High Value Supply Chains, Food Standards and Poor Farmers in Developing Countries:

The Case of Vegetable Exports From Senegal

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Introduction

Global trade in high-value agricultural products, such as fresh and processed fruits and vegetables (FFV), is increasing (Maertens and Swinnen, 2006). Especially in developing country exports these high-value products are gaining importance: their share in total agricultural exports from developing countries increased from 21% in 1980 to 41% in 2000 (Aksoy and Beghin, 2005). Despite the fact that participation in international trade is generally recognized to favour economic development, a recent debate in the literature casts doubt on the beneficial effect of high-value agricultural trade for developing countries. It is argued that new product and process standards for food quality and safety imposed by high-income countries introduce new barriers for developing country exports and are diminishing the gains from trade (Augier et al, 2005; Brenton and Manchin, 2002; Unnevehr, 2000). Moreover, some studies mention that high-value agricultural trade may do little for the fate of poor farmers as they are likely to be excluded from high-value supply chains while the rents in the chain are extracted by multinational companies and developing country elites (Dolan and Humphrey, 2000; Farina and Reardon, 2000; Reardon et al, 1999).

Empirical studies on the impact of high-value agricultural trade and tightening food standards have focussed on the question of poor farmers' participation as primary suppliers in high-value food chains and have presented a mixed picture. Several studies indicate that because of tough quality and safety standards high-value horticulture production and marketing increasingly originates from large industrial estates and that small farmers are increasingly excluded as suppliers to high-value markets (E.g. Reardon et al., 2003; Kirsten and Sartorius, 2002; Weatherspoon et al., 2001; Reardon and Barrett, 2000; Delgado, 1999; Key and Runsten, 1999; Gibbon, 2003; Weatherspoon and Reardon, 2003; Dolan and Humphrey; 2000; Kherallah,

2000). Very different findings come from a study by Minten et al (2006) on Madagascar and by Minot and Ngigi (2004) on Kenya, which find that a large share of FFV exports from these African countries is grown by small farmers on a contract-base. Apart from the contentious issue of poor farmers' participation in high-value supply chains, also the welfare effects of such participation remains an unresolved matter – that has received less attention in the empirical literature. Some studies find that small farmers included as contracted-suppliers in high-value food chains do gain from this (e.g. Minten et al, 2006). However, the overall welfare effects of high-value FFV trade in terms of rural income mobility, income equality and poverty reduction have rarely been assessed and quantified. Humphrey, Mc Culloh and Ota (2004) argue that a shift away from smallholder FFV production towards estate production is likely to contribute to an enhanced poverty-reducing impact of high-value agricultural trade because of new employment opportunities on estate farms. Yet, empirical evidence of such welfare effects are lacking.

This paper studies the welfare effects of high-value FFV exports from Senegal to the EU. We analyze how the structure of the export supply chain has changed in response to tightening food standards and investigate the impact for the local population. The study yields four important findings. First, we find that public and private food standards in the EU have lead to increased consolidation and increased vertical coordination in the FFV supply chain with a shift away from smallholder contract-based production to integrated estate production. Second, these structural changes have increased the participation of rural households, and especially poorer households, in the supply chains through wage employment on FFV estates. Third, we find that household participation in FFV export production, whether through contract-farming or through estate wage employment, generates significant income gains.

Fourth, high-value FFV trade has a major impact on rural poverty-reduction and the increasing prevalence of food standards is even enhancing this impact.

The structure of the papers is as follows. In a next section we describe the supply chain for FFV exports from Senegal to the EU and the importance of food standards in that chain. In section three we illustrate how the data for this study have been collected. In section four we analyse how the structure of the FFV export supply chain and household participation therein has changed. We analyse the welfare effects of these changes on the basis of a comprehensive econometric model in section five and with a simulation model in section six. Finally, we present the main conclusions and implications from our study.

High-value FFV exports from Senegal and EU Food Standards

FFV play a central role in Senegal's recent strategy of export diversification towards high-value export commodities. Exports of FFV from Senegal increased sharply over the past 15 years: from 2,700 ton in 1991 to 16,000 ton in 2005 (figure 1). The period of the sharpest growth was after 1997. During this period, the export of French beans alone increased from 3,300 ton to almost 7,000 ton. It now still represents almost half (42%) of the total volume FFV exports. Aside from beans, other major export crops include cherry tomatoes (23%) and mangoes (16 %).

Apart from some small volumes exported to neighboring countries, FFV are exported to the EU; in particular to France (40%), the Netherlands (35%) and Belgium (16%). Senegal ranks fourth as an external supplier of French beans to the EU, after Morocco, Egypt and Kenya. A quality premium is paid for French beans from Senegal. The EU buys Senegalese beans at a price that is about 70% higher then for beans imported from Egypt or Morroco (Eurostat, 2005). In addition, the price per

ton has increased – from 1,752 Euro in 2000 to 1,952 Euro in 2004 – while transport costs have decreased substantially due to a shift from air cargo to maritime transport. The validation of the label *Origine Sénégal* by the Senegalese government might have played an important role in this quality-upgrading.

FFV exports to the EU have to satisfy a series of stringent public and private food quality and safety standards. First, the EU legislation imposes high public standards concerning food quality and food safety for FFV. These include (1) the common marketing standards for FFV[1]; (2) phytosanitary measures such as maximum residue levels; (3) general hygiene rules based on HACCP control mechanisms; and (4) traceability requirements. These latter two requirements came into force since the General Food Law of 2002. Traceability regulations imply agro-food businesses within the EU to document from/to whom they are buying/selling produce such that products can be traced back to their origin in case of food safety problems. Food standards have become more stringent during the past years: e.g. new regulations concerning the phytosanitary treatment of wooden packaging material and maximum levels of contaminations by heavy metals apply since 2005 and 2002 respectively.

Second, in addition to these public standards, many large trading and retailing companies have engaged in establishing private food standards that are even stricter. For example the Euro-Retailer Produce Working Group (Eurep) has engaged in adapting traceability (and other) standards into the EurepGAP certification protocols. They increasingly require such certification from their overseas suppliers.

[1] Commission Regulation (EC) No 912/2001, an amendment of EC No 2000/96, specifies a classification for French beans based on quality and size, and stipulates provisions concerning the presentation and marketing of the beans.

The study area and data collection

To measure the impact of these developments we collected information at three different levels. First, we collected statistics on horticulture production and exports from existing data sources and conducted a series of qualitative interviews with experts, stakeholders and organizations.

Second, in April 2005, we conducted quantitative and structured interviews with nine of the 20 horticulture exporting companies in the Dakar region. This sample constitutes a mixture of firms recently entering the market and older companies, and a mixture of smaller and larger exporters who jointly represent 44 % of the exported volume French beans (table 1).

Third, we organized a large household survey in *Les Niayes* – the main horticulture zone in Senegal from which the majority (over 90%) of exported French beans originate. The majority of the population in this area are horticulture farmers producing a large variety of vegetables for the local market and French beans for export. In August – September 2005, we implemented a quantitative survey that covered 300 households in 25 randomly selected villages in two administrative regions – Dakar and Thiès – in the research area. The sample includes 159 households who do not participate in the export supply chain for French beans and 141 households who do participate. The latter group includes 82 households who have one or more household members employed as wage workers on agro-industrial FFV farms and 59 households who cultivate French beans on contract with an exporting company – and who might also have members employed as wage workers (24) or not (35). The sample was stratified on whether or not households hold a contract for French bean production, which resulted in and over sampling of these contract-farmers. To take into account the sampling design and draw correct inferences we use, in all

subsequent analyses, sampling weights that are calculated with information gathered at the village level.

In table 2 we present some key features of the household sample. There is a high degree of poverty among the sampled households: the average per capita household income is about 560,000 FCFA and 40% of the households live below the national rural poverty line of 181,770 FCFA a year[2] (table 2). However, the degree of poverty in the research area is much lower than the national poverty rate which is estimated at 48% for the country as a whole and at 57% for the rural population (République du Sénégal and Banque Mondial, 2004). Agriculture is by far the most important economic activity – constituting on average more than 70% of total household income. The average farm size among the sampled households is 4.6 ha, which is close to the national average of 4.3 ha in the survey year 1998/99 (Eastwood et al., 2006). About three fourths of the cultivated land is irrigated, either manually or with more advanced irrigation systems. Average household size is rather large with 16 members, which is typical for African rural households who live in extended families. Another striking feature is the general low level of education: 80% of the sampled household-heads have no formal education at all.

Impact of growth in high-value exports and standards

Structural changes in the export supply chain

The increasing and changing public and private food standards in the EU put pressure on FFV exporters in Senegal to stay up to date with the changing legislation and private standards and to make additional investments in order to comply with

[2] The national rural poverty line for Senegal was calculated from the ESAM II survey (*Enquête Sénégalaise auprès des Ménages*) that was conducted in 2001-2002. This national rural poverty line of 181,770 FCFA per year corresponds to 0.9669 USD/day and is hence close to the international poverty line of 1 USD/day (République du Sénégal and Banque Mondiale, 2004).

those standards. These growing demands also increase the need for tighter coordination in the high-value chains and have lead to important structural changes in the export supply chain for FFV in Senegal, with major implications for the Senegalese farmers. Key structural changes in the supply chain are increased consolidation at the level of the agro-exporting industry as well as at the level of primary producers; and increased vertical coordination with downstream buyers in the EU as well as with upstream suppliers. This translates into a decreasing volume of French beans that is procured from small farmers and an increase in vertically integrated FFV estate production.

Consolidation in the export sector

In fact, since 2000, the export sector is increasingly concentrated with smaller exporters dropping out. In 2002, French beans were exported through 27 companies. This number decreased to 24 in 2004 and in 2005 only 20 firms remained. During the last season in 2005, the three largest companies exported two thirds of the total volume of French beans, while in 2002 their market share was slightly less than half. This consolidation is at least partly the result from increasing EU food standards.

Because of financial constraints, only larger exporters are able to comply with stringent food standards. Since 1994, most exporters were organized in SEPAS (*Syndicat des Exportateurs des Produits Agricoles*). This organization coordinates the transport of FFV by plane or ship, provides market information – including information on food standards – and assists its members in the contact with overseas buyers. However, following the increasing EU standards, the seven largest FFV exporters founded the organization ONAPES (*Organisation National des Producteurs Exportateurs de Fruits et Légumes de Sénégal*) in 1999. One of their specific aims

was to comply with traceability standards and become EurepGAP certified. Four ONAPES companies are in our sample. Among these firms one – *Sepam* – is EurepGAP and HACCP certified (since 2004). Two other ONAPES firms – *Soleil Vert* and *Baniang* – and one SEPAS firm – *Agriconcept* – are in the process of certification and made substantial investments for this in the past couple of years. The remaining exporting companies, mainly smaller companies, are not certified, not in the processing of becoming certified and not undertaking particular investments in the scope of certification.

Increased vertical coordination

Vertical coordination increased, both downstream and upstream. First, the FFV exporting companies – especially larger firms – increasingly engage in tighter coordination with downstream importers and wholesalers in the EU market. Smaller exporters deal with importers through indicative agreements on the supplied quantity, which are not binding for either of the parties. Larger exporters have recently changed from such indicative agreements to more binding contracts with overseas buyers, which specify a fixed (minimum) price, the quantity to be delivered, the time of delivery and sometimes also include pre-financing to the suppliers. Among the reasons mentioned by exporting companies to engage in such tighter coordination are the volatility of prices in the EU market and the incidence of produce refusal by importers.

Second, to guarantee food quality and safety throughout the supply chain and to assure accurate timing of production and harvesting exporting firms – especially larger firms – increasingly rely on tighter vertical coordination with upstream suppliers of primary produce. This increased vertical coordination occurs in two

ways. The first is through more elaborate production contracts and tighter coordination within those contracts. Contracts signed with small family farms are typically specified for one season and indicate the area to be planted (usually 0.5 or 1 ha), all technical requirements and the price. As part of the contract, the firms provide technical assistance and inputs to the farmers; especially seeds and chemicals, sometimes also cash credit. Some firms go as far in contract-coordination as the complete management of fertilizer and pesticide application and daily or weekly inspection of the farmers' fields. Also field preparation, planting and/or harvesting can be coordinated and financed completely by the exporting firm. Especially larger exporters provide pre-financing and apply tighter contract-coordination while smaller exporters leave management decisions to the farmers. The most extreme case of contract-coordination is *Sepam*, who manages the whole production on farmers' land except for irrigation and harvesting.

A second, and even more radical, change towards vertical coordination is the shift from contract-farming with smallholders to large-scale estate production on agro-industrial farms. Larger exporters are increasingly engaging in fully integrated estate production on land that they buy or rent. In fact, the ONAPES exporting companies have agreed among themselves that each member should seek to be present in the market every season with a volume of at least 200 ton FFV and that at least 50% of the volume should originate from the companies own estate production – a measure that is having a profound impact on the structure of the export supply chain. Three firms in our sample have already substantially reduced procurement through contract-farming with smallholders: from 100% in their first year of operation to respectively 60% and 20% in the last season (table 2), in favor of integrated estate production. The companies cited quality rather than quantity to be the reason for this

change. Even firms that still fully rely on contract-farming mentioned fully integrated production to be an important strategy for compliance with food standards in the future and hence for the survival and growth of the firm.

Increased household participation

The participation of rural Senegalese households in high-value export markets increased dramatically. Our household survey data reveal that there has been a sharp increase in the overall participation of local households in the French bean export supply chain, from less than 10 % in 1992 to about 40 % in 2005 (figure 2). This increase has had major positive welfare implications for the rural population – as we will analyze in detail in the next sections. A simple comparison between participating and non-participating households already reveals that there is a large difference in per capita income: 391,000 FCFA for non-participants compared to 815,000 FCFA for participants.

However, as a result of supply chain restructuring, the nature of increased household participation in the export chain, and its effects on household well-being, differed strongly in the 1990s from more recent years. During the second half of the 1990s households increasingly participated in export production through contract-farming (figure 2). In 2000, an estimated 24% of local households in the research area produced French beans on contract with an exporting firm. However, from 2000 onwards, while household participation grew further, this was mostly through wage employment in the agro-industry while contract-farming decreased (figure 2). Employment in the French bean agro-industry has increased sharply from less than 10% of local households in 2000 to 35% in 2005. Yet, at the same time, the share of contract-farmers among the local population decreased from 24% to 8.5%. The survey

data indicate that in the period 2000-2005, 80 % of contract-farmers lost their contract. The firms with whom these farmers signed contracts either started their own estate production (e.g. *Sepam* and *Soleil Vert*) or exited the market. Among the reasons these farmers mention for the dissolution of their contract, 76% indicate the exporting firm to have ended the contract and do not always know the reasons why.

Hence, in summary, participation of rural farm households in high-standards FFV production continues to increase but their role is shifting from contract-farmers to estate workers. A comparison of total and per capita income across households indicates that household income for estate wage workers is more than twice as high and for contract-farmers more than four times higher compared to the income of non-participating households (table 3). This suggests the shifted nature of household participation has implications for the distribution of rural incomes. However, a more thorough analysis is need to attribute income differences to the participation in high-value export supply chains; which is done in the next sections.

Finally, an important issue is which households are participating in high-value export production through contract-farming and through wage employment, and which households are excluded. As a result of increased standards and supply chain restructuring, the smallest contract-farmers – with less land and agricultural equipment (table 4) – were excluded from contract-farming. Yet, more and more poorer households were included as estate wage workers. The figures in table 3 indicate that estate wage workers have less livestock and less non-agricultural equipment than non-participating households while there is no difference in landholdings, in the share of irrigated land and in agricultural equipment between those households. On the other hand, contract-farmers have higher landholdings, a higher share of irrigated land, more productive assets to cultivate the land and more

livestock (table 3). Both contract-farmers and agro-industrial employees have more labor endowments and a larger share of them is found in the Dakar region. So, both relatively better-off households and poorer households are involved in high-value FFV production but the former rather through contract-farming and the latter through estate wage employment.

Econometric analysis

Selection and treatment bias

The figures mentioned above suggest that household income for contract-farmers and for agro-industrial employees is substantially higher than the income for non-participating households. However, based on a simple comparison of means in table 3, it is impossible to satisfactorily attribute these differences in income to the impact of contracts with exporters and of employment on FFV estates. Contract-farmers might earn a higher income even if they had not participated in contract-farming because they hold larger amounts of productive assets such as land and livestock. Similarly, households participating in agro-industrial wage employment might earn higher incomes because they have larger labor endowments. A regression model is needed to disentangle these effects. Moreover, there might be unobservable factors (managerial ability, household preferences, etc.) that simultaneously enhance household income and increase the likelihood of a household to have a contract or to be employed in the FFV industry. Due to this self-selection problem, OLS regression models would lead to biased estimates and a more advanced econometric technique is needed.

We control for self-selection bias by using a treatment effects model (Wooldridge, 2001). We define a categorical variable that takes the outcomes $m = 0$,

1, 2, for three subgroups of households: non-participating households, estate wage workers, and contract-farmers respectively. For each subgroup of households, or for each treatment *m*:

$$Y_m = \alpha_m + \beta_m X_m + \mu_m, \qquad m = 0, 1, 2 \qquad (1)$$

where Y_m is the income of households receiving treatment *m*; and X_m a vector of exogenous variables assumed to affect household income. Because we are mainly interested in how income differs across *m* – measured by the coefficient α – and for simplicity, we restrict the model by imposing that β is equal across the different treatments. Using notation *i* to indicate individual households the model reduces to:

$$Y_i = \alpha M_i + \beta X_i + \mu_i \qquad (2)$$

where the treatment variable M_i is a vector of dummy variables for each outcome *m* = 0, 1, 2. Due to self-selection of treatment, M_i cannot be assumed to be exogenous and self-selection bias needs to be corrected for.

The specified model differs from a standard treatment effects model in that the treatment variable has more than two possible outcomes. In a binary treatment effects model, the self-selection of treatment is corrected for with a propensity score – which is the conditional probability of treatment, usually estimated using probit or logit regression models – a method pioneered by Rosenbaum and Rubin (1983). Resolving the selectivity bias in our model with three possible outcomes of the treatment variable is more complex and we use a solution that has been proposed by Bourguignon, Fournier and Gurgand (2002)[3]. These authors show that the coefficients

[3] Lee (1983) first described a method to the case where selectivity is modeled as a multinominal logit but as shown by Bourguignon et al. (2002) the results rely on fairly restrictive assumptions. Bourguignon et al. (2002) provide an alternative method for selectivity bias correction based on a multinominal logit model under the usual parametric assumptions. The selectivity correction function proposed by Bourguignon et al. (2002) involves all correlation coefficients between the disturbance

in equation (1) can be consistently estimated using a selectivity correction function as in equation (3):

$$Y_m = \alpha_m + \beta_m X_m + \left[\gamma_m q(P_m) + \sum_{s \neq m} \gamma_s \frac{P_s}{(P_s - 1)} q(P_s) \right] + \mu_m \qquad (3)$$

with P_m the conditional probability of treatment m and $q(P_m)$ an integral function of this probability. The probabilities P_m are conditioned by a set of exogenous variables Z_i and can be estimated by a multinominal logit (MNL) model (4):

$$P(M_i = m \mid Z_i) = \frac{\exp(\phi_m Z_i)}{1 + \sum_s \exp(\phi_s Z_i)} \qquad (4)$$

From estimating the MNL model (4) we derive the fitted probabilities P_m for each treatment m; we use these to construct selectivity correction functions for each treatment as in equation (3); include these functions in equation (2) and consistently estimate the coefficients α and β by least squares. With this method we obtain consistent estimators of the coefficients in the model but not of the standard errors as the two-step nature of the procedure is not accounted for in the least squares regression. Therefore, as proposed by Bourguignon, Fournier and Gurgand (2002), we use a bootstrap method to get robust standards errors and hypothesis testing.

The estimation of the treatment effects model in a two-stage procedure does not only address the issue of selection bias in correctly estimating the income effects but also yields insights into the determinants of household participation in high-value export production through contract-farming and estate wage employment. Both issues, the determinants of household participation and the effect of participation on household income, are important for analyzing the income and equity effects of trade in high-value commodities.

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term of the outcome equation of interest and the disturbance terms of all categorical latent expressions in the multinominal logit model whereas this is not the case in the method proposed by Lee (1983).

Expected effects and hypotheses

Our main interest is in the coefficients α_1 and α_2 of the two dummy variables m_1 and m_2 representing agro-industrial wage laborers and contract-farmers respectively. We hypothesize that both have a positive effect on Y or, in other words, that high-standards export production has a positive effect on rural incomes, whether it is realized through estate farming and associated rural employment or through contract-farming with smallholders. Other variables in the second stage of the model are a vector of exogenous variables X that are assumed to affect household income. These include physical assets – the area cultivated (*land*), the share of land under irrigation (*irrigation*), total livestock holdings (*livestock*), the value of farm and non-farm equipment (*eq_agr* and *eq_nonagr*) – and households' labor endowments (*labor*). As these productive endowments increase the income generating capacity of a household, we expect all these variables to have a positive effect on *Y*. We additionally include unearned income (*inc_unearned*) as an explanatory variable in the regression as this directly increases income irrespective of households' productive endowments.

In the first stage MNL model, the probability of household participation in contract-farming and estate wage employment is conditioned by a vector of exogenous variables *Z*. We include the following variables as elements of *Z*: *land, irrigation, livestock*, *eq_agr, eq_nonagr, labor, education* – the education level of the household, and *region* – a dummy variable for location in the Dakar region. In the literature it is often mentioned that processing and exporting firms prefer to contract with larger farms – as this reduces transaction costs – and with wealthier and better educated farmers – as these require less financial and technical assistance from the contractor-firm (Swinnen, 2005). Based on this argumentation, we expect the

variables *land, irrigation, eq_agr, labor* and *education* to increase the probability of contract-farming relative to no participation. The variable *region* is expected to have a positive effect in both equations of the multinominal logit model. Most FFV exporters are located in the Dakar region and therefore transaction costs related to contract-farming and transport costs related to estate employment are smaller for households living in this region.

Results and discussion

The results of the two stage estimation procedure are given in table 5 - the first stage MNL regression – and table 6 – the second stage OLS regression corrected for selectivity bias.

Explaining household participation in high-standards production

The results of the first stage MNL regression confirm that contract-farming is biased towards better-off (albeit still small) farmers with more productive assets while wage employment on FFV estates is undertaken by rather poorer, larger and lower educated households. This results directly from the estimated effects. First, households with more labor, more land and a higher share of irrigated land have a higher probability to be involved in FFV contract-farming with an exporting firm (table 4). So, FFV contract-farmers are the relatively better-off households among the rural smallholder population with more land and access to an irrigation system. Second, households with more labor, a lower education and less productive equipment have a higher probability of being involved in wage employment on FFV estates (table 4). Hence, wage employment on FFV estates is not directed to better-off households but rather to poorer and lower educated households.

These findings imply that household participation in the high-value export supply chain for French beans did not only increase sharply – as discussed above (figure 2) – but also turns out to be more equitable with the shift from smallholder contract-farming to integrated estate farming and associated employment after 2000. Despite the fact that the smallest farmers among the contract-farmers are excluded from French bean contract-farming; participation in this high-value export supply chain became more equitable as it includes more and poorer households as wage workers on agro-industrial estates.

The results empirically validate, on the one hand, the often heard argument in the literature that the smallest and poorest farmers are excluded from high-standards contract-farming and the benefits thereof (e.g. Reardon et al., 2003; Weatherspoon and Reardon, 2003; Kirsten and Sartorius, 2002; Reardon and Barrett, 2000; Gibbon, 2003; Weatherspoon et al., 2001; Farina and Reardon, 2000; Kerrallah, 2000; Delgado, 1999; Key and Runsten, 1999; Reardon et al., 1999) and on the other hand provide more general insights. The main reasons mentioned in the literature for the exclusion of the smallest farmers from high-value contract-farming are the high transaction costs in dealing with many small farmers and the difficulties in monitoring quality and safety standards (Key and Runsten, 1999; Swinnen, 2005). Our analysis shows that indeed smaller contract-farmers were excluded as a result of increased food standards and supply chain restructuring but that this is only a partial outcome. The overall outcome is an increased participation of rural households and of poorer households in high-standards supply chains, not through contract-farming but through agro-industrial employment.

Other effects in the MNL regression have the expected sign but are statistically not significant, except for the positive effect of the dummy variable

region. This effect means that location in the Dakar region – closer to agro-exporting firms – increases the probability of participating in high-value export production, whether through contract-farming or through wage employment, and indicates that transport and transaction costs are important in explaining participation in high-value export production.

Impact of participation in high-standards production on household income

The results of the second stage regression model show that participation in high-value FFV production, whether through estate wage employment or through contract-farming, significantly increases household income. After correction for selectivity bias we find that FFV estate workers and contract-farmers have incomes that are respectively 1.4 million and 3 million FCFA higher than for non-participating households (table 6) – or respectively about 60% and 120% higher than the average household income in the region[4].

These highly significant and large effects on household income demonstrate that rural households involved in high-value supply chains, do share in the gains from high-value export production. This is a key empirical finding as it has repeatedly been argued in the literature that the gains from high-value agricultural trade are captures by foreign investors and developing country elites (e.g. Dolan and Humphrey, 2000; Farina and Reardon, 2000; Reardon et al, 1999). Especially contract-farming has often been criticized to be a tool for agro-industrial firms and food multinationals to exploit unequal relationships with farmers and extract rents from high-value supply chains (Warning and Key, 2002). However, some recent empirical studies have demonstrated

[4] The income effect of contract-farming is significantly larger than the income effect of estate wage employment. There are many possible explanations for this that could be explored in a more detailed analysis.

the beneficial effect of contract-farming (e.g. Swinnen, 2005; Dries and Swinnen, 2004) and high-value agricultural trade (e.g. Gulati et al., 2006; Minten et al., 2006) for rural households in low-income countries. Our case-study from Senegal does not only add to this recent empirical evidence but additionally demonstrate that high-value agricultural trade benefits rural incomes even if it is realized through integrated estate farming and associated rural employment rather then through contract-farming. This result challenges the implicit assumption underlying some empirical studies that high-standard food production needs to integrate farm households as primary suppliers in the value chain if such production needs to benefit rural incomes. Our results show that also households involved as wage workers reap significant, albeit smaller, benefits from high-value agricultural production than contract-farmers do.

Finally, the coefficients of all other variables in the second stage regression have the expected sign and are statistically significant, except for the variable *livestock*. Households with more land, a higher share of irrigated land, more farm and non-farm equipment, and more labor[5] have higher incomes. A possible explanation for the insignificant effect of livestock holdings on household income is that it is important as a store of wealth rather than a productive asset in the research region.

Overall welfare effects

The findings from the econometric analysis demonstrate that high-value agricultural trade significantly adds to rural incomes but that the effect is smaller if household participation in the high-value supply chain is realized through estate wage employment rather then through contract-farming. Moreover, we find that contract-farming is biased towards relatively better-off farmers while wage employment on

[5] Labor endowments have a positive but decreasing effect on household income. A plausible explanation for this is the existence of intra-household free-riding in larger households.

FFV estates is undertaken by rather poorer households. Hence, the overall welfare effects for the local population in terms of an equitable distribution of income and poverty reduction are still ambiguous.

To understand the overall welfare implications of high-value agricultural trade, increased EU food standards and subsequent supply chain restructuring in Senegal, we simulate household income based on the estimated coefficients α and β (equation 2), for two hypothetical cases. In the first case both treatments m – contract-farming and estate wage employment – are set to 0, which corresponds to the case if there would be no French bean exports at all. For the second case treatments m are set according to household participation in contract-farming and estate wage employment in 2000. This second case simulates a situation in which there would have been no further expansion of French bean exports after 2000, no supply chain restructuring and in which the sector is dominated by smallholder contract-production. This case resembles the absence of increasing EU food standards and subsequent changes[6].

For these two hypothetical cases we estimate total household incomes based on the estimated coefficients in the previous regression model, use these estimates to calculate per capita incomes and derive poverty indicators and compare the results with the actual situation. The results of this simulation, displayed in table 7, are striking. First, high-value export horticulture reduces poverty by 17% in the research area. Without the possibility for rural households to participate in high-value FFV contract-farming and wage employment on FFV estates, the incidence of poverty in the region would have been 57 % – which equals the average rural poverty rate for Senegal – while actual poverty is only 40% (table 7). This is an extremely large and

[6] This simulation might suffer from overestimation as well as underestimation of household income. On the one hand, in the absence of increasing food standards French bean exports from Senegal might have grown faster and hence benefited more households. On the other hand, without strict food standards there might have been no quality upgrading and price increases in French bean exports and hence income gains would have been lower.

important effect; much larger than the overall reduction in rural poverty in Senegal from 66% in 1995 to 57% in 2002 (République du Sénégal and Banque Mondiale, 2004). The welfare impact of agricultural trade for poor households in developing countries has been debated a lot but not many studies have been able to quantify that effect as we have done here.

Second, we find that increased EU food standards and the subsequent shift away from smallholder contract-farming in favor of integrated estate farming has further contributed to an increased poverty-alleviating impact of high-value agricultural trade. The simulated case without increased food standards and supply chain restructuring results in a poverty rate of 44%, which is 4% higher than the actual incidence of poverty (table 7). This is again an extremely important empirical finding. Increasing food standards and a shift away from smallholder production are generally seen as particularly detrimental for the poverty situation in developing countries (e.g. Farina and Reardon, 2000; Kherralah, 2000; Reardon et al, 1999). Our findings for Senegal challenge this view and empirically prove that increased food standards can even enhance poverty reduction.

Third, high-standards exports do not only decrease the incidence of poverty, it also sharply decreases the severity of poverty. If there would have been no French bean exports, the poverty-gap-ratio in the region would be 1.43 while the actual poverty-gap-ratio is 0.66 (table 7). Moreover, the poverty-gap-ratio would have been much higher in the absence of increased food standards and subsequent supply chain restructuring. This means that on top of households moving out of poverty, high-value trade, food standards and the shift to estate farming also contribute to poor households moving closer to the poverty line. This adds to the previous findings and indicates that

more people are likely to evade poverty if high-standards exports can be sustained or expanded in the future.

Fourth, high-value trade increases average total and per capita income. Actual average per capita income is about 570,000 FCFA while it would have been only about 400,000 FCFA if households would not have the possibility to participate in high-value export production (table 7). However, a situation where export production is largely based on smallholder-contract production – as it was before food standards induced structural changes in the supply chain – would slightly increase average income to 600,000 (table 7). This difference is statistically not significant and is very small as against the huge reduction in poverty.

Implications

The results from our study show that high-value agricultural trade significantly benefits rural incomes and importantly contributes to reducing rural poverty. The analysis further shows that, contrary to the conventional arguments in the literature, increased food standards have resulted in a more equitable distribution of the income gains from trade among the rural smallholder population and in an enhanced poverty reduction. These findings imply that high-value agricultural trade – increasingly subject to stringent food standards – is an engine of pro-poor economic growth in developing countries. A key policy message is that developing countries should seek to be included in these high-value, high-standards supply chains.

The recent literature pays much attention to food standards imposed by high-income countries as technical (and scientifically justified) barriers for developing countries and for small businesses and poor farmers in these countries to participate in and gain from high-value trade. Our case-study however, demonstrates that increased

food standards do not necessarily lead to the exclusion of the weakest players in the supply chain but can entail new opportunities for the rural poor and actually be a catalyst for enhanced welfare. Increasing food standards undoubtedly put pressure on food supply chains and therefore an emphasis on supply chain dynamics is essential for exploiting new opportunities. Governments can play a proactive role in this: e.g. by refraining from policies that impede agro-businesses strategic responses and supply chain restructuring; by facilitating and promoting investment in high-value agro-industrial sectors; by paying attention to the strategic location of agro-businesses in poverty-prone areas, etc.

Conclusion

In recent years the FFV export sector in Senegal became increasingly concentrated at the level of the agro-exporting industry as well as at the level of primary producers, and increasingly vertically coordinated with downstream buyers in the EU as well as with upstream suppliers. There has been a shift away from smallholder contract-based production towards production on estate farms owned by large exporting companies. These structural changes in the FFV supply chain are (partially) driven by intensified public and private food standards in export markets.

Based on conventional arguments in the literature, one could expect these recent developments to be particularly bad from a rural development and pro-poor growth perspective. The comprehensive econometric analysis in this paper shows that this is not all the case. We find that with the restructuring of the supply chain, more households and more poor households participate in and share in the gains from high-value export agriculture through wage employment on vertically integrated estate

farms. These new opportunities have enhanced the equitable distribution of rural incomes and the poverty situation in the research area.

The overall conclusion of our study is that high-value agricultural production and trade – increasingly subject to stringent food standards – entails important opportunities for pro-poor economic growth in developing countries while and that an emphasis on supply chains dynamics is essential for exploiting these opportunities.

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Tables

Table 1: Characteristics of selected agro-exporting firms

Company name	Export volume in 2004 (ton)		Year entering Frecnh bean export	organisation membership
	French beans	other crops		
Soleil Vert	800	1100	2000	ONAPES[1]
Sepam	883	1410	1992	ONAPES
Master	68	0	1989	ONAPES
Baniang	80	150	1999	ONAPES
Agriconcept	100	80	2002	SEPAS[2]
ANS Interexport	64	0	2001	SEPAS
Pasen	30	0	2000	SEPAS
Agral Export	180	0	1992	SEPAS
PDG	173	239	1993	SEPAS

[1] ONAPES – Organisation National des Producteurs Exportateurs de Fruits et Légumes de Sénégal

[2] SEPAS – Syndicat des Exportateurs des produits Agricoles

Source: Authors interviews

Table 2: Changes in procurement system of selected agro-exporting firms

Company name	% of supply from contract-farming		Number of contracted farms	
	1st year of operation	last season	household farms (< 10 ha)	commercial farms (> 50 ha)
Soleil Vert	100	20	40	1
Sepam	100	60	50	2
Master	50	40	n.a.	n.a.
Baniang	85	85	n.a.	n.a.
Agriconcept	30	30	n.a.	n.a.
ANS Interexport	100	100	50	0
Pasen	100	60	8	0
Agral Export	100	100	30	0
PDG	100	100	45	0

n.a.: data not available

Source: Authors interviews

Table 3: Household characteristics for participants and non-participants in FFV export supply chains

Variables	Description	whole sample	non-participants	participants		
				total	wage laborers	contract-farmers
		(N=297)	(N=156)	(N=141)	(N=82)	(N=59)
Income						
income	Total household income (1000 FCFA)	2,471	1,467	3,970	3,384	6,100
inc_capita	Income per capita**** (1000 FCFA)	561	391	815	639	1,453
Physical assets						
land	Cultivated area (ha)	4.612	4.351	4.999	4.427	7.046
irrigation	Share of land under irrigation (%)	75.0	73.6	77.0	74.7	85.1
livestock	Livestock holdings (units *)	2.109	2.064	2.175	1.651	4.047
eq_agr	Value of farm equipment (1000 FCFA)	137.4	130.7	147.5	116.0	260.1
eq_nonagr	Value of non-farm equipment (1000 FCFA)	45.06	64.64	15.96	9.44	39.27
Human capital						
labour	Labour endowments **	7.423	6.724	8.461	8.476	8.407
education	Dummy for primary education ***	0.635	0.635	0.636	0.634	0.644
Location						
region	Dummy for Dakar region	0.563	0.506	0.648	0.659	0.610

* One livestock unit equals 1 cow, 0.8 donkey and 0.2 sheep or goat

** Labour endowments include all household members between the age of 12 and 60 who are able to work

*** Education is 1 for household-heads or any other member in the household having finsihed primary education

**** Per capita income is calculated using adult equivalent measures

Source: Authors survey

Table 4: Household characteristics for former and current contract-farmers

Variables	Description	contract-farmers: former	current
		(N=49)	(N=59)
Physical assets			
land	Cultivated area (ha)	3.924	7.046
irrigation	Share of land under irrigation (%)	81.2	85.1
livestock	Livestock holdings (units *)	2.755	4.047
eq_agr	Value of farm equipment (1000 FCFA)	139.5	260.1
eq_nonagr	Value of non-farm equipment (1000 FCFA)	47.83	39.27
Human capital			
labour	Labour endowments **	7.918	8.407
education	Dummy for primary education ***	0.673	0.644
Location			
region	Dummy for Dakar region	0.653	0.610

* One livestock unit equals 1 cow, 0.8 donkey and 0.2 sheep or goat

** Labour endowments include all household members between the age of 12 and 60 who are able to work

*** Education is 1 for household-heads or any other member in the household having finsihed primary education

Source: Authors survey

Table 5: Explaining participation: 1st stage regression results from a multinominal logit model

			Number of obs	297
			F(16, 280)	3.7200
			Prob > F	0.0000
Variables	Coefficient	odds ratio	Std. Err.	t statistic
AGRO-INDUSTRIAL EMPLOYMENT (*m* =1)				
land	0.0059	1.0059	0.0351	0.17
irrigation	0.0006	1.0006	0.0038	0.16
livestock	-0.0386	0.9622	0.0476	-0.81
eq._agr	-0.0004	0.9996	0.0007	-0.5
eq._nonagr.	-0.0018	0.9982	0.0009	-2.03**
labour	0.2271	1.2549	0.0500	4.54***
education	-0.4470	0.6396	0.3255	-1.37
region	0.8368	2.3090	0.3250	2.57***
constant	-2.4741		0.5825	-4.25
CONTRACT_FARMING (*m* =2)				
land	0.0856	1.0894	0.0287	2.98***
irrigation	0.0116	1.0117	0.0055	2.13**
livestock	0.0236	1.0238	0.0257	0.92
eq._agr	0.0006	1.0006	0.0006	0.96
eq._nonagr.	-0.0003	0.9997	0.0006	-0.57
labour	0.1367	1.1465	0.0605	2.26**
education	-0.0308	0.9696	0.3813	-0.08
region	0.9932	2.7000	0.3815	2.6***
constant	-5.0504		0.6989	-7.23

Significance level: *** 1%; ** 5%; *10%; and ° 15%

The outcome no participation (*m* =0) is used as the basecategory; the estimated coefficients of the other outcomes (*m* =1 and *m* =2) have to be interpreted relative to the basecaterory

Source: Author survey

Table 6: Impact of participation on income: 2nd stage regression results from an OLS regression

Number of obs	297
F(16, 280)	23.24
Prob > F	0
R-squared	0.2626

Variables	Coefficient	OLS estiamtes		Bootstrap estimates[1]	
		Std. Err.	t statistic	Std. Err.	t statistic
unearned income	0.926	0.051	18.01***	0.405	2.28**
land	325.6	171.8	1.89*	45.94	7.09***
irrigation	22.61	14.30	1.58°	3.572	6.33***
eq._agr	3.925	3.825	1.03	1.300	3.02**
eq._nonagr	3.722	4.512	0.82	2.088	1.78*
livestock	-35.85	178.7	-0.20	47.38	-0.76
labour	887.0	557.3	1.59°	197.9	4.48***
labour^2	-57.26	36.65	-1.56°	12.04	-4.76***
m_1 (wage employment)	1,419	827.5	1.72*	269.8	5.26***
m_2 (contract-farming)	3,051	1,257	2.43**	221.9	13.75***
corr_funct_m_1	16,868	22,165	0.76	8,653	1.95*
corr_funct_m_2	-11,360	31,964	-0.36	14,350	-0.79
corr_funct_m_3	6,778	8,952	0.76	2,789	2.43**
corr_funct_m_{12}	43,205	94,805	0.46	40,512	1.07
corr_funct_m_{13}	-4,481	50,383	-0.09	17,080	-0.26
corr_funct_m_{23}	-5,952	62,903	-0.09	25,145	-0.24
constant	-738.2	125,602	-0.01	51,870	-0.01

Significance level: *** 1%; ** 5%; *10%; and ° 15%

Note: the selectivity correction functions, corr_func_m_x, to account for self-selection bias of treatment m=0, 1, 2 were calculated from a multinomnial logit model.

[1] To account for the two-step nature of the procedure, standard errors are estimated using the bootstrap method with 50 bootstrap replications and bootstrap samples seleceted within each stratum of the original survey design.

Source: Author survey

Table 7: Poverty indicators for two alternative simulations, compared with the actual situation

	av. household income (1,000 FCFA)	av. per capita income (1,000 FCFA)	poverty head-count ratio	poverty gap ratio
Scenerio A	1,831	401	57%	1.44
Scenerio B	2,610	600	44%	1.22
Actual situation	2,545	573	40%	0.66

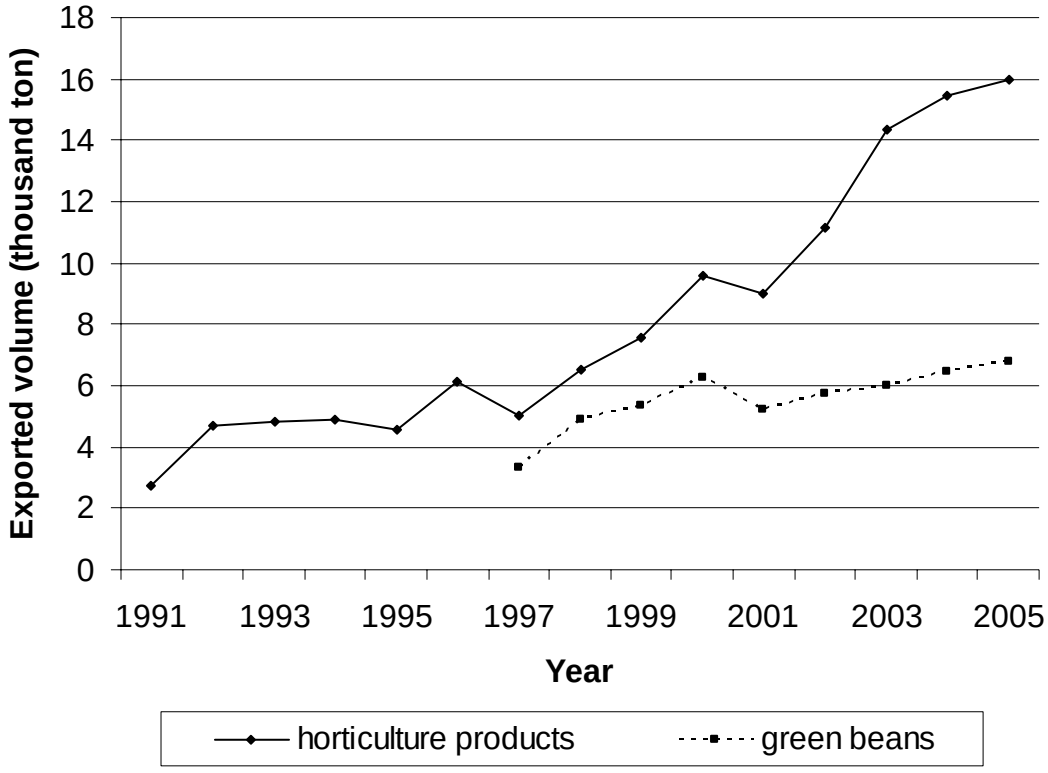
Scenerio A: no French bean exports at all

Scenerio B: French bean exports based on smallholder contract-farming as in 2000

Source: Author survey

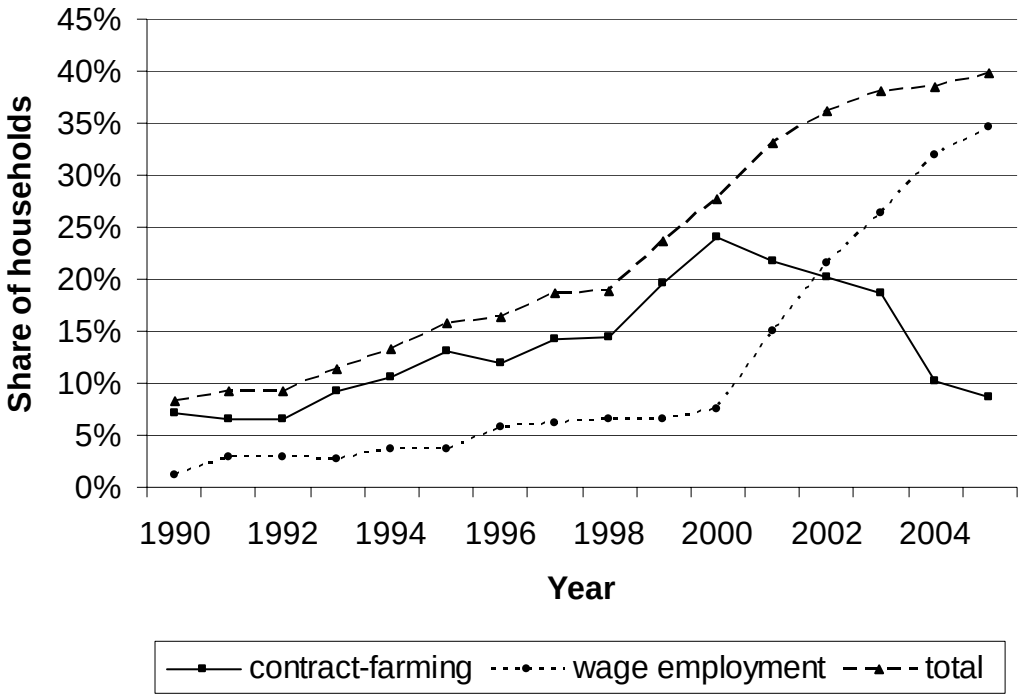
Figures

Figure 1: Exported volume (1,000 ton) of horticulture products from Senegal, 1987 - 2005



Source: calculated from DH – Direction de l'Horticulture (2005)

Figure 2: Share of households participating in French bean production through wage employment or contract-farming



The figure is based on recall data from a sample of 300 households in 2005. To account for demographic effects, households for which the household head did not reach the age of 25 in a particular year and households who migrated to the area only after a particular year were excluded from the figures for that year. To account for biases due to sampling design, sampling weights were used in the calculations.

Source: Calculated from survey data