disclosure of private information through certification (Jin & Leslie 2003; Saenger, Torero, & Qaim 2014), Bai (2021) shows that the credibility of the certificate matters. Our no-effect result of certification eligibility echoes her finding.

This paper is related to the growing empirical literature on the role of relationships and contracts in technology adoption and quality upgrading. While Cai and Szeidl (2018) find that general inter-firm relationships can enhance firm performance[1], we show that buyer-supplier relationships in the supply chain can induce quality upgrading and improve business performance. Moreover, the literature has shown that the lack of enforceable contracts makes producers subject to holdup problem (Krishna & Sheveleva 2017) and curtails incentives to provide high-quality products (Bai 2021; Macchiavello & Miquel-Florensa 2019) when quality is unobservable to buyers.[2] In this case, randomly providing contracts to producers may incentivize them to upgrade quality.[3] We contribute to this literature in two ways. First, in

[1] McMillan and Woodruff (1999) show prior information or experience can increase trust and relational contracts between Vietnamese firms. Macchiavello and Morjaria (2015) provides evidence on the role of reputation and relationships where enforcement is lacking.

[2] In such settings, producers may have to establish their reputations through repeated transactions with buyers (Bai 2021; Bai, Gazze, & Wang 2022; Björkman Nyqvist, Svensson, & Yanagizawa-Drott 2022; Zhao 2020). These papers highlight the dynamic learning and reputation-building during the final transaction stage, as a device to replace the role of contracts. By contrast, our paper emphasizes the role of mutual understanding and trust between farmers and exporters in increasing contract trade and incentivizing quality upgrading.

[3] Bold, Ghisolfi, Nsonzi, and Svensson (2022); Deutschmann, Bernard, and Yameogo (2021); Magnan, Hoffmann, Garrido, Kanyam, and Opoku (2021) examine the effect of market access on quality upgrading by randomly assigning contracts to farmers. Atkin, Khandelwal, and Osman (2017) show that exporting contracts randomly assigned to rug producers in Egypt

contrast to randomly assigned orders, we create an opportunity for farmers and downstream exporting intermediaries to meet and potentially establish business linkages. Second, we show that establishing buyer-supplier relationship could be a particularly effective way of facilitating contract formation.

This paper also contributes to the literature evaluating agricultural training programs in two ways (for example, see Magruder (2018)). First, we examine how training effects depend on who receives the training in the supply chain. Beaman, BenYishay, Magruder, and Mobarak (2021) show that targeting centrally connected farmers is important for technology adoption.[4] To our best knowledge, our paper is the first to study the effect of jointly training both buyers and producers. Second, we focus on a quality-enhancing technology rather than yield- or productivity-improving technologies as discussed in the literature. Our study shows that, compared to farmer-only training, farmer-exporter joint training on quality-enhancing technology results in much higher technology adoption, quality upgrading, and profits at the farm-gate.

2 Study Setting

2.1 Good Agricultural Practices (GAP)

Food safety and quality have become a primary concern for consumers. In response to rising demand for safe agricultural products, governments and agribusinesses have been working to promote the use of GAP in the production of fresh fruits and vegetables. GAP is a farm management system consisting of rules and procedures that guide producers to grow, harvest, and process agricultural products in accordance with international requirements on food safety and environmental protection (Food and Agriculture Organization 2016). In 2008,

improve producer skills and (largely observable) product quality.

[4]Suri (2011) provides evidence that heterogeneous returns to technology is a crucial determinant of farmers' adoption of hybrid maize.

Vietnam's Ministry of Agricultural and Rural Development developed VietGAP based on the GlobalGAP program to enhance regulations on pesticide and chemical use.

From an exporter's perspective, procuring products compliant with GAP is imperative for selling to foreign buyers. For instance, European importers and retailers increasingly demand GAP certification for Vietnamese agricultural products, as recent inspections in Europe and the United States have revealed violations of pesticide residue levels in fresh fruits and vegetables imported from Vietnam. In the case of dragon fruit, the European Commission's Rapid Alert System for Food and Feed (RASFF) reported 19 cases of rejections of shipments from Vietnam at the border due to detection of pesticide residue levels exceeding limits set by the EU (European Commission 2014-2019). In a 2017 inspection report, the California Department of Pesticide Regulation found illegal pesticide residue levels in 100 percent of samples of Vietnamese dragon fruit (California Department of Pesticide Regulation 2017).

Yet GAP adoption remains low among Vietnamese farmers, due to several factors. First, although farmers are aware of GAP standards, transfer of technology for implementing GAP may have been limited due to inexplicit guidelines and difficulty in self-learning GAP procedures. Second, if intermediaries, or buyers at the farm gate, cannot verify GAP compliance and safety of dragon fruit, then this may severely undermine farmers' incentives to comply with GAP standards due to low expectations of quality premium. Finally, other factors such as financial constraints may also prevent farmers from adopting GAP.

2.2 Dragon Fruit Supply Chain

Dragon fruit, better known as *pitaya* in South America and *thanh long* in Vietnam, is a cactus species grown in tropical regions as an ornamental plant or fruit crop (see Online Appendix Figure A-1 for a picture). As a perennial crop, the fruit is harvested twice a year in southern Vietnam, once during the dry season (October - February) and once during the wet season (March - September). In 2018, dragon fruit accounted for one-third of Vietnam's total export value of vegetables and fruits (General Office of Customs 2018). The largest export market is China, which accounts for over 90 percent of export volume in 2015 and about 80 percent of national output (Binh Thuan Dragon Fruit Center 2019). It is hard for Vietnamese dragon fruit to enter high-price markets (e.g., Canada, Japan, South Korea, Netherlands, and US) due to its quality problem.[5] Agricultural experts point out that inappropriate use of chemical pesticides and growth regulations during the on-farm production stage is the major factor hindering the production of high-quality dragon fruit (Trinh et al. 2018).

Figure A-2 illustrates the dragon fruit supply chain in Binh Thuan province, where our experiment was implemented. There are three main layers in the supply chain: farmers, intermediaries, and buyers from foreign or domestic markets. Most farmers operate on small plots, cultivating less than one hectare of land. Intermediaries can be exporters or domestic retailers. Exporters operate packing facilities at which fruits are cleaned, packed, and prepared for shipping to overseas markets. Domestic retailers supply to the regional or national domestic market. In the supply chain that we study, the share of products sold to the domestic market is only 3 percent. As a result, our study focuses on intermediaries in the export supply chain.

Exporters receive orders from overseas markets and decide the price, volume, and quality required to meet buyer demand (e.g., GAP compliance). They may purchase fruits directly from farmers or indirectly through small-scale local collectors o save searching and transaction costs, who can be considered middlemen in the supply chain, searching for farms that are ready for harvesting and purchasing fruits on behalf of exporters. Contract, including informal verbal arrangements and formal written contracts, is rarely used. Typically, farmers engage in spot trade with local collectors or exporters, bargaining at the farm gate before harvest. Price offers are based on grading criteria that largely depend on certain exterior features of the fruit, such as size and skin condition. One farmer may be approached by multiple buyers who compete to offer the highest price. Buyer-supplier relationship varies across seasons due

[5]Customs data show that the average unit price of dragon fruit exports to Canada, Japan, South Korea, Netherlands, and United States are 3-7 times higher than those to China.

to competition among buyers and lack of contract trade in the supply chain.

Food safety is difficult to observe and verify at the farm gate. Moreover, testing food safety in a laboratory is not only costly but also time consuming, which can be highly problematic for a perishable fruit. Hence, food safety tests are rarely conducted in local trade of perishable fruits such as dragon fruit. This creates information asymmetry on quality between farmers and intermediaries: the farmer possesses information on quality but intermediaries do not. This information asymmetry further discourages farmers from investing in quality-upgrading technologies. In this paper, we exploit a randomized field experiment to explore whether and how GAP training, buyer-supplier relationship, and certification eligibility affect farmers' GAP adoption and quality upgrading in the Vietnamese dragon fruit industry.

3 Experiment, Data, and Quality Measurements

The experiment was implemented across multiple districts in Binh Thuan province, which accounts for 55 percent of national production of dragon fruit in Vietnam (Binh Thuan Dragon Fruit Center 2019). We formed farmer-exporter clusters as our unit of randomization. The experiment is designed with two cross-randomized interventions. First, we randomly assigned each cluster to one of the four GAP training treatment arms in equal proportion; then within each assigned treatment arm half of the clusters were randomly assigned to be eligible for VietGAP certification and the other half were ineligible. Below we provide details of the sample selection process and the experimental design.

3.1 Sample Selection Details

Farmer group selection The unit of sample selection for farmers is a farmer group, consisting of around 15 farmers per group. Several reasons make the farmer group ideal as our unit of treatment group. First, farmer groups are self-organized and composed of farmers located in the same town.[6] By assigning treatment at the level of farmer groups, we allow for intra-group learning of a technology, which may increase technology adoption and reduce potential treatment spillovers across groups, given the group organization and geographic characteristics. Second, government support and policy interventions have been previously provided at the farmer group level in Vietnam. We follow this convention by assigning treatment at the same level. Finally, by regulation farmer groups have to be registered with their provincial agriculture agency before they can receive any assistance from the government. By partnering with a government agency we were able to use the list of registered farmer groups as the pool for random sampling in two major districts, namely, Ham Thuan Bac and Ham Thuan Nam (see Figure A-3 for a map). Treatments were randomized within 11 geographical strata in these two districts, where each stratum is either a single commune or a coalition of multiple communes. We randomly selected 88 out of 406 registered farmer groups and sent out letter invitations asking farmers to participate in our experiment. In total, 1,141 farmers from 88 farmer groups participated in the baseline survey and were offered training and certification eligibility treatments.[7]

Exporter (exporting intermediary) selection We also recruited exporters to participate in the GAP training program. However, unlike farmer groups, the list of exporters was not readily available. To create a list of exporters, we carried out a search and recruitment drive in the two districts in August 2017. In total, we found 325 dragon fruit exporters operating in the area, of which 228 eventually participated in our study.[8] Using geographic

[6]There may be more than one farmer group in a town. We limit our sample to one farmer group from each town to prevent treatment spillover across different groups.

[7]Some farmers in the selected farmer groups did not participate in the baseline survey and, therefore, are not included in our analysis.

[8]To incentivize exporter participation, BTDC offered to support the registration of exporters in the supply chain database that was to be launched in 2020 by the Vietnamese government.

information on the exporters and farmer groups, we matched each farmer group to on average 3 of the closest exporters to form a farmer-exporter cluster.

3.2 Experimental Design and Implementation

Figure 1 illustrates the experiment design. Our main sample consists of 88 farmer-exporter clusters, which is our unit of randomization. We randomly assign the 88 clusters in equal proportion to one of the four training treatment arms (22 clusters in each): (i) farmer-only training, in which only farmers in the cluster were invited to receive GAP training; (ii) exporter-only training, in which only exporters in the cluster were invited to receive GAP training; (iii) joint training, in which farmers and exporters in the cluster were both invited to receive GAP training in the same classes; and (iv) no training, which is our control group.

Then within each training treatment arm we randomly assign half of the clusters to be eligible for VietGAP certification. Farmers in the *eligible* group could receive VietGAP certification at the end of our study if they meet requirements on GAP standards assessed through a field audit and pesticide residue testing, while farmers in the *ineligible* group could not be certified. All farmers were notified of their eligibility at the start of the training program by our partner, the agricultural extension center in charge of VietGAP certification.[9] Review of the assessment results took place after the end of our second follow-up survey. Therefore, our study examines the effect of *eligibility for certification* rather than the effect of being certified. A summary of the certification process is presented in Online Appendix Table A-1.

The experimental design allows us to investigate three main questions in this paper. First, how and to what extent does training on quality-enhancing technology affect farmers' decisions to upgrade their farming practices and product quality? Second, compared with the conventional extension program to train farmers only, can training exporters, or training

[9]All of the administrative, training, and testing costs were subsidized as part our study yet only eligible farmers, which were randomly selected by us, could be certified.

them together with farmers generate larger effects? Third, how does certification eligibility on agricultural technology affect decisions on technology adoption and quality upgrading? If certification can credibly signal farming quality, then certification eligibility may provide incentives for farmers to adopt this technology.

To implement the interventions, we partnered with Binh Thuan Dragon Fruit Research and Development Center (BTDC), a provincial agricultural extension service agency. BTDC was an ideal partner for collaboration, as it conducts research on dragon fruit production, provides extension services to farmers, and is designated by the central government as the VietGAP certifier for dragon fruit. Agronomists at BTDC developed GAP training materials and conducted field audits for VietGAP certification. Our project provided GAP training and conducted surveys and audits with farmers and exporters in collaboration with BTDC.

Farmers and exporters were invited to attend GAP training sessions, which were instructed by BTDC staff. The training materials were designed specifically for implementing GAP in dragon fruit farming, covering five on-farm management sectors: (1) Pesticides; (2) Production Area and Tools; (3) Hygiene and Work Safety; (4) Soil, Water, and Waste; and (5) Fertilizers. Our training material laid out a practical step-by-step guide for implementing and monitoring GAP in the field along these five sectors. Figure A-4 shows several agricultural technologies – irrigation methods, pest control devices, and water management – introduced through our GAP training program. In addition, all farmers and exporters who participated in training were provided with a GAP checklist that was later used for auditing compliance with GAP. The English version of the checklist is provided in Table C-1.

Participants went through an intensive three-day training program, which included lectures, focus group discussions, and a field demonstration by experts on the last day of training. They were required to attend all sessions and daily attendance was recorded by BTDC staff.[10] At the end of the training program, BTDC organized a one-time group meeting between farmers

[10]After the last training session, participants with full attendance received a small payment of 100,000 Vietnamese Dong (about 4.3 US Dollars).

and exporters from the same cluster for all treatment and control groups. The meeting was intended to promote cooperation and partnership between farmers and exporters.

3.3 Surveys and Summary Statistics

Figure A-5 provides an overview of the timeline of the study. In total, we conducted three rounds of interviews with farmers and exporters, including a baseline survey and two follow-up surveys.[11] The baseline survey was performed in the winter of 2018, right before the training intervention. Farmers were asked questions on (a) demographic and farm characteristics, (b) farm production and transactions, (c) expenses on farm inputs, (d) self-reported GAP compliance, and (e) cognitive and non-cognitive abilities. The exporter survey was administered to the representative of each firm, who was often the owner or office manager of the firm. We asked questions on (a) firm characteristics, (b) trading and export activities, and (c) business expenses.

The two follow-up surveys were administered about 6 and 12 months after the training intervention, respectively, corresponding to the two harvest seasons after the training. Extension staff at BTDC visited farmers and exporters to conduct individual interviews. Each round of follow-up survey with farmers included a basic module that asked farmers to report on-farm production and transactions, an on-farm GAP audit module, and a product assessment module. Given the importance of obtaining a consistent measure of product characteristics across farms with different crop cycles, BTDC staff phoned each farmer in advance to check the production stage and expected harvest day to schedule the follow-up survey around the day of harvest.

Table A-2 reports the basic summary statistics from the baseline survey with farmers and exporters. Panel A shows farmer demographics and farm characteristics. The average farmer has around 11 years of experience in growing dragon fruit and cultivates a dragon

[11] All interviews were conducted in person, except the second follow-up survey with exporters which was conducted via phone due to the outbreak of COVID-19.

fruit farm of 0.75 hectares and around 750 dragon fruit trees. The balance check regarding farmer characteristics in Table A-3 suggests that the farmer sample seems well balanced across treatment and control groups and the attrition has been low in all surveys.

Panel B presents the summary statistics of farm-gate trade characteristics based on farmer reports of sales in the season prior to the intervention. Only 1 percent of farmers had a formal written contract with a buyer. The vast majority of farm-gate purchases are made by local collectors (90 percent); only 6 percent are purchased directly by exporters and 3 percent by domestic retailers. The high transaction between farmers and local collectors is not surprising, since local collectors receive orders from exporters and visit farms to collect and transport dragon fruit to exporters' packing facilities, behaving like agents representing the exporters.[12] Consistent with the customs data, 90 percent of transactions were for exports to China, 5 percent were for high-price Asian markets (excluding China), and 2 percent were exported to EU and US.

Panel C shows summary statistics on the characteristics of exporters. The average exporter had been in operation for almost nine years, and traded roughly 420 tons of dragon fruit during the past six months, or one season. The balance check in Table A-4 shows that exporter characteristics are not systematically different across treatment groups. Importantly, attrition rates of exporters are not significantly different between treatment and control groups, although they (26 percent) are higher than that of the farmers' (3 percent).

3.4 Measurements on Technology Adoption and Product Quality

We measure technology adoption using GAP compliance, which is constructed as the standardized score of an on-site audit of farmers' compliance with GAP standards. It is a

[12] During the pilot stage of this study, we discussed the possibility of including local collectors in our study with BTDC. In the end, BTDC recommended working with exporters because of logistical issues and for ensuring the efficacy of the program. We discuss how this potentially affects our study findings in Section 5.1.2.

comprehensive measure of farm production quality evaluated along five on-farm management sectors as listed in Section 3.2. The GAP audit was conducted twice (once in each survey round) by BTDC staff for all farmers in our study.[13] The auditors filled out the 32-item GAP checklist in which each item was marked as either pass or fail. GAP compliance is based on the number of items that a farmer passed in the audit.

We use pesticide residue as our main measure of product quality, which captures a key component of food safety and is typically unobserved by buyers. Pesticide residue tests were conducted at a private ISO-certified chemical testing laboratory. The test reports residue levels (mg/kg) for 18 pesticides on fruit samples collected from 264 randomly sampled farmers.[14] Safety regulations by governments and agricultural businesses mandate that a pesticide residue in food products cannot exceed a Maximum Residue Limit (MRL), which is the maximum concentration of a pesticide residue (expressed as mg/kg) that is legally tolerated in or on a food. We construct two indicators of product quality based on pesticide residue tests: (1) the mean level of pesticide residue; and (2) compliance to MRLs in each of the four countries – China, Japan, EU and US.

We incorporated an on-farm product assessment module in the follow-up surveys to measure observable product attributes along four main dimensions: sweetness, appearance (skin color and bract color), size (length and width), and weight. These product attributes represent product quality that can be directly observed and evaluated by buyers at the farm gate. Details on measurement methods are provided in Online Appendix E.

[13]For logistical and data quality reasons, farmers in the same stratum were audited by the same auditor.

[14]Due to a limited budget, we were only able to conduct tests using three farmers from each cluster, including the two spillover control clusters. Farmers were randomly chosen using a random number generator. In Online Appendix D, we provide detailed information on the field logistics for sample collection, the list of pesticides and their MRLs set by the EU, US, Japan, and China, and a sample report showing results from pesticide residue testing.

4 Technology Training, Adoption, and Quality Upgrading

This section presents experimental evidence on the impact of GAP training and certification eligibility on farmers' technology adoption, quality upgrading and sales performance. We first provide predictions derived from a theoretical model that captures several important features of the supply chain of interest. We then present visual evidence of the treatment effects, followed by the econometric specification and main estimation results.

4.1 Theoretical Predictions

We propose a stylized model that delivers testable predictions of the impact of technology training, buyer-supplier relationship, and certification eligibility on technology adoption and quality upgrading. The full model is provided in Online Appendix section F. The model features information asymmetry between exporters and farmers concerning the latter's GAP compliance at the production stage and product quality at the transaction stage. Such information friction depresses the farmer's incentive to adopt technology and improve product quality.

The model makes several predictions for our interventions. First, increasing farmers' GAP knowledge (e.g., through farmer training) may induce technology adoption and quality upgrading, as it lowers the production cost of quality, increasing production efficiency. Second, increasing exporter knowledge (e.g., through exporter training) alone may be ineffective as the low production efficiency on the supply side still prevents the farmer from providing high quality. Third, increasing both farmer and exporter knowledge or establishing a buyer-supplier relationship (e.g., through joint training) induces an increase in contract trade, resulting in improved technology adoption, quality upgrading and sales performance by lowering monitoring costs. The effect is stronger than the farmer only group because it relaxes the constraints on both demand and supply sides. Finally, providing certification improves technology adoption and quality upgrading, as (credible) certification mitigates asymmetric information on product quality and strengthens farmers' incentive to upgrade quality.

4.2 Graphic Evidence

Figure 2 presents bar graphs of the average outcome across the eight treatment groups, including the control group. Panel (a) shows the difference in farmers' GAP compliance rate across treatment groups. The left side of panel (a) shows the average GAP compliance, standardized by the control group's mean and standard deviation, of different training groups without certification eligibility and the right side shows that for training groups with certification eligibility. The main finding is that, while both the farmer training and joint training groups show significant increases in GAP compliance compared to the control group, the effect from joint training is much larger. By contrast, exporter training has an insignificant effect: farmers in the exporter training group had similar GAP compliance relative to those in the control group. Interestingly, certificate eligibility shows almost no difference in average GAP compliance between farmers with and without certificate eligibility, given that they receive the same training treatment.

In Panel (b), we compare the mean pesticide residue level across the treatment groups. The results are similar to Panel (a). Overall, the graphic evidence suggests that farmer-only and joint training produce visible impacts on technology adoption and quality upgrading with joint training producing much larger effects, whereas the effects of exporter training or certificate eligibility are small and insignificant statistically. In the rest of this section, we utilize our experimental data to estimate the causal impacts of technology training and certificate eligibility on farmers' technology adoption, product quality, and farm-gate trade.

4.3 Empirical Strategy

Our main empirical specification includes a linear specification with indicators for each of the three training treatments, certification eligibility treatment, and the interactions between them. The estimation equation is as follows:

$$\begin{aligned} Y_{icst} &= \alpha_0 + \Sigma_G \beta_G \text{Training}^G_{cs} + \gamma_0 \text{Eligible}_{cs} + \Sigma_G \gamma_G \text{Training}^G_{cs} \times \text{Eligible}_{cs} \\ &\quad + X_{ics} + \xi_s + \theta_t + \epsilon_{icst}, \end{aligned} \tag{1}$$

where Y_{icst} is a measure of technology adoption, output quality, or other performance measures for farmer i in farmer-exporter cluster c and stratum s in round t. $Training^G_{cs}$ is an indicator that takes the value 1 if cluster c is assigned to training treatment $G =$ {Farmer, Exporter, Joint}; otherwise, the value is 0. $Eligible_{cs}$ is equal to 1 if cluster c is eligible for VietGAP certification and 0 otherwise. X_{ics} is a vector of farmer and exporter characteristics collected from the baseline survey immediately before training. ξ_s is a vector of strata fixed effects that picks up variations arising from geographical differences. θ_t is a fixed effect for the survey round that picks up any survey round fixed effect or seasonal effect. ϵ_{icst} is the idiosyncratic error term.

Our coefficients of interest for evaluating the effects of different training interventions are the vector $\beta_G = \{\beta_{Farmer}, \beta_{Exporter}, \beta_{Joint}\}$: β_{Farmer} measures the impact of providing GAP training to farmers only, $\beta_{Exporter}$ measures the impact of providing GAP training to exporters only, and β_{Joint} measures the impact of providing GAP training to both farmers and exporters through joint training sessions. By comparing the estimates of different training treatments, we can test the relative effectiveness of each training program on technology adoption, product quality, and farm-gate performance. The coefficient γ_0 is interpreted as the difference in farmer outcomes between groups eligible and ineligible for VietGAP certification. Finally, the set of coefficients on Training × Eligible terms, $\gamma_G = \{\gamma_{Farmer}, \gamma_{Exporter}, \gamma_{Joint}\}$, estimate the differential effects of certificate eligibility with regard to different training treatments.

The theoretical framework in Section 4.1 predicts that the coefficient β_{Farmer} should be positive because GAP training increases farmer knowledge and thus improve their production efficiency. We also expect $\beta_{Exporter}$ to be insignificant because training exporters alone may not be effective when the supply-side constraint is not relaxed. The model also predicts that β_{Joint} should be larger than β_{Farmer} because joint training facilitates contract formation and incentivize technology adoption and quality upgrading. Finally, if the certificate is a credible signal of quality and therefore provides stronger incentive for quality upgrading, both γ_0 alone and the sum of γ_0 and any one of the γ_G should be positive.

The key identification assumption for causal interpretation of our coefficients is that farmers in treatment groups did not have systematically different outcomes from those in the control group for reasons other than the treatment itself. This assumption will be violated if, for instance, farmers self-selected into the GAP training program or were eligible for certification based on unobserved dimensions of farmers' abilities. As treatments were randomized across groups within geographic strata, we believe that a farmer's treatment status is unrelated to the unobserved error term. Nonetheless, we cannot completely rule out the presence of some factors that may arise as part of the training treatment, which may pose a potential threat to our causal interpretation. We provide corroborating evidence to show that these factors are unlikely to drive our main results.

We estimate (1) by using ordinary least squares estimation. In the main analysis, if the outcome is measured in both survey rounds, then we pool both rounds and estimate the average treatment effect. In the event we believe that treatment effects are expected to evolve across rounds or if seasonal or temporal factors may potentially influence the result, we show the estimates separately for each round. For estimating the effects of training and certification eligibility on farm-gate outcomes (e.g., price and profits) we follow McKenzie (2012) and include lagged outcomes from the baseline survey as controls.

Following recent studies that document proper inference techniques with randomized experiments (e.g., Young 2019), we further conduct randomization inference tests and report p-values based on 5,000 permutations.[15] In addition, to account for multiple hypothesis

[15] Online Appendix J provides details on the test and presents the full tables with P-values from randomization inference.

testing, we follow Anderson (2008) and adopt the two-stage false discovery rate control approach when interpreting the statistical significance of the results.

4.4 Impact on GAP Technology Adoption

We first present the results on the impact of training and certificate eligibility on GAP compliance in Table J-1. Column 1 reports the estimates from equation (1) using the standardized total score on the GAP audit as the outcome variable. We find four main results. First, consistent with the theoretical predictions in Section 4.1, when farmers receive technology training, they substantially improve their GAP compliance. As shown in the table, farmer-only training increases GAP compliance by 0.459 standard deviation. When focusing on compliance with pesticide management (Column 2) we find an increase by 0.352 standard deviation. Both estimates in Columns 1 and 2 are statistically significant at the 1% level. We also find a significant increase in GAP compliance in other areas, including production area and equipment (Column 3) and soil, water, and waste management (Column 5).

Second, compared with farmer-only training, joint training has a substantially larger effect on technology adoption. It increases farmers' GAP compliance by 0.676 standard deviation and GAP compliance of pesticide management in particular by 0.556 standard deviation. Both of them are substantially larger than and statistically different from the effects of farmer-only training at the 10% and 1% significance levels.

Third, exporter-only training has no significant effect on farmers' GAP compliance. If farmers' GAP knowledge can enhance quality upgrading, as to be shown below, then the no-effect result suggests that there is no knowledge transmission from exporting intermediaries to farmers in the exporter-only training group. This could be due to the market structure: without a formal contract, small farmers can freely choose buyers at harvest, exporters have no incentive to invest their time in training farmers. Alternatively, according to the model in Section 4.1, this no-effect of exporter training may arise if exporter knowledge mitigates asymmetric information only in contract trade, which is rare at the baseline.

Finally, we find no significant impact of eligibility for VietGAP certification on GAP compliance. Across six columns, none of the coefficients are statistically significant after adjusting for multiple hypothesis testing. Coefficients on interaction terms are also statistically insignificant, suggesting that being eligible for certification creates no additional effects of training on technology adoption. The insignificant effect of certification eligibility seems surprising and contradicts with our theoretical prediction, indicating that the certificate may not effectively solve the information asymmetry in the Vietnam dragon fruit supply chain.

Table A-5 reports estimates on GAP compliance by survey round to examine its temporal patterns. The results between the two rounds are quantitatively and qualitatively similar. Table A-6 reports the heterogeneous treatment effect with respect to farmer characteristics.[16] Across all 10 columns, the coefficient estimates of farmer training and joint training are quantitatively similar to those reported in Table J-1. Interestingly, farmers who received secondary education, have savings at a bank, and are present biased are likely to exhibit larger impacts of joint training on quality upgrading. Additionally, for farmer-only training, high level of entrepreneurship and having bank savings are positively associated with quality upgrading. Table A-7 shows no heterogeneous impacts of training with respect to exporters' characteristics, including age, facility size, and export volume to high-price markets.

To document how training drives farmers to comply with GAP, we provide two pieces of corroborating evidence: knowledge acquisition and investment in farm management practices. As shown in the literature, the lack of knowledge on proper technology may be a barrier to quality upgrading (Jack 2013; Magruder 2018). We first examine the treatment effect on the GAP knowledge of farmers and exporters by exploiting post-training test scores on GAP. We measure their GAP knowledge based on the answers to 10 relevant multiple-choice questions

[16]We restrict the set of farmer characteristics used here to those specified for heterogeneity analysis in our pre-analysis plan: gender, education, farming experience, farm size, savings at bank, business attitude, entrepreneurship, present bias, risk attitude, and raven's test score.

in the first follow-up survey after the training.[17] The standardized score of the 10 answers is used as a measure of knowledge of GAP technology. In the second follow-up survey, we asked farmers five questions on food safety awareness. In addition, our surveyors also conducted inspections at collection facilities of exporters to assess their compliance with Good Handling Practices (GHP), which is the intermediary counterpart to GAP providing standards for intermediaries in the food supply chain.[18]

Table A-8 shows that technology training substantially improves farmers' and exporters' knowledge on GAP. First, when only farmers (or exporters) are trained there are no improvements in the exporters' (or farmers') knowledge, suggesting no knowledge spillover from one group to the other. Second, jointly training farmers and exporters does not improve the farmers' knowledge of GAP more than when only the farmer is trained. This suggests that there was, if any, little knowledge transfer of GAP from exporters to farmers in joint training. Finally, we find no significant difference in exporters' compliance with GHP between treated and control groups as shown in column 4. This makes sense as the training focuses on farmers' GAP compliance rather than intermediaries' GHP compliance.

We next document evidence on farmers' input expenditure in support of farmers' investment in upgrading farm management practices in accordance with GAP standards. Table A-9 presents the results. Consistent with evidence on GAP compliance, Column 1 shows that farmer-only training and joint training both increased production costs; yet this can be only observed during the first season (Panel A) but not in the second (Panel B). One possible explanation for the difference across seasons is that farmers need to make investments to implement GAP, but once invested, reinvestment is not needed or is much smaller in the second season. Columns 2-8 show estimates for specific input categories. Spending on the facility increases by almost 200 percent during the first six months after training but is near zero in the latter six months. This finding is consistent with farmers incurring a fixed cost

[17] All survey questions are provided in Online Appendix Section C.

[18] Our treatments did not provide information or training on GHP.

for upgrading farm facilities to adopt GAP. Finally, VietGAP certificate eligibility does not significantly change farmers' input costs, consistent with the finding on GAP compliance.

4.5 Impact on Quality Upgrading

Table J-2 presents estimates of equation (1) using pesticide residue as the measure for product quality. Column 1 uses the average of 18 pesticide residue levels, where each residue level is normalized by EU's Maximum Residue Limit (MRL). The results show that farmer-only training reduces the average pesticide residue by 0.43 MRL units, which reflects a 31 percent drop from the control group's average residue level (1.4 MRL units). Joint training has a much larger effect, reducing the average pesticide residue by 0.67 MRL units, or about a 50 percent reduction relative to the control group's mean. Columns 2-5 examine treatment effects on compliance to MRLs of China, Japan, EU, and US, respectively. The dependent variable is an indicator variable equal to one if all 18 tested pesticides comply to the respective country's MRL. We find that joint training increases compliance to Japan's MRL by 0.24 from a base compliance rate of 0.55. We do not find any effect on compliance with other countries' MRLs.[19] Consistent with Table J-1, exporter-only training or certificate eligibility has no effect on pesticide residue levels.

Table A-10 presents treatment effects on observable product attributes. Each column is a separate regression with a different measure of product attribute standardized by the control group's mean and standard deviation. Because there are six observed attributes, we calculate the average z-score across six attributes as an index of overall product attribute (Column 1). Overall neither GAP training treatments nor certificate eligibility led to a significant change in observable product attributes.

[19]The country-differential effect may be due to large differences in MRLs across countries (for comparison, refer to Table D-1). The result implies that VietGAP may be particularly effective for qualifying for exports to countries with MRL similar to Japan's.

4.6 Impact on Farm Sales Performance

In this section, we focus on presenting findings on the effects of GAP training on farmers' business outcomes. The certification eligibility treatment is unlikely to directly affect farm sales performance through the VietGAP certificate because the certificate was awarded after the second followup survey and therefore farmers did not have the certificate nor did they know about the certification result at the time they sold their products.

Table J-3 reports results from estimating (1) for each survey round with various farm business outcomes: farm-gate prices, revenue, and profit. To account for potential spurious outliers, we winsorize the sample at the top and bottom one percentile for each outcome variable and survey round. The price and volume are in logarithm, and the revenue and profits are in their original levels because they have zeros and even negative values (for profits). Here price is defined as the volume-weighted average of prices sold to intermediaries by each farmer in each survey round. We construct two measures of revenue by using the farmer reports in the surveys. Direct revenue is the total seasonal revenue from dragon fruit farming reported by farmers. To account for possible misreports in total revenue, we separately calculated implied revenue as the sum of revenue (price $\times$ volume) from all transactions during the season as a double check. Finally, direct Profit is derived by subtracting cost from direct revenue and implied profit is calculated by subtracting cost from implied revenue. Panel A shows that training has no economically meaningful impact on farmers' business outcomes in the first season. However, in Panel B (second season), farmers in the joint training group sold dragon fruit at significantly higher prices (10.6 percent) and earned higher revenues (23 percent) and profits (27 percent) relative to the control group.

By contrast, farmer-only training has no economically significant effect on farm sales performance. This may seem surprising since farmers were making costly investment to upgrade quality when the profit gains turned out to be zero. Interviews with farmers suggest that this may be due to their high expectation of the training program initially.[20] In Figure

[20]Our GAP training program was advertised to participants as "Technology training

A-6, we show the farm-gate price premium associated with GAP compliance. The results suggest that only joint training has a positive correlation between farm-gate price and GAP compliance. The lack of GAP compliance premium in farmer-only training group may be due to the fact that farmers face constraints that cannot be removed by training farmers alone.

Table A-11 reports the treatment effects on product market destinations using farmer-exporter trade data.[21] Joint training significantly and substantially increases sales to high-price Asian markets, accompanied by a decline in sales to China. As there are no significant changes in total volume, these results suggest that training induced export reallocation from the low quality-low price Chinese market to other proximate markets that require higher quality and pay higher prices. We find no such effect in the farmer-only or exporter-only training groups.

Next, we present results on the effects of training on exporters' business performances. Table A-14 reports effects of training on various sales outcomes – price paid to suppliers (farmers or local collectors), price sold to buyers, trade volume, revenue, cost and profit. Across the two seasons, there is no significant training effects on exporters' sales. Admittedly, we may not be able to detect training effects on exporters' businesses given the larger scale of exporters compared to individual farmers.[22] Next, Table A-15 shows estimates of training on exporters' sales to different markets. Consistent with our previous finding using

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for dragon fruit export supply chain". Interviews with farmers at baseline indicate that farmers were eager to participate in order to join export supply chains for high-price Asian and European markets. Thus, participation in the training program may have raised their expectations about the returns to quality upgrading, which incentivized them to invest more.

[21]In Tables A-12 and A-13, we also report estimates on certification eligibility and on its interaction terms with training treatment for farm-gate sales.

[22]The share of export volume to high-price Asian markets is only 0.5-1% of exporters' total trade volume. Thus, even if joint training had increased exporters' trade volume to high-price markets, the impact on the overall average export price of the firm is small and hard to detect statistically.

farmers' sales data, the estimate on joint training in Column 2 of Panel B suggests that exporters increased sales to high-price Asia market by 22.5 percent although it is estimated without precision. Because the exporters receive higher prices for high-price Asian market (by $\exp(0.486) - 1 = 62.6$ percent) relative to Chinese markets as shown in Column 1 of Table A-16, the increased sales to these two markets after joint training represent a price gain to jointly trained exporters in the export markets. Overall, we believe that joint training had an impact on the farmer-exporter supply chain yet the impact is not sizable enough compared to the exporters' scale of trade.

Finally, one potential concern is the presence of treatment spillovers across farmer-exporter clusters, which could bias our estimates. To address this issue, we adopt two approaches, the first was designed before the experiment and the second we conduct as a post-experimental analysis.[23] The first idea is to test for spillovers by comparing key outcomes between control groups in treated districts and in districts without treatment. Table G-1 presents the results of this empirical exercise. While we do not find evidence of displacement or spillover effects on farm-gate price or volume we do find that farmers in treated districts have higher GAP compliance and lower profits. However, this result has to be interpreted with caution since such differences may be due to unobserved differences between the two control groups at baseline.

Next, we exploit each farmer's distance to the nearest farmer in the joint training treatment and run a difference-in-differences type regression to estimate its relationship with control group farmers' sales performance after the treatment, compared to before the treatment. Table G-2 reports coefficient estimates from exploiting distance to nearest jointly trained farmer. Across all six columns, the coefficient estimates are statistically insignificant. Table G-3 further shows no significant correlation between distance to jointly trained farmer and farmers' technology adoption nor quality upgrading. Overall, we do not find evidence to

[23]Online Appendix G provides more details on the design and methodology to test local treatment spillovers.

suggest displacement or spillover effects on control group farmers.

To summarize, we find that GAP training to farmers is substantially effective in inducing GAP adoption and promoting quality. However, the effect is even stronger when farmers and exporters are trained together. Yet, offering eligibility for VietGAP certification has no significant impact. Understanding the mechanisms driving these results is important for generating policy implications, as we do in the next section.

5 Discussion on Experimental Findings and Potential Mechanisms

5.1 Why Does Joint Training Have Larger Effects?

The larger impact of joint training on technology adoption, quality upgrading, and farm sales performance may arise from some special advantages associated with joint training, compared with farmer-only and exporter-only training. For instance, joint training may enhance the buyer-supplier relationship between the associated farmers and exporters; it may also change the market structure. This subsection discusses several potential mechanisms that may contribute to the larger effect of joint training.

5.1.1 Buyer-Supplier Relationship

The intensive interaction between farmers and exporters in joint training offers an opportunity for them to improve mutual understanding and trust, which help improve their relationship. As predicted by our model in Section 4.1, a better buyer-supplier relationship can increase contract trade by reducing monitoring costs. And the contract, which may formally or informally guarantee producers a quality premium, can promote technology adoption and quality upgrading (Deutschmann et al. 2021; Macchiavello & Miquel-Florensa 2019; Magnan et al. 2021). Although the design of the experiment does not allow us to separately identify the effect of buyer-supplier relationship, measures on trust obtained from a lab-in-the-field experiment and the observed outcome of trade types convey suggestive evidence that joint training improved the relationship between the associated farmers and exporters, which may have played an important role in promoting technology adoption and quality upgrading.

Joint training improves mutual trust. In the baseline survey, 44 percent of farmers indicated distrust towards exporters as the main reason for not contracting with them. From the farmer's perspective, the lack of trust in an exporter may cause fear of holdup by exporters, especially when contract enforcement is weak (Krishna & Sheveleva 2017). From the exporter's perspective, there is a fear of farmers reneging on contracts and selling to other buyers, which is of concern when exporters are constrained by contracts with foreign buyers.

We conduct a post-training lab-in-the-field trust game with all participants in our study to provide evidence on the impact of joint training on mutual trust between farmers and exporters. Right after concluding the training sessions in our experiment, we invited farmers and exporters to participate in a lab-in-the-field experiment in which participants played two games: a trust game and a dictator game. Both games were designed similar to Ashraf, Bohnet, and Piankov (2006), in which the trust game is designed to measure the level of trust a player (farmer or exporter) has toward her game partner, while the dictator game is designed to measure the level of kindness a player has toward her game partner. In Online Appendix section H we provide more detail on the design of the games.

As shown in Table J-4, we find strong evidence that joint training increases farmers' (exporters') trust in their exporter (farmer) partner. We do not find significant increase in trust in other training groups. Because the games were conducted just several days after training and long before the first harvest season, changes in trust should reflect the impact of the treatment and not the effect of farm-gate transactions between farmers and exporters in subsequent seasons. This suggests that the intensive interaction between farmers and exporters improved trust in the buyer-supplier relationship.

Joint training increases contract trade. If the intensive interaction in joint training improves buyer-supplier relationship, we should observe an increase in contract trade between the jointly trained farmers and exporters as predicted by our model in Section 4.1. Using detailed data on the use of formal and informal contracts in trade and trade partners recorded in our experiment, this subsection documents such experimental evidence.[24] Table J-5 reports the estimated effect of training and certification eligibility on farmer trade outcomes. Column 1 shows that joint training substantially increases the probability of trade of all types between farmers and exporters in the same cluster, which we term as within-cluster, by 30.9 percentage points, from a baseline of 7 percentage points in the control group. This is much larger than that for farmer-only training at 7.8 percent and exporter-only training whose effect is insignificant. As anticipated by the timing of the receipt of the certificate occurring after our second follow-up survey, we find no effect of certification eligibility on farm-gate trade.

Columns 2-5 explore the treatment effects on who and how farmers do trade at the farm-gate. Based on farmer reports in follow-up surveys, we categorize trade into spot trade and contract trade. Columns 2 and 3 demonstrate that joint training substantially increases spot trade with exporters in the same cluster, but reduces spot trade with exporters outside the cluster. Column 4 shows a significant increase in contract trade with exporters in the same cluster for joint training. Compared to the control group, where contract trade within the cluster consists of only 1 percent of all trade, farmers in joint training are 14 percentage points more likely to engage in contract trade with exporters in the same cluster. In contrast, there is no significant change in contract trade with buyers outside the experiment cluster.

To explore the association between trust and contract trade, we regress contract trade on the level of farmer's trust toward the exporter measured in the experiment. Table **??** shows that trust is indeed a significantly positive predictor of contract trade within a cluster. However, although joint training increases farmer's kindness toward the jointly trained exporters as shown in the dictator game, kindness does not predict contract trade. Thus, although we do not have direct evidence on the causal mechanism behind the increase in contract trade after joint training, the results from the lab-in-the-field experiment and contract trade provide suggestive evidence that joint training may have facilitated formation of contract trade through enhancing trust in buyer-supplier relationships (Otsuka, Nakano, &

[24]In Online Appendix I, we investigate dynamic formation of contract trade after training.

Takahashi 2016).[25] Moreover, the literature has documented a positive effect of contracting on prices, technology adoption, quality upgrading, and farm performance (Deutschmann et al. 2021; Macchiavello & Miquel-Florensa 2019; Magnan et al. 2021). Therefore contracting and the resulting higher prices provide incentives for farmers to upgrade quality.

5.1.2 Alternative Explanations

This subsection discusses several alternative explanations to the larger effects of joint training.

More effective farmer learning in the presence of potential buyers. One possibility is that farmers may have a stronger incentive to learn GAP technology when they are trained together with potential buyers (exporters), or they can learn more effectively through knowledge transfer from jointly trained exporters. This may increase farmers' technology adoption and quality upgrading in joint training. However, we find that joint training with exporting intermediaries does not improve farmers' motivation or effectiveness in learning GAP technology. As shown in Table A-8, joint training increases a farmer's knowledge by 0.228 standard deviation, which is not statistically different from the effect of farmer-only training (0.279 standard deviation). So more effective learning in the presence of potential buyers is unlikely to be the main factor leading to the larger effect of joint training.

Complementarity in quality production. Another possibility is that exporters may improve practices in the processing and packaging stage and perform better quality control/sorting after training, due to reasons such as improved exporter knowledge. The exporters' quality upgrading may complement farmers' production, providing stronger incentives for farmers to upgrade quality especially in joint training groups. While we admit that production complementarity may be important for quality upgrading in supply chains, it is unlikely to be the main driver of the larger effects of joint training in our case. Six months after the training, we conducted quality control audits at exporters' processing facilities and evaluated each exporter's handling of dragon fruit samples and quality control process.

[25] Figure A-7 shows heatmaps of price and product quality by contract type.

Column 4 of Table A-8 shows no difference in exporters' handling practices between the control and any of the treatment groups, suggesting that GAP training with exporters did not lead to quality upgrading in exporters' production processes.

Cutting off the middleman (local collectors) and changes in market structure. In the dragon fruit supply chain we study, 90 percent of the transactions occur between farmers and small local collectors, who act as another layer of "intermediation". The buyer-supplier relationship established in joint training may cut off the middlemen or change the market structure and competition in the local supply chain. This gives jointly trained farmers more bargaining power, because now they can use transactions with exporters as an "outside option". Cutting off middlemen also avoids double marginalization. The avoidance of double marginalization and stronger bargaining power ex-post can incentivize farmers to improve quality ex-ante (Krishna & Sheveleva 2017; Mitra, Mookherjee, Torero, & Visaria 2018). However, our data suggests that high-quality, high-price transactions mostly occurred in contract trade. Thus, while the shift in market structure could have influenced farmers' incentives to upgrade quality we believe that this cannot fully explain the increased use of contracts. Unfortunately, without detailed data on local collectors we are unable to empirically test this hypothesis.

Reduction of search friction. Another possibility is that joint training may mitigate the search friction between farmers and exporters.[26] However, it is unlikely to be the main mechanism for three reasons. First, the cost of travel to search for high-quality product should be relatively small given the proximity between farmers and exporters. Second, we organized a one-time meeting for farmers and exporters in the same cluster for all treatment and control groups. Such meeting may have allowed exporters to know better about farmers and reduced the search cost. Third, we also sample a spillover-proof control group of untreated farmers within the same province. As no meeting or other treatments are provided, we would expect this group to perform worse than our control group if reduced search friction does induce

[26]We thank Jie Bai for an insightful comment, which led to this discussion.

quality upgrading. Table G-1 shows no significant differences between these two groups, suggesting search friction is unlikely to be a major barrier for quality upgrading.

5.1.3 Cost-Benefit Analysis

By helping establish buyer-supplier relationship, joint training increases farmer profits by around 370 USD (8.6 Million Vietnamese Dong) after two seasons as shown in Table J-3. But how do these gains compare to the costs? The total expense of the project, including instructor fee, cost of materials, transportation, rental rate for classroom, is around 37 USD (or 870,000 Vietnamese Dong) per trainee. Given Vietnam's 2019 minimum wage rate (5.6 USD per day), the forgone wages from participating in the three-day program is 16.8 USD, which gives a total cost of 53.8 USD per trainee. From the perspective of farmer's welfare, that is a return of 6.9 dollars for each dollar spent on the joint training intervention.

This cost-effectiveness is comparable to other programs documented in the literature, if not better. For example, Cai and Szeidl (2018) show that the average annual profit margin from holding meetings to improve inter-firm relationship is more than twice of the estimated cost of hold these meetings. In the agricultural context, Bold et al. (2022) evaluate the importance of access to high-quality maize market. Their intervention can increase farmer profit by around 63-98 USD in one year, 4-6 times of its cost (15 USD). Cole and Fernando (2021) examines the impact of providing voice-based ICT agricultural advice for farmers and shows that such services, which cost 9.87 USD, increase the farmers profit by about 77 USD in a year. In Kondylis, Mueller, and Zhu (2017), farmers who receive training on a new agricultural technology earn yield and labor benefits of 150 USD, about twice of the training cost of 74 USD. These comparisons suggest that our joint intervention is quite cost-effective in improving farmers' business performance.

5.2 Why Does Certification Eligibility have an Insignificant Effect?

The main empirical findings strongly indicate that certification eligibility has no effect on improving farming practices or product quality. It could be the case that farmers do not adopt GAP technology because the certificate has no value on the market (i.e., zero price premium). To explore this possibility, we estimate the price difference between VietGAP certified and non-certified farmers controlling for farmer characteristics and various measures of product quality. This price difference would indicate to some extent the price premium associated with VietGAP certification. Specifically, we regress the farm-gate price from the first and second follow-up surveys on VietGAP certification, which equals to 1 if a farmer received a VietGAP certificate within the past two years and 0 otherwise.[27]

Note that we refrain from interpreting the price premium estimate as causal because there may be confounding factors (e.g., farmers with a VietGAP certificate or high-quality fruit may be better negotiators or have better connections with buyers). Nevertheless, we do control for an individual farmer's baseline characteristics and use price and quality information from two rounds of follow-up surveys in the regression.

Table A-17 presents the estimates of the price premium associated with the VietGAP certificate. We find no significant relationship between the two. This result is robust after controlling observed fruit attributes and GAP compliance (as a proxy for unobserved quality). This may explain the lack of additional incentives in the certificate eligibility treatment. As expected, we do find a robust positive price premium of output quality and observed fruit attributes, as shown in Columns 2-4.[28] This, although speculative, suggests that exporters

[27]We use past certificates because the certificate from our experiment was awarded only after our final follow-up survey. We only use certificates in the past two years (2017, 2018) as the VietGAP certificate has to be renewed every two years.

[28]In Figure A-8, we present price premium estimates for low-price and high-price markets, separately. GAP compliance shows a positive price premium only for the high-price market.

value compliance with GAP technology and, moreover, food safety.

The positive demand for quality from exporters, yet a zero price premium on quality certification, may seem puzzling. However, studies suggest that credibility of certification is a critical factor for obtaining a positive price premium (Abate, Bernard, de Janvry, Sadoulet, & Trachtman 2021; Bai 2021). For example, Bai (2021) provides experimental evidence in a watermelon market that sticker labeling certification technology (possible for noisy quality signal) does not induce higher prices than when no certification is provided, whereas laser-cut labeling increased profits by 30-40%.

6 Conclusion

This paper contributes to the literature and policy practices to promote technology adoption and quality upgrading, especially in agricultural sectors in developing countries. The main finding is that while training encourages farmers to upgrade quality, joint training has a much larger effect. However, exporter-only training or certificate eligibility have no significant effect on technology adoption and quality upgrading. Measures on trust obtained from a lab-in-the-field experiment and the observed outcome of trade types convey suggestive evidence that joint training increased the relationship between the associated farmers and exporters, which leads to more contract trade and may have played an important role in promoting technology adoption and quality upgrading.

Our findings have important policy implications. In particular, the findings suggest that training programs, widely adopted by many governments in developing countries, can be more effective if—in addition to transferring knowledge—they can help trainees to establish buyer-seller relationships and form contracts. The results also suggest that policy evaluations need to take into account the relationship between buyers and producers in supply chains to accurately assess the impact of training programs on technology adoption decisions and business performance.

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Figure 1: Experimental Design of GAP Training and Certification Eligibility

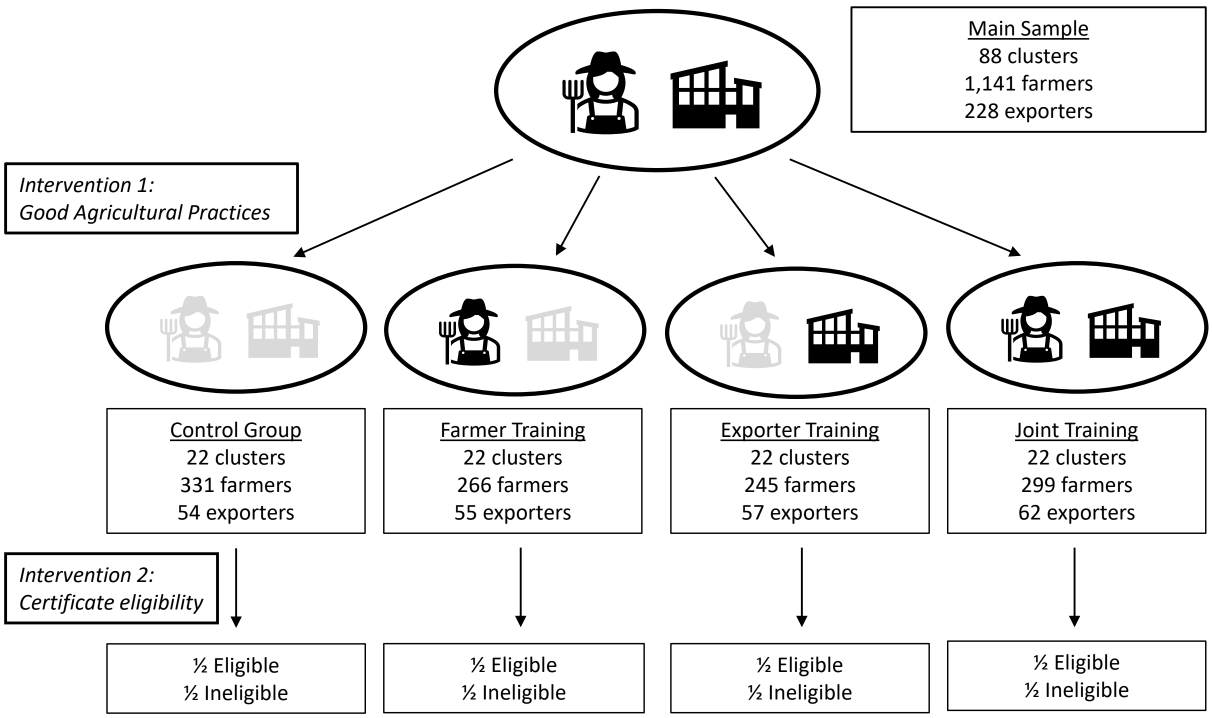

Figure 2: GAP Compliance and Pesticide Residue by Treatment Group

(a) Standardized GAP Compliance Rate

(b) Mean Pesticide Residue Level

Notes: Good Agricultural Practices Compliance Rate is the on-farm audit score standardized by the control group's mean and standard deviation. Mean Pesticide Residue Level is the mean of 18 pesticide residues in units of Maximum Residue Limits (MRL) found in fruit samples.

Table 1: Impacts of Training and Certificate Eligibility on GAP Compliance

Standardized scores from	Total	Pesticide	Equipment	Hygiene	Soil	Fertilizer
GAP audit ($N = 2197$) :	(1)	(2)	(3)	(4)	(5)	(6)
Farmer Training	0.459***	0.352***	0.340***	0.147	0.301***	-0.113
	(0.097)	(0.072)	(0.099)	(0.089)	(0.093)	(0.093)
Exporter Training	0.104	0.060	0.089	0.012	0.167	-0.207
	(0.105)	(0.076)	(0.112)	(0.099)	(0.104)	(0.116)
Joint Training	0.676***	0.556***	0.463***	0.202*	0.373***	0.029
	(0.123)	(0.081)	(0.107)	(0.090)	(0.116)	(0.090)
Certificate Eligibility (C.E.)	-0.058	0.030	-0.055	-0.190	0.128	-0.211
	(0.109)	(0.082)	(0.102)	(0.096)	(0.096)	(0.089)
C.E. × Farmer Training	0.068	-0.092	0.017	0.210	-0.151	0.533***
	(0.164)	(0.138)	(0.161)	(0.146)	(0.141)	(0.137)
C.E.× Exporter Training	-0.036	-0.029	0.010	0.080	-0.258	0.300
	(0.157)	(0.121)	(0.157)	(0.145)	(0.141)	(0.149)
C.E × Joint Training	0.188	-0.019	0.218	0.260	-0.073	0.234
	(0.192)	(0.111)	(0.167)	(0.161)	(0.160)	(0.128)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.08	0.01	0.29	0.54	0.52	0.06
Control mean (Pass/Total)	0.72	0.71	0.61	0.81	0.72	0.90
R-squared	0.16	0.11	0.15	0.13	0.08	0.05

Notes: Audit on GAP compliance was conducted in each of the two follow-up survey rounds. Audit scores are standardized by the control group's mean and standard deviation. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table 2: Impact of Training and Certificate Eligibility on Pesticide Residue

	Mean	Compliance to country's MRL			
Pesticide Residue Test ($N = 264$) :	Residue	China	Japan	EU	US
	(1)	(2)	(3)	(4)	(5)
Farmer Training	-0.432	-0.088	0.176	0.016	0.013
	(0.286)	(0.099)	(0.112)	(0.083)	(0.097)
Exporter Training	-0.004	-0.082	-0.151	-0.080	-0.101
	(0.279)	(0.085)	(0.105)	(0.086)	(0.095)
Joint Training	-0.671**	0.029	0.241**	-0.004	0.026
	(0.220)	(0.082)	(0.105)	(0.113)	(0.119)
Certificate Eligibility (C.E.)	-0.031	0.033	-0.169*	-0.057	-0.125
	(0.221)	(0.067)	(0.096)	(0.091)	(0.094)
C.E. × Farmer Training	-0.201	0.126	0.168	0.056	0.171
	(0.341)	(0.122)	(0.137)	(0.138)	(0.141)
C.E. × Exporter Training	-0.295	0.079	0.415**	-0.012	0.082
	(0.314)	(0.104)	(0.138)	(0.121)	(0.125)
C.E × Joint Training	-0.129	0.090	0.330*	0.131	0.074
	(0.293)	(0.101)	(0.141)	(0.149)	(0.151)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.33	0.17	0.53	0.81	0.90
Control mean	1.40	0.85	0.55	0.21	0.24
R-squared	0.22	0.26	0.24	0.15	0.16

Notes: Unit of observation is farmer. Outcome variable is constructed using pesticide test results from randomly sampled farmers. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table 3: Impact of Training on Farm Sales and Profits

	Farm-gate		Revenue		Profit	
	Price	Volume	Direct	Implied	Direct	Implied
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. First Followup Survey - Six months after training ($N = 1081$)						
Farmer Training	0.024	0.002	7.603	2.929	3.698	-0.887
	(0.032)	(0.072)	(9.560)	(7.962)	(7.046)	(6.985)
Exporter Training	0.030	0.030	12.960	6.418	9.285	5.299
	(0.028)	(0.071)	(9.871)	(7.677)	(7.250)	(7.146)
Joint Training	0.074	0.088	8.770	9.777	1.687	0.945
	(0.035)	(0.069)	(8.470)	(8.230)	(6.569)	(7.492)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.02	0.22	0.90	0.35	0.77	0.71
Control mean (in levels)	13.40	6.08	85.71	84.41	47.89	45.47
R-squared	0.20	0.43	0.39	0.42	0.30	0.32
Panel B. Second Followup Survey - Twelve months after training ($N = 1054$)						
Farmer Training	0.033	0.021	7.779	8.662	-5.926	-2.996
	(0.022)	(0.062)	(7.953)	(5.702)	(6.041)	(4.113)
Exporter Training	-0.041	0.016	6.690	7.150	-0.449	1.495
	(0.021)	(0.090)	(7.444)	(6.433)	(5.995)	(5.436)
Joint Training	0.106***	0.084	17.710	16.837**	8.605	9.232
	(0.027)	(0.060)	(7.207)	(5.829)	(5.483)	(4.648)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.01	0.29	0.10	0.10	0.00	0.00
Control mean (in levels)	11.53	6.24	75.41	74.17	31.47	28.28
R-squared	0.35	0.52	0.61	0.63	0.40	0.38

Notes: The price and volume are in logarithm, and the revenue and profits are in their original levels. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table 4: Impact of Training on Behavior in Trust and Dictator Games

	Trust Game				Dictator Game	
	1st stage (passed)		2nd stage (returned)		(passed)	
Proportion from:	farmer	exporter	farmer	exporter	farmer	exporter
To:	exporter	farmer	exporter	farmer	exporter	farmer
	(1)	(2)	(3)	(4)	(5)	(6)
Farmer Training	0.040	-0.020	-0.012	-0.005	0.036	-0.056*
	(0.032)	(0.022)	(0.041)	(0.043)	(0.042)	(0.030)
Exporter Training	0.013	0.012	-0.012	0.039	0.043	0.015
	(0.045)	(0.021)	(0.034)	(0.032)	(0.031)	(0.031)
Joint Training	0.158***	0.177***	0.001	0.024	0.106***	0.071**
	(0.044)	(0.022)	(0.032)	(0.032)	(0.040)	(0.029)
P-value ($H_0 : \gamma_{\text{farmer}} = \gamma_{\text{joint}}$)	0.01	0.00	0.76	0.51	0.14	0.00
Control mean	0.36	0.14	0.43	0.23	0.35	0.15
R-squared	0.39	0.52	0.31	0.16	0.34	0.20
Observations	207	208	207	208	202	202

Notes: This table reports treatment effects on outcomes of trust and dictator games. Columns 1-4 report the share of money a farmer or an exporter passed (first stage) or returned (second stage) to his or her partner in the trust game. Columns 5-6 show the share passed in the dictator game. Standard errors are clustered by farmer-exporter cluster and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table 5: Impact of Training and Certification Eligibility on Contract Trade

($N = 2730$)	Any Trade	Spot Trade		Contract Trade	
Cluster:	Within	Within	Outside	Within	Outside
	(1)	(2)	(3)	(4)	(5)
Farmer Training	0.078**	0.032	-0.056	0.038	0.001
	(0.026)	(0.025)	(0.035)	(0.020)	(0.028)
Exporter Training	0.031	0.005	-0.004	0.014	-0.014
	(0.021)	(0.021)	(0.042)	(0.019)	(0.023)
Joint Training	0.309***	0.148***	-0.244***	0.142***	-0.034
	(0.028)	(0.029)	(0.039)	(0.027)	(0.023)
Certificate Eligibility (C.E.)	0.021	0.006	-0.039	0.011	-0.005
	(0.022)	(0.022)	(0.037)	(0.021)	(0.025)
C.E. × Farmer Training	-0.074	-0.059	0.040	-0.015	0.015
	(0.040)	(0.035)	(0.052)	(0.028)	(0.040)
C.E. × Exporter Training	-0.005	0.005	0.054	-0.003	-0.027
	(0.034)	(0.034)	(0.050)	(0.025)	(0.028)
C.E. × Joint Training	0.080	0.044	-0.050	0.040	-0.027
	(0.044)	(0.043)	(0.055)	(0.049)	(0.036)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.00	0.00	0.00	0.00	0.15
Control mean	0.07	0.06	0.79	0.01	0.09
R-squared	0.16	0.11	0.11	0.18	0.10

Notes: Within cluster refers to trade with exporters in the same training cluster and Outside cluster refers to any intermediary, exporter or collector, not in the same training cluster. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

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A Appendix Tables & Figures

Figure A-1: Dragon Fruit Production

(a) Dragon Fruit

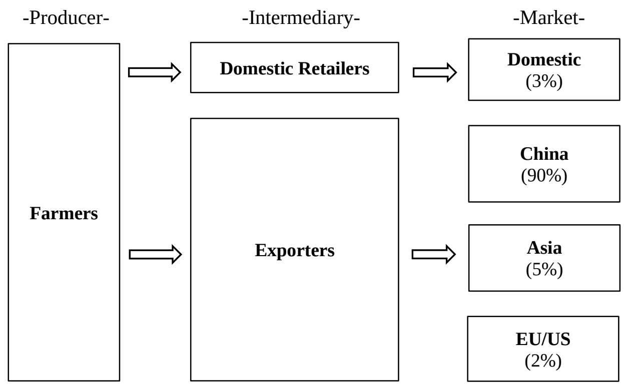
(b) Dragon Fruit Farm

(c) Harvesting

(d) Packing House

Source: figure (a) is a picture of dragon fruit downloaded from Wikipedia page, figures (b), (c), and (d) are from authors.

Figure A-2: Dragon Fruit Supply Chain in Binh Thuan Province



Notes: Volume Shares sold to each market in the baseline survey are reported in parentheses.

Figure A-3: Map of Binh Thuan Province

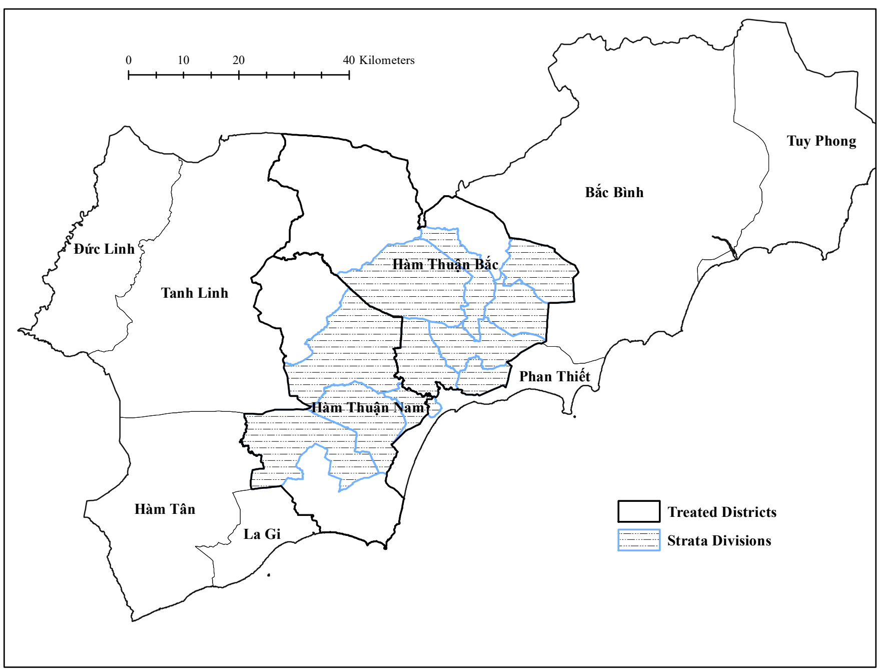


Figure A-4: Good Agricultural Practices for Dragon Fruit

(a) Drip Irrigation

(b) Spray Irrigation

(c) Hay Cover

(d) Fly Trap

(e) Snail Trap

(f) Manage Water

Source: The figures are from the VietGAP training material developed by Binh Thuan Dragon Fruit Research and Development Center.

Figure A-5: Timeline of Project

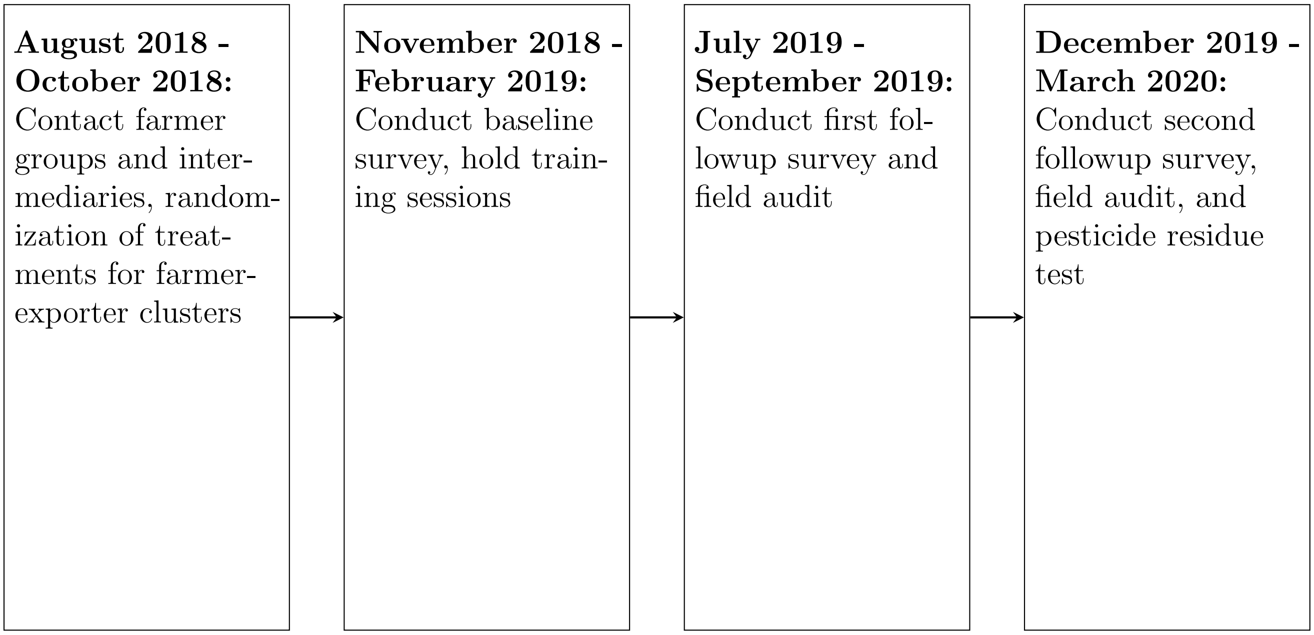
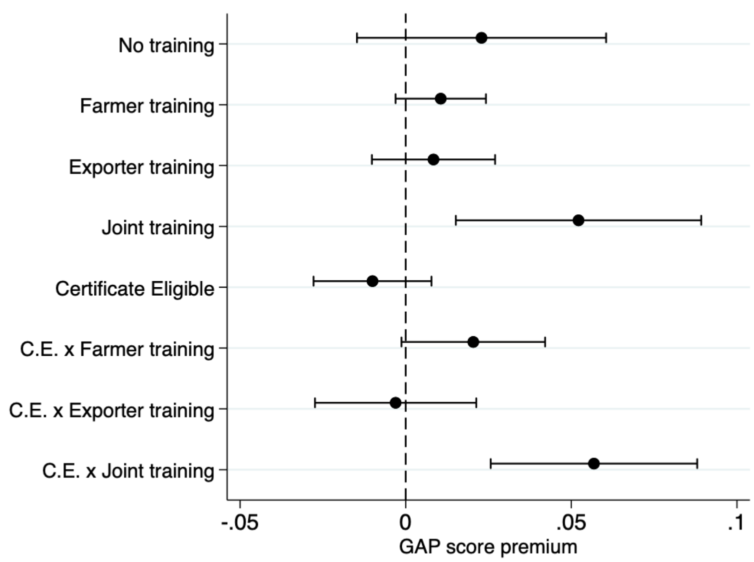
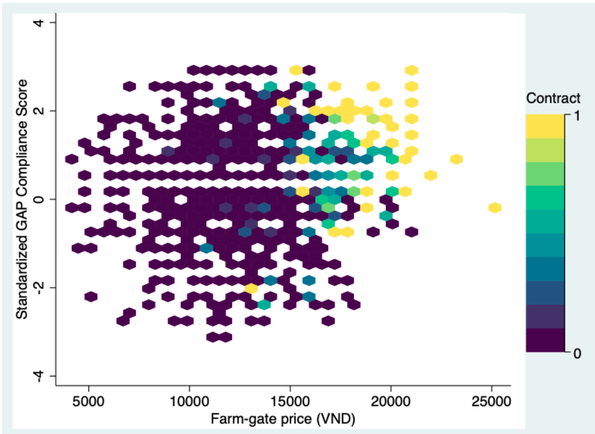


Figure A-6: Price Premium on GAP Compliance by Treatment Group

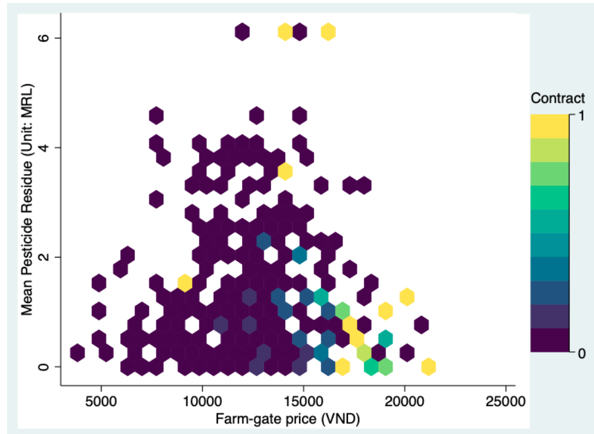


Notes: The figure plots estimated coefficients from regressing farmers' price on the standardized GAP audit score interacted with the treatment indicator. Data is from two rounds of followup survey. In the regression, we also control for all treatment indicators, farmer and intermediary baseline characteristics, VietGAP certification within two years, and strata and survey round fixed effects.

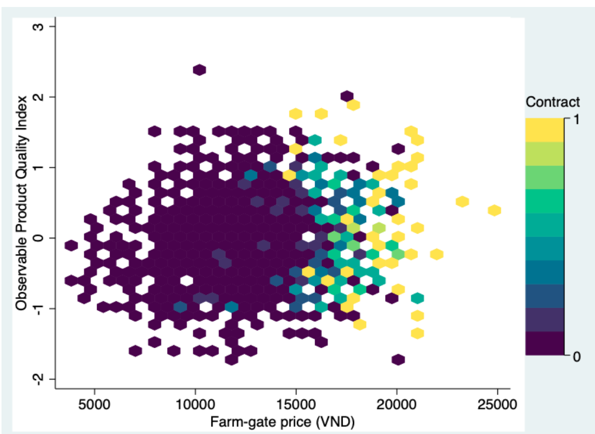
Figure A-7: Quality, Price, and Contract Trade



(a) GAP Compliance



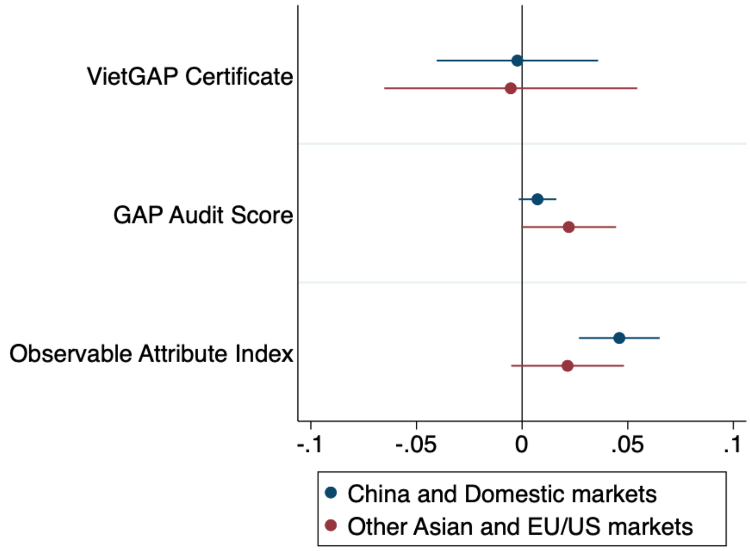
(b) Pesticide Residue



(c) Observable Quality Index

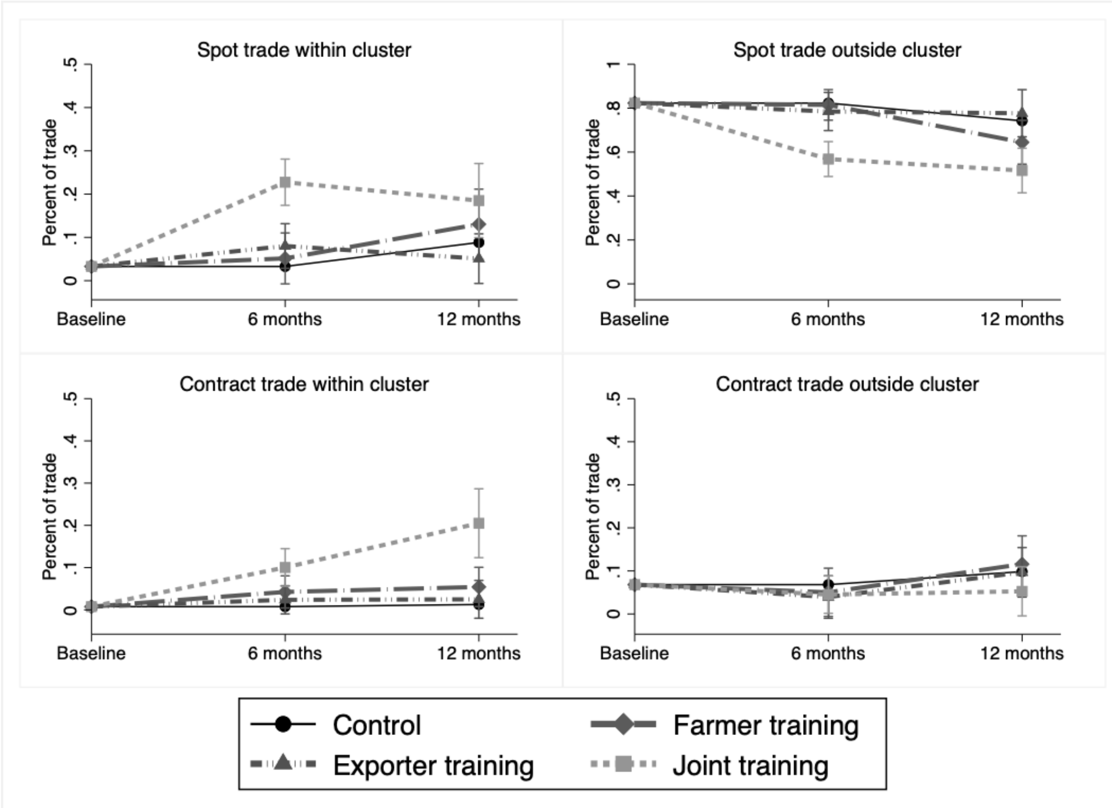
Notes: Heat maps visually represent the distribution of contract trade (bright color) and spot trade (dark color) along the dimensions of quality (y-axis) and price (x-axis). Dark-colored hexagons represent spot trade and light-colored represent contract trade. Medium-colored hexagons indicate a mix of spot and contract trade. As shown in panel (a), farmers are more likely to adopt GAP technology and receive higher prices when they are involved in contract trade rather than spot trade. This is also true when using pesticide residue as the quality measure as shown in panel (b). In contrast, in panel (c) we find no difference in observable product attributes between contract and spot trade. Such positive relationships between technology adoption/price and contract trade indicate that farmers may have stronger incentives to upgrade unobserved quality when they have contracts with intermediaries. This result is consistent with the literature documenting positive impact of contracting on technology adoption, quality upgrading, and farm performance (Deutschmann et al. 2021; Macchiavello & Miquel-Florensa 2019; Magnan et al. 2021).

Figure A-8: Price Premium on VietGAP Certificate and Product Quality by Market



Notes: The figure plots estimated coefficients for price premium. VietGAP Certificate is equal to one if a farmer received VietGAP certificate within past two years to baseline survey. Data is from two rounds of followup survey.

Figure A-9: Impact of Training on Contract Trade



Notes: This figure uses farmer reports on trade with intermediaries, including exporters and local collectors, collected during followup surveys. Spot trade refers to trade without any informal or formal contracting with the intermediary. Contract trade includes both informal and formal contracts. Trade within cluster denotes trade with exporters assigned to the same matched farmer-exporter cluster.

Table A-1: Dragon Fruit VietGAP Certification Process

Stage	In charge	Description
1. Registration	Farmer	Register farm for Vietgap certification
2. Field audit	Agency	Field assessment of compliance to standards
3. Residue testing	Agency	Arrange fruit sampling for pesticide testing
	Food test lab	Conduct pesticide residue analysis and report back to institution
4. Review	Agency	Review field audit and pesticide test results
5. Issue certificate	Agency	VietGAP certificate issued to farmer

Table A-2: Summary Statistics - Baseline Survey

	Obs.	Mean	Median	S.D.	Min	Max
Panel A. Farmer Characteristics						
Age	1141	45.59	45.00	12.58	18	88
Female	1141	0.34	0.00	0.47	0	1
Secondary Education	1141	0.70	1.00	0.46	0	1
Experience growing dragon fruit (years)	1141	10.69	10.00	6.07	0	40
Size of dragon fruit farm (hectares)	1141	0.75	0.50	0.73	0	10
Number of dragon fruit trees	1141	764.88	600.00	705.47	100	10000
Self-reported GAP compliance	1141	0.60	0.57	0.20	0	1
Volume sold (tons)	1141	10.05	6.00	12.19	0	120
Average price (1,000 VND/kg)	1141	12.69	12.00	3.53	2	25
Total Expenses on inputs (1 Million VND)	1141	74.56	39.00	154.87	0	4046
Panel B. Farm-gate Trade Characteristics						
Years farmer has known buyer	1883	4.88	4.00	3.46	0	22
Trade based on formal written contract	1883	0.01	0.00	0.10	0	1
Purchased by local collector	1883	0.90	1.00	0.29	0	1
Purchased by exporter	1883	0.06	0.00	0.24	0	1
Purchased by domestic retailer	1883	0.03	0.00	0.17	0	1
Product for Chinese market	1876	0.93	1.00	0.25	0	1
Product for high-price Asian market	1876	0.03	0.00	0.16	0	1
Product for EU/US market	1876	0.01	0.00	0.11	0	1
Product for Domestic market	1876	0.03	0.00	0.17	0	1
Panel C. Exporter Characteristics						
Years of intermediation business	228	9.31	8.00	5.26	1	24
Size of packing/collection facility (m^2)	228	1176.05	800.00	1148.89	50	7000
Trade volume (tons)	228	422.32	320.00	318.84	50	2000
Average purchase price (1,000 VND/kg)	228	15.26	15.00	2.33	10	22
Average sales price (1,000 VND/kg)	228	17.62	17.00	2.79	11	26

to be continued on the next page

Table A-2: Summary Statistics - Baseline Survey Cont'd

	Obs.	Mean	Median	S.D.	Min	Max
Expenses on labor (1M VND)	228	439.82	355.00	342.92	0	1800
Expenses on utility (1M VND)	228	280.08	142.50	403.47	0	3000
Expenses on materials (1M VND)	228	491.95	200.00	740.48	0	5000

Notes: This table provides summary statistics on farmer demographics, farm characteristics, and farmer-intermediary trade reported by farmers collected from baseline survey and exporting firm characteristics. The unit of observation in panel B is transaction reported by farmers.

Table A-6: Heterogeneous Impacts of Training and Certificate Eligibility

	Outcome variable: Total Score on GAP Compliance									
Characteristic: (indicator var.)	Female	Secondary Education	Farming Experience (≥ median)	Size of Farm (≥ median)	Savings at bank	Business attitude (≥ median)	Entrepre neurship (≥ median)	Present bias	Risk taking (≥ median)	Raven's test (≥ median)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Farmer Training	0.383***	0.220	0.475***	0.327***	0.221*	0.623***	0.249*	0.433***	0.519*	0.525**
	(0.130)	(0.216)	(0.138)	(0.118)	(0.128)	(0.178)	(0.143)	(0.117)	(0.272)	(0.210)
Exporter Training	0.104	0.139	0.064	-0.035	0.310**	0.243*	0.249	0.028	0.028	0.266**
	(0.129)	(0.187)	(0.171)	(0.190)	(0.131)	(0.128)	(0.159)	(0.125)	(0.117)	(0.132)
Joint Training	0.677***	0.519***	0.645***	0.597***	0.513***	0.638***	0.586***	0.612***	0.711***	0.793***
	(0.130)	(0.162)	(0.116)	(0.164)	(0.119)	(0.159)	(0.109)	(0.139)	(0.150)	(0.161)
Certificate Eligibility (C.E.)	-0.042	0.021	-0.216**	0.002	-0.048	-0.036	0.050	-0.022	-0.034	-0.080
	(0.128)	(0.145)	(0.091)	(0.143)	(0.122)	(0.107)	(0.148)	(0.126)	(0.152)	(0.172)
C.E. × Farmer Training	0.139	0.318	0.236	0.323	0.438**	0.027	0.224	0.022	0.032	0.096
	(0.196)	(0.266)	(0.197)	(0.230)	(0.187)	(0.242)	(0.209)	(0.187)	(0.359)	(0.299)
C.E. × Exporter Training	-0.036	0.076	0.097	0.015	-0.260	-0.191	-0.261	-0.006	0.009	-0.066
	(0.198)	(0.282)	(0.246)	(0.264)	(0.181)	(0.200)	(0.231)	(0.179)	(0.210)	(0.253)
C.E × Joint Training	0.149	0.012	0.344	0.247	0.303	0.265	0.179	0.141	0.086	0.164
	(0.203)	(0.235)	(0.238)	(0.245)	(0.201)	(0.218)	(0.208)	(0.204)	(0.258)	(0.258)
Farmer Training × Characteristic	0.215	0.325	-0.049	0.226	0.595***	-0.264	0.377**	0.117	-0.085	-0.107
	(0.198)	(0.247)	(0.250)	(0.193)	(0.208)	(0.194)	(0.173)	(0.246)	(0.306)	(0.254)
Exporter Training × Characteristic	0.000	-0.072	0.046	0.223	-0.461**	-0.245*	-0.266	0.296	0.107	-0.273**
	(0.179)	(0.234)	(0.173)	(0.238)	(0.216)	(0.142)	(0.168)	(0.235)	(0.141)	(0.121)
Joint Training × Characteristic	0.005	0.226**	0.017	0.145	0.470***	0.059	0.159	0.264**	-0.048	-0.190
	(0.123)	(0.112)	(0.157)	(0.154)	(0.142)	(0.133)	(0.108)	(0.126)	(0.082)	(0.130)
Certificate Eligibility × Characteristic	-0.037	-0.097	0.259	-0.075	0.009	-0.047	-0.232	-0.152	-0.034	0.021
	(0.147)	(0.110)	(0.157)	(0.149)	(0.151)	(0.132)	(0.169)	(0.178)	(0.167)	(0.191)
R-squared	0.16	0.16	0.15	0.16	0.18	0.16	0.16	0.16	0.16	0.16
Observations	2197	2197	2197	2197	2197	2197	2197	2197	2197	2197

Notes: Audit on GAP compliance were conducted in each of the two follow-up survey rounds. Audit scores are standardized by the control group's mean and standard deviation. Each column reports coefficients on interaction terms between training treatment indicator and individual characteristic. For interacting, farming experience, size of farm, business attitude, entrepreneurship, risk taking, raven's test are constructed as indicator variables equal to one if the value is above the sample median. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects and survey round fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-3: Balance of Baseline Farmer Characteristics Across Treatment Groups

	Mean difference									
Certification Treatment	Ineligible				Eligible					Joint
Training Treatment	No	Farmer	Inter.	Joint	No	Farmer	Inter.	Joint	N	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Age	46.1	-0.859	-1.35	-0.195	1.27	-1.27	0.479	-2.58	1139	.45
	[12.1]	(1.81)	(1.96)	(1.74)	(1.72)	(1.89)	(1.76)	(1.68)		
Female	0.364	0.001	-0.017	-0.037	-0.020	0.002	-0.043	-0.034	1139	.99
	[0.483]	(0.083)	(0.095)	(0.087)	(0.090)	(0.106)	(0.083)	(0.093)		
Secondary Education	0.669	0.055	-0.002	0.015	-0.025	-0.052	0.081	-0.037	1139	.79
	[0.472]	(0.087)	(0.083)	(0.073)	(0.071)	(0.095)	(0.098)	(0.086)		
Experience growing dragon fruit (years)	12.0	-1.22	-1.53	-1.84*	-0.839	-1.46	-2.15**	-0.120	1139	.38
	[5.45]	(1.12)	(1.03)	(0.980)	(1.12)	(0.959)	(0.974)	(1.18)		
Size of dragon fruit farm (hectares)	0.701	0.002	-0.004	0.093	0.037	0.044	-0.033	0.026	1139	.89
	[0.555]	(0.082)	(0.087)	(0.088)	(0.089)	(0.088)	(0.076)	(0.085)		
Number of dragon fruit trees	765.9	-38.8	-24.4	66.8	-2.89	-28.5	-121.5**	-60.5	1139	.32
	[519.5]	(75.5)	(77.0)	(79.3)	(73.6)	(80.6)	(58.7)	(73.8)		
Received any agricultural certificate before	0.442	-0.016	-0.090	-0.019	0.051	-0.190**	-0.030	-0.139	1139	.24
	[0.498]	(0.080)	(0.109)	(0.098)	(0.102)	(0.092)	(0.108)	(0.090)		
Ever received loan for farm investment	0.578	0.052	0.084	0.030	0.065	-0.040	0.052	0.021	1139	.77
	[0.496]	(0.064)	(0.073)	(0.071)	(0.067)	(0.078)	(0.077)	(0.080)		
Ever saved at bank	0.338	0.050	0.117	0.012	-0.010	0.039	0.0008	0.075	1139	.86
	[0.474]	(0.087)	(0.087)	(0.102)	(0.072)	(0.087)	(0.093)	(0.093)		
Mean score on trust measurement	2.68	-0.050	-0.121**	-0.031	0.009	-0.032	-0.069	0.019	1139	.09
	[0.400]	(0.065)	(0.050)	(0.057)	(0.045)	(0.051)	(0.057)	(0.036)		
Mean score on business measurement	2.51	-0.017	0.028	0.058	0.042	-0.021	0.034	0.044	1139	.51
	[0.320]	(0.044)	(0.038)	(0.038)	(0.040)	(0.042)	(0.053)	(0.056)		
Mean score on confidence measurement	2.57	-0.086	-0.120	-0.071	-0.026	-0.129*	-0.082	0.005	1139	.47
	[0.416]	(0.063)	(0.073)	(0.085)	(0.060)	(0.070)	(0.082)	(0.104)		
Raven matrices score	3.85	0.508	0.168	0.588	0.305	0.158	0.048	0.562	1139	.94
	[3.36]	(0.614)	(0.547)	(0.549)	(0.489)	(0.760)	(0.612)	(0.586)		
Time discounting - present biased	0.234	-0.063	0.020	-0.003	0.007	0.061	-0.043	0.064	1139	.37
	[0.425]	(0.054)	(0.051)	(0.057)	(0.056)	(0.058)	(0.061)	(0.067)		
Self-reported GAP compliance	0.572	-0.004	-0.018	-0.003	-0.011	-0.060*	-0.048	-0.017	1139	.51
	[0.188]	(0.033)	(0.037)	(0.033)	(0.030)	(0.033)	(0.044)	(0.038)		
Farm work hours	6.66	0.089	0.340	-0.265	-0.005	-0.018	-0.307	0.036	1139	.73
	[1.79]	(0.381)	(0.400)	(0.359)	(0.369)	(0.429)	(0.363)	(0.377)		
Volume sold (tons)	11.4	0.206	-1.92	-1.56	-0.863	-1.96	-3.89	-4.00	1139	.65
	[11.9]	(2.79)	(2.17)	(2.21)	(2.64)	(2.27)	(2.72)	(2.66)		
Average price (1,000 VND/kg)	12.5	-0.276	-0.353	0.437	0.001	-0.329	0.674	-0.820	1139	.82
	[3.52]	(0.936)	(0.964)	(1.16)	(0.966)	(1.01)	(1.09)	(0.998)		
Total Expenses on Inputs (1 Million VND)	73.6	12.0	1.33	-11.0	8.58	-0.101	-16.2	-29.3	1139	.67
	[95.3]	(26.9)	(20.7)	(18.6)	(25.0)	(20.6)	(21.0)	(24.2)		
Attrition in first follow-up survey	0.019	0.019	-0.0007	-0.000	-0.006	0.031	0.030	0.035	1139	.43
	[0.139]	(0.024)	(0.023)	(0.022)	(0.017)	(0.030)	(0.026)	(0.030)		
Attrition in second follow-up survey	0.026	0.011	0.034	0.013	-0.008	0.057	0.027	0.037	1139	.40
	[0.160]	(0.030)	(0.038)	(0.024)	(0.022)	(0.040)	(0.027)	(0.036)		

Notes: This table shows balance checks with farmer characteristics across randomized treatment arms. Column 1 reports average baseline characteristics for the control group Columns 2 to 8 report OLS regression coefficients of the seven treatment indicators. * denotes significance at 0.10; ** at 0.05; and *** at 0.01. Column 10 reports the p-value from testing the joint significance of treatment indicators.

Table A-4: Balance of Baseline Exporter Characteristics Across Treatment Groups

	Mean difference									
Certification Treatment	Ineligible				Eligible					Joint
Training Treatment	No	Farmer	Inter.	Joint	No	Farmer	Inter.	Joint	N	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Years of intermediation business	9.63 [5.47]	1.22 (1.34)	0.256 (1.19)	-0.126 (1.56)	-0.454 (1.36)	0.227 (1.50)	-1.41 (1.23)	-1.80 (1.17)	228	.29
Size of packing/collection facility (m^2)	1234.4 [1371.9]	-375.0 (289.9)	86.7 (347.8)	-264.9 (327.1)	214.6 (309.4)	-102.5 (321.2)	323.6 (341.0)	-318.7 (320.4)	228	.19
Trade volume (tons)	455.6 [366.1]	-84.0 (89.0)	-35.6 (95.1)	-76.3 (96.6)	42.1 (83.3)	-0.914 (96.6)	-7.89 (88.0)	-89.2 (85.4)	228	.39
Average purchase price (1,000 VND/kg)	15.6 [2.14]	-0.161 (0.628)	-0.599 (0.635)	-0.650 (0.544)	-0.074 (0.588)	-0.250 (0.582)	-0.538 (0.569)	0.013 (0.542)	228	.8
Average sales price (1,000 VND/kg)	17.6 [2.58]	0.272 (0.652)	-0.063 (0.695)	-0.165 (0.715)	0.407 (0.727)	-0.143 (0.734)	-0.101 (0.682)	0.148 (0.614)	228	.98
Self-reported GAP compliance	3.67 [1.39]	0.060 (0.358)	-0.410 (0.336)	0.235 (0.360)	-0.349 (0.413)	0.009 (0.305)	-0.696** (0.325)	-0.279 (0.400)	228	.03
Contract with buyer	0.420 [0.494]	-0.109 (0.098)	0.151 (0.112)	-0.076 (0.105)	0.081 (0.110)	-0.058 (0.104)	0.010 (0.096)	-0.094 (0.127)	228	.32
Years of experience with buyer	5.05 [2.65]	1.55** (0.749)	0.975 (0.629)	0.454 (0.865)	-0.041 (0.693)	0.012 (0.648)	0.308 (0.648)	0.202 (0.550)	228	.44
Volume of Chinese exports (tons)	369.8 [370.9]	-100.4 (71.5)	-59.5 (76.9)	-87.0 (74.2)	-51.9 (72.1)	-24.9 (71.4)	-42.0 (74.7)	-62.6 (74.9)	228	.66
Volume of high-price Asian exports (tons)	7.10 [20.8]	0.946 (7.01)	4.40 (6.83)	7.12 (10.7)	20.6* (12.4)	3.78 (5.95)	6.54 (7.38)	-5.90 (4.54)	228	.28
Volume of EU/US exports (tons)	0 [0]	0.018 (0.738)	0.206 (0.627)	0.240 (0.624)	0.768 (1.06)	0.074 (0.706)	0.194 (0.633)	3.32 (2.87)	228	.96
Volume of domestic sales (tons)	4.88 [17.0]	0.255 (3.94)	-4.18 (3.15)	-2.77 (3.20)	2.21 (4.46)	-1.08 (3.08)	-0.374 (3.61)	-2.22 (3.21)	228	.51
Expenses on labor (1M VND)	427.0 [293.0]	-66.0 (85.4)	27.3 (86.5)	-13.8 (99.9)	13.7 (84.3)	0.377 (88.3)	88.5 (101.8)	9.10 (89.7)	228	.86
Expenses on utility (1M VND)	320.1 [502.2]	-89.1 (112.3)	-13.9 (113.7)	-51.2 (134.6)	-6.78 (109.2)	-31.8 (116.6)	-27.8 (134.5)	-120.2 (109.2)	228	.84
Expenses on materials (1M VND)	513.8 [726.8]	-166.5 (170.2)	-86.5 (168.0)	-180.3 (196.7)	120.0 (166.4)	174.7 (271.3)	15.2 (252.3)	-110.2 (173.4)	228	.43
Attrition in first follow-up survey	0.148 [0.362]	-0.068 (0.079)	0.028 (0.101)	-0.056 (0.088)	0.002 (0.083)	-0.037 (0.078)	-0.046 (0.089)	-0.053 (0.074)	228	.96
Attrition in second follow-up survey	0.259 [0.447]	-0.016 (0.096)	0.020 (0.118)	0.020 (0.117)	-0.071 (0.098)	-0.044 (0.120)	0.061 (0.105)	0.057 (0.098)	228	.87

Notes: This table shows balance checks with exporter characteristics across randomized treatment arms. Column 1 reports average baseline characteristics for the control group Columns 2 to 8 report OLS regression coefficients of the seven treatment indicators. * denotes significance at 0.10; ** at 0.05; and *** at 0.01. Column 10 reports the p-value from testing the joint significance of treatment indicators.

Table A-5: Impacts of Training and Certificate Eligibility on GAP Compliance

	Audit report on Compliance					
	Total	Pesticide	Equipment	Hygiene	Soil	Fertilizer
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. First Followup Survey - Six months after training						
Farmer Training	0.490***	0.462***	0.315**	0.128	0.312**	-0.069
	(0.113)	(0.067)	(0.109)	(0.102)	(0.119)	(0.122)
Exporter Training	0.141	0.109	0.099	0.003	0.189	-0.163
	(0.118)	(0.084)	(0.107)	(0.120)	(0.125)	(0.127)
Joint Training	0.687***	0.628***	0.425**	0.209	0.397**	0.037
	(0.157)	(0.092)	(0.145)	(0.114)	(0.145)	(0.116)
Certificate Eligibility (C.E.)	-0.082	0.010	-0.077	-0.201	0.089	-0.143
	(0.124)	(0.078)	(0.114)	(0.109)	(0.121)	(0.112)
C.E. × Farmer Training	0.084	-0.044	0.009	0.201	-0.105	0.458**
	(0.190)	(0.124)	(0.195)	(0.167)	(0.166)	(0.164)
C.E. × Exporter Training	-0.046	-0.039	0.040	0.069	-0.287	0.285
	(0.180)	(0.125)	(0.172)	(0.170)	(0.169)	(0.165)
C.E × Joint Training	0.266	0.069	0.243	0.263	0.028	0.199
	(0.233)	(0.120)	(0.211)	(0.195)	(0.192)	(0.152)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.01	0.00	0.09	0.28	0.23	0.37
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.18	0.04	0.46	0.43	0.49	0.21
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.00	0.00	0.05	0.10	0.13	0.06
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.77	0.61	0.95	0.62	0.56	0.09
Control mean (Pass/Total)	0.71	0.69	0.58	0.79	0.70	0.89
Control standard deviation	0.10	0.15	0.20	0.20	0.16	0.18
R-squared	0.18	0.14	0.16	0.14	0.10	0.05
Observations	1106	1106	1106	1106	1106	1106
Panel B. Second Followup Survey - Twelve months after training						
Farmer Training	0.426***	0.238**	0.364***	0.166	0.287***	-0.159
	(0.101)	(0.095)	(0.109)	(0.088)	(0.089)	(0.092)
Exporter Training	0.059	0.006	0.073	0.021	0.144	-0.258
	(0.112)	(0.086)	(0.138)	(0.093)	(0.101)	(0.134)
Joint Training	0.660***	0.479***	0.497***	0.194*	0.347***	0.019
	(0.110)	(0.085)	(0.096)	(0.082)	(0.105)	(0.085)
Certificate Eligibility (C.E.)	-0.037	0.048	-0.035	-0.179	0.165	-0.279***
	(0.110)	(0.099)	(0.105)	(0.096)	(0.088)	(0.087)
C.E. × Farmer Training	0.050	-0.139	0.025	0.218	-0.197	0.606***
	(0.165)	(0.173)	(0.153)	(0.144)	(0.143)	(0.136)
C.E. × Exporter Training	-0.021	-0.014	-0.014	0.090	-0.230	0.321
	(0.162)	(0.138)	(0.169)	(0.145)	(0.138)	(0.167)
C.E × Joint Training	0.114	-0.102	0.198	0.259	-0.171	0.270
	(0.172)	(0.125)	(0.147)	(0.145)	(0.149)	(0.133)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.01	0.02	0.03	0.18	0.13	0.47
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.05	0.01	0.19	0.76	0.59	0.03
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.00	0.00	0.00	0.08	0.07	0.04
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.28	0.06	0.73	0.96	0.58	0.01
Control mean (Pass/Total)	0.74	0.72	0.63	0.83	0.74	0.92
Control standard deviation	0.09	0.14	0.19	0.19	0.15	0.17
R-squared	0.15	0.09	0.15	0.14	0.07	0.06
Observations	1091	1091	1091	1091	1091	1091

Notes: The results use data from two follow-up survey rounds: panel A shows the results from first follow-up survey and panel B shows the results from second follow-up survey. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-7: Heterogeneous Impacts by Exporter Characteristics

	Outcome variable: GAP Compliance			
Characteristic: (indicator var.)	Age ($\geq$ median)	Size Facility ($\geq$ median)	Export volume high-price Asia	Export volume high-price Asia/EU
	(1)	(2)	(3)	(4)
Farmer Training	0.538***	0.590***	0.462***	0.480***
	(0.149)	(0.131)	(0.097)	(0.098)
Exporter Training	0.137	-0.035	-0.008	0.009
	(0.131)	(0.085)	(0.107)	(0.109)
Joint Training	1.116***	0.733***	0.704***	0.726***
	(0.147)	(0.166)	(0.144)	(0.148)
Certificate Eligibility (C.E.)	-0.212*	0.188	-0.151	-0.121
	(0.116)	(0.144)	(0.130)	(0.127)
C.E. × Farmer Training	-0.067	-0.228	0.180	0.149
	(0.237)	(0.235)	(0.172)	(0.170)
C.E. × Exporter Training	0.083	0.058	0.098	0.080
	(0.190)	(0.162)	(0.193)	(0.188)
C.E. × Joint Training	-0.142	-0.005	0.186	0.148
	(0.229)	(0.230)	(0.200)	(0.200)
Farmer Training × Characteristic	-0.133	-0.222	-0.009	-0.046
	(0.212)	(0.173)	(0.041)	(0.050)
Exporter Training × Characteristic	-0.119	0.362	0.098	0.090
	(0.208)	(0.236)	(0.076)	(0.080)
Joint Training × Characteristic	-0.629***	-0.097	-0.012	-0.069
	(0.221)	(0.273)	(0.054)	(0.067)
Certificate Eligibility × Characteristic	0.270	-0.333	0.087	0.044
	(0.175)	(0.207)	(0.055)	(0.066)
R-squared	0.17	0.16	0.16	0.16
Observations	2197	2197	2197	2197

Notes: Audit scores are standardized by the control group's mean and standard deviation. Each column reports coefficients on interaction terms between treatment indicator and exporter characteristics. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects and survey round fixed effects. Standard errors are clustered by farmer-exporter cluster and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-8: Impacts of Training and Certificate Eligibility on GAP Knowledge

	Farmer		Exporter	
	GAP Knowledge	Food Safety Awareness	GAP Knowledge	GHP Compliance
	(1)	(2)	(3)	(4)
Farmer Training	0.279**	0.041	0.085	-0.063
	(0.102)	(0.131)	(0.160)	(0.118)
	[0.017]	[0.751]	[0.692]	[0.631]
Exporter Training	-0.070	-0.111	0.443**	0.117
	(0.099)	(0.090)	(0.198)	(0.094)
	[0.932]	[0.181]	[0.014]	[0.198]
Joint Training	0.228**	0.124	0.543***	-0.117
	(0.093)	(0.134)	(0.161)	(0.102)
	[0.001]	[0.118]	[0.001]	[0.148]
Certificate Eligibility (C.E.)	-0.017	0.008	-0.045	0.018
	(0.091)	(0.131)	(0.156)	(0.094)
	[0.770]	[0.759]	[0.804]	[0.846]
C.E. × Farmer Training	0.076	-0.061	-0.125	0.088
	(0.132)	(0.180)	(0.219)	(0.151)
	[0.716]	[0.687]	[0.638]	[0.584]
C.E. × Exporter Training	-0.006	-0.019	0.089	0.262
	(0.131)	(0.160)	(0.254)	(0.164)
	[0.874]	[0.826]	[0.387]	[0.892]
C.E × Joint Training	0.152	0.032	0.123	0.172
	(0.141)	(0.193)	(0.214)	(0.165)
	[0.407]	[0.556]	[0.207]	[0.402]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.00	0.17	0.04	0.20
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.61	0.53	0.00	0.67
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.00	0.04	0.58	0.06
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.89	0.23	0.95	0.28
Mean(Dep Var)	5.88	3.76	5.48	10.30
SD(Dep Var)	2.02	0.36	1.53	2.77
R-squared	0.16	0.22	0.36	0.77
Observations	1063	1063	201	201

Notes: This table reports treatment effects on farmer's knowledge of GAP, awareness of food safety, exporter's GAP knowledge, and compliance to Good Handling Practices (GHP). The results use data from two follow-up survey rounds. Dependent variables are standardized by the control group's mean and standard deviation. Knowledge is constructed as standardized score on test consisting of 10 multiple choice questions conducted during first follow-up survey round. Awareness is a self-report on pesticide use and food safety asked during second follow-up survey found (higher score indicates farmer has greater awareness on food safety issues). All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-9: Impacts of Training and Certificate Eligibility on Farm Input Costs

	Log transformed							
	Total	Pesticide	Facility	Equipment	Fertilizer	Labor	Utility	Hours
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. First Followup Survey - Six months after training								
Farmer Training	0.154	0.030	1.509***	1.022	-0.097	0.028	0.082	0.086
	(0.077)	(0.138)	(0.398)	(0.841)	(0.154)	(0.481)	(0.098)	(0.255)
Exporter Training	0.065	-0.073	0.446	-0.157	0.140	-0.229	-0.018	0.030
	(0.066)	(0.152)	(0.443)	(0.791)	(0.111)	(0.395)	(0.062)	(0.308)
Joint Training	0.193**	0.238	1.869***	1.978	-0.049	0.267	0.148	-0.024
	(0.066)	(0.135)	(0.514)	(0.881)	(0.129)	(0.463)	(0.126)	(0.197)
Certificate Eligibility (C.E.)	-0.052	-0.113	0.369	-0.282	-0.118	-0.440	-0.084	-0.247
	(0.066)	(0.128)	(0.541)	(0.969)	(0.130)	(0.618)	(0.093)	(0.185)
C.E. × Farmer Training	0.059	0.204	0.761	-0.133	0.279	0.417	0.106	0.338
	(0.104)	(0.177)	(0.820)	(1.356)	(0.241)	(0.742)	(0.139)	(0.331)
C.E. × Exporter Training	0.010	0.035	-0.014	0.327	0.009	0.783	0.076	0.035
	(0.098)	(0.188)	(0.668)	(1.388)	(0.240)	(0.592)	(0.113)	(0.377)
C.E × Joint Training	0.209	0.223	0.303	-0.411	0.236	0.958	0.252	0.618
	(0.109)	(0.186)	(0.795)	(1.367)	(0.214)	(0.770)	(0.169)	(0.250)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.30	0.45	0.03	0.21	0.16	0.46	0.27	0.85
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.66	0.03	0.47	0.30	0.75	0.53	0.60	0.60
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.11	0.01	0.01	0.02	0.19	0.16	0.15	0.82
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.81	0.11	0.89	0.35	0.63	0.41	0.53	0.71
Control mean (in levels)	34.44	3.29	0.22	2.91	9.40	9.33	8.33	5.36
R-squared	0.52	0.26	0.16	0.19	0.20	0.20	0.25	0.28
Observations	1080	1080	1080	1080	1080	1080	1080	1080
Panel B. Second Followup Survey - Twelve months after training								
Farmer Training	0.154	0.187	0.063	0.028	0.137	0.132	0.242**	0.280
	(0.086)	(0.083)	(0.211)	(1.116)	(0.145)	(0.133)	(0.076)	(0.138)
Exporter Training	0.015	0.040	0.035	-0.157	0.011	-0.149	-0.072	-0.206
	(0.080)	(0.069)	(0.261)	(1.372)	(0.133)	(0.217)	(0.087)	(0.254)
Joint Training	0.056	0.241**	-0.161	-0.663	0.059	-0.013	0.221**	0.282
	(0.061)	(0.077)	(0.210)	(1.035)	(0.130)	(0.117)	(0.077)	(0.148)
Certificate Eligibility (C.E.)	0.060	-0.077	-0.135	-1.381	0.124	0.153	-0.003	0.016
	(0.063)	(0.062)	(0.211)	(1.223)	(0.111)	(0.126)	(0.063)	(0.115)
C.E. × Farmer Training	-0.220	0.133	0.188	0.764	-0.346	-0.264	-0.215	-0.103
	(0.115)	(0.130)	(0.329)	(1.638)	(0.175)	(0.211)	(0.104)	(0.203)
C.E. × Exporter Training	-0.124	0.053	-0.068	1.653	-0.194	-0.201	0.104	0.213
	(0.088)	(0.103)	(0.356)	(1.752)	(0.175)	(0.207)	(0.102)	(0.281)
C.E × Joint Training	0.026	0.109	0.479	0.185	-0.127	-0.206	-0.052	0.003
	(0.102)	(0.119)	(0.323)	(1.545)	(0.253)	(0.266)	(0.115)	(0.205)
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.12	0.10	0.91	0.88	0.38	0.20	0.00	0.03
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.22	0.56	0.15	0.44	0.57	0.23	0.78	0.99
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.54	0.02	0.45	0.68	0.72	0.50	0.00	0.02
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.32	0.91	0.41	0.75	0.64	0.99	0.66	0.44
Control mean (in levels)	44.57	3.38	0.01	2.08	12.81	16.11	9.59	5.57
R-squared	0.67	0.45	0.06	0.28	0.30	0.37	0.54	0.27
Observations	1054	1054	1054	1054	1054	1054	1054	1054

Notes: This table reports treatment effects on farm input costs. The results use data from two follow-up survey rounds: panel A shows the results from first follow-up survey and panel B shows the results from second follow-up survey. All input costs, except respondent's work hour, are log transformed. Total is the sum of input costs and cost specified as other in the survey. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-10: Impacts of Training and Certificate Eligibility on Product Attributes

	Overall	Individual Product Attributes					
	Index	Sweetness	Skin	Bract	Length	Width	Weight
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Farmer Training	-0.014	0.106	-0.029	-0.055	-0.152	0.170	-0.122
	(0.054)	(0.166)	(0.079)	(0.115)	(0.128)	(0.100)	(0.106)
	[0.888]	[0.364]	[0.754]	[0.749]	[0.305]	[0.163]	[0.450]
Exporter Training	-0.031	0.148	0.029	-0.111	-0.101	0.081	-0.231
	(0.059)	(0.155)	(0.075)	(0.088)	(0.171)	(0.132)	(0.118)
	[0.927]	[0.537]	[0.466]	[0.324]	[0.779]	[0.298]	[0.172]
Joint Training	0.030	0.288	0.038	0.100	-0.072	0.020	-0.195
	(0.053)	(0.156)	(0.075)	(0.099)	(0.137)	(0.104)	(0.091)
	[0.137]	[0.129]	[0.441]	[0.132]	[0.898]	[0.690]	[0.207]
Certificate Eligibility (C.E.)	-0.080	0.161	-0.047	-0.076	-0.188	-0.034	-0.294**
	(0.035)	(0.159)	(0.062)	(0.104)	(0.097)	(0.097)	(0.081)
	[0.042]	[0.410]	[0.580]	[0.513]	[0.108]	[0.763]	[0.020]
C.E. $\times$ Farmer Training	0.116	-0.143	0.114	0.257	0.314	-0.044	0.195
	(0.072)	(0.245)	(0.119)	(0.157)	(0.161)	(0.144)	(0.128)
	[0.192]	[0.656]	[0.373]	[0.282]	[0.054]	[0.756]	[0.281]
C.E. $\times$ Exporter Training	-0.025	-0.143	-0.056	-0.081	-0.004	-0.083	0.216
	(0.074)	(0.258)	(0.105)	(0.168)	(0.195)	(0.160)	(0.145)
	[0.882]	[0.752]	[0.712]	[0.887]	[0.951]	[0.592]	[0.398]
C.E $\times$ Joint Training	0.005	-0.217	-0.034	-0.019	-0.004	0.018	0.288
	(0.074)	(0.227)	(0.099)	(0.159)	(0.186)	(0.160)	(0.143)
	[0.562]	[0.338]	[0.581]	[0.507]	[0.998]	[0.920]	[9.313]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.80	0.79	0.46	0.64	0.74	0.44	0.38
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.50	0.26	0.36	0.20	0.53	0.10	0.50
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.37	0.37	0.90	0.04	0.85	0.60	0.73
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.39	0.89	0.71	0.08	0.39	0.15	0.31
Control mean (in raw units)	-0.02	16.43	3.99	4.25	14.35	8.44	522.49
Control standard deviation	0.52	1.58	0.68	0.57	1.71	0.89	81.92
R-squared	0.32	0.37	0.14	0.11	0.31	0.25	0.42
Observations	2183	2183	2183	2183	2183	2183	2183

Notes: This table reports treatment effects on product attributes. The results use data from two follow-up survey rounds. Each product attribute is standardized by the control group's mean and standard deviation. Column 1 uses the average of the six standardized product attributes. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata and survey round fixed effects. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-11: Impact of Training on Market Destination

	Log(Sales Volume)			
	China	High-price Asia	Domestic	EU/US
	(1)	(2)	(3)	(4)
Panel A. First Followup Survey - Six months after training				
Farmer Training	0.317	0.073	-0.251	-0.080
	(0.414)	(0.312)	(0.169)	(0.126)
	[0.514]	[0.897]	[0.231]	[0.568]
Exporter Training	0.188	0.266	0.038	-0.101
	(0.411)	(0.326)	(0.176)	(0.101)
	[0.764]	[0.543]	[0.500]	[0.694]
Joint Training	-0.464	1.117***	-0.260	-0.059
	(0.432)	(0.319)	(0.170)	(0.128)
	[0.134]	[0.004]	[0.170]	[0.915]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.59	0.37	0.12	0.82
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.00	0.00	0.95	0.88
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.02	0.00	0.11	0.69
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.05	0.03	0.84	0.48
Control mean (in levels)	5.77	0.34	0.19	0.06
R-squared	0.12	0.13	0.05	0.11
Observations	1101	1101	1101	1101
Panel B. Second Followup Survey - Twelve months after training				
Farmer Training	-0.356	0.624	-0.250	0.068
	(0.392)	(0.341)	(0.126)	(0.127)
	[0.379]	[0.065]	[0.164]	[0.561]
Exporter Training	-0.330	0.440	0.029	0.090
	(0.406)	(0.370)	(0.143)	(0.156)
	[0.326]	[0.248]	[0.643]	[0.596]
Joint Training	-1.376*	2.080***	-0.176	0.002
	(0.506)	(0.497)	(0.102)	(0.152)
	[0.013]	[0.001]	[0.059]	[0.914]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{exporter}}$)	0.93	0.52	0.08	0.88
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.01	0.00	0.46	0.57
P-value ($H_0 : \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.01	0.00	0.19	0.61
P-value ($H_0 : \beta_{\text{farmer}} + \beta_{\text{exporter}} = \beta_{\text{joint}}$)	0.21	0.07	0.81	0.43
Control mean (in levels)	6.00	0.23	0.07	0.04
R-squared	0.13	0.17	0.08	0.15
Observations	1074	1074	1074	1074

Notes: This table reports treatment effects on product's market destination using data from two follow-up survey rounds. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-12: Impacts of Training and Certificate Eligibility on Farm Sales

	Farm-gate		Revenue		Profit	
	Price	Volume	Direct	Implied	Direct	Implied
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. First Followup Survey - Six months after training						
Farmer Training	0.024	0.002	7.603	2.929	3.698	-0.887
	(0.032)	(0.072)	(9.560)	(7.962)	(7.046)	(6.985)
Exporter Training	0.030	0.030	12.960	6.418	9.285	5.299
	(0.028)	(0.071)	(9.871)	(7.677)	(7.250)	(7.146)
Joint Training	0.074	0.088	8.770	9.777	1.687	0.945
	(0.035)	(0.069)	(8.470)	(8.230)	(6.569)	(7.492)
Certificate Eligibility (C.E.)	-0.002	-0.019	-11.993	-9.463	-10.500	-2.635
	(0.030)	(0.068)	(7.729)	(6.834)	(6.000)	(6.406)
C.E. × Farmer Training	-0.014	0.036	6.735	8.116	4.092	1.321
	(0.035)	(0.101)	(10.592)	(9.157)	(9.203)	(8.853)
C.E. × Exporter Training	-0.013	-0.035	-2.877	-3.802	0.388	-6.193
	(0.033)	(0.096)	(10.300)	(8.602)	(8.634)	(8.659)
C.E × Joint Training	0.030	-0.001	19.687	9.113	12.922	-0.092
	(0.042)	(0.100)	(11.903)	(9.716)	(8.754)	(8.217)
Control mean (in levels)	13.40	6.08	85.71	84.41	47.89	45.47
R-squared	0.20	0.43	0.39	0.42	0.30	0.32
Observations	1081	1081	1081	1081	1081	1081
Panel B. Second Followup Survey - Twelve months after training						
Farmer Training	0.033	0.021	7.779	8.662	-5.926	-2.996
	(0.022)	(0.062)	(7.953)	(5.702)	(6.041)	(4.113)
Exporter Training	-0.041	0.016	6.690	7.150	-0.449	1.495
	(0.021)	(0.090)	(7.444)	(6.433)	(5.995)	(5.436)
Joint Training	0.106***	0.084	17.710	16.837**	8.605	9.232
	(0.027)	(0.060)	(7.207)	(5.829)	(5.483)	(4.648)
Certificate Eligibility (C.E.)	-0.003	-0.005	13.178	11.776	1.480	1.175
	(0.018)	(0.065)	(7.331)	(6.045)	(5.371)	(4.677)
C.E. × Farmer Training	-0.036	-0.018	-17.554	-14.778	1.182	2.355
	(0.028)	(0.099)	(9.297)	(7.659)	(7.021)	(5.415)
C.E. × Exporter Training	0.037	0.070	-3.232	-4.431	8.965	6.865
	(0.029)	(0.107)	(8.653)	(7.738)	(6.928)	(6.508)
C.E × Joint Training	0.009	-0.015	-14.541	-9.346	-9.093	-4.839
	(0.040)	(0.091)	(9.785)	(8.109)	(7.132)	(6.338)
Control mean (in levels)	11.53	6.24	75.41	74.17	31.47	28.28
R-squared	0.35	0.52	0.61	0.63	0.40	0.38
Observations	1054	1054	1054	1054	1054	1054

Notes: Sales data was collected from two follow-up survey rounds. Estimates are separately reported in each panel. Price and volume are converted to log scales. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-13: Impacts of Training and Certificate Eligibility on Market Destination

	Log(Volume by Market)			
	China	High-price Asia	Domestic	EU/US
	(1)	(2)	(3)	(4)
Panel A. First Followup Survey - Six months after training				
Farmer Training	0.317	0.073	-0.251	-0.080
	(0.414)	(0.312)	(0.169)	(0.126)
Exporter Training	0.188	0.266	0.038	-0.101
	(0.411)	(0.326)	(0.176)	(0.101)
Joint Training	-0.464	1.117***	-0.260	-0.059
	(0.432)	(0.319)	(0.170)	(0.128)
Certificate Eligibility (C.E.)	0.234	0.165	-0.186	-0.214
	(0.411)	(0.346)	(0.159)	(0.115)
C.E. × Farmer Training	-0.632	0.204	0.441	0.215
	(0.513)	(0.444)	(0.261)	(0.170)
C.E. × Exporter Training	-0.214	-0.332	-0.023	0.176
	(0.464)	(0.393)	(0.240)	(0.140)
C.E × Joint Training	-0.802	0.138	0.237	0.609
	(0.674)	(0.478)	(0.247)	(0.299)
Control mean (in levels)	5.77	0.34	0.19	0.06
R-squared	0.12	0.13	0.05	0.11
Observations	1101	1101	1101	1101
Panel B. Second Followup Survey - Twelve months after training				
Farmer Training	-0.356	0.624	-0.250	0.068
	(0.392)	(0.341)	(0.126)	(0.127)
Exporter Training	-0.330	0.440	0.029	0.090
	(0.406)	(0.370)	(0.143)	(0.156)
Joint Training	-1.376*	2.080***	-0.176	0.002
	(0.506)	(0.497)	(0.102)	(0.152)
Certificate Eligibility (C.E.)	-0.103	0.260	-0.118	0.005
	(0.418)	(0.381)	(0.117)	(0.165)
C.E. × Farmer Training	0.066	-0.345	0.378	0.080
	(0.504)	(0.470)	(0.215)	(0.211)
C.E. × Exporter Training	0.443	-0.641	-0.172	-0.100
	(0.484)	(0.447)	(0.189)	(0.241)
C.E × Joint Training	-0.153	-0.602	0.197	0.415
	(0.786)	(0.699)	(0.168)	(0.378)
Control mean (in levels)	6.00	0.23	0.07	0.04
R-squared	0.13	0.17	0.08	0.15
Observations	1074	1074	1074	1074

Notes: This table reports treatment effects on product's market destination. The results use data from two follow-up survey rounds. The dependent variables in columns 1-4 use natural log of volume sold to each market. All specifications include farmer and exporter characteristics at baseline as control variables as well as strata fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-14: Treatment Effects on Exporters' Sales and Profits

	Price		Volume	Revenue		Cost	Profit	
	Purchase	Sell	Total	Direct	Implied	Total	Direct	Implied
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. First Followup Survey - Six months after training								
Farmer Training	-0.017	-0.012	-0.065	0.026	0.009	0.042	-122.710	-85.087
	(0.018)	(0.011)	(0.087)	(0.166)	(0.103)	(0.152)	(211.637)	(134.425)
Exporter Training	-0.017	-0.011	0.075	0.207	0.215	0.142	19.813	17.843
	(0.017)	(0.012)	(0.091)	(0.125)	(0.119)	(0.142)	(142.173)	(156.680)
Joint Training	-0.009	-0.004	-0.029	-0.017	-0.035	-0.008	-78.475	18.116
	(0.017)	(0.011)	(0.075)	(0.137)	(0.141)	(0.128)	(149.378)	(135.004)
Certificate Eligibility	-0.002	-0.012	0.161	0.132	0.142	0.131	-159.407	-52.202
	(0.016)	(0.012)	(0.083)	(0.128)	(0.132)	(0.112)	(134.568)	(152.665)
× Farmer Training	0.016	0.022	-0.151	-0.135	-0.149	-0.150	105.390	188.421
	(0.023)	(0.017)	(0.121)	(0.216)	(0.165)	(0.214)	(259.796)	(200.413)
× Exporter Training	0.014	0.023	-0.195	-0.173	-0.207	-0.177	37.126	-23.692
	(0.021)	(0.018)	(0.136)	(0.182)	(0.174)	(0.203)	(216.554)	(245.160)
× Joint Training	-0.001	0.001	-0.211	-0.169	-0.170	-0.165	71.706	-103.294
	(0.020)	(0.017)	(0.127)	(0.208)	(0.206)	(0.233)	(216.753)	(210.226)
Control mean	15.72	18.09	541.30	1651.30	1429.57	1306.09	345.22	123.48
R-squared	0.86	0.90	0.78	0.76	0.83	0.71	0.34	0.51
Observations	201	201	201	201	201	201	201	201
Panel B. Second Followup Survey - Twelve months after training								
Farmer Training	-0.016	-0.017	-0.025	-0.047	-0.027	0.061	-44.522	-60.665
	(0.025)	(0.018)	(0.095)	(0.199)	(0.153)	(0.115)	(164.525)	(151.388)
Exporter Training	-0.026	-0.013	0.002	0.186	0.066	0.287	45.545	-71.548
	(0.026)	(0.018)	(0.099)	(0.207)	(0.148)	(0.158)	(126.987)	(100.759)
Joint Training	-0.001	0.006	-0.047	0.021	-0.003	0.000	59.778	82.957
	(0.021)	(0.018)	(0.088)	(0.214)	(0.154)	(0.151)	(149.675)	(122.116)
Certificate Eligibility	0.004	-0.005	-0.017	0.093	-0.078	0.150	71.129	-78.537
	(0.024)	(0.016)	(0.094)	(0.197)	(0.148)	(0.122)	(136.632)	(106.507)
× Farmer Training	0.018	0.013	-0.016	-0.175	-0.034	-0.282	191.313	218.182
	(0.033)	(0.022)	(0.121)	(0.241)	(0.194)	(0.162)	(247.009)	(180.351)
× Exporter Training	0.009	0.014	0.102	-0.043	0.184	-0.145	-224.173	41.201
	(0.031)	(0.022)	(0.136)	(0.255)	(0.179)	(0.222)	(170.854)	(145.909)
× Joint Training	-0.036	-0.034	0.037	-0.197	0.017	-0.025	-121.870	-55.899
	(0.030)	(0.024)	(0.119)	(0.266)	(0.194)	(0.221)	(177.431)	(140.606)
Control mean	13.43	15.97	339.00	758.50	909.00	667.25	91.25	241.75
R-squared	0.79	0.86	0.84	0.76	0.83	0.80	0.25	0.44
Observations	167	167	167	167	167	167	167	167

Notes: This table reports treatment effects on exporter's sales performances. The results use data from two follow-up survey rounds with exporters. Direct revenue uses exporter reports on revenue and Derived revenue is the product of (average facility gate price - average farm gate price) and total volume sold in the survey. Cost is measured along three areas - hired labor, utility, and material (excludes dragon fruit purchase). Profit in column 7 is derived by subtracting cost from direct revenue and profit in column 8 is derived by subtracting cost from implied revenue. All specifications include exporter characteristics at baseline as control variables as well as strata fixed effects and survey round fixed effects. Standard errors are clustered by farmer-exporter group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-15: Treatment Effects on Exporters' Sales by Market

	Log(Volume)		
	China	High-price Asia	US/EU
	(1)	(2)	(3)
Panel A. First Followup Survey			
Farmer Training	-0.096	-0.063	0.013
	(0.126)	(0.172)	(0.019)
Exporter Training	0.094	0.152	-0.006
	(0.124)	(0.194)	(0.021)
Joint Training	-0.106	0.092	0.047
	(0.107)	(0.175)	(0.028)
Certificate Eligibility	0.182	0.004	0.007
	(0.115)	(0.227)	(0.065)
× Farmer Training	-0.074	0.123	-0.028
	(0.168)	(0.283)	(0.062)
× Exporter Training	-0.163	-0.319	-0.020
	(0.173)	(0.325)	(0.067)
× Joint Training	-0.312	0.070	-0.059
	(0.206)	(0.283)	(0.072)
Control mean	455.43	5.98	0.00
R-squared	0.64	0.73	0.88
Observations	201	201	201
Panel B. Second Followup Survey			
Farmer Training	0.146	-0.096	0.021
	(0.117)	(0.216)	(0.024)
Exporter Training	0.023	-0.070	0.016
	(0.125)	(0.265)	(0.027)
Joint Training	0.007	0.225	0.049
	(0.118)	(0.224)	(0.025)
Certificate Eligibility	0.082	-0.130	-0.094
	(0.116)	(0.279)	(0.055)
× Farmer Training	-0.151	0.351	0.063
	(0.149)	(0.343)	(0.052)
× Exporter Training	0.054	0.115	0.071
	(0.181)	(0.375)	(0.057)
× Joint Training	-0.018	0.149	0.060
	(0.159)	(0.377)	(0.062)
Control mean	262.00	1.25	0.00
R-squared	0.70	0.64	0.89
Observations	167	167	167

Notes: The results use data from two follow-up survey rounds with exporters. All specifications include baseline characteristics as well as strata fixed effects and survey round fixed effects. Standard errors are clustered by farmer-exporter group and reported in parentheses. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-16: Exporter's Trade Price by Market

	Log(Price sold to buyers)	Log(Price paid to sellers)
	(1)	(2)
High-price Asian markets	0.486***	
	(0.019)	
US or EU markets	0.700***	
	(0.043)	
Domestic markets	-0.287***	
	(0.035)	
Share of volume for High-price Asian markets		0.165*
		(0.084)
Share of volume for US or EU markets		0.145
		(0.100)
Share of volume for domestic markets		-0.147
		(0.107)
Mean price for Chinese market	14986.20	14276.63
R-squared	0.78	0.59
Observations	600	368

Notes: Column 1 reports estimates from regressing price exporter sold to buyer on buyer's market using transaction level data reported by exporters. Column 2 reports estimates from regressing price paid to sellers (either farmer or local collector) on exporter's share of volume sold to each market. We do not have data on price paid by exporter at the transaction level. The data is from two follow-up survey rounds. The baseline is mean price for Chinese markets. All specifications include exporter characteristics at baseline as control variables as well as strata fixed effects and survey round fixed effects. Standard errors are clustered by farmer-exporter group and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-17: Price Premium on VietGAP Certificate and Product Quality

	Log(Price received at farm-gate)			
	(1)	(2)	(3)	(4)
Have VietGAP certificate at baseline	0.002	0.003	0.009	0.009
	(0.020)	(0.020)	(0.019)	(0.018)
Standardized GAP audit score		0.028***		0.026***
		(0.006)		(0.006)
Product attribute index (mean of z-score)			0.052***	0.049***
			(0.009)	(0.009)
Mean of Dep Var (1000 VND per kg)	12.61	12.61	12.61	12.61
R-squared	0.26	0.28	0.27	0.29
Observations	2175	2175	2170	2170

Notes: This table reports estimates from an ordinary least squares regression of price on product characteristics. The results use farm-gate sales data from two follow-up survey rounds. Farm-gate price is the price farmer received in each sales transaction. Standard errors are clustered by farmer group and reported in parentheses. China market is omitted in specification. GAP compliance is the standardized score on the GAP audit. All product characteristics are standardized by the control group's mean and standard deviation. All specifications include farmer characteristics (age, female, education, experience, size of farm, time discounting, raven matrices score, savings at bank, loans, and measures on trust, entrepreneurship, and confidence) at baseline as well as strata and survey round fixed effects. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table A-18: Impacts of Training and Certificate Eligibility on Contract Trade

	Any Trade	Spot Trade		Contract Trade	
	Within cluster	Within cluster	Outside cluster	Within cluster	Outside cluster
	(1)	(2)	(3)	(4)	(5)
Panel A. First Followup Survey - Six months after training					
Farmer Training	0.059**	0.019	-0.008	0.035	-0.018
	(0.025)	(0.030)	(0.035)	(0.019)	(0.029)
Exporter Training	0.069**	0.047	-0.038	0.016	-0.029
	(0.025)	(0.026)	(0.044)	(0.017)	(0.025)
Joint Training	0.313***	0.195***	-0.255***	0.093***	-0.023
	(0.030)	(0.027)	(0.040)	(0.023)	(0.022)
Certificate Eligibility (C.E.)	0.027	0.006	-0.034	0.014	-0.011
	(0.022)	(0.022)	(0.037)	(0.020)	(0.028)
C.E. × Farmer Training	-0.034	-0.015	-0.028	-0.016	0.050
	(0.038)	(0.039)	(0.054)	(0.028)	(0.043)
C.E. × Exporter Training	-0.074*	-0.051	0.104	-0.017	-0.007
	(0.035)	(0.037)	(0.051)	(0.023)	(0.030)
C.E. × Joint Training	0.083*	0.033	-0.084	0.059	-0.012
	(0.043)	(0.042)	(0.055)	(0.041)	(0.037)
Control mean	0.07	0.03	0.83	0.01	0.08
R-squared	0.18	0.15	0.12	0.17	0.08
Observations	1376	1376	1376	1376	1376
Panel B. Second Followup Survey - Twelve months after training					
Farmer Training	0.093	0.042	-0.098	0.042	0.017
	(0.046)	(0.041)	(0.051)	(0.024)	(0.033)
Exporter Training	-0.007	-0.038	0.034	0.012	-0.002
	(0.032)	(0.029)	(0.055)	(0.023)	(0.029)
Joint Training	0.303***	0.097	-0.226***	0.192***	-0.046
	(0.039)	(0.044)	(0.052)	(0.042)	(0.029)
Certificate Eligibility (C.E.)	0.012	0.005	-0.039	0.008	-0.002
	(0.034)	(0.031)	(0.046)	(0.025)	(0.029)
C.E. × Farmer Training	-0.108	-0.099	0.099	-0.012	-0.015
	(0.061)	(0.053)	(0.068)	(0.033)	(0.044)
C.E. × Exporter Training	0.066	0.065	-0.005	0.011	-0.041
	(0.052)	(0.048)	(0.069)	(0.030)	(0.037)
C.E. × Joint Training	0.079	0.059	-0.023	0.021	-0.038
	(0.061)	(0.064)	(0.075)	(0.067)	(0.044)
Control mean	0.10	0.09	0.76	0.02	0.10
R-squared	0.18	0.12	0.11	0.20	0.15
Observations	1354	1354	1354	1354	1354

Notes: This table reports treatment effects on contract trading between farmers and intermediaries. The dependent variable in Column 1 indicates whether the farmer traded with exporter from same training group. Columns 2-3 report coefficient estimates on spot trade, and Columns 4-5 on informal or formal contract trade. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

B Sample Selection Details

B.1 Farmer group selection

The unit of sample selection for farmers is a farmer group, consisting of around 15 farmers per group. Several reasons make the farmer group ideal as our unit of treatment group. First, farmer groups are self-organized and composed of farmers located in the same town.[1] By assigning treatment at the level of farmer groups, we allow for intra-group learning of a technology, which may increase technology adoption and reduce potential treatment spillovers across groups, given the group organization and geographic characteristics. Second, government support and policy interventions have been previously provided at the farmer group level in Vietnam. We follow this convention by assigning treatment at the same level. Finally, by regulation farmer groups have to be registered with their provincial agriculture agency before they can receive any assistance from the government. By partnering with a government agency we were able to use the list of registered farmer groups as the pool for random sampling in two major districts, namely, Ham Thuan Bac and Ham Thuan Nam (see Figure A-3 for a map). Treatments were randomized within 11 geographical strata in these two districts, where each stratum is either a single commune or a coalition of multiple communes. We randomly selected 88 out of 406 registered farmer groups and sent out letter invitations asking farmers to participate in our experiment. In total, 1,141 farmers from 88 farmer groups participated in the baseline survey and were offered training and certification eligibility treatments.[2]

B.2 Exporter (exporting intermediary) selection

We also recruited exporters to participate in the GAP training program. However, unlike farmer groups, the list of exporters was not readily available. To create a list of exporters, we carried out a search and recruitment drive in the two districts in August 2017. In total, we found 325 dragon fruit exporters operating in the area, of which 228 eventually participated in our study.[3] Using geographic information on the exporters and farmer groups, we matched each farmer group to on average 3 of the closest exporters to form a farmer-exporter cluster.

[1]There may be more than one farmer group in a town. We limit our sample to one farmer group from each town to prevent treatment spillover across different groups.

[2]Some farmers in the selected farmer groups did not participate in the baseline survey and, therefore, are not included in our analysis.

[3]To incentivize exporter participation, BTDC offered to support the registration of exporters in the supply chain database that was to be launched in 2020 by the Vietnamese government.

C Question List

Table C-1: VietGAP Checklist

Num	Requirements	Pass	Fail
	Pesticide Management		
1	Apply integrated pest management (IPM) or integrated crop management (ICM) measures.		
2	Use pesticides on the list of permitted pesticides in Vietnam and apply according to the principle of 4 rights (right medicine, right time, right concentration, right method) or follow the instructions given by technicians and manufacturers.		
3	Purchase pesticides at qualified pesticide retailers.		
4	Place warning signboards in newly sprayed areas.		
5	Unused pesticides should be collected and treated according to hazardous waste regulations.		
6	In case of storing and using fuels, gasoline, oil and other chemicals ensure prevention of contamination, safety of workers, and prevention of fire.		
7	Pesticides and chemicals must be kept in proper packaging. If storing in another container the full name, instructions, expiration date should be specified as original package.		
8	Unused or expired chemicals must be collected and disposed according to regulations. Store chemicals according to instructions on product package or manufacturer's instructions.		
9	Plant varieties must be of clear origin, which are permitted for production and trade in Vietnam, and resistant to pests and diseases. Use healthy and clean seeds to reduce the use of pesticides.		
	Equipment and Production Area Management		
10	Chemical containers must be sealed and have warning signs. If stored in warehouse, the warehouse must have a lock and only entered by authorized personnel.		
11	Do not store or leave chemical containers in the preliminary processing area, living area or near water sources. Do not store with other products.		
12	Tools and materials need to be available in case of spillage of fertilizer, pesticide, and chemicals.		
13	Equipment and machinery for production and preliminary processing must be cleaned before, after use and maintained regularly for users to avoid contaminating the product.		
14	There must be a diagram of the production area, area for storing fertilizer, pesticide, equipment, machinery, production tools, and preliminary processing area (if any).		
15	Keep tracking list for purchased or self-produced input materials.		
16	Keep tracking list for monitoring production and consumption process.		
	Hygiene and Safety Management		
17	Need to provide safe working conditions, including basic equipments necessary for protection and safety of workers.		
18	Toilet, hand washing areas should be clean and have personal hygiene instructions.		
19	Labor protection (clothes, gloves, masks, boots) need to be cleaned before and after use and stored in a designated area and not kept together with fertilizer, pesticide and other chemicals.		
20	First aid equipment and instructions are ready for use in case of emergency.		
21	Workers need to follow protection guidelines suitable to their duty to limit the risk of contamination of products and health hazards.		
	Soil, Water, and Waste Management		
22	In case of using chemicals to treat soil, substrates, and water time, method, chemical, and isolation time must be recorded.		
23	Implement appropriate farming measures in accordance with soil and crop conditions to avoid environmental pollution and degradation of soil resources.		
24	There should be safeguards to prevent and control leakage of pesticides and fertilizers.		
25	The chemical and pesticide mixtures must be treated to ensure that they do not contaminate water sources and products.		
26	The substrate must have a clear origin and record of the composition of ingredient and supplements.		
27	Do not reuse fertilizer, pesticide, and chemical containers for storage.		
28	Used packages of fertilizer and pesticide must be collected and treated according to the law of environmental protection.		
29	Waste from production, preliminary processing, and toilets must be collected and disposed in accordance with environmental regulations.		
	Fertilizer Management		
30	Use fertilizers and supplements that are allowed to be produced and traded in Vietnam.		
31	If using animal and poultry manure as fertilizer, it must be composted and controlled for heavy metal as instructed.		
32	Fertilizers and supplements must be kept in proper packaging. If storing in another container the full name, instructions, expiration date should be specified as original package.		

Notes: English translated version of VietGAP checklist used for auditing GAP compliance.

Table C-2: VietGAP Knowledge Question Sheet

Item	Question
1	Who needs to be trained on VietGAP or have food safety certification? A. The facility manager B. Field worker C. Quality control worker D. All of the above E. I don't know
2	Which of the following contents must be recorded in the form of diary? A. Production log, pesticide distribution B. Production log, harvest C. Production log, pesticide, manure D. All of the above are correct E. I don't know
3	Which criteria must be analyzed in product samples? A. Pesticide residue limits B. Heavy metal limits C. Microbial limits D. All of the above E. I don't know
4	What are the requirements for using pesticides? A. Included in the list of permitted pesticide in Vietnam B. They must be on the list of permitted pesticide for plant you are growing C. According to the principle of "4 correct" D. All of the above are correct E. I don't know
5	What are the requirements in harvesting? A. Correct harvesting time, ensuring isolation of pesticides and animals B. Harvesting tools are clean C. The product does not come into direct contact with soil D. All of the above are correct E. I don't know
6	What is the proper method of preserving pesticides? A. Power pesticides above, liquid pesticides below B. Power pesticides below, liquid pesticides above C. Power pesticides and liquid pesticides are stored together D. All of the above are wrong E. I don't know
7	What must be done to manure before applying to crops? A. Incubation B. Incubation with controlling the heavy metal content C. Treatment with chemical drugs D. No need to process E. I don't know
8	How often should you conduct internal assessment of standards and conditions? A. Every 6 months B. Every 12 months C. Every 18 months D. Every 24 months E. I don't know
9	What are the requirements for maintaining production tools? A. Must be cleaned before using and maintained regularly B. Must be cleaned after using and maintained regularly C. Must be cleaned before and after using D. Must be cleaned before and after using and maintained regularly E. I don't know
10	Who develops standards for production processes using fertilizers and pesticides? A. The training center B. Intermediaries C. Local community D. Producers E. I don't know

Notes: English translated version of VietGAP test used to measure farmer's GAP knowledge.

Table C-3: Question about awareness of pesticides and safety

Item	Question (Respondents can respond on a 5-point scale: Strongly disagree, disagree, no opinion, agree, strongly agree)
1	I always wear protective gear (masks and gloves) when handling and spraying pesticides
2	High exposure to pesticides can cause sickness
3	I have experience being sick after using pesticides
4	High exposure to pesticides can harm the environment
5	Consuming pesticide residue on fruit can cause sickness
6	Consumers do not care about eating pesticide residue on dragon fruit
7	I know about chemicals on pesticides' labels
8	Pesticide use should be freely decided by each farmer
9	Pesticide use in farming should be regulated and monitored
10	Pesticide use in farming should be banned

Notes: English translated version of question sheet to measure awareness on pesticide and safety.

Table C-4: Exporter Good Handling Practices (GHP) Checklist

Num	Requirements	Pass	Fail
	Pest Control		
1	Measures are taken to exclude animals or pests from packing and storage facilities		
2	There is an established pest control program for the facility		
3	Interior walls, floors and ceilings are well maintained and are free of major cracks and crevices		
	Receiving		
4	Product delivered from the field which is held in a staging area prior to packing or processing is protected from possible contamination		
5	Prior to packing, product is properly stored and/or handled in order to reduce possible contamination		
	Washing/Packing Line		
6	Source water used in the packing operation is potable		
7	Processing water is sufficiently treated to reduce microbial contamination		
8	Water-contact surfaces, such as dump tanks, flumes, wash tanks and hydro coolers, are cleaned and/or sanitized on a scheduled basis		
9	Water treatment (strength levels and pH) and exposure time is monitored and the facility has demonstrated it is appropriate for the product		
10	Food contact surfaces are in good condition; cleaned and/or sanitized prior to use and cleaning logs are maintained		
11	Product flow zones are protected from sources of contamination		
	Packing House General Housekeeping		
12	Chemicals not approved for use on product are stored away from packing area		
13	The packing facility interior is clean and maintained in an orderly manner		
14	Outside garbage dumpsters are closed or are located away from packing facility entrances and the area around such sites is reasonably clean		
15	Packing facilities are enclosed		
16	Glass materials above product flow zones are contained in case of breakage		
17	Possible wastewater spillage is prevented from contaminating any food handling area by barriers, drains, or a sufficient distance		
18	Pallets and containers are clean and in good condition		
19	Packing containers are properly stored and protected from contamination (birds, rodents, and other pests)		
	Traceability		
20	Records are kept recording the source of incoming product and the destination of outgoing product which is uniquely identified to enable traceability		

Source: USDA Good Handling Practices Audit Verification Checklist Version 1.2. We adopted a Vietnamese translated version of this checklist to audit exporters' GHP compliance.

D Pesticide Residue Analysis

D.1 Sample Collection

For the sampling procedure we hired specialists, who were not BTDC staff, trained for sampling agricultural products for pesticide analysis. The specialists followed the visit schedule arranged between BTDC staff and farmers without knowing each farm's treatment status. At each farm, specialists collected 4-6 kilograms of dragon fruit samples and packed them in sealed plastic bags to prevent the samples from being contaminated. BTDC prepared the plastic bags which were each labelled with a unique farmer ID. Once specialists came back to BTDC with the collected samples, BTDC staff recorded farmer IDs and packed the samples in carton boxes as preparation for shipment. We hired a logistics company for overnight shipping: the boxes were picked up at BTDC and delivered to the laboratory the next day.

D.2 Pesticides Tested in our Study

Table D-1 presents the list of 18 pesticides, or active ingredients, that we tested in this study.[4] Based on the list of permitted pesticides issued annually by Vietnam's Ministry of Agriculture and Rural Development Ministry of Agriculture and Rural Development (2019), among the 18 pesticides, 17 pesticides were permitted for use in agriculture in Vietnam while 1 pesticide was not permitted for agricultural use. Pesticides can be grouped according to World Health Organization (WHO)'s hazard classification rule. Nine out of eighteen pesticides tested in this study are classified as moderately hazardous, two pesticides as slightly hazardous, and three pesticides as unlikely to cause an acute hazard. There are four pesticides without a hazard classification.

The last four columns show the MRL of each pesticide by country. In the main analysis, we use EU's MRL as the benchmark to test pesticide residue compliance due to two reasons: First, we believe that EU's MRL is most accurate. Its database allows the user to find MRL for a narrow subcategory of a fruit (i.e. MRL for dragon fruit is found in the cactus fruit group) whereas other country databases most likely provide MRLs only at large categories (i.e. MRL for dragon fruit is found in tropical-inedible group which includes a number of fruit groups). Second, compared to other countries, EU's MRL are more conservative and often considered to be of high standard in the food trading industry. According to interviews with exporters, most overseas buyers require EU MRLs for pesticide residue testing. Nevertheless, we also present results using MRLs for U.S., Japan, and China.

[4]The active ingredient (AI) in a pesticide is the chemical that actually causes the effect while the rest of the pesticide product is inert ingredients, such as water and additives.

Figure D-1: Example of Pesticide Residue Report

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KẾT QUẢ KIỂM NGHIỆM
ANALYTICAL RESULTS

Tên khách hàng / Client name: HONG KONG UNIVERSITY

Mã số mẫu / Sample ID : 200110038-1
Tên mẫu/ Name of Sample : **G3-HV-11530**
Mô tả mẫu/ Sample description : Thanh long đựng trong bao nhựa/ Dragon fruit in plastic bag
Nền mẫu / Matrix : Trái cây/ Fruit
Ngày nhận mẫu/ Date of sample received : 10 / 01 / 2020
Ngày trả kết quả / Date of result delivered : 21 / 01 / 2020

Chỉ tiêu phân tích Parameter (s)	Kết quả Result	Đơn vị Unit	LOD	Phương pháp Test method
Acetamiprid	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Azoxystrobin	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Chlorothalonil	KPH	mg/kg	0.01	AOAC 2007.01 (GC/MS) (*)
Chlorpyrifos	KPH	mg/kg	0.01	AOAC 2007.01 (GC/MS) (*)
Cyprodinil	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Difenoconazole	KPH	mg/kg	0.1	AOAC 2007.01 (LC/MS/MS)
Fipronil	KPH	mg/kg	0.01	AOAC 2007.01 (GC/MS)
Hexaconazole	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Metalaxyl and metalaxyl-M	KPH	mg/kg	0.01	AOAC 2007.01 (GC/MS) (*)
Phenthoate	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Prochloraz	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Pyraclostrobin	KPH	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Quinalphos	KPH	mg/kg	0.01	AOAC 2007.01 (GC/MS) (*)

BM.15.05a/05/BH.01.07.2019

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KẾT QUẢ KIỂM NGHIỆM
ANALYTICAL RESULTS

Tên khách hàng / Client name: HONG KONG UNIVERSITY

Mã số mẫu / Sample ID : 200110038-1
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Nền mẫu / Matrix : Trái cây/ Fruit
Ngày nhận mẫu/ Date of sample received : 10 / 01 / 2020
Ngày trả kết quả / Date of result delivered : 21 / 01 / 2020

Chỉ tiêu phân tích Parameter (s)	Kết quả Result	Đơn vị Unit	LOD	Phương pháp Test method
Carbendazim and benomyl	0.20	mg/kg	0.01	AOAC 2007.01 (LC/MS/MS) (*)
Dithiocarbamates	0.071	mg/kg	0.05	J. Agric. Food Chem.2001,49,2152-2158(GC/MS)
Permethrine (sum of isomers)	0.13	mg/kg	0.01	AOAC 2007.01 (GC/MS) (*)

Ghi chú / Note:
KPH / N.D: Không phát hiện / *Not - Detected*; LOD: Giới hạn phát hiện / *Limit of Detection.*
(*) Phương pháp được Vilas (ISO/IEC 17025:2017) công nhận / *The method is accredited by Bureau of Accreditation (VILAS)*

Phụ trách phòng thí nghiệm
Officer in charge of laboratory

MS. Trinh Thi Minh Nguyet

Giám đốc
Director

MBA. Nguyen Thi Kieu Hanh

BM.15.05a/05/BH.01.07.2019

(a) Pesticides Not Detected in Sample (b) Pesticides Detected in Sample

Notes: Scanned image of report on pesticide residue analysis results from one of our study participants.

Table D-1: Tested Pesticides - Hazard Classiciation and Maximum Residue Limit

No	Pesticide Name	WHO Hazard Classification	Maximum Residue Level (mg/kg) E.U.	U.S.	Japan	China
Permitted for use in agriculture under Vietnam regulation						
1	Chlorpyrifos	II	0.01	0.1	0.05	2
2	Difenoconazole	II	0.15	1.5	0.07	0.05
3	Fipronil	II	0.005	0.01	0.005	0.02
4	Metalaxyl	II	0.01	4	0.2	0.2
5	Permethrin	II	0.05	1	2	2
6	Phenthoate	II	0	0.01	0.1	1
7	Prochloraz	II	0.05	0.01	0.05	7
8	Quinalphos	II	0.01	0.01	0.02	0.5
9	Tebuconazole	II	0.01	0.05	0.1	0.05
10	Hexaconazole	III	0.01	0.01	0.2	0.05
11	Thiabendazole	III	0.02	3	3	3
12	Azoxystrobin	U	0.3	2	1	0.3
13	Chlorothalonil	U	0.01	0.5	0.2	0.2
14	Acetamiprid	UK	0.01	0.5	0.2	2
15	Cyprodinil	UK	0.02	2	0.3	0.5
16	Dithiocarbamates	UK	0.05	0.01	0.6	2
17	Pyraclostrobin	UK	0.02	0.04	0.02	0.05
Not permitted for use in agriculture under Vietnam regulation						
18	Carbendazim	U	0.1	0.01	2	0.5

Notes: This table provides the list of pesticides tested in the residue analysis. Vietnam's regulation is based on 2019's permitted list of pesticides for use in agriculture (Ministry of Agriculture and Rural Development, 2019). Hazard classification is based on World Health Organization's recommended classification of pesticides (WHO, 2009). Hazard classification indicators: II - moderately hazardous, III - slightly hazardous, U - unlikely hazardous, UK - classification is unavailable. Maximum Residue Level (MRL) is the highest level of a pesticide residue that is legally tolerated in a food when pesticides are applied correctly. E.U. MRLs are obtained from the European Commission MRL database (EC, 2019). Pesticide MRL marked with 0 indicates disapproval of use in agriculture.

E Product Assessment

This section provides details on the assessment procedure and methods used in the followup surveys. We assess a product's observable characteristics mainly along four dimensions: (a) sweetness, (b) appearance, (c) size, and (d) weight. Upon arriving at the farm, surveyors directly sampled two dragon fruits from the farmer's field.[5] Sweetness was measured using a refractometer, which is a field device designed to measure soluble sugar content (degree brix) in fruits and vegetables. To account for sugar content variation across different parts of the fruit, surveyors collected measures at three different parts – top, middle, and bottom – of each fruit. We use the mean value as a measure of sweetness of the fruit. Appearance was rated on a 0-5 point scale on the fruit's skin and bract to assess whether visual defects, such as brown spots, were present. The length and width of the fruit were measured with a vernier caliper, and weight was measured using a portable scale. Next, we illustrate in detail the tools and assessment standards used by surveyors for each dimension.

Sweetness To measure sweetness of the fruit we use Degrees Brix – or total soluable content – which is commonly used by winemakers and fruit growers as a measurement of sugar level in fruits. A higher degree of Brix indicates higher sugar level and sweeter taste. Brix can be measured using a refractometer by squeezing fruit juice onto the surface of the refractometer and viewing the juice through light. We sampled fruit juice from three different parts of the fruit (top, middle, bottom) and use the mean Brix level as a measure of sweetness. Figure E-1 shows an image of a surveyor using the refractometrer and an image of parts of the fruit from which the juice sample is taken.

Appearance - skin and bract Surveyors assessed the fruit's appearance by rating the skin and bract on a 0-5 point scale. To obtain consistent ratings across surveyors we attached descriptions to each rating that surveyors could use when assessing the fruit. Table E-1 shows the descriptions of the ratings used for the assessment.

Size and Weight We use a vernier caliper to measure the length and width of the main part of the fruit. We use a portable scale to measure the weight of the fruit. Figure E-2 shows images of surveyors measuring the size and weight with the respective tools.

[5]Farmers were compensated for sampling of fruits at a fixed rate of 15,000 VND per kilogram.

Figure E-1: Measuring sweetness of dragon fruit

(a) Surveyor using refractometer (b) Sample from top, middle, and bottom

Figure E-2: Measuring size and weight of dragon fruit

(a) Surveyor using vernier caliper (b) Surveyor using portable scale

Table E-1: Appearance assessment ratings and descriptions

	Rating	Description
Skin	0	Uneven red and translucent skin, many black/brown spottings
	1	Uneven red and translucent skin, some black/brown spottings
	2	Slightly pale red or dark skin, some black/brown spottings
	3	Light red or slightly dark skin, little black/brown spottings
	4	Evenly red and shiny skin, little black/brown spottings
	5	Evenly red and shiny skin, no black/brown spottings
Bract	0	Yellow color and withered
	1	Dark red, slightly yellow, withered at the edges
	2	Mix of yellow and red, no withering
	3	Slightly dark red, smooth texture
	4	Mix of red and green, smooth texture
	5	Bright green, glossy and smooth texture

F Model

This section proposes a stylized framework characterizing the interaction between farmers and exporters in the dragon fruit supply chain in Vietnam. The main purposes are to (1) capture key features of the setting under consideration, (2) provide theoretical foundations for the experiment design, and (3) deliver predictions to be tested in the empirical section.

F.1 Setup

Consider a farmer (he) interacting with one exporting intermediary (she) in three stages: contracting stage, farming stage, and transaction stage. Before the farming stage, the farmer and the exporting intermediary (henceforth, exporter) decide whether to engage in contract trade or otherwise spot trade. Then the farming stage begins and the farmer chooses the level of investment that determines the quality of output. Finally the transaction is completed following the trade type they chose at the beginning.

Contract Decision Before making any production decisions, the farmer and the exporter first decide whether to form a contract or not. Having a contract could be beneficial to both sides. It insures the farmer a high price for a high-quality product and can also procure for the exporter her desired product. Of course, the benefit comes at a cost. The farmer may be punished severely for violating the contract by not fulfilling with required quality. The exporter need to pay high costs to monitor the farmer and enforce the contract, given the poor contracting environment.

We consider a simple contract type. The exporter promises to pay the farmer a high price and maintains the contract unless a violation is detected–the farmer is caught slacking off during production and thus cannot deliver the desired quality. Once violation is detected by the exporter, the farmer cannot obtain the promised payment from the exporter and can only sell to the low-quality market. In that case, the price is given by the spot trade on the low-quality market, provides a lower payoff than in the spot trade. Moreover, he can never engage in contract trade thereafter. Being in the contract allows the exporter to monitor the farmer's GAP compliance during production by, for example, visiting the farm and conducting inspections at a cost. The monitoring provides additional information on quality and enables the exporter to utilize the learnt information to discipline the farmer. The exporter's monitoring cost, $c(K_I, R)$, is decreasing in exporting intermediary's knowledge on GAP, $K_I \in [0, 1]$, and the strength of the buyer-supplier relationship, R. Intuitively, a more knowledgeable exporter can monitor production more efficiently at lower cost. In better buyer-supplier relationships, the exporter has more trust in the farmers, also resulting in lower monitoring cost. Upon paying the monitoring cost, the exporting intermediary can observe the farmer's true GAP adoption with probability K_I or she observes nothing (i.e. monitoring fails and violation cannot be detected) with probability $1 - K_I$. The probability of monitoring failure $1 - K_I$ can reflect the level of moral hazard that the farmer does not produce in the right way before the transaction occurs. And higher level of exporting intermediary's knowledge can mitigate the moral hazard problem in contract trade.

The contract decision depends on both farmer and exporter knowledge, their relationship, and their expected payoff in the spot trade. On the supply side, the farmer's GAP knowledge determines the production costs of quality (as we will explain later in the discussion of the farming stage). Therefore, a farmer with low knowledge may find it more profitable to trade on the spot market because providing the high quality required by the contract may be too costly. On the demand side, the exporter's knowledge and his relationship with the farmer determine her costs of monitoring the farmer's GAP compliance during the production stage. An exporter with low knowledge may also not prefer contract trade, due to the potential inaccuracy of monitoring and the high monitoring cost.

Farming Stage The farmer grows one unit of dragon fruit. The quality can either be low or high, $q \in \{0, 1\}$ and the probability of providing high quality output depends on the level of GAP adoption $i \in [0, 1]$ by the farmer.[6] For a given level of i, the output quality is high with probability i and low with probability $1 - i$. As GAP is designed to improve food safety, an unobservable attribute, we assume that quality is hard to observe—i.e., the exporter cannot discern food safety through observable attributes, such as fruit size or skin condition.[7] The variable cost of production is $c(i) = \frac{1}{2K_F} i^2$ where $K_F \in [0, 1]$ represents the farmer's knowledge on GAP. The more knowledgeable the farmer is, the more efficiently he produces.[8] For any GAP adoption $i > 0$, the farmer also has to incur a fixed cost f of GAP adoption, which represents the up-front investment in facilities or equipment that is necessary for adopting GAP.

Transaction Stage At harvest, the exporter and the farmer meet and complete the trade. If the two sides engage in contract trade, then output is delivered and payment is made according to the contract terms, as discussed before and will be detailed later. Otherwise, they engage in spot trade and the exporter makes a price offer to the farmer based on the quality signal she receives. In spot trade, there is information asymmetry at the transaction stage because the exporter cannot perfectly observe the true quality and thus cannot make price offers based on the true quality. Such information friction reduces the farmer's incentive to produce high-quality fruit because his quality improvement cannot be fully observed by exporters. Instead, the exporter observes an imperfect quality signal $s \in \{Good, Bad\}$ and makes a price offer based on it. We assume a simple signal structure. If the true quality is high, the signal is always good. If the true quality is low, then the signal is good with probability σ, and is bad with probability $1 - \sigma$, where $\sigma \in (0, \frac{1}{2})$ represents the level of asymmetric information on output quality and reflects the exporter's inability to discern

[6]In general, GAP adoption i includes all physical (such as chemicals) or non-physical (such as effort) inputs spent on learning, acquiring and adopting proper farming practices according to GAP standards.

[7]As supporting evidence, our empirical analysis shows no change in observable attributes from GAP training.

[8]Alternatively, we may assume that production cost doesn't change in knowledge, but rather increases the probability of producing high quality given i. The qualitative predictions are the same.

high-quality from low-quality product during spot trade.[9]

After purchasing from the farmer–either through spot trade or contract trade–the exporter then sells the output to one of the two final markets: the high-price market or low-price market. We assume that quality is observable by the high-price final market buyers because the high-price export market requires high quality and have strict mandatory testing for food safety.High-price markets also impose strict requirements for food safety and only accepts high quality. If output quality turns out to be low and the product is therefore rejected by the high-price market, then the value of the product becomes zero and the exporter bears all of the losses.[10] By contrast, the low-price market accepts all quality levels. The price on the final market is exogenously given by $\underline{P}$ at the low-price market and $\bar{P} > \underline{P}$ at the high-price market. Exporters trading with low-price market buyers are in perfect competition, paying the farmer $\underline{P}$ and earning zero profit. Exporters trading with high-price market buyers possess some extent of market power because of certain entry barriers (e.g., establishing business relationships with overseas importers). The exporter pays the farmer $\mu\bar{P}$ and earns $(1-\mu)\bar{P}$ for high-quality product , where $\mu \in (0, 1]$ is the markdown ratio of the exporter price. The markdown represents the revenue share earned by the farmer and reflects the exporter's market power in the downstream market.

That is, in spot trade, the exporter pays the farmer $\mu\bar{P}$ if she believes the quality to be high and pays $\underline{P}$ if she believes it to be low. In contract trade, the exporter pays the farmer $\mu\bar{P}$ if there is no violation and otherwise the farmer can only sell to the low-quality market at $\underline{P}$ in this period and can never engage in contract trade thereafter. We normalize $\underline{P} = 0$ and $\bar{P} = 1$. With this normalization, the farmer will fully adopt GAP ($i = 1$) in a friction-less world with perfect information, perfect knowledge (for both farmer and exporter), and prefect competition ($\mu = 1$).

F.2 Detailed Analysis

Spot Trade Suppose the farmer and the exporter engage in spot trade. If the exporter observes a bad signal, she knows it for sure that the quality is low. She pays the farmer $\underline{P}$ and then sells the product to the low-price market. If the exporter observes a good signal, she is uncertain about the quality and offers price based her expectation about the quality. Let $\beta \in (0, 1)$ be the exporter's belief that the true underlying quality is high, $\beta = E[q = 1|s = Good]$. As the exporter bears all the loss in case of low quality, her expected revenue from the final market is given by $\beta\bar{P}$. Therefore, she offers farm-gate price $\beta\mu\bar{P}$. In equilibrium, the expected quality should be consistent with the true quality distribution.

[9]Given the context, it is plausible to assume that exporter knowledge only mitigates the moral hazard in the contract partially but not the adverse selection in spot trade. This is because GAP provides knowledge on high quality production technology and on-farm management standards. Accordingly, K_I reflects how well the exporting intermediary knows about the right way to produce, rather than how to distinguish quality of the outputs.

[10]This assumption is based on interviews with dragon fruit exporting intermediaries. Exporters do not test with individual smallholder farmers which makes it difficult to penalize individual farmers. Moreover, second sale is difficult in the case of dragon fruit because it is a perishable product.

Then in equilibrium, the exporter's belief upon good signal is given bye

$$\beta = \frac{i}{i + (1-i)\sigma}.$$

Then exporter's demand (p_G, p_B) as a of farmer's adoption i is

$$p_G = \frac{i}{i + (1-i)\sigma}\mu\bar{P}, p_B = \underline{P}$$

where p_G is the price offer under a good signal and p_B is that under a bad signal.

Back to the farming stage, suppose the farmer has already made the up-front investment f and can adopt some GAP $i > 0$. Given the exporter's strategy (p_G, p_B), the farmer chooses GAP adoption i to maximize his expected payoff:

$$\max_i [i + (1-i)\sigma]p_G + [1 - i - (1-i)\sigma]p_B - \frac{1}{2K_F}i^2 - f.$$

Then farmer's optimal GAP adoption, conditional on he made the up-front investment is

$$i = (1-\sigma)K_F(p_G - p_B).$$

If the farmer does not make the investment, the farmer cannot adopt GAP and inputs nothing $i = 0$. As no investment is made, the exporter knows it for sure that the quality is low. She offers price $\underline{P}$ to the farmer and sells them to the low-price market. In that case, the farmer earns zero. Then the farmer will make the investment if the expected benefit from adopting positive GAP exceeds the cost f. Otherwise, he does not make the investment and does not adopt GAP.

Combining the best responses of the two sides, we are able solve for the equilibrium. Let $U^* = \frac{K_F}{2}(\mu\bar{P})^2 - \frac{1}{2K_F}(\frac{\sigma}{1-\sigma})^2 - f$ denote the farmer's equilibrium payoff from making the investment and thus adopting some GAP $(i > 0)$. The farmer will make the investment if $U^* > 0$. The strategies for the farmer and the exporter i_{spot}, p_{spot} and their payoffs U_{spot}, V_{spot} in spot trade are given as follows

$$\begin{array}{lll}
\text{If } U^* \geq 0, \begin{cases} i_{spot} = K_F\mu\bar{P} - \frac{\sigma}{1-\sigma} \\ p_{spot} = (\frac{\mu\bar{P}}{1-\sigma} - \frac{\sigma}{(1-\sigma)^2K_F}, 0) \end{cases} & , \begin{cases} U_{spot} = \frac{K_F}{2}(\mu\bar{P})^2 - \frac{1}{2K_F}(\frac{\sigma}{1-\sigma})^2 - f \\ V_{spot} = K_F(1-\mu)\mu(\bar{P})^2 - \frac{\sigma(1-\mu)\bar{P}}{1-\sigma} \end{cases} & ; \\
\text{If } U^* < 0, \begin{cases} i_{spot} = 0 \\ p_{spot} = (0, 0) \end{cases} & , \begin{cases} U_{spot} = 0 \\ V_{spot} = 0 \end{cases} & .
\end{array}$$

The critical knowledge cutoff with which the farmer is indifferent between investing or not is $K_F^\dagger = \frac{f + \sqrt{f^2 + (\mu\bar{P}\frac{\sigma}{1-\sigma})^2}}{(\mu\bar{P})^2}$. As farmer knowledge increases, the variable cost of production is lower, and the farmer is more willing to adopt GAP by making the investment. Then in spot trade, the farmer will adopt some GAP if $K_F > K_F^\dagger$ and will not adopt GAP otherwise. Moreover, the level of GAP adoption in spot trade increases with farmer knowledge and decreases with level of information asymmetry.

Contract Trade Alternatively, the farmer and the exporter can engage in contract trade. As legal enforcement is often lacking in developing countries, formal contract is usually infeasible. Therefore, we consider a version of informal contract with infinite time horizon and discount factor δ. At the beginning of the farming stage, the two parties specify a contract. If either side deviates from the contract, then the contract terminates and they have to go back to spot trade thereafter forever. If both sides obey the contract, then they continue to engage in contract trade in the next period.

Though quality is not observable and cannot be contracted on, the exporter can alternatively contract on GAP adoption and use the monitoring result to make sure the farmer obeys the contract. Note that a contract that specifies full adoption is equivalent to the one that requires high quality. In addition to the output to be delivered, the contract also specifies a payment to be paid at harvest. When farmer fully adopts GAP and produces high quality, the overall benefit of the product is $\bar{P}$ and the best price the exporter can offer is $\mu\bar{P}$. Consider the following simple version of contract which requires $i = 1$ from the farmer and price of $\mu\bar{P}$ from the exporter. If the exporter finds partial or no adoption of GAP during monitoring, then she declines to make the payment to the farmer and will never engages in contract trade with that farmer. In this case, the farmer can only turn to the last resort–spot market that aiming for low quality–and gets a price of $\underline{P}$. Otherwise, if the exporter monitors full adoption or the monitoring provides no information (in the case of monitoring failure with probability $1 - K_I$), she trusts the farmer and pays the agreed $\mu\bar{P}$ to the farmer according to the contract.

Let $U_{contract} = \mu\bar{P} - \frac{1}{2K_F} - f$ and $V_{contract} = (1-\mu)\bar{P} - c(K_I, R)$ denote the farmer's and the exporter's equilibrium payoff in the contract. If the contract is valuable enough such that both sides can threaten the other side with terminating the contract, no one has incentive to deviate and the informal contract can be self-enforced. To see this, we check the incentive constraints for both the farmer and the exporter.

On the farmer's side, he may deviate from the contract by slacking off during production. The deviation that generates the highest payoff in the current period is to adopt nothing $i = 0$. With probability K_I, his deviation is detected by the exporter. If this happens, the exporter will not make the payment and will terminate the contract. The farmer has to go back to low-quality market this period and engage in spot trade in future. To ensure that the farmer obey the contract, the following must hold

$$K_I[\mu\bar{P} - \underline{P} + \delta(U_{contract} - U_{spot})] \geq \frac{1}{2K_F}$$

where LHS is the farmer's current loss from no payment and future loss from termination of the contract , and the RHS represents the cost saved from adopting nothing. Similarly, on the exporter's side, she may violate the contract by always claiming detection of partial adoption $i < 1$ and cutting the promised payment to the farmer. To ensure the exporter always make the specified payment,

$$\delta(V_{contract} - V_{spot}) \geq \mu\bar{P}$$

where the LHS represents the exporter's loss from violation and the RHS is the money saved by paying nothing to the farmer.

When both incentive constraints are satisfied, the contract is sustainable. If both parties are better off under contract, $U_{contract} > U_{spot}$ and $V_{contract} > V_{spot}$, they will engage in contract trade. Otherwise, they engage in contract trade. Combine these four constraints, we derive the conditions with which the farmer prefers to engage in contract trade: $K_F > K_F^*(K_I)$ where $K_F^*(K_I) = \max\{\frac{1+\frac{1}{\delta}-\sqrt{(1+\frac{1}{\delta})^2+(\frac{\sigma}{1-\sigma})^2-1-\frac{1}{K_I\delta}}}{\mu\bar{P}}, \frac{1-2\sigma}{(1-\sigma)\mu\bar{P}}\}$, and the exporter prefers to engaging in contract trade: $K_I > K_I^*(K_F)$ where $K_I^*(K_F)$ is such that $c(K_I^*(K_F), R) = \frac{(1-\mu)\bar{P}}{1-\sigma} - K_F(1-\mu)\mu(\bar{P})^2 - \mu\bar{P}$.

As our follow-up surveys are conducted within two harvest seasons, in deriving the following prediction, we consider the short-term/middle-term effects and assume that the two critical cutoffs $K_F^*(K_I)$ and $K_I^*(K_F)$ are fixed, and denote them as K_F^* and K_I^*.

F.3 Failure of Quality Provision at the Baseline

The farmer and the exporter will engage in contract trade if they are both better off under the contract. If either side does not benefit from contract trade, then spot trade is chosen. In spot trade, the farmer will adopt GAP ($i > 0$) if the expected payoff from the transaction exceeds the fixed cost f. Otherwise, he chooses not to adopt and always supplies low quality.

Proposition 1. *At baseline, there exist K_F^*, K_I^* and $K_F^\dagger$ such that*

1. *The farmer is willing to accept the contract if $K_F > K_F^*$. The exporting intermediary is willing to offer the contract if $K_I > K_I^*$. Hence, they engage in contract trade if and only if $K_F > K_F^*$ and $K_I > K_I^*$.*

2. *In spot trade, the farmer does not adopt GAP ($i = 0$) and the exporter always pays $\underline{P} = 0$ if $K_F < K_F^\dagger$. The farmer adopts some GAP ($i > 0$) and the exporter pays a positive price upon a good signal if $K_F \geq K_F^\dagger$. Moreover, the optimal level of GAP adoption and optimal price upon a good signal increase with K_F and decrease with σ.*

3. *In contract trade, the farmer fully adopts GAP ($i = 1$) and the exporter offers $\mu\bar{P}$.*

The detailed analysis and proof are relegated to Online Appendix F. Proposition 1 sheds light on the reasons for low quality provision at he baseline. Part 1 provides possible explanations for why the parties do not engage in contract trade even though it can potentially deliver higher quality. When the farmer's knowledge is low, his production efficiency is low, so that it is very costly to fully adopt GAP—a supply-side constraint. When the exporting intermediary's knowledge is low, her cost of monitoring the farmer is high, so that she is not willing to engage in contract trade—a demand-side constraint. Part 2 identifies barriers preventing the farmer from producing high quality in spot trade: as before, there is a supply-side constraint (i.e., low production efficiency due to low farmer knowledge) and a demand-side constraint (i.e., adverse selection problem due to an imperfect signal). Part 3 shows that a contract is a powerful instrument to sustain GAP adoption and therefore high quality provision. To sum up, Proposition 1 shows that the reasons for lack of high quality provision include low farmer knowledge K_F, low exporting intermediary's knowledge K_I and imperfect signaling σ.[11]

[11]Of course, there might be alternative explanations to low-quality provision. For example,

F.4 Predictions

Our experiment is motivated by two key barriers to technology adoption and quality upgrading as outlined in the previous model: the supply side constraint (GAP knowledge) and demand side constraint caused by the asymmetric information on product quality. Accordingly, our treatments are designed to mitigate each of these barriers through different types of training and certification eligibility. Specifically, the farmer-only training treatment can raise farmers' knowledge level K_F, thus reduce the production cost $c(i) = \frac{1}{2K_F}i^2$ and improve their production efficiency; the exporter-only training treatment can increase exporting intermediaries' knowledge level K_I and reduce monitoring failure. As the exporter are more efficient in observing the farmer's true adoption, exporter training can mitigate the moral hazard problem in contract trade. In the joint training, we train farmers and exporters simultaneously, relaxing constraints on both sides. In addition, joint training, where farmers and exporters are trained together in the same class, also provides an opportunity for farmers and exporters to interact with each other and potentially establish buyer-supplier relationships, which increases R and further reduces the demand side constraint. Offering certification eligibility, which we cross-randomize with the training treatment arms, serves as an incentive device since once farmers receive certification it can send a quality signal to exporters and potentially eliminate adverse selection in spot trade, $\sigma = 0$.

As expected, those interventions will impact farmers' GAP adoption, the quality of their products, exporters' price offers, and contract formation. The effects may depend on the parameters at the baseline. To be consistent with our empirical setting and more generally with the agricultural sector in developing countries, we assume that both farmers' and exporters' knowledge levels are sufficiently low at the baseline to hinder contract trade formation between farmers and exporters ($K_F < K_F^*$ and $K_I < K_I^*$).

Corollary 1. *The model implies several testable predictions specific to each treatment in our experiment:*

1. *Farmer training: if farmers' knowledge K_F increases, farmers may increase GAP adoption, upgrade quality, and receive higher prices at the farm gate.*

2. *exporter training: if exporting intermediaries' knowledge K_I increases, there may be no effect on GAP adoption or farm-gate price if the fixed cost of farmer's investment is high.*

3. *Joint training: if both farmers' knowledge K_F and exporting intermediaries' knowledge K_I increase, and the buyer-supplier relationship R increases, then contract trade*

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the price offered by high-quality market buyers, $\bar{P}$, may be low or the exporter may possess excessive market power rendering the markdown μ insufficient to incentivize farmers to produce high-quality goods. As we show through our empirical analysis, the returns to adopting GAP and exporting to the high-price market are significantly positive, suggesting that low pricing on high-quality products may not be the main reason for low adoption of GAP. As a result, we focus on knowledge and asymmetric information and leave the role of market structure on quality provision for future research.

increases. In this case, farmers increase GAP adoption and upgrade quality, and the transaction price increases more than that in the farm-training group.

4. *Certification eligibility: If in anticipation σ will decrease substantially, then farmers may increase GAP adoption and upgrade quality to receive the certification and the transaction price increases.*

Corollary 1 follows directly from the analysis of Proposition 1. In the farmer training group, farmers may become willing to accept contracts as their knowledge K_F increases. But as exporters are still unwilling to offer contracts due to low exporting intermediary knowledge, $K_I < K_I^*$, they still engage in spot trade. According to Proposition 1, as farmers' knowledge increases, they increase GAP adoption and upgrade quality. Because higher quality elicits better quality signals and improve exporters' expectations for quality, the farm-gate price also increases.

For the exporter training group, because the farmers have low GAP knowledge and high investment costs, they will engage in spot trade. Because exporter's GAP knowledge only helps reducing monitoring costs in contract trade, exporter training has no effect on technology adoption.

In the joint training group, the increased farmer knowledge reduces production costs, relaxing the supply side constraint. The increased GAP knowledge for exporters and the improved buyer-supplier relationship also reduce the exporter's cost of monitoring farmers, relaxing the demand side constraint. As a result, the jointly trained exporters and farmers are more likely to form contracts. Because they start to engage in contract trade, the farmer's optimal decision is to fully adopt GAP $i = 1$ and exporters pay the maximum price $\mu \bar{P}$. Technology adoption, output quality and price increase more than in the farmer-only training group.

Finally, if certification can credibly reveal the true quality, then there is no information asymmetry on quality. If farmers anticipate that the level of asymmetric information σ will decrease, then certification eligibility will provide an incentive for farmers to increase GAP adoption and upgrade quality, leading to higher price offers.

G Testing for Potential Treatment Spillovers

At the stage of designing this experiment, we were concerned about potential spillovers across treatment groups to non-treated groups within the treated districts. Such technology spillovers may bias our estimates of treatment effects. To address this issue we sampled four farmer groups within the same province but from outside the two districts in which we ran the training programs and designated them as spillover-proof control groups.[12] These spillover-proof control groups were located sufficiently far away from any treated farmer group, so the probability of knowledge spillovers from treated groups to these farmer groups in untreated regions is extremely low. As we did with the control groups in treated regions, we provided no training to these groups but conducted all three rounds of surveys.

Our method for examining spillovers is to test differences in the main outcome variables between control farmers in treated districts and control farmers in untreated districts. As we compare across districts, we leave out the strata fixed effects from the specification because the strata fixed effects will absorb the difference in outcomes between treated and untreated districts in this test. Instead, we include the shortest road distance, calculated using Google map, from each farmer group's commune to the center of the provincial capital, Phan Thiet, to control for determinants of farm outcomes correlated with proximity to city. Notwithstanding, one caveat is the potential for unobserved geographical differences between treated and untreated districts: a region may naturally produce higher quality products than others due to some reasons. As a result, the more reliable result is the difference in the changes in performance variables between these two regions, whenever these variables are available. The results are presented in Appendix Table G-1. The first column shows the mean of outcome variables of farmers in untreated districts (spillover-proof control group). The coefficient estimate of the difference between the control group in treated districts and control group in untreated districts is shown in the second column followed by the standard error and p-value.

Panel A tests the difference in baseline characteristics (before training) and shows that control farmers in treated and non-treated districts in general have similar demographics and performance. In Panel B, we find that control farmers in treated and non-treated districts are indifferent in their knowledge and awareness on the GAP technology. Farmers in the treated districts have higher GAP compliance than those in untreated districts, although they do not seem to have significantly better pesticide residue and observable product attributes.[13] However, the quality difference between these two groups of farmers, if any, may arise simply from geographic differences and it may already exist before the role out of our training intervention as discussed above. We are not able to remove the potential geographic difference in the quality regressions, because we only have data on the quality measures in the surveys conducted after the training.

[12]The sampling of spillover-proof groups as to serve as another control group is included in the pre-analysis plan of this study.

[13]When we test differences separately for each of the five areas of GAP management, we find treated district farmers to have higher compliance in equipment management and fertilizer management than farmers in untreated districts but no difference is found in pesticide management.

As a result, an indirect but more convincing way is to examine the changes in farm performance measures for which we have data both before and after the training intervention (e.g. prices, output, costs, etc.). Panel C compares the changes in these farm performance measures between the control farmers in the treated and non-treated districts, before and after the training. The difference in changes of output prices between these two types of control farmers are statistically insignificant and economically small. Similarly, they are indifferent in the changes in output volume, revenue, and input costs. The change in profits between these two controlled farmer groups is marginally significant after the training. However, it is negative. This result shows that, if any, the profits for control farmers in the treated districts decrease relative to those in the non-treated districts, which goes against a positive spillover effect on the quality produced by control group farmers. These results indicate that it is unlikely to have significant spillover of training effect from trained farmer groups to control groups in the treated districts. In addition, because a one-time meeting between farmers and exporters is organized in the control group (in the treated district) but not for those in the spillover-proof control group (in the non-treated district), the results also suggest that reduction of search friction is unlikely to drive the greater effect of joint training, as discussed at the end of Section 5.

Moreover, if there are indeed any spillovers across treatment groups and control groups within the treated districts, then our estimates will understate the effect of training on farmers' quality upgrading and performance. The true effect can be even greater in this case than our estimates. As a result, the bottom line is that our estimates can be considered as a lower bound of the training effects, which are already significant economically.

Table G-1: Test difference between control farmers in treated and untreated districts

	Mean of	Treated − Untreated			
	Untreated	Coefficient	S.E.	p-value	Obs.
Panel A. Baseline Characteristics					
Age	46.38	-0.228	3.002	0.940	373
Female	0.60	-0.301	0.250	0.241	373
Secondary education	0.71	0.093	0.121	0.449	373
Experience growing dragon fruit	10.14	0.070	2.250	0.975	373
Number of dragon fruit trees	938.33	21.01	150.08	0.890	373
Log(Average price)	13.15	0.168	0.433	0.701	373
Log(Volume sold)	14.57	-0.003	0.132	0.983	373
Total revenue	168.02	63.401	56.432	0.273	373
Total input cost	131.82	-16.545	59.013	0.782	373
Profit (revenue - cost)	36.20	79.947	59.385	0.191	373
Panel B. Quality Upgrading					
Knowledge	5.29	-0.163	0.191	0.402	368
Awareness	3.72	-0.387	0.249	0.135	365
GAP compliance - Total	0.67	0.650	0.193	0.003	733
GAP compliance - Pesticide	0.68	0.235	0.186	0.220	733
Mean pesticide residue	1.21	0.117	0.540	0.830	72
Compliance to Japan standards	0.67	-0.042	0.241	0.863	72
Mean Product Attribute	0.09	-0.015	0.147	0.918	727
Panel C. Farm-gate sales (Log difference between survey round and baseline)					
Δ Log(Average price)	12.61	-0.012	0.034	0.722	670
Δ Log(Volume sold)	7.03	-0.004	0.076	0.957	670
Δ Total revenue	86.18	-25.808	28.358	0.372	670
Δ Total input cost	43.66	12.991	25.696	0.618	670
Δ Profit (revenue - cost)	44.22	-40.791	33.159	0.231	670

Notes: This table reports differences in baseline characteristics and follow-up survey outcomes between control group farmers in treated districts and untreated districts (outside the two districts in which training intervention was implemented). Specifications include farmer characteristics at baseline as control variables, log of distance to provincial capital city, and survey round fixed effects. Standard errors are clustered by farmer group.

As our second empirical exercise, we exploit the distance to the nearest farmer in the joint training treatment and estimate its relationship with control group farmers' sales performance, directly utilizing the randomization of our experiment. Specifically, we run a difference-in-differences type regression to test the impact of distance on farmers' sales performance after the treatment, compared to before the treatment. If there is any displacement, we expect that the interaction term, $post\ training \times distance\ to\ the\ nearest\ jointly\ trained\ farmers$, would have a positive coefficient on farm performance—the farther, the less displacement, if any.

We include farmer and survey round fixed effects to account for time-invariant farmer-level characteristics and time-varying seasonal factors correlated with both distance to jointly trained farmer and farm-gate sales. Moreover, to account for farmer and exporter densities, we interact the number of all participant farmers and exporters within two kilometers distance to the focal farmer with the post training indicator and include them as control variables.

The estimates are reported in Table G-2. The coefficients can be interpreted as the difference in the changes in farm-gate sales after the training program between control-group farmers near and farther away from jointly trained farmers. If there was a displacement effect of joint training on farm sales of control group farmers, then we would expect the coefficients to be positive and statistically significant. Across all six columns, the estimated coefficients are statistically insignificant. The magnitude of the coefficient estimates for farm-gate price, volume and revenue are small enough to assuage concerns on sizable displacement effects on farm sales. Both direct (self-reported) and implied profit are statistically insignificant. Although direct profit is estimated with a positive coefficient the estimate of implied profit, which is calculated by the researcher using farm-gate price and volume, is close to zero. These results suggest that there may have been no displacement effect of joint training on farm sales of control group farmers.

Next, we present some thoughts on the potential reasons for the "no displacement" result. One possible reason is the "replacement effect". Consider a simple example with 2 exporters, one in the control group and the other in the treatment group, and 2 farmers, again one in the control group and the other in the treatment group. Before the treatment, suppose the treatment exporter was sourcing from the control-group farmer, and the control-group exporter sourced from the treatment farmer. After the treatment farmer and exporters are jointly trained, they form a contract to trade with each other, generating a displacement on the control farmer who lost her initial buyer. However, this also releases a buyer (control exporter), from whom the control farmer can trade with. As a result, such "replacement" effect cancels, or at least mitigates the displacement effect. Another possible reason is that the existence of displacement effect assumes that there is capacity constraint from the exporters. However, the purchases from jointly trained farmers only account for a small share of the exporter's total purchase, hence it is unlikely to reach its capacity constraint and, therefore, the displacement effect may be small in this case.

Finally, another valid concern is the potential offsetting effects of positive spillover and negative displacement. It is possible that the displacement effect existed, but there was also a positive spillover, which happened to offset each each other. In this case, we cannot detect their existence using our analysis above. However, results in Table G-3 suggest that this is unlikely. In the table, we test this hypothesis of positive spillover by examining the relationship between a farmer's distance to the nearest jointly trained farmer and technology adoption and quality upgrading, although the lack of baseline data on GAP compliance and quality prevents us from pursuing a difference-in-differences strategy as above. Columns 1-3 in Table G-3 suggest no significant correlation between distance to the nearest jointly trained farmer and technology adoption or quality of control group farmers. Hence, the offsetting explanation is unlikely, further supporting the no displacement results as above. Note that this result seems inconsistent with the findings from comparing control farmers in treated and untreated districts (Table G-1): farmers in treated districts show higher GAP compliance than farmers in untreated districts. Of course, one potential explanation to this difference is that there are baseline differences between farmers in treated and untreated areas but not between farmers within the treated area. Unfortunately, we do not have pre-experiment data on quality to further explore this possibility.

Table G-2: Displacement Effects on Farm Sales of Farmers in No Training Groups

	Farm-gate		Revenue		Profit	
	Price	Volume	Direct	Implied	Direct	Implied
	(1)	(2)	(3)	(4)	(5)	(6)
Post Training × Distance to nearest jointly trained farmer (km)	0.039	-0.612	2.786	1.263	7.675	-0.184
	(0.026)	(1.351)	(15.547)	(15.019)	(7.312)	(6.893)
Farmer Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Control mean (in levels)	12.48	6.35	81.33	80.20	40.46	39.11
R-squared	0.50	0.45	0.66	0.66	0.56	0.55
Observations	953	953	953	953	953	953

Notes: This table reports displacement effects on farm sales of farmers in no training groups. Data is based on farmer reports from the baseline survey and two follow-up surveys. Outcomes on price and volume are log transformed. Post Training refers to the two follow-up survey periods. All specifications include farmer density and exporter density interacted with post training period as well as farmer and survey round fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table G-3: Spillover Effects on Technology Adoption and Quality Upgrading of Farmers in No Training Groups

	GAP Compliance Score	Pesticide Mean Residue	Observable Attribute Index
	(1)	(2)	(3)
Distance to nearest jointly trained farmer (km)	-0.033	0.689	0.011
	(0.078)	(1.556)	(0.046)
Control mean (Pass/Total)	0.72	1.40	-0.00
Control standard deviation	0.10	1.34	0.52
R-squared	0.22	0.80	0.39
Observations	650	66	644

Notes: Column 1 is standardized audit score based on the control group's mean and standard deviation. Column 2 scales residue levels by the pesticide's Maximum Residue Limit (MRL) according to EU. Column 3 is the average of z-scores of six observable product attributes. All specifications include baseline farmer and exporter characteristics, farmer density and exporter density within two kilometers as well as strata and survey round fixed effects. Standard errors are clustered by farmer group and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

H Trust and Dictator Games

The experimental results from trust and dictator games provide another piece of evidence on the important mechanism of farmer-exporter relationship on contract trade. The games were conducted after the training sessions but before the first round of follow-up survey. Both farmers and exporters in the same cluster were invited to participate in the games. We asked all clusters including the control group to participate in this lab-in-the-field experiment.

The trust and dictator games were designed similar to Ashraf et al. (2006). More specifically, the trust game consisted of two stages. In the first stage, all participants were asked to allocate $100,000 where any amount allocated to her partner will be tripled. In the second stage, the partner would decide how much from the tripled amount to give back to the sender. When actually playing the second stage we used a fixed amount of $150,000 VND for the partner to allocate rather than using the actual amount sent by the sender to control for different responses arising from the amount allocated in the first stage.[14] In the dictator game, all participants played the role of a dictator and was asked to allocate $100,000 VND between herself and her partner.

For each stage of the game, we randomly matched all participants with a partner. Thus, a farmer could be partnered with another farmer or an exporter and vice versa. Each participant privately met with the game administrator to make sure they completely understood the rules and the administrator recorded the participant's decision. The match was only revealed to the dictator or sender in the trust game and all game decisions were kept confidential. To incentivize truthful reporting we informed participants that two pairs will be randomly selected at the end of the experiment and pay them using one of the game outcomes. Following Ashraf et al. (2006), we interpret the amount passed in the first stage of the trust game as a combination of trust and kindness and the amount passed in the dictator game as unconditional kindness. Previous studies have shown a strong relationship between measures of trust in experimental settings and real world outcomes in loan repayment (Karlan 2005) and information sharing in supply chains (Ozer, Zheng, & Ren 2014).

[14]In the second stage of the trust game in Ashraf et al. (2006) participants were asked to allocate fixed amounts for several possible first stage outcomes. Due to time limits we only used one fixed amount $150,000 which would be the tripled amount if the sender shared half of her initial pay in the first stage.

I Contract Formation Dynamics

In Figure A-9 and Table A-18, we further examine the effect of different training interventions on the evolution of spot trade and contract trade at 6 months and 12 months after the training. The figure reports the parameter estimates of the treatment indicator for each of the three training groups and the mean of the control group, together with the 95 percent confidence intervals of the parameter estimates.[15] As shown in the top left panel, joint training substantially increases within-cluster spot trade from about 4 percent in the baseline to about 25 percent in the first season of harvest although it slightly falls in the second season. The top right panel shows a remarkable fall in spot trade outside cluster for farmers in joint training.

The bottom panels show that joint training increases contract trade within the cluster, climbing from almost zero to about 20 percent in the second season, but not outside the cluster. By contrast, the effects of farmer-only and exporter-only training on spot trade and contract trade within clusters are much smaller: they are statistically insignificant or only marginally significantly different from zero in the first season of harvest after training.

The difference in dynamics of contract trade between joint training and other groups can be partly attributed to the fact that for joint training part of the spot trade established in the first harvest season developed to contract trade in the second harvest season. Specifically, in the joint training group, around 15 percent of spot trade within the cluster in the first harvest season converted to contract trade within the cluster in the second harvest season. By contrast, in other training groups, none of the 55 spot trade within the cluster led to a contract in the second season. This observation suggests that the effect of joint training on contract trade cannot be fully explained as a one-time leap to another steady state, but possibly a dynamic process of contract formation in which farmers and exporters gradually adopt contract trade through accumulation of experience in the buyer-supplier relationship.

Interestingly, the increase in within-cluster trade roughly offsets the decline in outside-cluster trade after training, as shown in Figure A-9. Likewise, the increase in within-cluster contract trade roughly offsets the decline in spot trade in the second season. This suggests that farmers are not adding more buyers, but rather are replacing former buyers with new ones. Specifically, farmers replace their previous outside-cluster buyers by within-cluster buyers after the treatment. They also replace their within-cluster spot trade buyers with contract trade buyers. This substitution effect seems more pronounced in the joint training group.

[15]Certification eligibility related treatment variables are included in the estimation. We do not report the results here.

J Randomization Inference Test

The test is implemented by re-randomizing the assignment of treatment separately for each training or certification treatment without altering the other treatments within each stratum. Specifically, since there are three training treatments in our study, one permutation involves three independent trials of randomization, where we re-randomize only one of the three training treatments while holding the other two treatment assignments and certification eligibility assignment unchanged. Then in a separate trial we fix the training assignments and re-randomize the assignment to certification eligibility.

Below we report the results from the tables in the main text with p-values from randomization inference test.

Table J-1: Impacts of Training and Certificate Eligibility on GAP Compliance

Standardized scores from GAP audit ($N = 2197$) :	Total (1)	Pesticide (2)	Equipment (3)	Hygiene (4)	Soil (5)	Fertilizer (6)
Farmer Training	0.459***	0.352***	0.340***	0.147	0.301***	-0.113
	(0.097)	(0.072)	(0.099)	(0.089)	(0.093)	(0.093)
	[0.003]	[0.003]	[0.052]	[0.154]	[0.036]	[0.372]
Exporter Training	0.104	0.060	0.089	0.012	0.167	-0.207
	(0.105)	(0.076)	(0.112)	(0.099)	(0.104)	(0.116)
	[0.454]	[0.398]	[0.463]	[0.903]	[0.246]	[0.169]
Joint Training	0.676***	0.556***	0.463***	0.202*	0.373***	0.029
	(0.123)	(0.081)	(0.107)	(0.090)	(0.116)	(0.090)
	[0.006]	[0.001]	[0.018]	[0.062]	[0.061]	[0.796]
Certificate Eligibility (C.E.)	-0.058	0.030	-0.055	-0.190	0.128	-0.211
	(0.109)	(0.082)	(0.102)	(0.096)	(0.096)	(0.089)
	[0.548]	[0.789]	[0.556]	[0.119]	[0.301]	[0.179]
C.E. × Farmer Training	0.068	-0.092	0.017	0.210	-0.151	0.533***
	(0.164)	(0.138)	(0.161)	(0.146)	(0.141)	(0.137)
	[0.834]	[0.709]	[0.949]	[0.267]	[0.445]	[0.011]
C.E.× Exporter Training	-0.036	-0.029	0.010	0.080	-0.258	0.300
	(0.157)	(0.121)	(0.157)	(0.145)	(0.141)	(0.149)
	[0.819]	[0.798]	[0.989]	[0.662]	[0.142]	[0.086]
C.E × Joint Training	0.188	-0.019	0.218	0.260	-0.073	0.234
	(0.192)	(0.111)	(0.167)	(0.161)	(0.160)	(0.128)
	[0.636]	[0.948]	[0.469]	[0.288]	[0.782]	[0.193]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.08	0.01	0.29	0.54	0.52	0.06
Control mean (Pass/Total)	0.72	0.71	0.61	0.81	0.72	0.90
R-squared	0.16	0.11	0.15	0.13	0.08	0.05

Notes: Audit on GAP compliance was conducted in each of the two follow-up survey rounds. Audit scores are standardized by the control group's mean and standard deviation. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table J-2: Impact of Training and Certificate Eligibility on Pesticide Residue

Pesticide Residue Test ($N = 264$) :	Mean Residue	Compliance to country's MRL			
		China	Japan	EU	US
	(1)	(2)	(3)	(4)	(5)
Farmer Training	-0.432	-0.088	0.176	0.016	0.013
	(0.286)	(0.099)	(0.112)	(0.083)	(0.097)
	[0.128]	[0.530]	[0.190]	[0.825]	[0.875]
Exporter Training	-0.004	-0.082	-0.151	-0.080	-0.101
	(0.279)	(0.085)	(0.105)	(0.086)	(0.095)
	[0.980]	[0.403]	[0.185]	[0.139]	[0.140]
Joint Training	-0.671**	0.029	0.241**	-0.004	0.026
	(0.220)	(0.082)	(0.105)	(0.113)	(0.119)
	[0.020]	[0.749]	[0.090]	[0.987]	[0.826]
Certificate Eligibility (C.E.)	-0.031	0.033	-0.169*	-0.057	-0.125
	(0.221)	(0.067)	(0.096)	(0.091)	(0.094)
	[0.914]	[0.719]	[0.199]	[0.492]	[0.238]
C.E. × Farmer Training	-0.201	0.126	0.168	0.056	0.171
	(0.341)	(0.122)	(0.137)	(0.138)	(0.141)
	[0.593]	[0.397]	[0.392]	[0.715]	[0.267]
C.E. × Exporter Training	-0.295	0.079	0.415**	-0.012	0.082
	(0.314)	(0.104)	(0.138)	(0.121)	(0.125)
	[0.416]	[0.508]	[0.012]	[0.920]	[0.528]
C.E × Joint Training	-0.129	0.090	0.330*	0.131	0.074
	(0.293)	(0.101)	(0.141)	(0.149)	(0.151)
	[0.783]	[0.390]	[0.174]	[0.434]	[0.658]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.33	0.17	0.53	0.81	0.90
Control mean	1.40	0.85	0.55	0.21	0.24
R-squared	0.22	0.26	0.24	0.15	0.16

Notes: Unit of observation is farmer. Outcome variable is constructed using pesticide test results from randomly sampled farmers. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table J-3: Impact of Training on Farm Sales and Profits

	Farm-gate		Revenue		Profit	
	Price	Volume	Direct	Implied	Direct	Implied
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. First Followup Survey - Six months after training ($N = 1081$)						
Farmer Training	0.024	0.002	7.603	2.929	3.698	-0.887
	(0.032)	(0.072)	(9.560)	(7.962)	(7.046)	(6.985)
	[0.565]	[0.978]	[0.649]	[0.770]	[0.758]	[0.903]
Exporter Training	0.030	0.030	12.960	6.418	9.285	5.299
	(0.028)	(0.071)	(9.871)	(7.677)	(7.250)	(7.146)
	[0.618]	[0.743]	[0.213]	[0.262]	[0.400]	[0.632]
Joint Training	0.074	0.088	8.770	9.777	1.687	0.945
	(0.035)	(0.069)	(8.470)	(8.230)	(6.569)	(7.492)
	[0.172]	[0.509]	[0.407]	[0.310]	[0.849]	[0.890]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.02	0.22	0.90	0.35	0.77	0.71
Control mean (in levels)	13.40	6.08	85.71	84.41	47.89	45.47
R-squared	0.20	0.43	0.39	0.42	0.30	0.32
Panel B. Second Followup Survey - Twelve months after training ($N = 1054$)						
Farmer Training	0.033	0.021	7.779	8.662	-5.926	-2.996
	(0.022)	(0.062)	(7.953)	(5.702)	(6.041)	(4.113)
	[0.161]	[0.787]	[0.268]	[0.129]	[0.192]	[0.458]
Exporter Training	-0.041	0.016	6.690	7.150	-0.449	1.495
	(0.021)	(0.090)	(7.444)	(6.433)	(5.995)	(5.436)
	[0.171]	[0.893]	[0.451]	[0.443]	[0.684]	[0.520]
Joint Training	0.106***	0.084	17.710	16.837**	8.605	9.232
	(0.027)	(0.060)	(7.207)	(5.829)	(5.483)	(4.648)
	[0.004]	[0.128]	[0.001]	[0.022]	[0.055]	[0.104]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.01	0.29	0.10	0.10	0.00	0.00
Control mean (in levels)	11.53	6.24	75.41	74.17	31.47	28.28
R-squared	0.35	0.52	0.61	0.63	0.40	0.38

Notes: The price and volume are in logarithm, and the revenue and profits are in their original levels. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table J-4: Impact of Training on Behavior in Trust and Dictator Games

	Trust Game				Dictator Game	
	1st stage (passed)		2nd stage (returned)		(passed)	
Proportion from:	farmer	exporter	farmer	exporter	farmer	exporter
To:	exporter	farmer	exporter	farmer	exporter	farmer
	(1)	(2)	(3)	(4)	(5)	(6)
Farmer Training	0.040	-0.020	-0.012	-0.005	0.036	-0.056*
	(0.032)	(0.022)	(0.041)	(0.043)	(0.042)	(0.030)
	[0.248]	[0.632]	[0.788]	[0.288]	[0.433]	[0.734]
Exporter Training	0.013	0.012	-0.012	0.039	0.043	0.015
	(0.045)	(0.021)	(0.034)	(0.032)	(0.031)	(0.031)
	[0.414]	[0.634]	[0.657]	[0.311]	[0.537]	[0.722]
Joint Training	0.158***	0.177***	0.001	0.024	0.106***	0.071**
	(0.044)	(0.022)	(0.032)	(0.032)	(0.040)	(0.029)
	[0.001]	[0.063]	[0.444]	[0.272]	[0.078]	[0.072]
P-value ($H_0 : \gamma_{\text{farmer}} = \gamma_{\text{joint}}$)	0.01	0.00	0.76	0.51	0.14	0.00
Control mean	0.36	0.14	0.43	0.23	0.35	0.15
R-squared	0.39	0.52	0.31	0.16	0.34	0.20
Observations	207	208	207	208	202	202

Notes: This table reports treatment effects on outcomes of trust and dictator games. Columns 1-4 report the share of money a farmer or an exporter passed (first stage) or returned (second stage) to his or her partner in the trust game. Columns 5-6 show the share passed in the dictator game. P-values from randomization inference are reported in square brackets. Standard errors are clustered by farmer-exporter cluster and reported in parentheses. * denotes statistical significance at 0.10, ** at 0.05, and *** at 0.01.

Table J-5: Impact of Training and Certification Eligibility on Contract Trade

($N = 2730$)	Any Trade	Spot Trade		Contract Trade	
Cluster:	Within	Within	Outside	Within	Outside
	(1)	(2)	(3)	(4)	(5)
Farmer Training	0.078**	0.032	-0.056	0.038	0.001
	(0.026)	(0.025)	(0.035)	(0.020)	(0.028)
	[0.004]	[0.251]	[0.100]	[0.026]	[0.967]
Exporter Training	0.031	0.005	-0.004	0.014	-0.014
	(0.021)	(0.021)	(0.042)	(0.019)	(0.023)
	[0.264]	[0.868]	[0.967]	[0.499]	[0.584]
Joint Training	0.309***	0.148***	-0.244***	0.142***	-0.034
	(0.028)	(0.029)	(0.039)	(0.027)	(0.023)
	[0.000]	[0.002]	[0.004]	[0.006]	[0.224]
Certificate Eligibility (C.E.)	0.021	0.006	-0.039	0.011	-0.005
	(0.022)	(0.022)	(0.037)	(0.021)	(0.025)
	[0.638]	[0.792]	[0.436]	[0.643]	[0.815]
C.E. × Farmer Training	-0.074	-0.059	0.040	-0.015	0.015
	(0.040)	(0.035)	(0.052)	(0.028)	(0.040)
	[0.107]	[0.096]	[0.472]	[0.628]	[0.802]
C.E. × Exporter Training	-0.005	0.005	0.054	-0.003	-0.027
	(0.034)	(0.034)	(0.050)	(0.025)	(0.028)
	[0.878]	[0.917]	[0.414]	[0.918]	[0.461]
C.E. × Joint Training	0.080	0.044	-0.050	0.040	-0.027
	(0.044)	(0.043)	(0.055)	(0.049)	(0.036)
	[0.625]	[0.648]	[0.699]	[0.692]	[0.571]
P-value ($H_0 : \beta_{\text{farmer}} = \beta_{\text{joint}}$)	0.00	0.00	0.00	0.00	0.15
Control mean	0.07	0.06	0.79	0.01	0.09
R-squared	0.16	0.11	0.11	0.18	0.10

Notes: This table reports treatment effects on contract trading between farmers and exporters. The results use farm-gate sales data from two follow-up survey rounds. Within cluster refers to trade with exporters in the same training cluster and Outside cluster refers to any intermediary, exporter or collector, not in the same training cluster. Standard errors are clustered by farmer group and reported in parentheses. P-values from randomization inference are reported in square brackets. * denotes false discovery rate controlled statistical significance at 0.10, ** at 0.05, and *** at 0.01.