

# What price precaution? European harmonisation of aflatoxin regulations and African groundnut exports

Tsunehiro Otsuki, John S. Wilson and Mirvat Sewadeh

*The World Bank, Washington, DC, USA*

Received October 2000, final version accepted May 2001

## Summary

The effects of varying regulatory standards on trade in agricultural products are at the forefront of policy debate. This paper employs a gravity model to estimate the impact of changes in aflatoxin standards on trade flows of groundnut products using trade data for Europe and Africa during 1989–1998. Results suggest that a 10 per cent tighter aflatoxin standard in European countries will reduce edible groundnut imports by 11 per cent. A new European Union regulation on aflatoxins will result in a trade flow that is 63 per cent lower than when the Codex Alimentarius international standards are followed.

**Keywords:** EU food safety regulation, Africa, groundnuts, aflatoxins standards, gravity model

**JEL classification:** F14, Q17

## 1. Introduction

Growing concern among both regulators and consumers about food safety and environmental protection led to revisions in sanitary and phytosanitary standards in a number of industrialised countries during the 1990s. Public debate and concern about the health risks of food, use of new technologies such as genetically engineered organisms, and levels of sanitary standards have been especially prominent in Europe. The European Commission has also increasingly relied on the ‘precautionary principle’ to drive policy. This principle suggests that scientific uncertainty about specific risks to human health or safety provides a legitimate basis for regulation and action to ban or restrict certain activities, including imports. Many developing countries that rely on agricultural production and access to international export markets to drive national income view these issues very differently. Agricultural exporters in regions such as Africa and the Middle East regard the increased

The views and interpretations expressed in this paper are those of the authors and do not necessarily represent the views and policies of the World Bank or of its Executive Directors or the countries they represent.

use of import bans and harmonisation of regulatory standards as protection that exceeds the level indicated either by international trade law or sound science. Moreover, compliance requirements on exporters impose costs on developing countries, such as the cost of upgrading production systems, processing and storage equipment, and quality control stations. Henson *et al.* (2000) outline many of these specific challenges in detail.

Developing countries have had difficulty meeting increasing compliance requirements for food imports (Finger and Schuler, 1999). The increasing number of complaints at the World Trade Organisation (WTO) made by developing countries about sanitary and phytosanitary standards imposed by industrialised countries partly reflects this difficulty (Wilson, 2000). The dispute over the use of hormones in beef between the US and Europe, and a WTO ruling in 1999 that the European import ban lacked a sound scientific basis, represents one of the most highly charged examples. Recent changes in European regulation of a toxic substance found in foodstuffs (aflatoxin) provide another important case study of the balance between risk, safety and exports of an important agricultural product by developing countries. This paper attempts to quantify the trade effect of standards on certain products. It does not seek to explore whether one level of regulatory stringency should be preferred over another.

The EU announced the harmonisation of maximum allowable aflatoxin levels in imported foodstuffs in 1998. It is useful to identify how these types of standards affect trade flows and to identify forgone export revenue and impact on consumer welfare. As reviewed in Maskus and Wilson (2001), the empirical evidence and information on the trade impact of standards is extremely limited. Although the importance of providing estimates of how standards affect trade flows is clear, little baseline information has been produced to inform trade policy decision-making. We address this deficiency through a case study based on empirical analysis.

The difficulty of providing economic indicators of the trade impact of standards lies partly in the limited availability of information on exact regulatory requirements and data. Most studies have relied on hypothetical simulation-based analyses rather than on statistical analysis (e.g. Calvin and Krissoff, 1998; Paarlberg and Lee, 1998). Furthermore, the economic literature on standards and other non-tariff barriers remains limited, compared with the vast stock of studies of the impact of tariffs on trade and welfare. The analytical framework for understanding the role of standards and the relation to trade is thus not adequately established.

This paper seeks to improve understanding of the specific impact of regulatory standards on trade. We develop an econometric method to measure the trade flow effect of standards imposed by importers' domestic regulation. On the basis of the results, we estimate potential export revenue gains and losses that result from changing standards. We focus on trade in groundnut (peanut) products. We examine trade data on groundnut oil, groundnuts for consumption (edible groundnuts) and groundnut seeds between 14 member states of the EU, Switzerland, and nine African countries between 1989 and 1998.

The EU legislation to harmonise aflatoxin standards was to be effective in April 2002 (European Commission, 2001). We predict its potential impact on trade flows, and compare it with trade patterns under conditions where international standards set by the joint FAO–WHO (Food and Agriculture Organisation–World Health Organisation) Codex Alimentarius (Codex)—the body charged with the development of international standards for food safety and consumer protection—are implemented.

Groundnuts are widely grown in developing countries and are consumed directly, or indirectly through their oil. Groundnut products for direct consumption include roasted and salted peanuts, peanut butter and chocolate-based products. They are also one of the most important oilseeds used in agriculture worldwide (International Trade Forum, 1999).

Exports of groundnuts and related products are important for African countries. The value of African exports of groundnut products totalled US\$230 million or 2 per cent of its total agricultural exports in 1998 (FAO, 1998).<sup>1</sup> Submissions to the WTO by several African countries responding to the EU regulation demonstrated a gap between the required standards and the level that they are currently capable of complying with, given available technologies and current farming practices. Europe is the most important market for African countries. The EU market took on average two-thirds of groundnut exports from African countries between 1989 and 1998 (United Nations COMTRADE Records). Therefore, standards imposed on these products are of great concern to African countries.

This paper also examines the effect of past colonial ties between Europe and Africa, as their residual effect on trade should be separated from that of standards. Links between the UK, France, Portugal and their former colonies in Africa may still significantly affect trade patterns and this effect could be confused with the effect of regulatory standards. Therefore, we control for past colonial ties, to obtain unbiased estimates of the effect of the standards on trade.

The paper is organised as follows. Section 2 discusses risk assessments and what we know about the science of aflatoxins. This section also reviews the aflatoxin standards in EU member countries before harmonisation. It then outlines the new European Commission regulation on maximum aflatoxin levels and sampling procedure on foodstuffs, with particular focus on groundnut products. Section 3 presents an econometric model and evaluates potential impact of tightening aflatoxin standards on groundnuts trade. It also examines how this impact has been changing over time. Section 4 conducts a simulation analysis on trade flows associated with varying the level of aflatoxin standards, and compares trade outcomes under the harmonised EU aflatoxin standards and an international standard. Section 5 reviews some policy implications based on our empirical results.

1 This estimate is based on the average EU prices of groundnut products in 1998.

## 2. Background to aflatoxin regulation

### 2.1. Health implications of aflatoxins

Aflatoxins are a group of structurally related toxic compounds that contaminate certain foods and lead to the production of acute liver carcinogens in the human body. Aflatoxins are commonly produced by fungal growth in cereals, nuts, fruits and vegetables. The major aflatoxins of health concern are designated B1, B2, G1 and G2, and these toxins are usually found together in foodstuffs. Aflatoxin B1 is usually predominant and is the most toxic of the four categories. It has been identified in corn and corn products, groundnuts and groundnut products, cottonseed, milk, and tree nuts such as Brazil nuts, pecans, pistachio nuts and walnuts (UNDP–FAO, 1998). Aflatoxins were discovered in 1960 following the deaths of 100,000 turkeys in the UK and high incidences of liver disease in ducklings in Kenya and hatchery trout in the USA (US Food and Drug Administration, 2000).

A 1997 report by the Joint FAO–WHO Expert Committee on Food Additives (JECFA) concluded that ‘aflatoxins should be treated as carcinogenic food contaminants, the intake of which should be reduced to levels as low as reasonably achievable’. The JECFA analysed the potential human health impact of aflatoxins for two hypothetical levels (10 parts per billion (ppb) and 20 ppb). It is estimated that reducing the standard from 20 ppb to 10 ppb in countries where the percentage of carriers of hepatitis B is around 1 per cent, as is the case in EU member states, would result in a drop of the population risk of approximately two cancer deaths per year per billion people.<sup>2</sup>

Until 1997, members of the EU implemented different standards for aflatoxins in groundnuts. The stringency of the standards varied across countries. France and Denmark, for instance, set the standard for Aflatoxin B1 at 1 ppb, whereas Portugal had its standard at 25 ppb.

In 1997, a European Union regulation (European Commission, 1997) first set a uniform standard for aflatoxins at a maximum acceptable level of 10 ppb in groundnuts subject to further processing, and at 4 ppb in groundnuts intended for direct human consumption. In 1998, the EU Regulation was then amended (European Commission, 1998a) by relaxing the total aflatoxin standard in groundnuts subject to further processing at 15 ppb (8 ppb for Aflatoxin B1), and at 4 ppb (2 ppb for Aflatoxin B1) in groundnuts intended for direct human consumption. An EU Directive (European Commission, 1998b) also established sampling and analytical methods for the control of the levels for contaminants in groundnut products. The EU regulation set a date of 1 January 1999 by which the EU members were to implement the

2 The JECFA estimated that if a 10 ppb total aflatoxin standard is implemented, population potency is 39 cancer deaths per year per billion people, with uncertainty range between seven and 164 people. In comparison, a 20 ppb standard will yield potency rates equal to 41 cancer deaths per year per billion people, with uncertainty range between eight and 173 cancer deaths. This implies that the 20 ppb standard will lead to two additional cancer deaths per billion people compared with the 10 ppb standard. The estimates assumed a population with 1 per cent carriers of hepatitis B (i.e. European population) and used potency values equal to 0.3 cancers per year per 100,000 people among carriers of hepatitis B and 0.01 cancers per year per 100,000 population among non-carriers.

necessary laws to comply with the new standards. The enactment date was then revised to 5 April 2002 (European Commission, 2001).

The new EU aflatoxin standards were tighter than those that had been implemented in most EU members. For eight EU members (Belgium, Greece, Ireland, Italy, Luxembourg, The Netherlands, Spain, Sweden), the regulation meant that they must reduce the acceptable aflatoxin levels in their imports of groundnuts by more than 50 per cent.

The new EU regulation triggered serious concerns among exporters of food products subject to the announced regulations. Many exporting countries, including Bolivia, Brazil, Peru, India, Argentina, Canada, Mexico, Uruguay, Australia and Pakistan, requested that the European Union provide the risk assessment on which it had based its proposed standard (WTO, 1998c). In comments submitted to the WTO, a representative of The Gambia maintained that the proposed standard would 'effectively restrict entry of The Gambia's groundnuts and essentially the groundnuts from producer countries in the developing world to the EU' (WTO, 1998a). The representative of Peru emphasised that the measure constituted 'an unjustifiable trade barrier and a violation of the Agreement on Sanitary and Phytosanitary Standards' (WTO, 1999).

## **2.2. How does the European standard compare with international standards?**

Australian standards for total aflatoxins in groundnuts subject to further processing, and those intended for direct human consumption, are set at 15 ppb and 5 ppb, respectively. The USA adopts 20 ppb as the maximum level for the contaminant. The EU standard has a more stringent regulatory effect than those in other developed countries, because standards are specifically set for Aflatoxin B1.

Although the EU standards for total aflatoxins are 15 ppb in groundnuts for processing and 4 ppb in groundnuts for direct consumption, the EU standards for Aflatoxin B1 in these two categories of product are set at 8 ppb and 2 ppb, respectively. These levels are more stringent than those set by Codex, which does not establish a separate standard for B1 but assumes that approximately 70 per cent—or around 10 ppb of the total aflatoxin level of 15 ppb—is usually accounted for by Aflatoxin B1. Therefore, the international standard suggests that products that contain levels of Aflatoxin B1 as high as 10 ppb would be acceptable for both types of groundnuts, as long as the total level of aflatoxins does not exceed 15 ppb. Similarly, the US standard, which is set at 20 ppb for both types of groundnut products, would effectively allow B1 contamination levels that are as high as 14 ppb.

## **2.3. European requirements on sampling procedures**

The EU regulation on aflatoxin also specifies the sampling procedure and methods of analysis. These requirements may constitute a compliance problem for the least developed African exporters.<sup>3</sup> The distribution of

3 For an overview of the complexity of the process of compliance with food safety regulations, see Henson and Heasman (1998).

aflatoxin in groundnuts is very non-homogeneous. Aflatoxin contamination in groundnuts is generally more variable in single fields, single test plots or single lots than contamination in other crops. The sample needed for testing contamination levels in groundnuts is five times as large as that needed for examining maize, for example.

The sampling methods specified by the EU Directive (European Commission, 1998b) are similar to the Dutch Code ( $3 \times 10$  kg), which requires that three tests are conducted on a randomly drawn 30 kg sample. Each sample has to pass the three tests before the shipment is allowed to enter its targeted market. In the case of bulk raw nuts, the implementation of this procedure presents difficulties because, as noted above, aflatoxin is not evenly distributed throughout an entire batch. As a result, the sampling procedure could lead to unnecessary rejections of significant amounts of groundnut shipments. Regulations that are being currently discussed by the Codex Alimentarius Commission require that the average aflatoxin levels in the samples meet the standard, rather than each sample independently. The USA also requires that the average aflatoxin levels in the three samples meet the standards.<sup>4</sup> In sum, under the proposed Codex regulations, three samples that have levels of aflatoxins equal to 20 ppb, 10 ppb and 15 ppb would be accepted. These same samples could lead to the rejection of a whole shipment of groundnuts under the new EU regulations.

The FAO has recommended that testing a single 20 kg sample for aflatoxin content would yield results that are reliable enough to eliminate the risk for the consumer and that stricter requirements would not bring significantly more safety (Saqib, 2000).

There are no specific estimates available for African countries on the potential costs of compliance with the EU regulations, or the expected rejection levels of various African food products subject to the new standards. However, Australia maintained in a submission to the WTO that 'the proposed sampling procedure is unduly onerous and likely to be costly. Under the proposed sampling plan it is estimated that up to 75 per cent of lots rejected would be good lots' (WTO, 1998b).

Compliance costs and costs associated with rejection can be significant to exporters of groundnut products. The US peanut industry estimates that complying with the EU sampling method would result in an additional US\$150 cost per lot (a lot contains on average 16 tons) for raw groundnuts. The industry also estimated that the method would lead, on average, to rejection of 30 per cent of US groundnut exports.<sup>5</sup>

African countries' exports of groundnut products are heavily dependent on the European market. As shown in Table 1, between 1985 and 1998 56 per cent of African exports of edible groundnuts, 61 per cent of exports of groundnut oil, and 74 per cent of groundnuts exported for oilseeds were sold in EU countries.

4 Source with the US peanut industry, interviewed on 9 August 2000.

5 National Peanut Council of America, Memo to the Ministry of Agriculture, Fisheries and Food, 18 April 1997.

**Table 1.** Share of export value of groundnut products by destination: 1985–1998

	Edible groundnuts (%)	Groundnut oil (%)	Groundnuts for oil seeds (%)
East Asia and Pacific	27	30	15
European Union	56	61	74
Middle East	2	3	10
North America	14	4	–
Rest of the world	1	2	1

Source: Computed from United Nations COMTRADE Records.

### 3. The analytical framework

#### 3.1. Methodology

Economic analysis of food safety standards has mainly taken a cost–benefit approach (see, e.g. Calvin and Krissoff, 1998; Paarlberg and Lee, 1998). Although this type of approach can identify the relationships between anticipated damage and welfare and price changes, it cannot link the severity of standards with welfare and price changes, as independent measures of standards are not used in the analysis. Price or welfare change itself is interpreted as showing the severity of standards.

Statistical analysis of the economic effects of standards and other non-tariff barriers is scarce. Several researchers have developed an econometric approach to measure the trade impact of standards. Swann *et al.* (1996), Blind and Jungmittag (1999) and Moenius (1999) employed an econometric model where trade flows were regressed on a proxy for standards along with other factors that promote or divert trade. Swann *et al.* and Blind and Jungmittag regressed import and export on the stock of country-specific and internationally shared standards, in the context of the UK–Germany trade and Germany–world trade, respectively. Although these studies focused on a single country against a single or multiple trading partners, Moenius extended their scope by treating a multiple-importer–exporter case. He employed a bilateral trade model known as a gravity model. A gravity model is used to explain bilateral trade flows using key economic variables that represent the size of a country's economy, such as Gross National Product (GNP) and population, and the geographical distance between countries. In its econometric form, trade flow is regressed on these key economic variables. A gravity model was first developed by Tinbergen (1962) and Pöyhönen (1963) to explain bilateral trade flows by trading partners' GNP and geographical distance between countries. The gravity model has been developed to include additional variables for examining the effect of trade promoting and limiting factors. Aitken (1973) estimated a gravity model, which included dummy variables for membership in a free trade area, to examine its trade creation effect. In Moenius' model, the trade creation effect of bilaterally shared standards and

the trade limiting effect of country-specific standards were examined by including the indices of these standards as explanatory variables.

We employ a gravity model in a similar specification to that used by Moenius. A gravity model is useful, as we analyse multiple importing and exporting countries. Unlike the studies of Swann *et al.*, Blind and Jungmittag, and Moenius, which use counts of standards, we include a variable to quantify the severity of standards. The major drawback with using simple counts of standards is that standards may vary in terms of severity and specifications, and hence, in their impact on trade. When a quantitative measure of the severity of standards is available, the estimated coefficient for the standards variable can be directly used for policy implications. We use data on the maximum allowable aflatoxin levels specified for a particular food product in a given importing country as such and standard data are available for several countries in the EU.

### 3.2. Model specification

Our specification of the gravity equation is as follows:

$$\ln(M_{ij}^{k,t}) = b_0^k + b_1^k \ln(GNPPC_i^t) + b_2^k \ln(GNPPC_j^t) + b_3^k \ln(DIST_{ij}) \\ + b_4^k \ln(ST_i^{k,t}) + b_5^k \ln(RAIN_j^t) + b_6^k COL_{ij} + b_7^k YEAR + \varepsilon_{ij}^{k,t} \quad (1)$$

where  $M_{ij}^{k,t}$  denotes volume traded in product  $k$  from African country  $j$  to EU country member  $i$  in year  $t$ . It is obtained from UN COMTRADE records. The parameters  $b$  are coefficients to be estimated. The last term  $\varepsilon_{ij}^{k,t}$  is the error term and is assumed to be normally and independently distributed with mean zero.  $GNPPC_i^t$  and  $GNPPC_j^t$  are real per capita GNP in EU country  $i$  and African country  $j$  in year  $t$  adjusted to the 1995 US dollar.  $DIST$  is geographical distance between countries  $i$  and  $j$ .

$ST_i^{k,t}$  is the maximum aflatoxin level imposed on groundnut products import by EU importing country  $i$  in year  $t$ . It is obtained from an FAO survey of mycotoxin (aflatoxins are types of mycotoxins) standards on food and feed stuffs in 1995 (FAO, 1995). Data on the maximum allowable level of aflatoxins in terms of parts per billion are available for all European countries in this study, but are only available for the single year 1995. Using the 1995 regulatory data for a regression with observations from other years implies the assumption that aflatoxin regulations in Europe have not changed throughout the period covered by our analysis although it is possible that, for some countries, the maximum aflatoxin level may have changed over time. However, use of panel data is necessary because of the limited number of data points for any given year. Import and export flows are often unreported, and hence, data for a single year are insufficient to ensure a reliable regression. If the relative severity of standards among European countries did not change significantly, then the effect of misspecification of the maximum aflatoxin levels before and after 1995 will be small.

$RAIN_j^t$  is the average rainfall in African country  $j$  in year  $t$ . It is included because groundnut production can be sensitive to climate conditions,

especially to rainfall. On the other hand, rainfall can negatively affect product quality, as nuts stored in storage facilities are likely to accumulate humidity, and hence aflatoxin levels are likely to rise. *COL* is the colonial tie dummy. It equals one if there was a colonial tie between countries *i* and *j*, and is zero otherwise. *YEAR* is a linear time trend (*YEAR* = 1 in 1989). This variable is included to control for technological change and time-trending factors that are common across the countries studied.

Trade data include annual bilateral trade volumes over the period 1989–1998. We include only 10 years because the assumption of time-invariant aflatoxin standards becomes less plausible over a longer period. We study 14 EU member countries and Switzerland as importers of groundnut products, and nine African countries that are major exporters of groundnut products in Africa.

About two-thirds of the world production of groundnut seeds is crushed for oil and the remaining one-third is consumed as food. In general, large-seeded varieties are used for roasting and confections, and small-seeded types are used for peanut butter and oil. Three groundnut products were considered for analysis, edible groundnuts, groundnuts for oilseeds and groundnut oil. Edible groundnuts fall under the EU-defined category of groundnuts for direct consumption. Groundnuts for oilseeds fall under the category of groundnuts subject to further processing. SITC Revision 1 code 05172 was used for data on edible groundnuts. Unfortunately, this category also includes edible nuts other than groundnuts. They are pistachio, chestnuts, hazelnuts, almond and walnuts. However, FAO trade statistics confirm that groundnuts have a very large share (88 per cent) of this category from Africa. SITC Revision 1 codes of 4214 and 2211 are used for groundnut oil and groundnuts for oilseeds, respectively.

Groundnut oil is not subject to the new aflatoxin regulation in Europe. However, groundnut producers who face difficulty in meeting the aflatoxin standard for edible groundnuts can sell their products to oil producers instead of incurring high compliance costs. Therefore, a decrease in exports of edible groundnuts as a result of strict standards is likely to lead to a shift of exports to groundnut oil. We also examine whether aflatoxin standard can affect groundnut oil exports.

There are factors that cannot be directly observed because of lack of information. For example, production technology and regulatory systems can vary across exporting countries, but information is not available for all the African countries covered by this study. In particular, regulatory variables are not always maintained by a central agency, and where they are available, they are usually costly to obtain. These unobserved factors are assumed to be controlled for by exporting country dummies.

Despite the advantages of a gravity model in analysing bilateral trade flows, the assumptions inherent in this model limit the interpretation of the results. Such assumptions include perfect international product substitutability (Bergstrand, 1989). In our case, differences in product characteristics other than threshold levels of product quality in terms of aflatoxin contamination

are ignored. If the omitted characteristics are important, the predictive power of our results may be affected. According to the WTO submissions regarding groundnut trade (WTO, 1998a, 1999), however, the aflatoxin regulations have been a dominant concern. Hence, the effect of the omitted characteristics is expected to be smaller than the effect of the aflatoxin regulation.

As a result of the structure of a gravity model, the separate effects of the variable representing standards on import demand and export supply cannot be isolated. On the demand side, tighter standards imply higher product quality, thereby increasing demand. On the supply side, tighter standards work as a barrier to trade, as they tend to lead to a higher rejection rate at the border and/or to the imposition of higher compliance costs for the exporters. Accordingly, the coefficient estimate for the standards variable is interpreted as the net result of its effects on import demand and export supply.

The simulation results are based on short-run responses. The model does not incorporate dynamic behaviour of producers to comply with the tighter standards so as to expand exports. Although some producers can comply at a lower cost than others, this is not reflected in the results. Furthermore, there may be long-run contracts between trading firms or trade arrangements specific to a particular pair of countries, which mitigate the short-run loss of exports when the standards are tightened. Vertical integration between different stages of producers (growers, processors and distributors), and between EU consumers and producers or exporters in Africa, can also mitigate the short-run loss. Consequently, the results from the model tend to overestimate the loss.

### 3.3. Results

Regressions are run on pooled data for the three groundnut products and on data for each product separately. In the pooled regression, oilseeds and oil dummies are used for the coefficients of per capita GNP, rainfall and standards, as well as the intercept. The difference between the pooled and unpooled regressions is that the coefficients for the remaining explanatory variables (year and colonial dummies) are assumed to be common across products in the pooled regression. A fixed-effects model is used for these regressions where groups are defined with respect to exporting countries.

Table 2 shows the results of the pooled regression. The pooled regression is tested against the unpooled regressions using an *F*-test. The *F*-value is below the critical value at the 5 per cent significance (= 2.11), and hence we accept the pooled regression.

Coefficient estimates can be interpreted as elasticities, as the model is estimated in log-linear form. On the basis of the regression estimates, elasticities and *t*-values of imports with respect to per capita GNP, rain and the standards variable are computed and reported in Table 3. The coefficient estimate for the product of the oil dummy variable and a given explanatory variable measures deviation of the elasticity of oil imports from that of edible groundnut imports. Hence, elasticity of oil imports with respect to that variable is computed by adding the coefficient estimate for the product term to that

**Table 2.** Result of the pooled regression with three types of groundnut products (fixed-effects model with respect to exporting countries)

Dependent variable	Slope dummy	Coefficient	<i>t</i> -value
Quantity traded			
Intercept		4.626	0.06
	Oil	11.524	1.24
	Oilseeds	-11.814	-1.13
Per capita GNP Europe		0.881**	4.16
	Oil	0.584**	2.00
	Oilseeds	-0.198	-0.74
Per capita GNP Africa		-0.320	-0.29
	Oil	-0.001	0.00
	Oilseeds	-0.144	-0.70
Distance		-0.175	-0.21
Standards		1.107**	2.94
	Oil	-0.042	-0.09
	Oilseeds	-0.907*	-2.06
Rain		-0.240	-1.17
	Oil	0.105	0.60
	Oilseeds	0.295	1.75
Year		-0.009	-0.19
Colonial tie		1.235**	4.20
Number of observations		464	
Adjusted $R^2$		0.585	
<i>F</i> -value against unpooled regressions, d.f. = (6,440)		1.93	

\*, \*\* Significance at the 5 per cent and 1 per cent levels, respectively.

**Table 3.** Estimated elasticities of import quantity of groundnut products

	Edible	Oil	Oilseeds
Standards	1.107** (2.94)	1.065** (3.52)	0.200 (0.85)
Per capita GNP Europe	0.881** (4.16)	1.465** (7.13)	0.683** (4.10)
Per capita GNP Africa	-0.320 (-0.29)	-0.321 (-0.17)	-0.464 (-0.43)
Rain	-0.240 (-1.17)	-0.135 (-0.63)	0.055 (0.27)

Values in parentheses are *t*-values.

\*, \*\* Significant at the 5 per cent and 1 per cent levels, respectively.

for edible groundnut imports. The elasticities of oilseed imports are derived by a similar calculation.<sup>6</sup> A *t*-value is used to evaluate the statistical significance of the elasticities of imports of each product with respect to standards, per capita GNP and rain.

The effect of importer's per capita GNP is positive and significant for all groundnut products. This variable is considered to account for the income effect of importing countries, and hence, this result is consistent with prior expectations. The effect of exporter's per capita GNP and rainfall on imports is insignificant for all products. Rainfall may have offsetting effects on groundnut exports; adequate rainfall can increase groundnut harvests but higher humidity also implies likely aflatoxin contamination in stored groundnuts, which tends to reduce the average product quality.

The effect of the colonial tie dummy is positive and highly significant. This implies that on average an African country will export more to a European country with which it had a previous colonial tie. For example, Egypt, The Gambia, South Africa, Sudan, Nigeria and Zimbabwe export more to the UK than to continental Europe, whereas Mali, Senegal and Chad export more to France than to other EU countries.

This result suggests that colonial ties affect trade patterns between Africa and Europe in a systematic manner. Language and cultural assimilation may have created strong dependence on the market in the ex-colonial power. Historical trade relationships are also important factors in facilitating access to markets. In other words, entry to new markets would require investment in researching consumers' tastes and exploring distribution channels. These factors can appear as trade-limiting, and it is necessary to separate their impact from that of standards. Ignoring colonial ties could lead to an underestimation of the trade diversion effect of standards when a colonial tie exists, if stricter standards and ex-colonial status are positively correlated.

The estimated elasticity for the standards variable is positive and significant for edible groundnuts and groundnut oil, but insignificant for groundnuts for oilseeds. The impact of past aflatoxin regulations is hence evident in the edible groundnut and groundnut oil trade, but the results suggest that exports of groundnuts for oilseeds were not sensitive to the regulations. This is possibly because regulations in Europe were less strict on foodstuffs intended for further processing, or because the aflatoxin level is reduced when the skin of the nuts is removed.

As standards have a significant negative effect on groundnut oil trade flows, this suggests that the net effects of standards on edible groundnuts and oil were complementary (the direction of change is the same) rather than offsetting. The net effect of standards may appear complementary because European countries that imposed high aflatoxin standards tended also to have other obstacles to the importation of groundnut oil.

6 For example, the elasticity of edible groundnut imports with respect to standards is 1.107, that of imports of groundnuts for oilseeds is 0.200 (= 1.107 - 0.907), and that of groundnut oil imports is 1.065 (= 1.107 - 0.042).

**Table 4.** Elasticity of import quantity of groundnut products with respect to aflatoxin standards over time

	Edible		Oil		Oilseeds	
	Elasticity	<i>t</i> -value	Elasticity	<i>t</i> -value	Elasticity	<i>t</i> -value
1989–1993	0.832	0.35	1.236	2.27	0.010	0.22
1990–1994	0.862	1.61	0.816	1.43	0.118	0.30
1991–1995	1.267	2.53	0.678	1.41	0.379	0.89
1992–1996	1.454	3.64	0.292	0.62	0.266	0.68
1993–1997	1.547	4.30	0.454	1.05	0.884	2.27
1994–1998	1.831	5.20	0.526	1.37	0.804	2.15

The coefficient on distance is insignificant. This implies that geographical distance is not a factor determining the trade pattern. For example, South Africa, which is furthest from Europe, has the largest share of its edible groundnut exports (52 per cent) and the second largest share of its exports of groundnuts for oilseeds (17 per cent) in exports of these products in entire Africa.

On the basis of the regression for 1989–1998, the elasticity of import quantity with respect to standards is computed as 1.11, 0.20 and 1.065 for edible groundnuts, groundnuts for oilseeds and groundnut oil, respectively. The elasticity estimates and the statistical significance of standards vary across time, possibly reflecting change in ‘sensitivity’ of trade flows to the aflatoxin standard.

Table 4 shows the elasticities estimated in regressions that include subsets of observations for five consecutive years with 1 year increments. The unpooled regressions are used, as elasticities and *t*-values can be estimated directly. The impact of the standards on edible groundnuts and groundnuts for oilseeds becomes greater over time. Both the elasticities and statistical significance (*t*-value) of these coefficients increased rapidly towards 1998. Compared with groundnuts for oilseeds, the result for edible groundnuts indicates a larger increase in *t*-values. This is perhaps because consumers’ concern about the health risk of aflatoxin intake has grown in Europe. Increasing public awareness of the risks of a contaminant may have led to more rigorous implementation of the regulation at the border, whereas the standard may have not changed on paper. Although the standards are assumed unchanged over time, actual inspection at the European border may have become more rigorous. This trend is not observed in the groundnut oil trade, however. The elasticity and *t*-value of this coefficient generally decrease over time. This implies that groundnut oil exports have become less sensitive to aflatoxin standards in edible nuts.

Despite possible change in aflatoxin standards in the EU countries, this result generally supports the robustness of the significance of the effect of

the aflatoxin standard on trade flow that is found in the regression for the entire period. The recent subset of observations particularly supports the implication of the aflatoxin standard.

#### 4. Simulation analysis

On the basis of the previous regression results, we predict gains or losses in the value of trade in groundnut products between Europe and Africa under various levels of aflatoxin standards adopted uniformly by EU countries. We also evaluate the potential effect of EU harmonisation at the specific aflatoxin levels agreed. The estimated elasticity of groundnut imports with respect to Aflatoxin B1 standard is used to predict the change in trade flows. The base year for the projected changes is 1998, and all the variables (volumes, prices) are measured at their 1998 values.

This simulation analysis is carried out for edible groundnuts only. Although groundnut oil is not itself subject to the EU new regulation, the average elasticity for the whole period of groundnut oil imports with respect to aflatoxin standards in edible nuts is significant and positive (see Table 3). This suggests that the impact of harmonised aflatoxin standards on oil imports should also be quantified. However, this elasticity declined in value and became insignificant during the 1990s (see Table 4). By contrast, the average estimated elasticity of groundnuts for oilseeds is statistically insignificant but became significant during the 1990s. Therefore, the total impact of EU harmonisation on African exporters of groundnut products is likely to be greater than the impact measured in terms of edible groundnuts.

Many missing observations in the trade data used in our analysis make it necessary to recover some trade volumes by prediction. Volume is predicted by using the pooled regression. Once volume is predicted, the following formula is used to predict changes in volume associated with changes in standards:

$$d\hat{y}_{ij}^k = \phi^k \frac{\hat{y}_{ij}^k}{ST_i^{k,t}} (ST_i^{k*} - ST_i^{k,t}) \quad (2)$$

where  $d\hat{y}_{ij}^k$  is predicted change in trade flow volume from African country  $j$  to European country  $i$  for product  $k$ ,  $\phi^k$  is the estimated elasticity of trade flow of product  $k$  with respect to standards (from Table 3),  $\hat{y}_{ij}$  is predicted volume, and  $ST_i^{k*}$  is the hypothetical maximum aflatoxin level.

Upper and lower bounds are imposed on  $d\hat{y}_{ij}$  to avoid two extreme cases. The lower bound is imposed to prevent a negative change in volume exceeding the base traded volume as a consequence of a tighter standard. The lower bound is defined as follows:

$$\text{if } d\hat{y}_{ij} < 0 \text{ and } |d\hat{y}_{ij}| \leq \hat{y}_{ij}, \text{ then } |d\hat{y}_{ij}| = \hat{y}_{ij}.$$

The upper bound is imposed to avoid a change in volume above the production capacity of a country as a consequence of relaxing a standard. The upper bound limits an increase in volume to 100 per cent of the volume traded in

1998. It is defined as follows:

$$\text{if } d\hat{y}_{ij} > 0 \text{ and } d\hat{y}_{ij} > \hat{y}_{ij}, \text{ then } d\hat{y}_{ij} = \hat{y}_{ij}.$$

The predicted change in value traded is then derived by using the unit prices of these products, which are computed from FAO agricultural trade statistics for 1998. Unit prices at the borders of respective European countries are multiplied by  $d\hat{y}_{ij}$ . They are equal to the total value of import of each groundnut product for a given year divided by the total volume for each European country for that year. That is, the predicted total change in value of imports to Belgium is computed as

$$d\hat{v}_{(\text{Belgium}, \bullet)}^k = p_{\text{Belgium}}^k \sum_{j=1}^9 d\hat{y}_{(\text{Belgium}, j)}^k \quad (3)$$

where  $d\hat{v}_{(\text{Belgium}, \bullet)}^k$  denotes the change in the total value of imports from Africa to Belgium, and  $p_{\text{Belgium}}^k$  denotes the unit price for product  $k$ , at the Belgian border. The predicted total change in value of the exports from Nigeria is computed as

$$d\hat{v}_{(\bullet, \text{Nigeria})}^k = \sum_{i=1}^{14} p_i^k d\hat{y}_{(i, \text{Nigeria})}^k. \quad (4)$$

Here, it is assumed that African countries face the same price for their exports to a given European country. Import tariffs are not considered, for simplicity. If tariff had been incorporated into the unit price, then the price net of tariffs is the price that African countries receive. Therefore, the absolute value for  $d\hat{v}^k$  for European producers tends to be greater than for African producers of the same product.

Tables 5 and 6 show simulation results for the predicted change in value traded for different hypothetical levels of aflatoxin standards (1–9 ppb). Tables 5 and 6 illustrate predicted change in value of import of edible groundnuts from Africa to Europe, aggregated for European importing countries and African exporting countries, respectively. This simulation is based on the estimated elasticities of import quantity with respect to standards from the regression in the most recent five years 1994–1998 and volume traded in 1998.

#### 4.1. Simulation of outcomes under varying levels of standards

Our results can be used to predict the trade effect of the EU regulatory harmonisation. The new levels for Aflatoxin B1 applied by EU country members are 2 ppb for selected foodstuffs (nuts, dried fruits), and edible groundnuts fall under this category. Under this new regulation, seven EU members are tightening restrictions, five are maintaining the same level, and two countries are relaxing their standards compared with 1995. Switzerland is not included in this simulation analysis. The 2 ppb level is 20 per cent tighter than the median level (2.5 ppb).

The findings in Table 5 suggest that an application of the 1 ppb standard to edible groundnuts would lead to a US\$482,000 or 72 per cent reduction in the

**Table 5.** Predicted change in value of edible groundnut imports from Africa to EU corresponding to varying Aflatoxin B1 standards

	1 ppb		2 ppb (EU new)		4 ppb		9 ppb (Codex)	
	US\$1,000	%	US\$1,000	%	US\$1,000	%	US\$1,000	%
Austria	0.0	0	+5.7	+100	+5.7	+100	+5.7	+100
Bel–Lux	–32.1	–89	–24.1	–66	–8.0	–22	+32.1	+89
Denmark	–5.7	–55	0.0	0	+10.3	+100	+10.3	+100
Finland	–5.2	–66	–1.7	–22	+5.2	+66	+7.8	+100
France	0.0	0	+49.2	+100	+49.2	+100	+49.2	+100
Germany	–46.7	–55	0.0	0	+84.3	+100	+84.3	+100
Ireland	–14.5	–89	–10.9	–66	–3.6	–22	+14.5	+89
Italy	–119.8	–89	–89.8	–66	–29.9	–22	+119.8	+89
Netherlands	–42.1	–89	–31.6	–66	–10.5	–22	+42.1	+89
Portugal	–90.8	–100	–90.8	–100	–84.5	–93	–64.3	–71
Spain	–54.7	–89	–41.1	–66	–13.7	–22	+54.7	+89
Sweden	–11.9	–66	–4.0	–22	+11.9	+66	+17.9	+100
UK	–59.0	–55	0.0	0	+106.6	+100	+106.6	+100
EU	–482.4	–72	–238.9	–36	+123.0	+18	+480.6	+72

**Table 6.** Predicted change in value of edible groundnut exports from Africa to EU corresponding to varying Aflatoxin B1 standards

	1 ppb		2 ppb (EU new)		4 ppb		9 ppb (Codex)	
	US\$1,000	%	US\$1,000	%	US\$1,000	%	US\$1,000	%
Chad	–10.1	–67	–4.0	–27	+2.8	+19	+11.2	+74
Egypt	–18.8	–73	–9.4	–36	+5.8	+22	+19.7	+76
The Gambia	–56.7	–73	–28.8	–37	+16.5	+21	+57.6	+74
Mali	–2.6	–67	–1.0	–27	+0.7	+18	+2.8	+73
Nigeria	–25.7	–73	–13.0	–37	+7.6	+21	+26.3	+75
Sudan	–80.1	–73	–40.2	–37	+24.4	+22	+83.1	+75
Senegal	–98.1	–67	–39.3	–27	+26.7	+18	+106.5	+73
South Africa	–151.8	–73	–76.3	–37	+46.2	+22	+156.7	+75
Zimbabwe	–38.4	–82	–26.8	–57	–7.7	–16	+16.8	+36
Africa	–482.4	–72	–238.9	–36	+123.0	+18	+480.6	+72

value traded from the 1998 level. All EU countries except Austria and France are estimated to shut down imports from Africa. If the 2 ppb level, which is equivalent to the new EU standard, is applied, the reduction will be US\$239,000 or 36 per cent, which is almost half of the change in the 1 ppb case. With a maximum of 4 ppb, seven EU countries will increase imports whereas five will decrease them. Under the 9 ppb standard, which is equal to the imputed level of the Codex international standard (to be discussed in more detail below), Austria, Denmark, Finland, France, Germany, Sweden and the UK would double imports. The others would increase import values by 89 per cent, except Portugal, which would reduce them by 71 per cent.

The results in Table 6 suggest that all African countries examined in the analysis will experience a reduction in the value of exports under the 1 ppb and 2 ppb standards. Interestingly, the impact of harmonisation is slightly milder for former French colony countries, compared with the British colony countries. These former French colonies faced a higher standard imposed by France before harmonisation. Colonial ties appear to have important implications for these predicted results.

#### **4.2. A comparison of the impact under EU harmonisation and the international standard**

Finally, we compare the predicted consequences of EU regulatory harmonisation and the Codex international standards. Codex does not set standards on Aflatoxin B1 alone, but, to establish a baseline estimate for an international standard, we assume a 9 ppb standard for the three groundnut products based on the standard on the level of total aflatoxins contamination (15 ppb). The composition of Aflatoxin B1 in all aflatoxins in food can vary across products and samples. The variation is normally between 50 and 70 per cent. We assume, therefore, that 60 per cent of all aflatoxins are in fact Aflatoxin B1. Given this assumption, Aflatoxin B1 contamination should be below 9 ppb to sustain total aflatoxins below a 15 ppb level.

Edible groundnuts exhibit a significant difference between the two scenarios. The predicted export value of edible groundnuts under EU harmonisation is US\$430,000 or 36 per cent lower than that under the Codex standard, which is US\$1.15 million. Of the EU countries, Italy accounts for the greatest share of the difference between the two scenarios, which is US\$210,000 or 88 per cent of the total difference from the EU edible groundnut imports between the two scenarios. This is because Italy constituted 20 per cent of the total share of edible groundnut imports in 1998 among the 14 EU countries studied.

Among the African countries, South Africa accounts for the greatest difference between the two scenarios, which is US\$233,000 or the 32 per cent of the total edible groundnuts export from the nine African countries.

As they are based on estimated regression coefficients, these results are necessarily subject to statistical error. In addition, our gravity model rules out the effect of many other factors that can affect groundnut trade. These include

market prices, and industrial structure in the production and processing sectors in exporting countries, including vertical integration and contractual relationships between growers, processing and exporting firms.

## **5. Implications and conclusions**

This paper seeks to quantify the effects of tightening food safety standards at the borders of industrialised countries on important food exports from developing countries. It also examines the trade impact of harmonising standards to levels higher than the international food safety standards suggested by Codex. These questions are important, as the trade policy debate continues over decision-making on risk, sound science and the use of economic analysis in dispute settlement cases at the WTO.

Complying with new food safety regulations also requires infrastructure and expertise that are often unavailable to the least developed African countries. The FAO has investigated various compliance problems in developing countries (FAO, 1997). Some of the problems that were highlighted by the FAO study are: lack of funds and resources allocated to research on aflatoxins, scarcity of highly trained and experienced personnel, inadequate facilities for safe aflatoxin research, lack of maintenance of laboratory facilities and inadequate infrastructure.

In addition, analytical methods used to detect aflatoxin levels in food products have developed much more quickly in developed countries than have farming methods in developing countries. The availability of sensitive equipment has allowed developed countries to implement increasingly strict standards on aflatoxins, making it progressively more difficult for exporting countries to comply with such standards. Finally, diverting African exports of groundnuts to other markets is not easy, as the EU is the world's largest single importer of groundnuts.

In our case study, we explored empirical evidence on the trade impact of standards on aflatoxin contamination imposed by European importers, at differing levels of regulatory protection. We focused on groundnuts for direct human consumption (edible groundnuts) and groundnuts for oilseeds between 14 member states of the EU, Switzerland, and nine African countries in the 10 years before 1998. A gravity model is developed to measure empirically the trade flow effect of standards imposed through domestic regulation at the border. The trade-impeding impact of tightening the standards is found to be the greatest for edible groundnuts; a 10 per cent reduction of maximum allowable level of Aflatoxin B1 will lead to an 11 per cent reduction of export of edible groundnuts, whereas the aflatoxin regulation appears not to affect trade in groundnuts for oilseed.

We also examined how the impact of the standards changed over time. We find that the impact of the standards increased for edible groundnuts and oil seeds over time. One hypothesis is that this may reflect more stringent requirements for inspection imposed in Europe, as a result of increased consumer concern about the health risks of contaminated nuts.

We also estimate the effect of harmonising these standards in the EU. On the basis of the regression results, calculations of potential export revenue gains and losses with changing standards are provided. Seven EU country members ended up tightening the Aflatoxin B<sub>1</sub> standards, three maintain the same level, and two relax their standards compared with the pre-1998 levels. The 2 ppb level for edible groundnuts is 20 per cent tighter than the median standard level, which is 2.5 ppb. The estimated loss for African exporters of edible groundnuts totals US\$238,000 (36 per cent of the total value traded in 1998). As EU imports of groundnuts for oilseeds also appear to be sensitive to aflatoxin standards imposed on edible groundnut imports, the total impact of EU harmonisation on African exporters of groundnut products is likely to be greater than the impact measured in terms of edible groundnuts.

There are trade-offs in costs and benefits from any regulatory intervention. We find that the loss of export revenue from Africa, with the EU setting a standard more stringent than the international standard suggested by Codex, is estimated at US\$720,000 million. If this aflatoxin regulation affects trade in other food products, the loss is expected to be even greater.

## Acknowledgements

The authors would like to thank Julie G. Adams, Keith E. Maskus, Francis Ng, Michelle P. Sharrow, three anonymous referees and the editor for helpful comments and suggestions.

## References

- Aitken, N. D. (1973). The effect of the EEC and EFTA on European trade: a temporal cross-section analysis. *American Economic Review* 63: 881–892.
- Bergstrand, J. H. (1989). The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade. *Review of Economics and Statistics* 71(1): 143–153.
- Blind, K. and Jungmittag, A. (1999). The impacts of innovations and standards on German trade in general and on trade with the UK in particular. *Internal Paper of Fraunhofer* 2: 205–221.
- Calvin, L. and Krissoff, B. (1998). Technical barriers to trade: a case study of phytosanitary barriers and U.S.–Japanese apple trade. *Journal of Agricultural and Resource Economics* 23(2): 351–366.
- European Commission (1997). Commission Regulation (EC) No. 194/97 of 31 January 1997 (Setting Maximum Levels for Certain Contaminants in Foodstuffs). *Official Journal of the European Communities* L 031, 01/02/1997: 48–50.
- European Commission (1998a). Commission Regulation (EC) No. 1525/98 of 16 July 1998 (Amending Regulation (EC) No. 194/97 of 31 January 1997 Setting Maximum Levels for Certain Contaminants in Foodstuffs). *Official Journal of the European Communities* L 201, 17/07/1998: 43–43.
- European Commission (1998b). Commission Directive 98/53/EC of 16 July 1998 (Laying Down the Sampling Methods and the Methods of Analysis for the Official Control of the Levels for Certain Contaminants in Foodstuffs). *Official Journal of the European Communities* L 201, 17/07/1998: 93–101.

- European Commission (2001). Commission Regulation (EC) No. 466/2001 of 8 March 2001 (Setting Maximum Levels for Certain Contaminants in Foodstuffs). *Official Journal of the European Communities* L 077, 16/03/2001: 1–13.
- FAO (Food and Agriculture Organisation) (1995). *Worldwide Regulations for Mycotoxins 1995: a Compendium*. Rome: FAO.
- FAO (Food and Agriculture Organisation) (1998). FAO statistical databases. Rome: FAO. <http://apps.fao.org> [Accessed 28 August 2000].
- FAO–WHO (Food and Agriculture Organisation–World Health Organisation) (1997). Acceptable daily intakes, other toxicological information, and information on specifications. *Proceedings of the Joint FAO/WHO Expert Committee on Food Additives*, Rome, 17–26 June 1997.
- Finger, J. M. and Schuler, P. (1999). Implementation of Uruguay Round Commitments: the Development Challenge. Policy Research Working Paper 2215. Washington, DC: World Bank.
- Henson, S. and Heasman, M. (1998). Food safety regulation and the firm: understanding the compliance process. *Food Policy* 23(1): 9–23.
- Henson, S., Loader, R., Swinbank, A., Bredahl, M. and Lux, N. (2000). *Impact of Sanitary and Phytosanitary Measures on Developing Countries*. Reading: University of Reading, Centre for Food Economics Research.
- International Trade Forum (1999). Exporting groundnuts. <http://newafrica.com/agriculture/crops/groundnuts.htm> [Accessed 15 August 2000].
- Maskus, K. E. and Wilson, J. S. (2001). A review of past attempts and the new policy context. In K. E. Maskus and J. S. Wilson (eds), *Quantifying Trade Effect of Technical Barriers: Can it be Done?* Ann Arbor, MI: University of Michigan Press.
- Moenius, J. (1999). Information versus product adaptation: the role of standards in trade. Manuscript, University of California, San Diego. <http://weber.ucsd.edu/~jmoenius/hp/stantrad6.pdf> [Accessed 5 September 2000].
- Paarlberg, P. L. and Lee, J. G. (1998). Import restrictions in the presence of a health risk: an illustration using FMD. *American Journal of Agricultural Economics* 80: 175–183.
- Pöyhönen, P. (1963). A tentative model for the volume of trade between countries. *Weltwirtschaftliches Archiv* 90(1): 93–99.
- Saqib, M. (2000). A study of the impact of environmental requirements on India's export performance and the scoping study for environmentally friendly products, FAO, mycotoxin prevention and control in foodgrains— aflatoxin research on grain in Asia. UNCTAD. <http://www.fao.org/docrep/x0036e/x0036e1e.htm> [Accessed 28 August 2000].
- Swann, P., Temple, P. and Shurmer, M. (1996). Standards and trade performance: the UK experience. *Economic Journal* 106: 1297–1313.
- Tinbergen, J. (1962). *Sharing the World Economy: Suggestions for an International Economic Policy*. New York: Twentieth Century Fund.
- US Food and Drug Administration (2000). Foodborne pathogenic microorganisms and natural toxins handbook. USFDA. <http://vm.cfsan.fda.gov/~mow/chap41.html> [Accessed 30 August 2000].
- UNDP–FAO (United Nations Development Programmes–Food and Agriculture Organisation) (1998). Regional network inter-country cooperation on preharvest technology and quality control of food grains (REGNET) and the ASEAN grain postharvest programme, Bangkok, Thailand. <http://www.fao.org/inpho/vlibrary/x0036e/x0036e00.htm> [Accessed 30 August 2000].

- Wilson, J. S. (2000). The development challenge in trade: sanitary and phytosanitary standards. Paper prepared for WTO Meeting on Sanitary and Phytosanitary Standards, Geneva, 19 June 2000.
- WTO (1998a). The Committee on Sanitary and Phytosanitary Measures (Submission by The Gambia), G/SPS/GEN/50. Geneva: WTO.
- WTO (1998b). The Committee on Sanitary and Phytosanitary Measures (Draft EC Regulation—Aflatoxin Control, Submission by Australia), G/SPS/GEN/61. Geneva: WTO.
- WTO (1998c). The Committee on Sanitary and Phytosanitary Measures (Summary of the Meeting Held on 15–16 September 1998), G/SPS/R/12. Geneva: WTO.
- WTO (1999). The Committee on Sanitary and Phytosanitary Measures (Summary of the Meeting Held on 10–11 March 1999), G/SPS/R/14. Geneva: WTO.

