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Pecuniary versus Non-pecuniary Interventions to Influence Farmers' Behavior: Evidence from Field Experiment in Vietnam

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Abstract

Encouraging farmers to adopt pro-environmental production is vital to the promotion of sustainable agriculture. Previous observational studies emphasize the importance of economic incentives and information access to the farmer's decision; however, due to endogeneity issues, little strong causal evidence is available. This study makes an original contribution by experimentally examining the impacts of subsidy and information treatments on farmers' adoption of organic fertilizer. To do so, we analyze data from a randomized controlled trial (RCT) conducted on 1287 small-scale tea farmers in Vietnam. We find significant impacts of our information treatment and a 50% price subsidy. Interestingly, the effect of the former is approximately one-third that of the latter. Subgroup treatment analysis reveals that the information treatment performs well for members of certification groups. Thus, to induce farmers to adopt pro-environmental production behaviors, information provision can partially substitute for subsidies to reduce the burden on the public budget.

Keywords– RCT, Information treatment, Subsidy treatment, Pro-environmental behaviors, Organic fertilizer, Farmers.

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1 Introduction

The adoption of organic fertilizer in farming is necessary to realize sustainable agriculture. Although chemical fertilizer contributes substantially to crop yields and food security, the excessive use of chemical fertilizer leads to environmental damage such as soil deterioration, water contamination, and biodiversity loss (Mozumder and Berrens, 2007; Sierra et al., 2015; Tilman et al., 2001). Norse (2005) notes that only 30-50% of chemical fertilizer is absorbed by crops, which means that a significant amount is lost in the soil, in turn polluting groundwater. The adoption of organic fertilizer alongside chemical fertilizer can mitigate the environmental impacts of chemical fertilizer (Duan et al., 2016; Ji et al., 2018). However, farmers often prefer chemical to organic fertilizers (Smith et al., 2007). The slow impact of organic fertilizer on crop yield makes farmers reluctant to adopt it (Khaliq et al., 2006). Paul et al. (2017) indicate that a lack of information, cost and laboriousness are major constraints influencing Caribbean farmers' use of compost. Therefore, how we can encourage farmers to adopt organic fertilizer is a crucial question.

Scholars have been increasingly interested in investigating the determinants of farmers' adoption of pro-environmental production (Hattam et al., 2012; Läpple and Rensburg, 2011; Läpple and Kelley, 2013; Mzoughi, 2011). Some studies report evidence of the importance of economic incentives in a farmer's decision (Tur-Cardona et al., 2018; Wang et al., 2018). Moreover, a growing number of studies highlight the substantial effects of information access, particularly the role of informal information networks such as neighbors and fellow farmers (Genius et al., 2006; Läpple and Kelley, 2013; Wollni and Andersson, 2014). However, these works are based primarily on observed data; thus, it is difficult to attribute causality due to endogeneity problems. The causal impacts of economic incentives and information treatments on the adoption of pro-environmental production, therefore, remain unclear.

Previous experimental literature on the effects of information provision focuses primarily on the pro-environmental behaviors of consumers in developed countries (see Allcott (2011), Costa and Kahn (2013), and Handgraaf et al. (2013) for energy saving behaviors; Ferraro et al. (2011) and Ferraro and Price (2013) for water conservation; and Bohner and Schlüter (2014), Reese et al. (2014), and Schultz et al. (2008) for hotel towel reuse). Findings from such experimental studies can hardly be applied to the context of the pro-environmental production behaviors of farmers in developing countries for two reasons. First, compared to citizens in developed countries, rural farmers in developing countries typically have much lower education levels and environmental awareness, which might constrain the impacts of information-related interventions (Farrow et al., 2017). Second, the impoverished status of the farmers negatively affects their

patience, which makes them favor production decisions offering quick economic returns (Tanaka et al., 2010). Because the impacts of sustainable practices on crops are not immediately visible, there is further difficulty in changing farmers' behaviors with simple information.

In an effort to fill these research gaps, we conduct a randomized controlled trial (RCT) to examine whether subsidy and information treatments improve the adoption of organic fertilizer. In addition, we compare the effects of an information treatment and a 50% price subsidy, an approach that is rare in the literature. This study is conducted in Vietnam, a developing country now facing serious agricultural pollution due to the excessive use of chemical fertilizer.

Our study contributes to the current research on the impacts of subsidy and information treatments on the pro-environmental production behaviors of farmers in three ways. First, we implement an RCT, which can eliminate selection bias and produce precise causal estimates. In our experiment, a 50% price subsidy and an information treatment are randomly assigned to 1287 farmers in Vietnam. Second, our experimental design allows us to compare the effects of two different interventions, the subsidy and information provision, which provides crucial evidence for policy implementation. Subsidies are costly and impose a burden on increasingly limited public funds, especially for developing countries facing high budget deficits. Moreover, the design of the optimum subsidy to improve the use of organic fertilizer requires the estimation of a full price response function, which is difficult. Therefore, it is worth studying non-pecuniary interventions that can substitute for subsidies. Third, while most experimental research on pro-environmental behaviors is conducted in developed countries, to the best of our knowledge, this is the first experimental study examining farmers' pro-environmental production behaviors in a developing country[1]. Our case study in Vietnam can additionally provide experimental evidence on the impact of subsidy and information treatments on the adoption of organic fertilizer in a developing country.

The remainder of this paper is organized as follows: Section 2 provides background on fertilizer use in Vietnam and the study site. Section 3 describes the sampling method, and section 4 presents the experimental design. Results and discussions are provided in section 5. Section 6 concludes by offering policy implications.

[1] Using a business management game as an experimental device, Peth et al. (2018) examine the effect of different information treatments on farmers' compliance with the minimum-distance-to-water rule in Germany. In our RCT, farmers' actual decisions are observed as the experimental outcome. Moreover, we conduct our RCT in Vietnam, a developing country that exhibits low levels of environmental awareness and a high level of environmental deterioration relative to developed countries.

2 Background on fertilizer use in Vietnam and study site

2.1 Background on fertilizer adoption, particularly in tea farming

Vietnam faces agricultural pollution (e.g., water contamination, soil acidification and soil fertility loss) caused by excessive use of chemical fertilizers and pesticides[2] (Nguyen, 2017). There are two main reasons for the overuse of these agro-chemicals. The primary reason is the limited awareness of farmers. Most farmers in Vietnam held the mistaken view that higher inputs would result in higher crop yields; thus, chemical fertilizer was overused (Nguyen, 2017). For example, in coffee farming, Nitrogen (N), Diphosphorus pentoxide (P_2O_5), and Potassium oxide (K_2O) were applied at excessive rates of 50%, 210% and 30%, respectively, compared to the recommended levels (Nguyen, 2017). Nguyen (2017) also showed that rice farmers in the Mekong Delta, the largest rice-producing region in Vietnam, employed between 20% and 30% more chemical fertilizer than the advised levels. The availability of cheap chemical fertilizers and pesticides in local markets also led to their improper use. Vietnam formerly promoted the use of agro-chemicals to improve agricultural production. The price of chemical fertilizers and pesticides declined by 50% due to the removal of import restrictions in 1991 (Nguyen, 2017). Moreover, fertilizer and pesticide retailers have been extremely common at the district, commune and village levels[3]. The numerous advertising campaigns and sponsorship of public activities in rural areas by agro-chemical companies persuaded farmers to try their products (Nguyen, 2017). Nguyen (2017) reported that from 1985 to 2005, chemical fertilizer consumption in Vietnam rose by 10% per year, reaching 25 million tons in 2004.

Vietnam is one of the world's largest tea producers, ranked 6th in tea production and 5th in the volume of tea exports (FAOSTAT, 2016). Approximately 400,000 households cultivate tea, and over 1.5 million jobs have been created by the Vietnamese tea industry (Wal, 2008). Although tea production plays an important role in the country's economic development, tea cultivation has considerable environmental impacts. Tea is a perennial crop harvested for young shoots and leaves; thus, nutrient requirements (especially N) for tea production are particularly high. As a result, heavy synthetic N fertilization is applied in tea farming, which can lead to nitrate pollution of water and soil acidification (Oh et al., 2006; Yang et al., 2018). Hong et al. (2016) reported that chemical fertilizers and pesticides were overused in tea farming in Vietnam.

[2]Vietnam ranks 17th in the world in fertilizer consumption (FAO, 2015)

[3]The commune is the local administrative unit, which is between the district and village levels.

Using stochastic frontier analysis, they also revealed the high environmental inefficiency (23.97%) of these inputs in tea cultivation. Previous studies have emphasized the benefits of organic fertilizer in tea farming (see Nghia (2008) for reducing chemical residues in the soil, water and tea products; see Ji et al. (2018) on improving soil bacterial diversity and tea yield).

Given this background information, tea production in Vietnam provides a compelling case study for motivating farmers to use organic fertilizer.

2.2 Background on study site

We selected Thai Nguyen Province as our study site for two reasons[4]. First, Thai Nguyen is the largest green tea-cultivating region in Vietnam. The harvested tea area is 17,380 ha, and the total fresh yield was 194,200 tons in 2016 (GSO, 2016). Although Thai Nguyen green tea is the most famous green tea brand in domestic markets, tea farmers in Thai Nguyen often overuse chemical fertilizers and pesticides (Hong et al., 2016). Second, Thai Nguyen has the largest number of groups of tea farmers certified in good agricultural practices (GAP), and 39 of the 67 domestic certified groups (VietGAP groups) were based in this province as of June 2018 (VietGAP, 2018)[5]. VietGAP is a domestic set of standards implemented in 2008 by the Ministry of Agriculture and Rural Development to encourage farmers to produce clean and safe agricultural products. VietGAP follows the GAP standards announced by ASEAN in 2006. Because both VietGAP and our treatments are intended to encourage farmers to adopt organic fertilizer, our aim is to investigate whether our treatments perform well in the context of VietGAP members, who receive multiple trainings on agricultural sustainability.

Dai Tu District is the largest tea region in Thai Nguyen Province, accounting for 30% of the province's tea area[6]. In 2017, this district implemented a program to subsidize the certification fees of new VietGAP groups; as a result, 16 new VietGAP groups in 10 communes were established in December 2017. In total, Dai Tu has 20 VietGAP groups, the largest number of VietGAP groups of any region in Thai Nguyen. Therefore, we selected Dai Tu district to conduct our field experiment.

[4]Thai Nguyen is located in northern Vietnam, the center of which is 80km from Hanoi, the Vietnamese capital. The total provincial area is 3533.1 km2, and the total provincial population was 1.17 million people in 2014. Thai Nguyen Province consists of one city and 8 districts. See http://english.thainguyen.gov.vn/-/natural-conditions.

[5]See Tran and Goto (2018) for further details on VietGAP programs in Vietnam and Thai Nguyen.

[6]See http://daitu.thainguyen.gov.vn/-/le-hoi-tra-ai-tu-nang-cao-gia-tri-cho-san-pham-tra-phat-trien

3 Design of the randomized controlled experiment

3.1 Sampling method

A two-step sampling procedure was employed: village sampling and household sampling.

In the first step, we purposively selected communes and sampled the villages in these communes. We had intended to choose the 10 communes that had established new VietGAP groups in December 2017[7]. However, we only obtained permission to conduct our research in 9 communes: Binh Thuan, Tien Hoi, Khoi Ky, Phu Xuyen, Van Yen, My Yen, Phu Cuong, Hoang Nong and La Bang[8]. In each commune, we chose all villages with active VietGAP groups and their neighboring villages without active VietGAP groups[9]. In total, 30 villages were selected, including 4 villages used in a pilot survey and 26 villages in our main survey.

After the sample villages were chosen, we used the power calculation to determine our sample size. According to previous experimental studies on chemical fertilizer usage (e.g., Duflo et al., 2011; Carter et al., 2014), we selected a standard deviation of 0.49 and an expected average treatment effect (ATE) of 0.1. We selected a power of 80% with a significance level of 5%. We also selected treatment and control groups of equal sample size. We considered two pairwise comparisons: subsidy treatment versus control and information treatment versus control. Based on these settings, the power calculation suggested that each group should have 378 tea households; thus, the total sample size of our experiment should be at least 1134 tea-cultivating households.

In the second step, tea-cultivating households were randomly sampled for the experiment and face-to-face interviews. Member lists of VietGAP groups and tea-cultivating household lists in the selected villages were provided by communal officers and village leaders. The tea-cultivating household lists included households that had a tea farm and produced tea in 2017. We sampled 45 households in every village during the main survey and 36 households in every village during the pilot survey[10]. In villages without an active VietGAP group, 45 households were randomly chosen from the list of tea-cultivating households. In villages with an active VietGAP group, we selected all members from the member list of the VietGAP group due to the relatively small number of VietGAP members. The remaining households were randomly selected from the

[7]This is because one of the objectives of our overall project is to evaluate the impact of VietGAP certification on tea farmers. Considering new VietGAP groups allow us to collect information before and after the implementation of VietGAP.

[8]We were unable to obtain permission to conduct our research in Luc Ba Commune.See figure 1 for detail location of our selected communes

[9]In Hoang Nong Commune, we conducted our research only in villages with certified tea groups following a request from the local government.

[10]Viet Yen Village in My Yen Commune had only 42 households. Of these, 36 households were tea-cultivating households. Therefore, we could only select 36 households

tea-cultivating household list of the village after excluding households on the member list.

To avoid leaking treatment information, the experiment and survey in each village were completed within a day. We divided investigators into two teams, with each team including six investigators and one manager. Two teams conducted the experiment and household survey in two neighboring villages simultaneously on a single day (each team visited one village). Investigators and managers received the list of selected households and list of alternative households[11]. During the visit, if a selected household was not at home for the entire day, an alternative household was chosen, moving from the top to the bottom of the list. In some villages, some selected households returned home after we visited the alternative households; thus, we re-visited these selected households.

3.2 Treatment design

3.2.1 How and why do information treatment affect pro-environmental behavior

A description of the experiences of farmers who have adopted organic fertilizer is selected as our information treatment. In this session, we discuss how and why the information treatment affects pro-environmental behavior of farmers through Theory of Planned Behavior (TPB) and logic of appropriateness(citation).

According to TPB, a person's intention towards a behavior is the most crucial predictor of performing (or not performing) this behavior. There are three factors used to determine the intention, which are attitude toward the behavior, subjective norm, and perceived behavioural control. Attitude toward the behavior shows the person's positive or negative evaluation of performing the behavior. In term of adopting organic fertilizer, attitude can be affected by the expectations of organic fertilizer on the farming. Subjective norm includes influence from "important referents", for example family members, close friends, and farmer colleagues on acting the behavior.

3.2.2 Design of treatment groups and control group

In this section, we discuss the selection of organic fertilizer used for our experiment and the design of our groups: control group, information treatment group and subsidy treatment group[12].

We collaborated with Thai Nguyen University of Agriculture and Forestry (TUAF) to use

[11] The lists of alternative households included non-selected tea-cultivating households in the village and were sorted randomly.

[12] This experiment was registered with the AEA RCT Registry before its interventions' start date. The RCT ID is AEARCTR-0003084

their scientific product, NTT organic fertilizer, in our experiment to avoid the problem of counterfeit fertilizer in Vietnam[13]. NTT organic fertilizer was approved by the Department of Crop Production, Ministry of Agriculture and Rural Development in 2011 and has since been available on the market. Raw materials include peat and pig, chicken, buffalo, and cow manure. Microorganisms are used to break down organic substances[14]. According to the producer's recommendations, this organic fertilizer can be used after each harvest; however, ideally the fertilizer should be applied in both the spring (February-March) and the rainy season (June-August). NTT organic fertilizer can improve soil structure and benefit the crop's root development, which increases its ability to absorb nutrients and resist difficult conditions such as drought and flood.

Our experiment included three groups: the control group, subsidy treatment group and information treatment group. The design of these groups is given in table 1. Basic information on the dangers of excessive chemical fertilizer use and the role of organic fertilizer was shown to all participants in the sample via a 2-minute video (general video). This video was excerpted from the video "Why Soil Matters" published by The Greens-European Free Alliance[15]. The entire sample received free shipping to ensure that all farmers faced identical prices. A 50% price subsidy was given only to farmers in the subsidy treatment group, while a 3-minute video including the experiences of farmers who had applied organic fertilizer was shown only to farmers in the information treatment group. Thus, information treatment group watched 5 minutes of video, including the general video (2 minutes) and information treatment video (3 minutes).

A description of the experiences of farmers who had adopted organic fertilizer was selected as our information treatment. The literature demonstrates the potential of this treatment. According to Farrow et al. (2017), people might regard the behavior of others as evidence of what is most effective. Wollni and Andersson (2014) also found that farmers were more likely to convert to organic farming if their neighbors also adopted organic farming. To encourage Malawi farmers to employ pit planting, Beaman et al. (2016) suggested the need for several "seed" farmers with experience with this technology in rural networks. Moreover, BenYishay and Mobarak (2018) found that farmers were best persuaded by "peer farmers" facing similar agricultural conditions and constraints to themselves compared with "lead farmers" or extension workers.

In our experiment, we selected three tea farmers with a variety of age, gender, place of residence, tea farms and usage time to share their experience with adopting organic fertilizer in

[13]In 2013, there were 1483 reported violations pertaining to the distribution of low-quality fertilizers and pesticides in Vietnam's southern provinces (Nongnghiep.vn accessed dated July 30th 2014. https://nongnghiep.vn/ngan-chan-phan-bon-thuoc-bvtv-gia-kem-chat-luong-post128850.html).

[14]NTT organic fertilizer has organic content (humus) of 35% and humid acid content of 6-8%. The ratio of N:P:K is 2.5:1:1, and its pH is 6.

[15]We obtained permission to use the original video from The Greens-European Free Alliance.

a 3-minute video. They described how using organic fertilizer strengthened their tea's health and improved soil texture and how to correctly apply organic fertilizer. Because the purpose of the video was not to advertise any fertilizer brand, the tea farmers did not mention any brand's name. The first two farmers lived in Tan Cuong area in Thai Nguyen Province, the most famous region for high-quality green tea in Vietnam. The third farmer lived in Dai Tu District; however, the village where he lived was not among our target villages.

3.3 Implementation of the RCT

Our experiment was implemented as follows. Assistants from a village (often the village's leaders) took investigators to the selected tea households. After introducing a field investigator to a household's representative, she/he then took other investigators to other selected households. To avoid any noise in the household's decision, the village assistants were not allowed to remain at the household during the visit. Thereafter, the investigator introduced purpose of the visit, and the household was asked to decide whether they would participate in our experiment[16].

Our experiment had 2 sessions: an RCT and a questionnaire survey[17](see the supplemental documents for detail information regarding guidance for investigators when conducting RCT and questionnaire survey).

In the first session (the RCT), the household chose a lottery from a box consisting of 3 lotteries, which were associated with the 3 following groups[18].

Control group: The control group watched a general video (2-minute video) on a tablet and was offered an opportunity to buy NTT organic fertilizer at the regular price but with free shipping[19]. The general video was presented in supplemental materials (See https://youtu.be/6ppWwrV4d8k).

Subsidy treatment group: The subsidy treatment group also watched the general video on a tablet and was offered the opportunity to buy NTT organic fertilizer at half price (subsidy of 50%) with free shipping.

Information treatment group: The information treatment group watched a 5-minute video on a tablet and was offered the opportunity to buy NTT organic fertilizer at the regular

[16]Oral informed consent was obtained. Then, the household received an envelope containing 30,000VND (approximately 1.3USD) from the investigator as compensation for participating in our experiment.

[17]This questionnaire survey focused primarily on background information about the households. In addition, 750 selected households from full sample were asked about their stated preferences on participating in a hypothetical VietGAP program.

[18]The lotteries were renewed every 2 days to maintain the quality of randomization

[19]Different agencies provided different prices. Therefore, the regular price in this study was the price the manufacturer offered to farmers if they bought organic fertilizer at the factory in Thai Nguyen City and transported the fertilizer home themselves.

price but with free shipping. The 5-minute video was given in supplemental materials (See https://youtu.be/iBjtaXyy5ps).

To avoid the disappointment effect, the contents of the non-selected lotteries were not mentioned to households. Following the result of the lottery, investigators showed the video (2-min video or 5-min video) and then explained the support provided (free shipping or free shipping plus a 50% subsidy) to the household. The package of NTT organic fertilizer was also displayed (see the supplemental materials).

The household then had to decide whether to purchase the organic fertilizer at this time[20]. A simple contract was provided to households that wanted to order organic fertilizer (see the supplemental materials). It included the household's information, organic fertilizer information, the quantity ordered and the delivery date. The ordered quantity was specified in terms of bags. One bag weighed 25kg and cost 65,000 VND (approximately 2.8 USD). The maximum purchase quantity through our experiment was 200kg (8 bags) due to budget constraint. Two copies of the contract were signed by the household's representative. The household and the investigator each received one copy. The contract was nontransferable. To guarantee that short-term liquidity constraints did not prevent households from making a decision on the spot, the households would make full payment on the delivery date instead of during the visit. In the second session (questionnaire survey), the households were asked for background information such as the household members, landholding, tea farm information, experience using organic fertilizer, VietGAP certification, credit and assets. Household information was collected using a smart phone-based questionnaire in Vietnamese[21].

On the delivery date, organic fertilizer was transported to the village center. In each village, two investigators and one village assistant were responsible for distributing the organic fertilizer. We delivered the organic fertilizer on Wednesdays for villages visited on Mondays and Tuesdays[22]. We delivered the organic fertilizer on Sundays for villages visited on Thursdays, Fridays and Saturdays. After showing the contract and making full payment, households claimed their organic fertilizer and signed a list acknowledging receipt.

[20] Investigators explained to the farmers that the study was on the transition to sustainable agriculture. The decision to purchase was freely made, and households' decisions would not affect any future benefits such as agricultural programs offered by the local government and promotions offered by the fertilizer company.

[21] We used ODK Collection, an open Android application for smart phones, to manage and accelerate the interview process and data entry. Not only household information but also images of the respondents and GPS data on the households were collected through this application.

[22] During pilot survey, we conducted the experiment on July 2nd (Monday) and July 3rd (Tuesday). We distributed organic fertilizer on July 4th (Wednesday) and July 5th (Thursday). During the last week of the main survey, we conducted the experiment on July 23rd (Monday), July 24th (Tuesday), and July 25th (Wednesday). Then, we distributed organic fertilizer on July 26th (Thursday).

4 Data and estimation approach

4.1 Data description

We collected primary data in July 2018. A pilot survey was conducted from July 2nd to July 5th. The main survey was performed from July 9th to July 26th. In total, 1295 tea-cultivating households participated in our experiment, including 136 households in the pilot survey (a response rate of 94.4%) and 1159 households in the main survey (a response rate of 99.3%). However, for 8 households, the owners transferred their tea farms to their children in 2018; thus, we excluded them. The sample size for data analysis was 1287 tea-cultivating households consisting of 412 households in the control group (32.01%), 448 households in the subsidy treatment group (34.81%), and 427 households in the information treatment group (33.18%). The sample sizes of these groups were 9%, 18% and 13% larger, respectively, than those suggested by the power calculation. In our RCT, we followed some principles to attain the high response rate. First, the investigator was introduced to household's representative by village's leader, which induced high credibility to selected households. Second, if a selected household was not at home, the village's leader would made a phone call to confirm the available time, and the investigator would re-visited this household. As mentioned in the previous session, if a household was not available for whole day, an alternative household was chosen, moving from the top to the bottom of the list.

We examined the impacts of subsidy and information treatments on two outcome variables reported on delivery date[23]. The first is a binary variable indicating whether a household decided to purchase organic fertilizer through the experiment (hereafter "purchase dummy"). The second is a discrete variable indicating the quantity in kilogram of organic fertilizer purchased by the household (hereafter "purchase quantity").

During our visit, we collected two types of information: respondent characteristics (e.g., age, gender, education, relationship to the household head) and household characteristics (demographic information, experience using organic fertilizer, and some wealth information). In Vietnam, it is common for several generations to live under one roof, and the oldest person is often reported as household's head in the family record book[24]. Thus, the primary decision maker in a family and the household head could be different individuals. We collected information on both of them during our survey; 59% of our respondents were household heads, while 71% of our respondents were the primary decision maker in the family.

[23]There were 45 households who changed their decisions after the RCT session. To confirm the robustness of the results, we reported initial decision made at the end of the RCT session on the appendix (table A.2)

[24]The family record book includes information on each member in a household such as name, birth date, gender, and relationship to the household head.

Summary statistics on both respondent and household characteristics are presented in tables 2 and 3. Table 3 further reports pre-treatment differences between the control group and the treatment groups. In general, the respondent and household characteristics were balanced, except for gender of the respondent (the difference between the control and subsidy treatment groups was significant at the 10% level). Because the treatments were random assigned, any observed difference was attributable to sampling rather than a systematic difference.

Table 4 reports descriptive statistics for the outcome variables. The uptake rate of the full sample, control group, subsidy treatment group and information treatment group is 63%, 50%, 79% and 59%, respectively. While the average purchase quantity in those groups is 102.1kg, 74.0kg, 142.2kg and 87.1kg, respectively. Figure 1 depicts bar charts of the purchase quantity by each group. The white columns, grey columns and black columns represent the control group, subsidy treatment group and information treatment group, respectively. Compared to the control group, the subsidy treatment group was more likely to purchase the maximum quantity (200kg). The number of non-buyers in the subsidy treatment group was much lower than in the control group. Compared to the control group, the information treatment group had more households buying 200kg and 100kg of fertilizer and fewer non-buyers.

4.2 Estimation approach

Our main objective was to evaluate the causal effect of the information treatment and subsidy treatment on farmer behavior. We did so by estimating the ATEs of these two treatments relative to the control group. Because the farmers were assigned randomly to the treatment and control groups, a simple comparison of the means of the outcomes yields unbiased estimates of the ATEs[25].

We followed Neyman et al. (1935) and Athey and Imbens (2017) in estimating ATEs as follows:

$$\hat{\tau} = \bar{Y}_t^{\text{obs}} - \bar{Y}_c^{\text{obs}} = \frac{1}{N_t} \sum_{i:W_i=1} Y_i^{\text{obs}} - \frac{1}{N_c} \sum_{i:W_i=0} Y_i^{\text{obs}} \tag{1}$$

where N_t and N_c are the sample sizes of the treatment group (subsidy treatment group or information treatment group) and control group, respectively. (Y_i^{obs}) is the outcome (purchase decision or purchase quantity) of tea-cultivating household i. W_i indicates the treatment status of household i.

[25]We also provide estimates obtained after controlling for a number of characteristics at baseline in the appendix (table A.2). These results are consistent with those from a simple comparison of means.

$$W_i = \begin{cases} 0, & \text{if household } i \text{ belongs to the control group} \\ 1, & \text{otherwise} \end{cases}$$

5 Results and discussion

5.1 Average treatment effects

The ATEs are reported in table 5. The results from the households' initial decision, changed decision and final decision are shown in the first two columns, the next two columns and the last two columns, respectively. In general, the interventions had substantial impacts on both the purchase decision and purchase quantity for farmers who received them. The effects are consistent and statistically significant for all three stages.

Subsidy treatment

The impacts of the subsidy treatment were considerable and robust, regardless of whether we consider the initial decision, changed decision or final decision. Regarding the initial decision, a 50% price subsidy led to a 25.7% increase in organic fertilizer purchase decision and 62.5kg increase in the quantity of organic fertilizer purchased. Both are significant at the 1% level. Given a take-up rate of 52% and take-up quantity of 78.3kg among control farmers, these effects represent a 49.4% and 79.8% increase relative to the control group, respectively. The results for the changed decision and final decision stages are not significantly different. The results in the third and the fourth columns indicate that the subsidy treatment led to a 25.4% increase in purchase decision and a 63.3kg increase in purchase quantity after the changed decision stage. For the final decision, purchase decision increased by 28.1% and the quantity purchased increased by 68.2kg. These effects are all significant at the 1% level.

Information treatment

We found substantial and consistent effects for farmers receiving the information treatment. The effects of the treatment were not significantly different across the three stages: initial decision, changed decision and final decision. Regarding the initial decision, the information treatment induced an 8.2% increase in purchase decision and a 13.0kg increase in purchase quantity, both of which are significant at the 5% level. The control farmers showed a take-up rate of 52% and take-up quantity of 78.3kg; thus, these effects represent a 15.8% and 16.6% increase relative to the control group, respectively. The results from the changed decision stage indicate a 7.5% increase in purchase decision and an 11.9kg increase in purchase quantity. These outcomes increased by 8.1% and 13.0kg, respectively, at the final decision stage. All outcomes are significant at the 5%

level.

Our findings suggest that both the subsidy treatment and information treatment had substantial, significant and consistent impacts on the behavior of tea farmers. Although the 50% subsidy had remarkable impacts, it was an extremely costly intervention. Showing videos of the experience of farmers who had adopted organic fertilizer, an economical information treatment, had an effect on purchase decisions equal to approximately one-third of that of the 50% price subsidy. Policy makers seeking to influence farmers' behavior can regard such an information treatment as a substitute for subsidies.

5.2 Subgroup treatment effects

Policy makers are increasingly interested in subgroup treatment effects to determine the groups for which treatment performs best. In this study, we designed two treatments, subsidy and information, to encourage farmers to adopt organic fertilizer and promote sustainable agriculture, which is also the purpose of VietGAP. Members of VietGAP groups had to participate in several trainings on the adoption of pesticides and fertilizers to produce clean and safe agricultural products. Thus, we examine the conditional average treatment effect (CATE) with respect to VietGAP membership, in other words, whether our treatments worked well in the context of VietGAP membership[26].

The results are presented in table 6. We found substantial and statistically significant impacts of the subsidy and information treatments on both purchase decision and purchase quantity, regardless of whether we considered the initial decision, changed decision or final decision. The CATE point estimates for VietGAP members were much higher than the corresponding ATE values, especially for the information treatment.

For the purchase decision, the effect of the information treatment was 2.5 times higher for VietGAP members than for the full sample. The CATE at the initial decision, changed decision and final decision was 19.7%, 21.6%, and 21.7%, respectively, while the ATE was 8.2%, 7.5%, and 8.1%, respectively. Interestingly, the CATE of our information treatment on the purchase decision was equal to nearly two-thirds that of the 50% subsidy in price.

For purchase quantity, the CATE of the information treatment for VietGAP members was approximately three times higher than the corresponding ATE. The value of the former at the initial decision, changed decision and final decision stage was 37.5kg, 39.4kg, and 40.6kg, respectively, while the value of the latter was 13.0kg, 11.9kg, and 13.0kg, respectively. The

[26]Because VietGAP was an endogenous variable, we could not directly compare the impacts of our treatments between VietGAP members and non-members. We address this limitation in the discussion section.

CATE of our information treatment on purchase quantity was equal to half of that of the 50% subsidy.

5.3 Discussion

The impacts of a price subsidy on farmers' decision to adopt new technology has been examined in several studies (see Karlan et al. (2014) and Mobarak and Rosenzweig (2012) for the take-up of rainfall index insurance; see Duflo et al. (2011) for the take-up of chemical fertilizer). The results indicate that farmers are highly price elastic. However, the new technologies examined in previous studies were generally intended to increase or ensure a farmer's yield. Our study contributes to this literature by considering farmers' pro-environmental behavior in pursuit of sustainable agriculture. We evaluated the impact of a 50% price subsidy on farmers' decision to adopt organic fertilizer.

Regarding the take-up of organic fertilizer, Wang et al. (2018) found that subsidies positively influenced farmers' decision to adopt organic fertilizer instead of chemical fertilizer. Due to non-random assignment of this subsidy to farmers, the authors found it difficult to attribute causality. Regarding farmers' stated preference on accepting bio-based fertilizers, Tur-Cardona et al. (2018) found that farmers preferred bio-based fertilizers if their nitrogen content was similar to mineral fertilizers but had a price approximately 65% of that of chemical fertilizer. Because previous studies have reported only on correlation and stated preferences, the causal impacts of price subsidies on organic fertilizer adoption remain unclear.

With these previous studies in mind, we conducted an RCT to eliminate the endogeneity problem. We examined the causal influence of a 50% price subsidy on farmers' take-up of organic fertilizer. We found that the 50% subsidy induced a significant increase in both the purchase decision and the purchase quantity. As farmers are highly price elastic, a large subsidy can have remarkable effects on their decision to adopt organic fertilizer.

The information treatment is considerably more cost effective than the subsidy. Information treatments are increasingly applied to induce pro-environmental behaviors by consumers in developed countries (see Farrow et al. (2017) for a review). However, to the best of our knowledge, there is no experimental study on the impacts of information treatments on farmers' pro-environmental production behaviors in developing countries, which exhibit low levels of environmental preferences and high levels of environmental deterioration.

To address this research gap, we implemented an RCT to examine the impact of an information treatment on the pro-environmental behavior of Vietnamese farmers in the context of adopting organic fertilizer. Our results indicate that the information treatment has a substantial

positive impact on both the purchase decisions and purchase quantity of farmers. Specifically, the increase in the take-up rate due to the information treatment was equal to approximately one-third of that of the 50% subsidy.

The substantial positive impacts of the information treatment on farmers' behavior can be interpreted as follows. Farmers were convinced by the testimony other farmers gave about their experience in our information treatment. Our findings can be supported by the following experimental studies. Examining the adoption of pit planting and Chinese composting in Malawi, BenYishay and Mobarak (2018) found that farmers were best persuaded by peer farmers facing agricultural conditions and constraints similar to their own than they were by other communicators. Moreover, Beaman et al. (2016) suggested the need for several "seed" farmers who have experience with a new technology when diffusing this technology within rural networks in Malawi. In our experiment, farmers might have expected similar returns to the three farmers in the treatment information when they decided to purchase organic fertilizer. In a review paper on pro-environmental behavior, Farrow et al. (2017) concluded that social information could affect an individual's behavior because people take the behavior of others as evidence of what is most effective.

The CATE results for VietGAP members also showed substantial and statistically significant impacts on farmers' purchase behavior. Specifically, the CATE in the information treatment on purchase decision and purchase quantity was 2.5 times and 3 times higher, respectively, than the corresponding ATE values. Due to the non-randomness of VietGAP membership, the substantial CATE could be interpreted as VietGAP membership or other covariates driving self-selection into VietGAP groups. Further research is necessary to determine the hidden reasons for the remarkable CATE of the information treatment for VietGAP members. One possible approach is to randomly assign VietGAP membership and our information treatment to the farmers.

6 Conclusions and policy implications

This study evaluates the effects of a subsidy treatment and an information treatment on the pro-environmental behavior of farmers in the context of adopting organic fertilizer using a randomized controlled trial. The former is a 50% subsidy on the price of organic fertilizer, while the latter entails presenting a video on the experience of farmers using organic fertilizer. In addition, we examine the conditional average treatment effect for VietGAP membership.

The results show substantial, significant and consistent impacts on both purchase decision and the purchase quantity by farmers receiving our interventions. Interestingly, the effect of our information treatment, a non-monetary intervention, on the purchase decision is equal to

one-third of that of the 50% subsidy, an extremely costly monetary intervention. To enhance pro-environmental behavior by farmers, both subsidy and information treatments represent viable and effective policy tools. To reduce the burden on the government budget, policymakers could consider information treatments as substitutes for subsidy treatment.

With regard to subgroup treatment effect, the CATE results indicate that our information treatment worked well in the context of farmers who were members of a VietGAP group. When training is conducted for VietGAP members, the experiences of farmers using organic fertilizer should be included to induce members to apply organic fertilizer.

The external validity of our study may be limited to tea farmers in Vietnam. However, not only the tea sector but also other crop sectors such as coffee, rice, and maize have experienced the overuse of chemical fertilizers (Nguyen, 2017). In addition, Asia is the largest consumer of chemical fertilizer, accounting for 58.5% of the world total (FAO, 2015). Thus, our findings could offer a reference for enhancing environmentally friendly behavior by crop farmers in Asian countries, specifically the adoption of organic fertilizer.

In addition, our findings primarily reflect the short-run impacts of subsidy and information treatments on farmers' pro-environmental behavior. Further research is needed to examine the persistent impacts of both treatments in the long run.

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Appendix

Table A.1

Table A.2

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Table 1: Design of treatments

Groups	**General information (2-minute video)**	**Free shipping**	**Subsidy treatment (50% price subsidy)**	**Information treatment (3-minute video)**
Control group	x	x		
Subsidy treatment group	x	x	x	
Information treatment group	x	x		x

Table 2: Descriptive statistics of baseline characteristics

Variables	Full sample (n=1287)		Control group (n=412)		Subsidy treatment group (n=448)		Information treatment group (n=427)	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Household demographics								
Market distance (km)	1.90	1.18	1.92	1.17	1.83	1.07	1.95	1.29
Family size	3.86	1.34	3.87	1.33	3.88	1.30	3.83	1.40
VietGAP dummy	0.26	0.44	0.25	0.43	0.28	0.45	0.26	0.44
Credit dummy	0.34	0.47	0.33	0.47	0.32	0.47	0.36	0.48
Experience with bio-compost								
NTT organic fertilizer knowledge dummy	0.05	0.22	0.05	0.23	0.06	0.23	0.04	0.19
Organic fertilizer usage dummy	0.49	0.50	0.51	0.50	0.47	0.50	0.50	0.50
Dummy of organic fertilizer usage Jan-Apr 2018	0.26	0.44	0.25	0.43	0.27	0.44	0.28	0.45
Quantity of organic fertilizer usage Jan-Apr 2018 (kg)	159.97	420.26	147.44	392.41	174.83	488.58	156.46	365.69
Land area (ha)								
Tea farm	0.32	0.23	0.32	0.22	0.32	0.19	0.33	0.28
Forest land	0.22	0.48	0.23	0.54	0.22	0.46	0.21	0.45
Annual crop land	0.09	0.10	0.09	0.10	0.09	0.10	0.09	0.11
Perennial crop land	0.35	0.26	0.34	0.23	0.35	0.23	0.35	0.30
Number of assets 6/2018								
Motorbike	1.77	0.85	1.75	0.81	1.79	0.86	1.76	0.89
TV	1.04	0.30	1.04	0.28	1.04	0.30	1.05	0.33
Fridge	1.01	0.28	1.00	0.22	1.01	0.33	1.01	0.29
PC	0.11	0.35	0.10	0.34	0.10	0.32	0.14	0.38
Air conditioner	0.06	0.26	0.05	0.26	0.07	0.27	0.06	0.26
Interviewee characteristics								
Age	47.20	10.98	46.71	11.04	47.48	11.08	47.31	10.63
Education (years)	7.42	2.30	7.45	2.24	7.53	2.36	7.27	2.29
Female dummy	0.46	0.50	0.49	0.50	0.43	0.50	0.47	0.50
Household head dummy	0.59	0.49	0.57	0.50	0.59	0.49	0.60	0.49
Primary decision maker dummy	0.71	0.45	0.70	0.46	0.71	0.46	0.72	0.45

Table 3: Baseline comparisons among groups

Covariates	Subsidy treatment vs. Control			Information treatment vs. Control			Information treatment vs. Subsidy treatment		
	Diff	**S.E**	**t-value**	**Diff**	**S.E**	**t-value**	**Diff**	**S.E**	**t-value**
Household demographics									
Market distance(km)	-0.092	0.076	-1.206	0.023	0.085	0.274	0.115	0.080	1.445
Family size	0.008	0.090	0.093	-0.035	0.094	-0.373	-0.044	0.091	-0.478
VietGAP dummy	0.031	0.030	1.035	0.008	0.030	0.253	-0.024	0.030	-0.787
Credit dummy	-0.011	0.032	-0.352	0.023	0.033	0.710	0.035	0.032	1.081
Experience about bio-compost									
NTT organic fertilizer knowledge dummy	0.002	0.016	0.155	-0.016	0.014	-1.109	-0.018	0.014	-1.282
Organic fertilizer usage dummy	-0.034	0.034	-0.998	-0.011	0.035	-0.312	0.023	0.034	0.688
Dummy for organic fertilizer usage Jan-Apr 2018	0.018	0.030	0.596	0.026	0.030	0.866	0.008	0.030	0.282
Quantity of organic fertilizer usage Jan-Apr 2018 (kg)	27.393	30.383	0.902	9.024	26.176	0.345	-18.369	29.284	-0.627
Land area (ha)									
Tea farm	0.002	0.014	0.130	0.007	0.017	0.394	0.005	0.016	0.314
Forest land	-0.009	0.034	-0.276	-0.022	0.034	-0.653	-0.013	0.031	-0.420
Annual crop land	0.003	0.007	0.406	-0.001	0.007	-0.141	-0.004	0.007	-0.538
Perennial crop land	0.012	0.016	0.750	0.010	0.019	0.552	-0.002	0.018	-0.089
Number of assets 6/2018									
Motorbike	0.045	0.057	0.782	0.006	0.059	0.110	-0.038	0.059	-0.646
TV	-0.001	0.020	-0.054	0.006	0.021	0.266	0.007	0.021	0.313
Fridge	0.002	0.019	0.095	0.007	0.018	0.388	0.005	0.021	0.239
PC	-0.002	0.022	-0.076	0.031	0.025	1.265	0.033	0.024	1.398
Air conditioner	0.016	0.018	0.887	0.005	0.018	0.292	-0.011	0.018	-0.604
Characteristics of interviewee									
Age	0.764	0.755	1.012	0.600	0.748	0.802	-0.164	0.735	-0.223
Education (years)	0.080	0.157	0.510	-0.175	0.156	-1.118	-0.255	0.157	-1.624
Female dummy	-0.059*	0.034	-1.750	-0.024	0.035	-0.702	0.035	0.034	1.047
Household head dummy	0.021	0.034	0.622	0.029	0.034	0.854	0.008	0.033	0.245
Primary decision maker dummy	0.004	0.031	0.119	0.015	0.031	0.482	0.011	0.031	0.372

* Significant at 10%.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 4: Descriptive statistics of outcome variables

Outcomes	All sample (n=1287)		Control group (n=412)		Subsidy treatment group (n=448)		Information treatment group (n=427)	
	Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
Initial decision								
Purchase decision (dummy)	0.64	0.48	0.52	0.50	0.78	0.41	0.61	0.49
Purchase quantity (kg)	104.33	88.97	78.28	85.23	140.74	83.57	91.28	85.67
Changed decision								
Purchase decision (dummy)	0.65	0.48	0.53	0.50	0.79	0.41	0.61	0.49
Purchase quantity (kg)	105.11	88.60	79.13	84.69	142.41	82.83	91.04	85.24
Final decision								
Purchase decision (dummy)	0.63	0.48	0.50	0.50	0.79	0.41	0.59	0.49
Purchase quantity (kg)	102.08	89.03	74.03	83.70	142.19	83.08	87.06	85.14

Table 5: ATE on purchase decision and purchase quantity

	Initial decision		**Changed decision**		**Final decision**	
	purchase decision (1)	**purchase quantity (2)**	**purchase decision (3)**	**purchase quantity (4)**	**purchase decision (5)**	**purchase quantity (6)**
Subsidy treatment	0.257***	62.460***	0.254***	63.285***	0.281***	68.158***
	(0.031)	(5.759)	(0.031)	(5.715)	(0.031)	(5.691)
Information treatment	0.082**	13.000**	0.075**	11.916**	0.081**	13.032**
	(0.034)	(5.902)	(0.034)	(5.868)	(0.034)	(5.831)
Observations	1287	1287	1287	1287	1287	1287

Note: Standard errors are reported in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 6: CATE for VietGAP membership

	Initial decision		**Changed decision**		**Final decision**	
	purchase decision (1)	**purchase quantity (2)**	**purchase decision (3)**	**purchase quantity (4)**	**purchase decision (5)**	**purchase quantity (6)**
Subsidy treatment	0.310***	74.518***	0.328***	77.959***	0.347***	81.842***
	(0.060)	(11.152)	(0.060)	(11.021)	(0.060)	(10.930)
Information treatment	0.197***	37.520***	0.216***	39.431***	0.217***	40.587***
	(0.067)	(11.842)	(0.066)	(11.768)	(0.067)	(11.725)
Observations	339	339	339	339	339	339

Note: Standard errors are reported in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

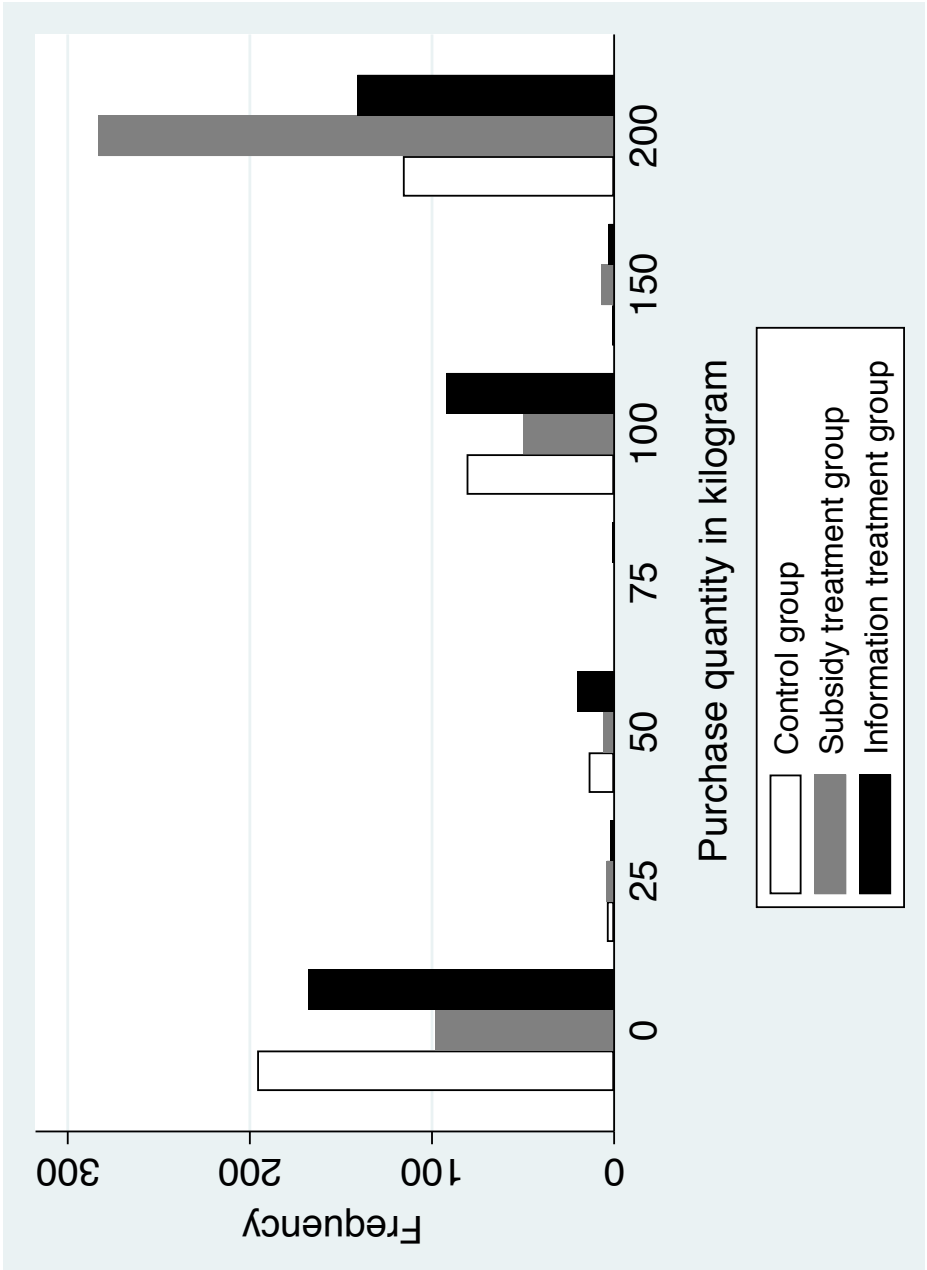

Figure 1: Purchase quantity (kg) by each group at initial decision

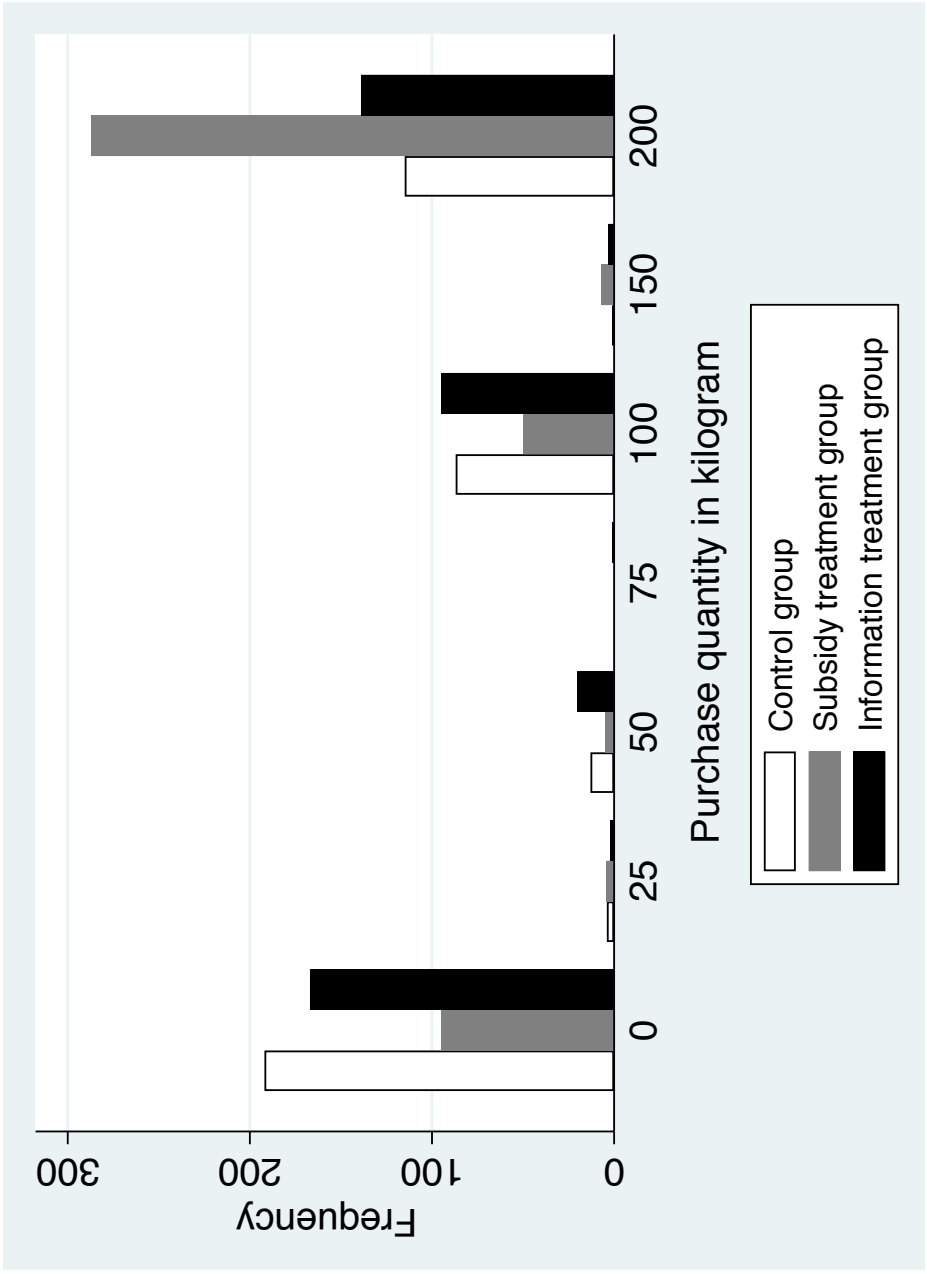

Figure 2: Purchase quantity (kg) by each group at changed decision

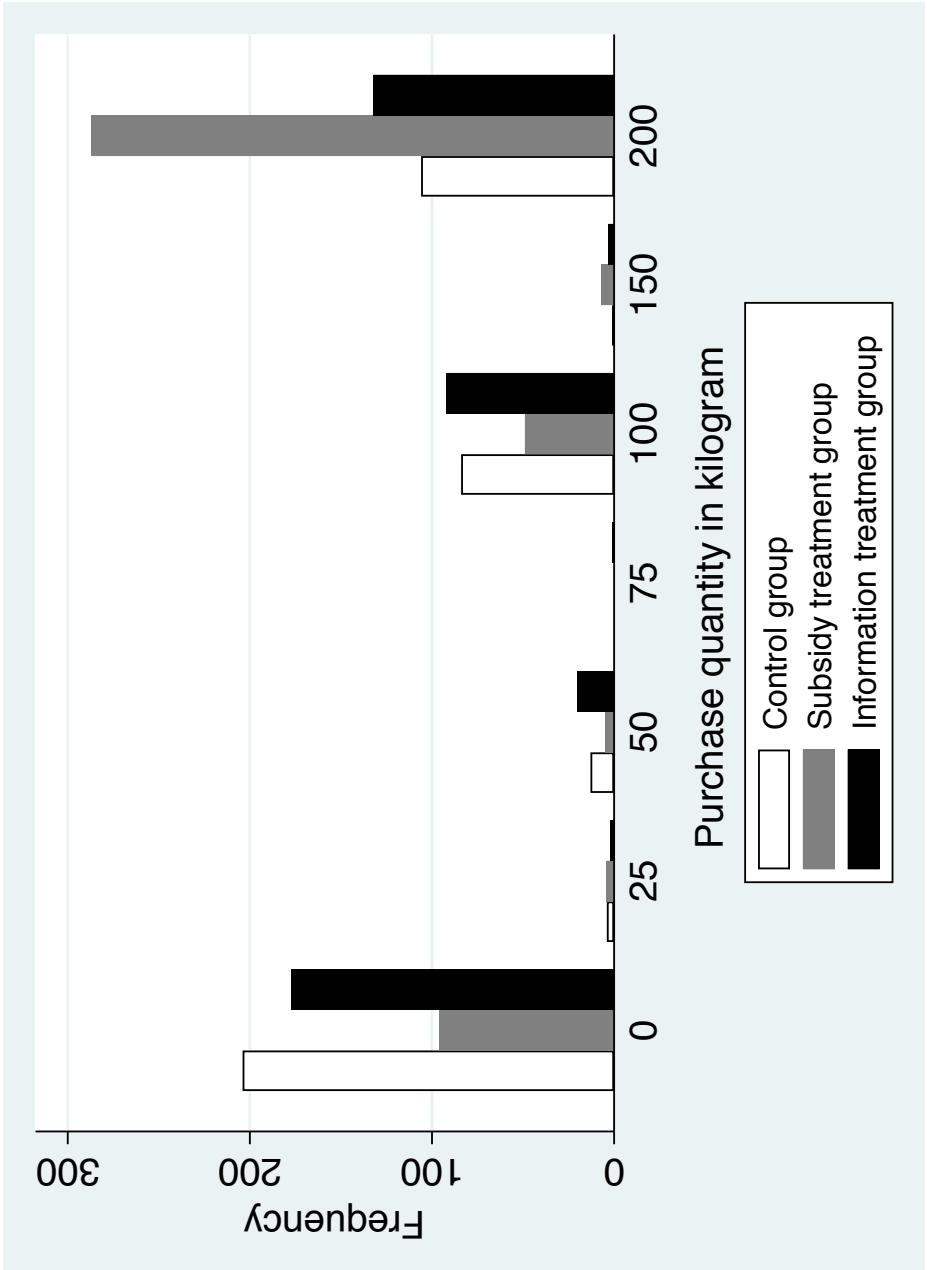

Figure 3: Purchase quantity (kg) by each group at final decision

Table A.1: Description of selected variables

Variables	Description
Baseline characteristics	
Household characteristics	
Market distance(km)	Distance from the household to the village market (km)
Family size	Total number of household members
VietGAP dummy	1 if household is currently a member of a VietGAP group; 0 otherwise
Credit dummy	1 if household currently has a loan from a financial institution; 0 otherwise
NTT organic fertilizer knowledge dummy	1 if household has ever heard about NTT organic fertilizer; 0 otherwise
Organic fertilizer usage dummy	1 if household has ever used organic fertilizer; 0 otherwise
Dummy for organic fertilizer usage Jan-Apr 2018	1 if household adopted organic fertilizer from January 2018 to April 2018; 0 otherwise
Quantity of organic fertilizer usage Jan-Apr 2018 (kg)	Quantity of organic fertilizer adopted from January 2018 to April 2018 (kg)
Tea farm	Total area of tea
Forest land	Total area of forest landholdings (ha)
Annual crop land	Total area of annual crop landholdings (ha) (paddy field)
Perennial crop land	Total area of perennial crop landholdings (ha) (land for cultivating tea and fruits)
Motorbike	The number of motorbikes owned by the household as of June 2018
TV	The number of TVs owned by the household as of June, 2018
Fridge	The number of refrigerators owned by the household as of June 2018
PC	The number of computers or laptops owned by the household as of June 2018
Air conditioner	The number of air conditioners owned by the household as of June 2018
Characteristics of interviewee	
Age	Age of the interview
Education (years)	Years of education of the interviewee (year)
Female dummy	1 if interviewee is female; 0 otherwise
Household head dummy	1 if interviewee is household head; 0 otherwise
Primary decision maker dummy	1 if interviewee is primary decision maker of the household; 0 otherwise
Outcome variables	
Purchase decision	1 if household decides to purchase NTT organic fertilizer; 0 otherwise
Purchase quantity	Quantity of NTT organic fertilizer purchased by household (kg)

Table A.2: ATE for purchase dummy and purchase quantity after controlling for baseline characteristics (OLS regression)

	Initial decision				**Changed decision**				**Final decision**			
	purchase decision	**purchase decision**	**purchase quantity**	**purchase quantity**	**purchase decision**	**purchase decision**	**purchase quantity**	**purchase quantity**	**purchase decision**	**purchase decision**	**purchase quantity**	**purchase quantity**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Subsidy treatment	0.257***	0.257***	62.460***	62.825***	0.254***	0.255***	63.285***	63.720***	0.281***	0.281***	68.158***	68.674***
	(0.032)	(0.032)	(5.789)	(5.724)	(0.032)	(0.032)	(5.750)	(5.687)	(0.032)	(0.032)	(5.731)	(5.675)
Information treatment	0.082**	0.081**	13.000**	12.617**	0.075**	0.073**	11.916**	11.517**	0.081**	0.079**	13.032**	12.706**
	(0.032)	(0.032)	(5.856)	(5.786)	(0.032)	(0.032)	(5.817)	(5.748)	(0.032)	(0.032)	(5.799)	(5.736)
Household characteristics		Yes		Yes		Yes		Yes		Yes		Yes
Interviewee characteristics		Yes		Yes		Yes		Yes		Yes		Yes
Observations	1287	1287	1287	1287	1287	1287	1287	1287	1287	1287	1287	1287

Note: Standard errors are reported in parentheses.
Household characteristics include market distance, family size, VietGAP dummy, credit dummy, NTT organic fertilizer knowledge dummy, organic fertilizer usage dummy, tea farm, forest land, annual crop land, motorbike, TV, fridge, PC, and air conditioner.
Interviewee characteristics include age, education, and female dummy.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

SUPPLEMENTAL MATERIALS

A. Videos with subtitles

2-minute video: https://youtu.be/6ppWwrV4d8k

5-minute video: https://youtu.be/iBjtaXyy5ps

B. Contract of organic fertilizer purchase

CONTRACT OF ORGANIC FERTILIZER PURCHASE

1. Household information

Name of the representative:……Household ID:…….

Telephone number:……

Address (village and commune name):……..

2. Information on organic fertilizer purchase

Brand: NTT organic fertilizer – A scientific product of Thai Nguyen University of Agriculture and Forestry

Order quantity (kg):……(25kg per package – maximum 200 kg)

Price: 2,600 VND/kg

Type of support from the project (treatment received by the household):…….

Date of delivery:…….

Time and place of delivery: From 9 AM to 12 PM at the village center

Total payment:…….....

Please bring this contract letter on the date of delivery.

For further information, contact 0866692896 (Duc) or 0866692898 (Thu)

Signature of the household representative

C. Package of NTT organic fertilizer (Vietnamese and English)

Front package

Back package

HƯỚNG DẪN SỬ DỤNG

1. Lượng phân:

- Cây chè: bón lót với lượng 4 - 5 tấn/ha. Bón thúc với lượng 0,5 - 1 kg phân/ 1kg chè búp tươi.
- Cây rau và các loại cây trồng khác, tùy giống mà lượng bón cho phù hợp. Tuy nhiên 1 kg phân NTT thay thế 3 - 4 kg phân chuồng truyền thống.

2. Tác dụng:

- Tăng năng suất chè, nước chè có màu xanh, vị đậm, hương thơm đặc trưng.
- Cải tạo đất, hạn chế rửa trôi chất dinh dưỡng.
- Cung cấp dinh dưỡng cân đối cho cây trồng.
- Tăng hiệu quả sử dụng phân khoáng.
- Hạn chế sâu bệnh hại, bảo vệ môi trường.

3. Cách bón:

- Cây chè: Nếu bón lót thì nên bón sâu, lấp đất rồi trồng cây. Nếu bón thúc thì bón sau mỗi lần thu hái hoặc bón định kỳ 3 tháng 1 lần. Nên bón sâu hoặc xới xáo đất. Sau khi bón dùng nước tưới đủ ẩm.
- Cây rau: nên bón sâu và tưới nước giữ ẩm.
- Sử dụng kết hợp các loại phân khoáng để mang hiệu quả kinh tế tối ưu.

Sản phẩm nằm trong danh mục các loại phân bón được phép sản xuất và kinh doanh tại Việt Nam, kèm theo Thông tư số 29/2011TT-BNNPTNT, ngày 15/4/2011 của Bộ trưởng NN&PTNT

Đơn vị sản xuất: Công ty Cổ phần Việt Mỹ
Địa chỉ: Xưởng SX phân bón Trường ĐH Nông lâm

Điện thoại Tư vấn và Cung cấp Sản phẩm
DĐ: 0912 573 112

(Logo)

NTT ORGANIC FERTILIZER

PRODUCED ENTIRELY FROM PIG AND CHICKEN FECES

(Picture)

An advanced organic fertilizer specialized for tea, vegetables and horticultural crops

BRINGING PROSPERITY TO VIETNAMESE AGRICULTURAL PRODUCTS

INGREDIENTS (%) Organic matter 35; Humic Acid 6; Moisture 20; $N : P_2O_5 : K_2O = 2.5 : 1 : 1$

WARNING

- Preserve in shaded well-ventilated places. Wash your hands after using
- This product is safe for people, animals and the environment

Date of packaging **Date of expiry: 12 months**

Production batch no.

Net weight: 25 ± 0.5 kg

A SCIENTIFIC PRODUCT OF THAI NGUYEN UNIVERSITY OF AGRICULTURE AND FORESTRY

Address: Thai Nguyen City, Thai Nguyen Province

INSTRUCTIONS

1. Amount of application

- Tea crops: 4-5 tons/ha for basal fertilizing and 0.5 – 1 kg/ 1kg of fresh tea for top-dressing fertilizing
- Vegetables and other crops: Application amount depends on crop type; however, 1 kg of NTT organic fertilizer can substitute for 3 – 4 kg of traditional manure.

2. Functions

- Improve the productivity of tea crops and enrich the greenness, taste and special flavor of tea.
- Revitalize the soil and prevent nutritional erosion.
- Provide balanced nutrition to crops.
- Improve the efficiency of synthetic fertilizer application.
- Reduce pests and diseases and protect the environment

3. Method of application

- Tea crops: For basal fertilizing, burry the organic fertilizer after plowing, then plant tea plantlets. For top-dressing fertilizing, apply the organic fertilizer after harvest or once every 3 months. The ground should be slightly ploughed. Apply water after fertilizer application to maintain moisture.
- Vegetables: plough and burry the organic fertilizer, and apply water to maintain moisture.
- Combining this product with synthetic fertilizers delivers optimal economic efficiency.

This product is on the list of fertilizers legally permitted to produce and sell in Vietnam, indicated in Circular no. 29/2011TT-BNNPTNT issued 15/4/2011 by the Minister of Agriculture and Rural Development

Manufacturer: Viet My Stock Company

Address: Fertilizer manufacturing factory of Thai Nguyen University of Agriculture and Forestry

Contact for detailed information and purchase orders

Tel.: 0912 573 112