Can Fresh Produce Farmers Benefit from Global Gap Certification?

The case of lychee producers in Madagascar

Julie SUBERVIE, INRA, UMR 1110 MOISA, F-34000 Montpellier, France. subervie@supagro.inra.fr
Isabelle VAGNERON, CIRAD, UMR MOISA, F-34398 Montpellier, France

Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

Can Fresh Produce Farmers Benefit from Global Gap Certification?

The case of lychee producers in Madagascar♦

Julie Subervie* and Isabelle Vagneron**

Abstract:

It has only been a few years since the private standard GlobalGap has been introduced in the Malagasy lychee value chain. Since the year 2005, under pressure from some European importers, many exporters have chosen to intensify relations with small-scale farmers and have assisted them in achieving GlobalGap certification. Indeed, in contrast with countries where farmers seeking certification have to pay for it, in Madagascar certification costs have been entirely supported by exporters themselves, often with financial support and technical assistance from donors and trade facilitators. This has entailed an unexpected situation, characterized by a boom in the number of certified farmers when development programs started, followed by a disengagement of some exporters, who have chosen to opt out of the GlobalGap compliance process as soon as financial supports ended. Taking advantage of this very specific context in the form of a natural experiment, we aim at understanding potential mechanisms through which Malagasy farmers may benefit from GlobalGap standards and assessing consequences on their marketing performances using original dataset. The results generally do not show any significant impact of certification on prices received by farmers. However, they suggest that certified farmers may have an opportunity to sell larger quantities because of a mechanical interest from exporters or because they are able to improve both quality and quantity by using new infrastructure built for requirements. On average, currently certified producers sell about 4.5 tons, which means 1 ton more than what they would have sold, had they not been uncertified. This estimate appears driven by certified farmers who carry their product to the treatment plant by themselves.

Key words: standards; certification; developing countries; exports; fresh produce.
JEL: Q12, Q17, Q56.

♦ We thank Eliane Ralison (FOFIFA) and Rémi Proust for collecting the data and building the database. We gratefully acknowledge financial support from the European Commission under its 7th Framework Program. We are grateful for useful comments from -John Humphrey, Miet Maertens, Sylvaine Lemeilleur, Céline Bignebat, Liesbeth Colen, and Monica Schuster at the NTM Impact WP7 technical meeting in Montpellier (April 2011).
* INRA, UMR 1110 MOISA, F-34000 Montpellier, France. Corresponding author : subervie@supagro.inra.fr
** CIRAD, UMR MOISA, F-34398 Montpellier, France.

I. Introduction

Private standards play an increasing role in the governance of global food markets. Developed in the 1990s in response to consumer scares, private standards in the food sector initially focused on food safety. They subsequently extended to incorporate broader issues such as environmental protection, employment practices, animal welfare, etc. Private standards vary tremendously according to: (a) who developed them (individual companies, business coalitions with private companies and/or NGOs, networks of multiple stakeholders); (b) who adopts them (farmers, processors, whole chain) and (c) what issues they address (food safety, traceability, provenance, environmental issues). Nevertheless, initially developed to improve reputation and avoid from blame, private standards are increasingly used by downstream operators to exert control over the entire production process (Dolan and Humphrey, 2000; Freidberg, 2007; Vagneron et al., 2009).

The proliferation of private agrifood standards is likely to set new challenges for farmers and food chain operators, especially those located in developing countries (Henson and Humphrey, 2010). In Sub-Saharan Africa, several countries (e.g. Ghana, Kenya, Madagascar, Senegal) have been following strategies aimed at diversifying their agriculture towards non-traditional agricultural products (fruits, vegetables, flowers, spices) as a mean to increase export earnings while fighting poverty (Asfaw et al., 2008; 2010). In many of these countries, non-traditional crops are produced by smallholders; their main target is the European Union market (Henson et al., 2011; Okello et al., 2011). In these countries, the rise of private agrifood governance has triggered growing concerns that compliance with increasingly stringent private standards may undermine the competitiveness of farmers and exporters, and their ability to benefit from the opportunities of high-value food markets located in developed countries.

In fresh produce field, one of the most important standards is GlobalGap, a private voluntary standard created by a consortium of European retailers in 1997. Based on a framework of Good Agricultural Practices (GAPs) aimed at ensuring compliance with public food safety requirements, GlobalGap has since then broadened its focus to encompass environmental protection, employment practices and animal welfare. It is today one of the most widely applied private agrifood standards in the world (Eurofruit Magazine, 2008). In the case of GlobalGap, several studies stress the cost of ensuring and demonstrating compliance with the standard for small farmers from developing countries. Indeed, Asfaw et al. (2010) show that for smallholders, the investment costs (e.g. infrastructure, equipment) to become GlobalGap certified accounts for 30% of their annual crop income. Similarly, Graffham et al. (2007) also reveal high costs of compliance. Comparing the effects of GlobalGap on various sizes of Kenyan vegetable farmers, Mausch et al. (2009) show that smallholders bear high certification costs and must wait over two years to recover their investment in certification but perform better in terms of revenue-cost ratio. Several studies show that the existence of economies of scale in investment for compliance tends to handicap smallholders (Chemnitz, 2007; Asfaw et al., 2008; Mausch et al., 2009). On the other side, only a few studies emphasize the benefits for those who succeeded in becoming certified. According to Asfaw et al. (2010), not only do certified farmers receive higher incomes, they also enjoy improved bargaining power and more secured relations with their buyer, and keep participating in export markets. Finally, some studies stress collateral positive effects such as increased salaried employment (Maertens and Swinnen, 2009) or improved health outcomes among farmers (Asfaw et al., 2010).

Taking as a starting point the existing but very scarce empirical literature on the impact of private standards on smallholders in developing countries, the aim of this paper is to measure the effects of GlobalGap on the marketing performance of certified lychee producers in Madagascar. Globalgap was first introduced into Madagascar's lychee value chain in 2005 under the pressure of a handful of European importers. In contrast with countries where the compliance costs are borne by the farmers (who may or may not be supported by donors or by NGOs), in Madagascar GlobalGap certification costs for lychees are entirely supported by the exporters with financial support and technical assistance from donors and trade facilitators. The initial boom in the number of certified farmers that accompanied donor involvement in 2007-2008 was soon followed by a large and sudden drop, as several exporters chose to abandon the certification when donor support dried up. Taking advantage of this very specific context, which takes the form of a natural experiment, we assess the impact of GlobalGap on the marketing performance of certified lychee producers in Madagascar. Performance is measured through traded volumes and selling prices.

In the course of our research we tested the following hypotheses: (a) in comparison with a situation without GlobalGap, lychee exporters increase their sourcing from certified farmers; (b) as a collateral effect, compliance with GlobalGap requirements increases the quantity and/or the quality of lychees provided by certified farmers (we thus expected a positive impact on the volumes sold by the farmers); (c) exporters who sell certified lychees might benefit from a price premium, which may in part be transmitted to the farmers. Our results suggest a positive impact of certification on quantities sold by certified farmers. On average, currently certified producers sell larger quantities than their matched counterparts. In 2009, they sold about 4.5 tons of lychees, i.e. 1 ton more than what they would have sold, had they not been uncertified. Conversely, our results fail to show that currently certified producers receive higher prices. The remaining of the article is organized as follows: the next section describes the lychee value chain in Madagascar, the emergence and the specificities of the GlobalGap standard for lychee production. Section three presents the empirical framework and discusses the identification strategy. It is followed by a description of the data and by descriptive statistics in the fourth section. The main results of our study are presented and discussed in section five. Sections six discusses the interpretation of the results and concludes.

II. Lychee export sector in Madagascar and Global Gap standards

a. Lychee value chain

Madagascar is the main lychee supplier for the European Union. In 2006, the total value of lychee exports reached nearly USD 3 million, almost 9% of all exports (WorldBank, 2007). Since 2004, Madagascar exports an average volume of 20,000 metric tons each year. In Europe, lychee consumption is both highly seasonal and very short. Lychees from Madagascar arrive in Europe between mid-November and mid-January. As a result of such concentration in time (the campaign lasts 3 months) and space (Toamasina province), a variety of actors temporarily participate in lychee related activities (pickers, collectors, transporters, exporters) before returning to other activities the rest of the year.

The lychee production area extends over 800 km along the eastern coastline between Toamasina and Fort Dauphin and involves over 30,000 families (Thierry, 2007). Total annual production was estimated at roughly 180,000-200,000 metric tons between 2003 and 2006 (WorldBank, 2007). The production area for exported lychees is concentrated around the island's main harbor: Toamasina (Tamatave) and the neighboring districts of Vavatenina, Fénérive-Est, Tamatave II, Brickaville and Vatomandry. Around 30 exporters operate in Toamasina. Exporters work through collectors and directly with producers for their lychee supply. In both cases they pay in advance for their lychees. The rest of the year, these companies export other commodities. Exporters are in charge of sorting and applying chemical treatment to the lychees, packaging and bringing the lychees to the boats. Exporters are quite a heterogeneous group in terms of turnover activity. While some exporters only operate during the lychee season and do not have their own packaging unit, others collect large volumes of lychees and are in relation with several importers. Recently, some exporters started producing lychees themselves in large orchards.

Over 3,000 collectors operate in the area (WorldBank, 2007). Two main types of collectors can be distinguished: (a) professional collectors - who also collect cloves, vanilla, pepper, coffee, the rest of the year - are based in Tamatave. They work with one or several exporters and have their own network of trusted suppliers to whom they provide cash advances and technical advice; they only collect lychees for the export market; (b) more occasional collectors from Tamatave or Antananarivo, whose participation depends on market opportunities, on the availability of a vehicle to bring the lychees to the exporters' treatment plants and packaging units. These operators sell to the exporters by queuing in front of their treatment plants. They have no contract with the producers and may switch producers from one year to the other. Once the export season is over, they sell the remaining lychees on local markets or in Antananarivo.

Most lychee producers (80 to 90%) only own a few trees - less than 20 - that are scattered on their plots. Trees are not very well tended and receive little inputs. The main activity is the organization of the harvest using both family and seasonal workers from neighboring villages. Workers are in charge of picking, sorting and packaging the lychees in traditional baskets (garaba). Most producers have little knowledge about markets and depend on the collectors to market their lychees.

b. EU requirements and the emergence of GlobalGap standards

Under the Everything but Arms agreement (2001), Madagascar enjoys a duty-free and quota free access to the European Union for fruits and vegetables (Minten, Randrianarison, Swinnen, 2009). However, important public regulations limiting the entry of fresh fruit and vegetable into the EU include: EC Regulations 396/2005 and 178/2006 on pesticide regulation and the general food safety regulation imposing traceability of food products within the EU (EC regulation 178/2002) (Codron, Giraud-Heraud, Soler, 2005). In the case of imported products such as lychees, it is the responsibility of the importer to ensure compliance with the relevant requirements. Moreover, stringent public health standards regulate lychee exports[1]. In the case of Madagascar, maximum residue levels for sulfur are difficult to comply with for lychee exporters due to the need for post-harvest treatment with sulfur. Authorized in the European Union for table grapes, blueberries and lychees (since 2006), sulfur treatment in foodstuffs is regulated through Directive 95/2/EC on food additives. In the USA, sulfur treatment is only authorized for postharvest use on grape. As a result, lychees from Madagascar cannot be sold on the US market.

The main private quality standard used in the EU for fresh produce is GlobalGAP, which provides a set of guidelines established to ensure the hygiene and safety of agricultural products. As most lychee trees are unattended, GlobalGAP focuses mainly on harvest (access to clean water for pre-harvest hand washing, packaging of lychees) and post-harvest procedures (safety, hygiene and working conditions at the sulfur treatment plant, respect of maximum residue limits).

[1] Lychees deteriorate rapidly unless proper handling techniques are employed. SO2 fumigation is considered as the most effective and practical postharvest treatment to control color change for lychees. However, there has been increasing concern about sulfur residues in fruit in recent years, as some consumers are sensitive to sulphites. A maximum residue limit of 10 ppm sulfur is set in Europe, Australia and Japan. In the USA, sulfur is only registered for postharvest use on grape (Jiang et al., 2003).

For lychees as for other fresh produce, GlobalGap offers different certification options: farmers may be certified either individually (option 1) or as a group (option 2). Under group certification (option 2), the farmer group is required to set up an Internal Control System (ICS) with qualified staff from its members. The external certification body examines the working of the ICS and inspects a random sample of farmers each year. Group certification allows: to share auditing costs and some investments (e.g. pesticide store) among group members; to share information and to build capacity within the group; to increase farmer motivation to comply through peer pressure on members. It is perceived as more feasible for small farmers, and as a means to reduce the risk of smallholders' exclusion from value chains (Will, 2011). Certification is obtained when passing an on-farm inspection and paying a fee that must be renewed every year. Quality management systems must be developed to ensure safe pesticide use, and compliance with handling and hygiene standards. Last, exporters must be able to trace production back to a specific farm from which it was procured in order to ensure the compliance of the product with the standard. Compliance with the standard involves fixed costs (e.g. the construction of sheds and of latrines with running water) and recurring costs (e.g. record keeping of all farm activities related to the production of the certified crop, both at the individual and the group level, monitoring costs).

Recently, some exporters have received financial support from donors as part of development projects. Supported by the USA, the Millenium Challenge Account (MCA) is a government program aimed at reducing poverty in rural areas. During the 2006-2007 lychee campaign, the MCA provided technical, financial and organizational support to the lychee value chain, namely for quality upgrading and Globalgap certification. The program ended with the military coup of 2009. Similarly, the USAID-funded project called BAMEX (Business and Market Expansion) was designed to promote and develop business, trade and market development in Madagascar. BAMEX supported the lychee value chain through various actions, including the design of a "Lychee Action Plan" (2007), the development of procedure manuals for quality management along the lychee value chain, the lobbying for financial support from International Finance Corporation in order to obtain technical assistance to comply with GlobalGAP requirements and certification, the development of communication aids for the 2008 session of Fruit Logistica's "International Fruit and Vegetable Show". The program ended in 2008 (USAID, 2008).

The year 2007 was characterized by a peak in the number of certified producers in the country: in 2007-2008, 1,136 lychee farmers were certified and nearly 2,000 tons of GlobalGAP certified lychee were exported (Ramananarivo et al., 2011). After the withdrawal of donors, it is clear that the number of certified producers has declined substantially, falling to roughly 100 producers (based again on the evidence of certification bodies).[2] Such phenomenon has entailed an unexpected situation where lychee exporters have the opportunity to source from both certified farmers, ex-certified farmers, and never-certified farmers. In our empirical analysis, we exploit this specific feature of the lychee chain in 2009 which takes the form of a natural experiment.

III. Empirical framework

a. Empirical model

The relationship between the Malagasy lychee producers and exporters can be analyzed in the conceptual framework proposed by Barrett (2011), where firms (exporters here) make the contracting choice sequentially. First, they choose where to locate its procurements activities (Toamasina and the neighboring districts of Vavatenina, Fénérive-Est, Tamatave II, Brickaville and Vatomandry). Second, they select the farmers who are able to comply with their requirements (location, production capacity, and education levels notably). Thirdly, farmers may accept or not. In the Malagasy case, qualitative evidence shows that costs supported by farmers are actually negligible compared to exporters' costs. Actually, their main investment is time they allocate to GlobalGap training sessions. This entails that lychee farmers systematically accept to participate in the certification process when they are offered to.

In our framework, the exporter opts for a farmer's certification if the benefits (B) associated to certification are higher than costs (C). We do not observe such benefits and costs, but we observe whether a farmer has achieved GlobalGap certification or not, and we observe factors (X) that drive the net benefit $(B - C)$. This helps us write a straightforward model of participation in GlobalGap process:

$$GG_i = 1 \ if \ GG_i^* > 0 \qquad (1)$$
$$GG_i = 0 \ if \ GG_i^* \leq 0$$

$$\text{with } GG^* = B_i - C_i = bX_i + \varepsilon_i$$

GG_i^* is a latent variable and GG_i is a dummy which takes value 1 if the farmer i has achieved ceritification process and zero if not; ε_i is a random error term.

[2] It is still low today with 188 certified farmers in April 2010 (FoodPLUS, 2010); 145 as for December 2011 (http://www.globalgap.org/cms/upload/Resources/Publications/Newsletter/120321_AR11_web-FINAL.pdf).

The probability for a farmer to be certified is thus:

$$P(GG_i = 1) = P(bX_i + \varepsilon_i > 0) = F(bX_i) \quad (2)$$

where $F(.)$ is the standard normal cumulative distribution function.
We then model the impact of GlobalGap certification on marketing performances of certified farmers taking into account that many other factors are likely to affect his outcome:

$$y_i = f(X_i, GG_i) \quad (3)$$

The central feature of this model is that factors X drive both the probability for a farmer to be certified and his outcome level: they are factors of selection bias. For example, it is reasonable to suppose that exporters that seek farmers for certification will reach those with high productive potential, i.e. owning a large number of lychee trees; and this productive potential also determines the level of outcome (the quantity sold) outside the GG channel. We thus include in vector X the number of lychee trees by age and the quantities sold in the pre-certification season. Qualitative evidence on farmers' selection into the certification process also indicates that farmers' ability to rapidly harvest and transport the lychees to the sulfur treatment plants located in Tamatave are important criteria for exporters. We thus include in vector X a measure of the harvest workforce available, a dummy which takes on the value one if the farmer is located in the early produce area (south of the export region) and value zero if not, the distance from the village to Tamatave, and a dummy that takes on the value one if the farmer carries the products to Tamatave by himself and value zero if not. We also include into vector X the education level of farmers, supposing that GlobalGap training requires at least being able to read. Finally we take into account the existence of a contract between the farmer and the exporter, supposing that the exporter will seek farmers for certification among those he already known as good suppliers.
Note that although there may be additional factors affecting the outcome level apart from vector X, we do not explicitly add them to the model as long as they do not drive the probability to be certified (indeed adding them will not change the value of the parameter δ that we aim to recover). Moreover in the case under study, we failed to find variables that would be likely to influence the outcome outside vector X.
Another important feature of this model is the existence of additional factors likely to influence the probability for a farmer to be certified. Such factors are exogenous in the sense that they do not affect the outcome level directly (hence omitting them in equation (3) does not create bias), and they are unobserved (they are stored in ε in equation (2)). Taking into account the very specific context of

the Malagasy lychee chain, we argue that at least two factors are likely to exogenously explain the decision for an exporter to pay for a farmer's certification. First, exporters may benefit from financial support from development projects. This mechanically reduces their costs C, which in turn increases the probability that they opt for certification. Second, exporters may have to cope with new requirements from buyers in terms of improved food safety, which threaten their expected benefit B in case they would not be able to comply with them.

In that context, there are various potential mechanisms through which certified farmers may benefit from GlobalGap standards in terms of marketing performances. Marketing performance is measured through traded volumes to the main buyer (in all cases the main buyer is the exporter that seek certification) and prices they receive (in Malagasy ariary/kg). As compared with a situation without GlobalGap standards, exporters are expected to increase sourcing from certified farmers to the detriment of uncertified farmers. In practice, this would mean that certified farmers who are able to carry their lychees to Tamatave by themselves have priority to the sulfur treatment plant and have the possibility to sell all their products, while without certification there would be no guarantee that the full quantity they offer would be sold, quantities that can be loaded on board by each exporter being limited by an individual quota.[3] However, most farmers generally sell their lychees to a collector who reaches them at the farm gate and acts as an intermediary between the exporter and the farmers (Kersting, 2012). As compared with a situation without GlobalGap standards, we may suppose that the collector who reaches certified farmers take all garaba baskets that can be offered, while in the absence of certification he would have taken the bother to sort out the best baskets in order to limit chances to be refused lychees at the treatment plant. Moreover, as a collateral effect, compliance to GlobalGap requirements may increase quantities provided by certified farmers who are trained for the upkeep and care of the trees and have access to water points to irrigate, making them able to grow larger quantities. We thus expect a positive impact on sold quantities at the producer level. Exporters who sell certified lychees may also benefit from a price premium; this may translate in a price premium for farmers too. We thus also expect a positive impact on prices certified farmers received.

b. Estimators and identification strategy

Our parameter of interest is the average gain from certification for the subset of farmers who were actually certified in 2009. It answers the question "how much did certified farmers get (in terms of

[3] Moreover, certified farmers may have the opportunity to sell larger quantities than those under pre-harvest contract.

additional quantity sold or price premium received) compared to what they would have experienced without participating in the certification process?”. One straightforward way to get an estimate of such impact is to run ordinary least squares on $y_i = \alpha + \beta . X_i + \delta . GG_i + \gamma_i$, where δ is the impact of GlobalGap certification we aim to recover. However, in addition to the assumption of linearity, this would require to suppose that δ is constant across X, meaning that the impact of certification is the same for all certified farmers. Without any evidence for such assertion, we thus opt for the widely-used matching approach, which does not require specifying the functional form of the outcome equation (3) and relaxes the hypothesis of a constant effect.

Let Y^1be the potential outcome (quantities sold or prices received) of a farmer in the certified state and Y^0 his potential outcome in the uncertified state. In this framework, our parameter of interest is called the average treatment effect on the treated (ATT). It is the difference between the average level of outcome we observe in 2009 in the certified farmer group and the level we would have observed had they remained outside the certification process (the so-called counterfactual situation):

$$ATT = E(Y^1 - Y^0 | GG = 1) = E(Y^1 | GG = 1) - E(Y^0 | GG = 1). \quad (4)$$

Obviously, we cannot observe both terms $E(Y^1|GG = 1)$ and $E(Y^0|GG = 1)$ for the same farmer at the same time. More precisely, we can get data on $E(Y^1|GG = 1)$ and on $E(Y^0|GG = 0)$ but we do not observe $E(Y^0|GG = 1)$. In order to cope with this, we make the traditional assumption that given the set of observable factors X, potential outcomes are independent of the certification status (Rubin, 1977). Hence, after controlling for X, the mean potential oucome is the same for certified and uncertified (this assumption is called the conditional independence condition or selection on observables): $E(Y^0|X, GG = 1) = E(Y^0|X, GG = 0)$. We are thus able to recover ATT conditional on X:

$$ATT(X) \ = E(Y^1|X, GG = 1) - E(Y^0|X, GG = 0) \quad (5)$$

If we believe that factors X which create selection bias are all observable - meaning that we can measure all of these factors through available data - we can use matching estimators to estimate $ATT(X)$. Matching estimator gets rid of selection bias due to observables by comparing the outcomes of certified farmers with outcomes of similar matched uncertified farmers (Imbens, 2004). There are varieties of matching estimators. The quality of the data collected allowed us to use the difference-in-differences (DID) matching estimators[4] : nearest-neighbor matching (Abadie et al. 2004), kernel-based matching, and local linear matching (Leuven and Sianesi 2003). DID matching estimators allow for temporally invariant differences in outcomes between treated and their matched counterparts. It takes the following form:

$$\hat{\Delta}_{D=1}^{DID} = n_1^{-1} \sum_{i \in I_1} \left[Y_{it}^1 - Y_{it'}^1 - \sum_{j \in I_0} W_{ij} \left(Y_{jt}^0 - Y_{jt'}^0 \right) \right] \tag{6}$$

where I_1 denotes the group of certified farmers, I_0 denotes the group of uncertified farmers, n_1 is the number of certified farmers in I_1. Matching estimators we use differ in how matched uncertified farmers are selected through the matching procedure. This is driven by the weights W_{ij} that we assign to potential matches given their characteristics X.[5] It is important that these variables X are not affected by the certification (Imbens, 2004), that is why we take their values prior to the emergence of GlobalGap standard in the Malagasy lychee value chain (2005). Note that the matching procedure is also valid when applied to the summary statistic $Pr(GG = 1|X)$, the propensity score, rather than X directly (Rosenbaum and Rubin, 1983). To do so, we estimate equation (2) in a first stage in order to get the predicted probabilities of participation in the certification process. Finally, we also run linear regressions as a robustness check. We use the asymptotically-consistent estimator of the variance of the nearest-neighbor matching estimator provided by Abadie and Imbens and we implement a bootstrap procedure (500 repetitions) to get an estimator of the variance of the kernel and the local linear matching estimators.

The validity of matching estimators relies on strong statistical assumptions. And yet, we argue that in the special case of Madagascar, we can reasonably suppose that they hold. First, based on qualitative evidence, we can safely assume that the conditional independence condition is valid because there

---

[4] Traditional matching estimators assume that after conditioning on a set of observable characteristics, outcomes are conditionally mean independent of certification participation. However, for a variety of reasons there may be systematic differences between participant and nonparticipant outcomes, even after conditioning on observables that could lead to a violation of the identification conditions required for matching. A DID matching strategy, as defined in Heckman, Ichimura, and Todd (1997), and Heckman, Ichimura, Smith and Todd (1998) allows for temporally invariant differences in outcomes between participants and their matched nonparticipants counterparts (Todd, 2007). It is analogous to the traditional cross-sectional matching estimator in the sense that it requires that:

$$E(Y_t^0 - Y_{t'}^0 | X, GG = 1) = E(Y_t^0 - Y_{t'}^0 | X, GG = 0)$$

[5] The nearest-neighbor matching estimator we use in the analysis matches each certified farmer to the four closest uncertified farmers in terms of vector X (or propensity score). Both kernel and local linear matching estimator construct a match for each certified farmer using a weighted average over all uncertified farmers (see for example Tood (2008) for a formal definition of weights in each case).

are actually few factors that are likely to be sources of selection bias and we are able to observe them. But most of all, in contrast with countries where farmers seeking certification have to pay for it, in Madagascar certification costs have been entirely supported by exporters themselves, often with financial support and technical assistance from donors and trade facilitators. This has entailed an unexpected situation, characterized by a boom in the number of certified farmers when development programs started, followed by a disengagement of some exporters, who have chosen to opt out of the GlobalGap compliance process as soon as financial supports ended. Taking advantage of this very specific context which takes the form of a natural experiment, we targeted ex-certified farmers when we selected uncertified farmers from the lychee farmer population, supposing that both certified and ex-certified farmers display similar characteristics, even unobserved ones. This guaranties the existence of a large common support, another condition for validity of the matching procedure (Heckman, Ichimura and Todd, 1997), which implies that we are able to find both currently certified and uncertified farmers with high probability of being certified given their characteristics X. Factors' variability on the exporter side (pressure from buyers and financial support) thus acts here as a natural experiment in the sense that it insures that both certified and uncertified with similar characteristics X coexist at the same time. Hence, controlling for observable characteristics X and temporally invariant unobservable ones only adds accuracy to the estimate.

The basic intuition behind this strategy is the following: when comparing currently certified farmers to ex-certified farmers with similar X (similar location, production and education levels, etc.), we actually compare farmers who supply two different types of exporters: those who chose to pay for certification because of market forces and/or because they benefit from financial support, and others who decided to give up certification because support programs ended and/or because European demand in terms of food safety standards does present a credible threat for them. Actually both mechanisms seemed to play a role in (de)certification process. Indeed, development programs providing financial support for certification ended in 2008 which was immediately followed by a disengagement of some exporters, who chose to opt out of the GlobalGap compliance. At the same time however, increased pressure from buyers encouraged exporters who were already linked to them not to give it up and others to enter into the certification process. Consequently our sample includes certified farmers from the certification boom of 2007 but also more recently certified ones. Secondly, we can also assume that the treatment received by one farmer (certification here) does not affect outcomes for another farmer.[6]) And yet, it is often difficult to ignore potential general equilibrium effects when assessing the impact of food standards, as they are likely to affect the FFV

[6] This assumption is referred to in the literature as the Stable Unit Treatment Value Assumption (SUTVA).

market as a whole, meaning that we would not be able to find any control group in this case. However, in the special case of the lychee market in Madagascar in 2009, certified farmers account for a very small share of traded quantities (only 100 farmers among 30,000). Therefore, even a significant impact on them is not likely to result in a general equilibrium effect, in the sense that even if exporters significantly increase sourcing from certified farmers to the detriment of non-certified farmers, the change in the average outcome in the non-certified group will be too small to be statistically detectable. Moreover, exporters do not source from both certified and ex-certified farmers: this means that increasing sourcing from certified farmers will be to the detriment of never-certified farmers rather than ex-certified farmers. Hence we can safely assume that our control group, which includes ex-certified farmers only, will not be contaminated by the impact of certification on certified farmers - if there is any.

IV. Data and descriptive statistics

a. Sampling and data

The survey has been run in August 2010. It has been a recall survey about what happened during the marketing season 2009/2010. The followings topics have been investigated through the questionnaire: household's general characteristics, household's assets, land, lychee production, lychee marketing, EurepGAP/GlobalGAP standards, other cash crops, social network, saving and credit, other activities, health and consumption. Moreover, regarding data requirements for the analysis, the survey also included some questions referring to the pre-certification period, namely season 2005-2006.

The targeted population is that of export producers of lychee. The study area covers the districts of Brickaville, Vatomandry, Tamatave, Vavatenina, and Fenerive East, a large corridor along the East coast which is the main exporting region of lychees. The survey covers a total of 506 producers, surveyed individually even if they belong to a group or association. The sample includes:

- 73 farmers, who were certified during the 2009 lychee season. Thereafter these producers are named certified farmers. Hopefully, this group includes the majority of producers actually certified in 2009 across the country;[7]
- 232 farmers, who were not currently certified in 2009 but have been certified at least once since 2005 lychee season; in what follows, they are named ex-certified farmers.

Our sample also includes 201 farmers, who have never been certified; they are called never-certified farmers. Main part of the analysis is based on comparisons between certified farmers and ex-

[7] This is another specific feature of this study. It has only been a few years since the private standard GlobalGap has been introduced in the Malagasy lychee value chain. We thus had the opportunity to survey almost all certified farmers existing in 2009.

certified farmers. However, the never-certified group will be used to assess main determinants of selection used by exporters who seek certification.

Uncertified villages have been selected based on the following conditions: being in the same area as certified producers and having lychee producers with a number of trees close to that of GlobalGAP producers. In practice, once the villages have been selected on the basis of the geographical criteria, the enumerators had to go door-to-door randomly until they get the number of respondents that had been set for each village.

b. Descriptive statistics

Table 1 shows that, in our sample, lychee farmers who have experienced certification (certified and ex-certified farmers) do not differ from other lychee farmers in terms of age, farm size, family size, access to water, and non-agricultural activity. Despite the fact that we targeted uncertified farmers owning a high number of trees, the groups still differ on the productive potential and marketing performances. Moreover, both the maximum and the minimum price received by farmers who have experienced certification seem higher than for other lychee farmers, which would suggest that they are able to produce a higher quality and/or supply exporters at the very beginning of the lychee season when prices are relatively high. Both certified and ex-certified farmers also have more often the ability to reach Tamatave by themselves to sell their products. In accordance with our sampling plan targeting farmers of each type located in the same area, in all three groups the distance from Tamatave is around 120 km. Moreover, farmers who have experienced certification seem to remain part of a kind of professional network as they are usually under contract with their main buyer. Interestingly, lychee producers who have never been certified have even never heard of the GlobalGap standard. This basic information confirms that certification is driven by exporters only: farmers are offered to be certified by the exporters themselves, meaning that farmers who produce large quantities and have developed the trust in their relationship with the exporter are more likely to be chosen for certification.

Basic statistics on the cumulative number of years as a certified producer show that it could be one or two mainly. The majority of ex-certified farmers (153) have been certified once in 2007, the year the number of certified producers was the highest. Our intuition is that compliance is not a very heavy burden in the case of lychee producers in Madagascar. They must follow one or two training per year. They are sometimes but not always inspected. They do not seem constrained by the collector, at least not more than other producers. Some of them benefit from cash advance loans. Required infrastructure built for certification can be sheds to store lychees, water-points, water pump, latrines alongside fields, and fences.

V. Results

a. What are the determinants of farmer participation in certification?

In order to identify the main characteristics of farmers that make them more likely to be chosen by exporters who seek certification, we use data collected on farmers who have never experienced certification in order to compare them to farmers who were certified in 2009 or had been certified at least once before 2009 – the so-called ex-certified farmers. Conditional probabilities for certification are computed by estimating a probit model, which includes all variables X, as shown in equation (2). Note that we apply model (2) to a sample which includes farmers who have never been certified, because we want to detect to what extent they differ from farmers who have already been certified. However, because we run the survey on never-certified farmers having a large number of lychees and living in the neighborhood of certified farmers, we may not be able to show the importance of either the geographical location or the productive potential. Results of the probit regression are displayed in Table 2. As expected, they show no significant effect of the distance to Tamatave. On the other hand, the number of oldest trees remains higher for farmers who have already experienced certification compared to others. Moreover, it appears that both the level of education (the dummy takes on value 1 if the farmer has at least completed elementary school) and the ability of the farmer to reach the treatment plant play an important role in the selection process.

b. Does certification increase marketing performances of certified farmers?

We now turn to the impact analysis. In accordance with our identification strategy, we apply the propensity score matching to a sample which includes certified and ex-certified farmers only. From the equation of participation (2), the propensity scores are calculated for each farmer of the sample. Propensity scores are first used to define the common support, i.e. the subset of certified farmers for which the density of ex-certified farmers with similar level of X is high enough. To do so, we apply the standard procedure (Todd, 2007): after excluding points for which the estimated density is zero, we exclude an additional small percentage of the remaining points for which the estimated density is positive but very low. The graph of the distribution of propensity scores suggests that densities are high enough for a wide range of propensity scores (see Figure 1), which is the expected result in our framework, where the participation in certification varies with some unplanned events such as financial support from donors that happens to be exogenous. Matching procedure is considered successful when significant differences of covariates X among certified and ex-certified are removed.

We test the balancing property following the algorithm proposed by Becker and Ichino (2002) and conclude that it is satisfied[8].

Main results on the impact in terms of quantities sold by certified farmers are displayed in Table 3. Description of the estimators used is given in Table 12. All estimators indicate that currently certified producers sell larger quantities than their matched counterparts (ex-certified).[9] In 2009, they sold about 4.5 tons, which is 1 to 1.4 tons (depending on the estimator considered) more than what they would have sold, had they remained outside the certification system. As explained before, various scenarios may explain such a result. We thus run additional estimates which aim to challenge them when it is possible with available data. First, we run identical estimations on the subset of farmers who carry their lychees to Tamatave themselves (see Table 5). We estimate even higher impacts for this subgroup, while nothing significant can be detected for the subset of farmers who sell at the farm gate (Table 6). These results suggest that the 1-ton-impact we estimate based on the whole sample is driven by the Tamatave group only. Table 4 gives the mean level of the outcome (the quantity sold to the main buyer) in each group reaching Tamatave. It shows that certified farmers (on the common support) sold about 7.3 tons in 2009, which means that they would have sold only 5.6 tons had they been uncertified (see the estimated mean level of outcome in the control group, column 4). Because applying the DID-matching estimator to outcome levels amounts to apply the matching estimator to outcomes in difference, we can also interpret the estimated impact in terms of variations over the period 2005-2009: we observe an increase of 2 tons in the certified group while we would have observe an increase of 0.3 tons in the absence of certification.

We also apply the DID-matching estimator to the probability that a farmer sells all his lychees to the same buyer, and detect a significant impact for subgroup of farmers who go to Tamatave while we failed to detect any significant impact for the certified group that sell at the farm gate (Tables 7 and 8). Both results are consistent with the hypothesis that certified farmers who reach Tamatave may have priority to the treatment plant and have the opportunity to sell larger quantities.[10] On the other hand, it seems that certified farmers who sell to the collector at the farm gate do not benefit from certification since the probability that they sell all their products to the same buyer is not significantly higher compared to a situation without certification. Finally we apply our identification

[8] Becker and Ichino algorithm splits the sample into k equally spaced intervals of the propensity score. Then within each interval, it tests that the average propensity score of treated and control units does not differ. If the test fails in one interval, it splits the interval in half and tests again. In our analysis, the final number of blocks is 5. It ensures that the mean propensity score is not different for treated and controls in each block.

[9] Note that we run OLS regressions on the full sample, without excluding any certified farmers, contrary to what we must do when applying matching estimators.

[10] This is in line with qualitative evidence according to which some of the sulfur treatment plants have specific sorting lines for certified products.

strategy to the probability that farmers irrigate their lychees and estimate that such probability is significantly higher for certified farmers compared to a situation without certification (Table 9). This seems to be in line with the hypothesis that certified farmers have the opportunity to improve their production thanks to GlobalGap infrastructure, and yet we cannot conclude about this given that the observed outcome is a dummy which takes on value 1 if the farmer states that he irrigates his trees in 2009 and else zero. Indeed, such variable does not capture any *change* in agricultural practices, meaning that we cannot exclude that this difference between groups was already significant in 2005.
Finally, our results fail to show with precision that on average currently certified producers receive higher prices than what they would have received had not they been certified (see Tables 10 and 11). These results confirm previous qualitative evidence which indicates that certification does not guarantee price premium at the exporter level either.

VI. Conclusion

It has only been a few years since the private standard GlobalGap has been introduced in the Malagasy lychee value chain. Since roughly the year 2005, under pressure from some European importers, many exporters have chosen to intensify relations with small-scale farmers and have assisted them in achieving GlobalGap certification. Indeed, in contrast with countries where farmers seeking certification have to pay for it, in Madagascar certification costs have been entirely supported by exporters themselves, often with financial support and technical assistance from donors and trade facilitators. This has entailed an unexpected situation, characterized by a boom in the number of certified farmers when development programs started, followed by a disengagement of some exporters, who have chosen to opt out of the GlobalGap compliance process as soon as financial supports ended. Taking advantage of this very specific context which takes the form of a natural experiment, we aim at understanding all potential mechanisms through which Malagasy farmers may benefit from GlobalGap standards and assessing consequences on their marketing performances using original dataset.

Econometric analysis indicates that, compared to the farmers who were never GlobalGap certified the lychee farmers who have been GlobalGap certified at least once have a higher productive potential and higher marketing performances. They are also more likely to reach Tamatave by themselves to sell their products and remain part of a kind of professional network. Moreover, our results suggest a positive impact of certification on quantities sold by certified farmers. On average, currently certified producers sell larger quantities than their matched counterparts. In 2009, they sold about 4.5 tons of lychees, i.e. 1 ton more than what they would have sold, had they not been uncertified. Conversely, our results fail to show that currently certified producers receive higher prices. Such results are thus not much encouraging from a development point of view. Indeed, the impact estimated by our study is concentrated on the most successful lychee farmers, i.e. those who are able to comply with exporters requirements and to bring the lychees to the treatment plant by themselves. As more and more farmers enter the GlobalGap market, it is unsure what the benefit for farmers would be. It seems however that GlobalGap has enabled lychee exporters to consolidate the value chain in a very competitive and highly unstable international market.

Finally, as far as European consumers are concerned, it is as yet quite difficult to assess the benefits associated with the GlobalGap standard. Following positive controls made by importers on lychee samples arriving into the European Union for sulfur residues, stakeholders have taken steps to ensure full compliance with public food safety regulations.[11] However, some important issues remain. For example, traceability is not fully and thoroughly enforced, as side-selling seems to be a frequent practice. Indeed, several exporters mention accepting lychees from uncertified farmers (previously certified?) who are hence integrated into the GlobalGap market through informal arrangements and sourcing practices that are far from transparent.

VII. References

Abadie, A.; Drukker, D.; Herr, J. L. & Imbens, G. W. (2004), 'Implementing matching estimators for average treatment effects in Stata', Stata Journal 4(3), 290-311.

Asfaw, S.; Mithofer, D. & Waibel, H. (2007), 'What Impact Are EU Supermarket Standards Having on Developing Countries Export of High-Value Horticultural Products? Evidence from Kenya'(7870), Technical report, European Association of Agricultural Economists.

Asfaw, S.; Mithöfer, D. & Waibel, H. (2010), 'Agrifood supply chain, private-sector standards, and farmers' health: evidence from Kenya', Agricultural Economics 41(3-4), 251-263.

Barrett, C. B.; Bachke, M. E.; Bellemare, M. F.; Michelson, H. C.; Narayanan, S. & Walker, T. F. (2011), 'Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries', World Development(article in press).

Chemnitz, C.; Grethe, H. & Kleinwechter, U. (2007), 'Quality Standards for Food Products - A Particular Burden for Small Producers in Developing Countries?'(7926), Technical report, European Association of Agricultural Economists.

Codron, J.-M.; Giraud-Heraud, E. & Soler, L.-G. (2005), 'Minimum quality standards, premium private labels, and European meat and fresh produce retailing', Food Policy 30(3), 270-283.

Dolan, C. & Humphrey, J. (2000), 'Governance and Trade in Fresh Vegetables: The Impact of UK Supermarkets on the African Horticulture Industry', The Journal of Development Studies 37(2), 147-176.

---

[11] The Programme Initiative Pesticides, together with the European Union, a Guidefor Auto-Control in the Lychee Value Chain to help all stakeholders respect Maxidmum Residue Limits for sulphur. For more, see the page: http://www.ctht.org/docs/GSAC-Litchi-GEL-V1-nov-2011.pdf

Freidberg, S. (2007), 'Supermarkets and imperial knowledge', Cultural Geographies 14(3), 321-342.

Graffham, A.; Karehu, E. & MacGregor, J. (2007), 'Impact of EurepGAP on small-scale vegetable growers in Kenya', Technical report, Fresh Insights number 6.

Hammoudi, A.; Hoffmann, R. & Surry, Y. (2009), 'Food safety standards and agri-food supply chains: an introductory overview', European Review of Agricultural Economics 36(4), 469-478.

Heckman, J.; Ichimura, H.; Smith, J. & Todd, P. (1998), 'Characterizing Selection Bias Using Experimental Data', Econometrica 66(5), 1017-1098.

Heckman, J. J.; Ichimura, H. & Todd, P. E. (1997), 'Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme', Review of Economic Studies 64(4), 605-54.

Henson, S. & Humphrey, J. (2010), 'Understanding the Complexities of Private Standards in Global Agri-Food Chains as They Impact Developing Countries', The Journal of Development Studies 46(9), 1628-1646.

Henson, S.; Masakure, O. & Cranfield, J. (2011), 'Do Fresh Produce Exporters in Sub-Saharan Africa Benefit from GlobalGAP Certification?', World Development 39(3), 375 - 386.

Jiang, Y., L. Yao, A. Lichter, J. Li, 2003. "Postharvest biology and technology of lychee fruit", Food, Agriculture & Environment, 1(2) : 76-81.

Leuven, E. & Sianesi, B. (2003), 'PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing', Statistical Software Components, Boston College Department of Economics.

Maertens, M. & Swinnen, J. F. (2009), 'Trade, Standards, and Poverty: Evidence from Senegal', World Development 37(1), 161 - 178.

Maret, F.Anderson, K. & Masters, W. A., ed., (2009), Distortions to agricultural incentives in Africa, World Bank Publications, chapter Madagascar, pp. 101-125.

Mausch, K.; Mithofer, D.; Asfaw, S. & Waibel, H. (2009), 'Export Vegetable Production in Kenya under the EurepGAP Standard: Is Large More Beautiful than Small?', Journal of Food Distribution Research 40(3).

Minten, B.; Randrianarison, L. & Swinnen, J. F. (2009), 'Global Retail Chains and Poor Farmers: Evidence from Madagascar', World Development 37(11), 1728 - 1741.

Ouma, Stefan, 2011. "Global Standards, Local Realities: Private Agrifood Governance and the Restructuring of the Kenyan Horticulture Industry, Economic geography, 86(2):197–222.

Ramananarivo, R., S. Ramananarivo, A.O. Mahafeno, H. Imbiky, L.J. Raharijaona, 2011. "The fruit farmers' challenges and the globalgap norms requirements. toamasina, Madagascar", ISHS Acta Horticulturae 911

Swinnen, J. & Vandemoortele, T. (2009), 'Are food safety standards different from other food standards? A political economy perspective', European Review of Agricultural Economics 36(4), 507-523.

Thierry, B. & Schneider, E. (2007), 'Etude de cas programme pays Madagascar - Filiere Lychee', Technical report, Programme de Promotion des Revenus Ruraux.

Todd, P. E. (2007), Chapter 60 Evaluating Social Programs with Endogenous Program Placement and Selection of the Treated, in T. Paul Schultz & John A. Strauss, ed., , Elsevier, , pp. 3847 - 3894.

Will, 2011. « GlobalGAP smallholder group certification - Challenge and opportunity for smallholder inclusion into global value chains, In Bernd M. and J. van der Meulen (Eds.) *Private food law: Governing food chains through contract law, self-regulation, private standards, audits and certification schemes*, Wgaeningen: Wageningen University Press.

Vagneron, I.; Faure, G. & Loeillet, D. (2009), 'Is there a pilot in the chain? Identifying the key drivers of change in the fresh pineapple sector', Food Policy 34(5), 437 - 446.

World Bank (2007), 'Les implications structurelles de la libéralisation sur l'agriculture et le développement rural', Technical report, Programme RuralStruc.

Table 1: Descriptive statistics

Variable	Certified farmers			*Ex-certified farmers*			Other lychee farmers		
	Obs	Mean	Std. Dev.	*Obs*	*Mean*	*Std. Dev.*	Obs	Mean	Std. Dev.
time as a certified farmer (years)	72	2,5	1,2	*232*	*1,4*	*0,6*	201	0,0	0,0
family size (nb of people)	72	5,6	1,8	*232*	*5,4*	*2,0*	201	5,2	2,2
head of hh age (years)	72	49,7	13,2	*232*	*49,5*	*11,7*	201	52,5	14,5
head of hh education (takes value 1 if has at least completed elementary school)	72	0,7	0,5	*232*	*0,4*	*0,5*	201	0,3	0,5
land size (ha)	72	9,2	18,4	*232*	*5,2*	*4,3*	200	5,7	5,9
non-agricultural activity (yes=1; no=0)	72	0,6	0,5	*232*	*0,6*	*0,5*	201	0,5	0,5
rice area (ha)	72	0,5	0,8	*232*	*0,7*	*1,4*	201	0,4	1,0
cassava area (ha)	72	0,2	0,4	*232*	*0,4*	*0,7*	201	0,6	0,9
maize-sorgho area (ha)	72	0,4	0,9	*232*	*0,5*	*0,8*	201	0,3	0,7
nb of lychee trees (1 to 4 years of age)	72	28,4	64,6	*232*	*15,7*	*25,5*	201	15,3	25,1
nb of lychee trees (5 to 7 years of age)	72	6,0	20,7	*232*	*10,4*	*29,9*	201	6,6	15,9
nb of lychee trees (8 to 15 years of age)	72	15,4	36,8	*232*	*6,8*	*14,6*	201	8,3	27,7
nb of lychee trees (16 to 30 years of age)	72	12,0	20,1	*232*	*10,1*	*21,0*	201	7,4	12,7
nb of lychee trees (more than 30 years of age)	72	28,3	40,1	*232*	*12,4*	*18,3*	201	6,6	13,8
sold quantity to main buyer (kg)	72	6708,4	7577,0	*231*	*2649,6*	*3093,7*	201	1932,2	4704,8
minimum price received (Ar/kg)	72	350,4	171,5	*232*	*319,1*	*152,4*	201	246,2	112,9
maximum price received (Ar/kg)	72	651,6	285,9	*232*	*558,5*	*180,8*	201	446,1	163,5
lychee tree maintenance (yes=1; no=0)	72	1,0	0,2	*232*	*1,0*	*0,1*	201	0,9	0,2
irrigation (yes=1; no=0)	72	0,2	0,4	*232*	*0,1*	*0,3*	201	0,1	0,3
transport of lychee to Tamatave is supported by the farmer (yes=1; no=0)	72	0,5	0,5	*232*	*0,4*	*0,5*	201	0,1	0,2
distance from community to Tamatave (km)	67	121,2	62,9	*221*	*109,6*	*53,7*	195	122,9	76,1
has a written contract with the buyer (yes=1; no=0)	72	0,8	0,4	*232*	*0,6*	*0,5*	201	0,0	0,2
member of producers association (yes=1; no=0)	72	0,8	0,4	*232*	*0,9*	*0,3*	201	0,3	0,4
know GlobalGap certification process (yes=1; no=0)	72	1,0	0,0	*232*	*1,0*	*0,0*	201	0,0	0,2
main buyer provides equipment and/or vehicle (yes=1; no=0)	72	0,1	0,3	*232*	*0,1*	*0,3*	201	0,0	0,0
main buyer provides cash advance loans	72	0,6	0,5	*232*	*0,6*	*0,5*	201	0,2	0,4

required infrastructure built for certification : a shed to store lychees (yes=1; no=0)	72	0,5	0,5	*232*	*0,9*	*0,3*	-	-	-
required infrastructure built for certification : a water-point (yes=1; no=0)	72	0,2	0,4	*232*	*0,5*	*0,5*	-	-	-
required infrastructure built for certification : a water pump (yes=1; no=0)	72	0,1	0,3	*232*	*0,2*	*0,4*	-	-	-
required infrastructure built for certification : latrines alongside fields (yes=1; no=0)	72	0,4	0,5	*232*	*0,7*	*0,5*	-	-	-
required infrastructure built for certification : a fence (yes=1; no=0)	72	0,2	0,4	*232*	*0,1*	*0,3*	-	-	-
nb of inspections incurred	72	2,5	2,2	*232*	*1,8*	*1,6*	-	-	-
nb of training sessions	72	2,4	1,5	*231*	*1,6*	*0,9*	-	-	-

Table 2: Determinants of farmers' participation in certification process: marginal effects from probit regression

	dy/dx	Std.	z		P>z	[95% C.I.]	
head of hh education	0,112	0,051	2,200	**	0,028	0,012	0,212
nb of lychee trees (1 to 4 years of age)	0,000	0,001	-0,040		0,972	-0,002	0,002
nb of lychee trees (5 to 7 years of age)	0,001	0,001	0,850		0,398	-0,001	0,004
nb of lychee trees (8 to 15 years of age)	-0,001	0,001	-1,010		0,314	-0,004	0,001
nb of lychee trees (16 to 30 years of age)	0,001	0,002	0,360		0,718	-0,003	0,004
nb of lychee trees (more than 30 years of age)	0,005	0,002	3,040	***	0,002	0,002	0,008
nb of lychee trees lost in natural disaster	0,003	0,004	0,810		0,419	-0,004	0,010
workforce 2005	0,003	0,002	1,300		0,194	-0,001	0,006
early produce area*	0,040	0,072	0,550		0,582	-0,102	0,181
contract with exporter*	0,131	0,100	1,310		0,192	-0,066	0,328
distance to Tamatave	0,000	0,000	-0,380		0,702	-0,001	0,001
transport of lychee to Tamatave*	0,416	0,042	9,790	***	0,000	0,332	0,499
sold quantity to main buyer (kg)	0,000	0,000	-1,370		0,169	0,000	0,000

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Table 3: Impact of certification on sold quantity to the main buyer (ATT on all certified farmers)

estimator	att	se	stat	
nnm_4_ps	1303,4	568,0	2,29	**
nnm_4_x	1087,7	603,4	1,80	*
psm_kernel	1292,2	565,7	2,28	**
psm_llr	1335,4	587,9	2,27	**
ols_ps	1431,7	439,6	3,26	***
ols_x	1454,6	377,8	3,85	***

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Table 4: Mean outcomes by groups that reach Tamatave to sell lychees

	treated				untreated		controls
	(1)		(2)		(3)		(4)
	n	all	n	support	n	all	
level	35	9936	20	7272	100	3957	5580
diff	35	1549	20	1963	99	-119	271

Note: The sample includes certified farmers reaching Tamatave to sell their products. Column (1) gives the level of quantity sold in the certified farmers' group; column (2) gives it for the farmers' group on the common support; column (3) gives it for ex-certified farmers; column (4) gives the estimated value of the counterfactual level, given the smallest ATT estimated (att=1692, see Table 5).

Table 5: Impact of certification on sold quantity to the main buyer (ATT on certified farmers reaching Tamatave)

estimator	att	se	stat	
nnm_4_ps	1692,1	817,2	2,07	**
nnm_4_x	2016,5	1076,6	1,87	*
psm_kernel	2186,2	788,8	2,77	***
psm_llr	2111,7	1147,8	1,84	*
ols_ps	2556,5	705,7	3,62	***
ols_x	1950,1	725,9	2,69	***

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Table 6: Impact of certification on sold quantity to the main buyer (ATT on certified farmers selling at the farm gate)

estimator	att	se	stat
nnm_4_ps	1119,4	952,2	1,18
nnm_4_x	221,7	752,2	0,29
psm_kernel	686,3	883,7	0,78
psm_llr	482,6	783,8	0,62
ols_ps	380,2	535,2	0,71
ols_x	435,1	497,6	0,87

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Table 7: Impact of certification on the probability to sell all baskets to the same buyer (ATT on certified farmers reaching Tamatave)

estimator	att	se	stat	
nnm_4_ps	0,26	0,10	2,60	***
nnm_4_x	0,25	0,15	1,67	*
psm_kernel	0,25	0,11	2,22	**
psm_llr	0,26	0,11	2,40	**
ols_ps	0,35	0,11	3,28	***
ols_x	0,31	0,13	2,38	**

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Note: because of data availability, we use cross-sectional matching instead of DID-matching.

Table 8: Impact of certification on the probability to sell all baskets to the same buyer (ATT on certified farmers selling at the farm gate)

estimator	att	se	stat
nnm_4_ps	-0,12	0,13	-0,94
nnm_4_x	-0,13	0,12	-1,10
psm_kernel	-0,05	0,11	-0,49
psm_llr	-0,02	0,13	-0,18
ols_ps	-0,08	0,10	-0,80
ols_x	0,04	0,11	0,36

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Note: because of data availability, we use cross-sectional matching instead of DID-matching.

Table 9: Impact of certification on the probability to irrigate (ATT on all certified farmers)

estimator	att	se	stat	
nnm_4_ps	0,18	0,07	2,68	***
nnm_4_x	0,18	0,07	2,57	***
psm_kernel	0,19	0,06	2,96	***
psm_llr	0,18	0,06	2,84	***
ols_ps	0,14	0,05	2,80	***
ols_x	0,14	0,05	2,86	***

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.
Note: because of data availability, we use cross-sectional matching instead of DID-matching.

Table 10: Impact of certification on maximum price received (ATT on all certified farmers)

estimator	att	se	stat	
nnm_4_ps	57,59	49,11	1,17	
nnm_4_x	78,26	38,58	2,03	**
psm_kernel	68,82	44,56	1,54	
psm_llr	66,74	45,70	1,46	
ols_ps	70,08	33,91	2,07	**
ols_x	69,75	20,93	3,33	***

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Table 11: Impact of certification on minimum price received (ATT on all certified farmers)

estimator	att	se	stat	
nnm_4_ps	33,21	29,56	1,12	
nnm_4_x	22,64	24,06	0,94	
psm_kernel	27,06	30,63	0,88	
psm_llr	19,84	33,12	0,60	
ols_ps	37,80	23,32	1,62	
ols_x	38,74	17,38	2,23	**

Note: *att* is the estimated ATT; *se* is the standard error; Three asterisks *** (resp. **, *) denote rejection of the null hypothesis (att=0) at the 1% (resp. 5%, 10%) significance level.

Table 12: Definition of estimators

Name	Definition
NNM_PS_4	nearest neighbor matching (propensity score)
NNM_X_4	nearest neighbor matching (covariates)
PSM_Kernel	kernel matching
PSM_LLR	local linear matching
OLS_X	OLS (covariates)
OLS_PS	OLS including (propensity score)

Figure 1: Density of propensity scores by group