

Indo-US Trade in Wheat and Mango: A Game-Theoretic Approach to SPS Standards

Siddhartha K. Rastogi
Satish Y. Deodhar

W.P. No.2008-03-04
March 2008

The main objective of the working paper series of the IIMA is to help faculty members, research staff and doctoral students to speedily share their research findings with professional colleagues and test their research findings at the pre-publication stage. IIMA is committed to maintain academic freedom. The opinion(s), view(s) and conclusion(s) expressed in the working paper are those of the authors and not that of IIMA.



INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 015
INDIA

Indo-US Trade in Wheat and Mango: A Game-Theoretic Approach to SPS Standards

Siddhartha K. Rastogi

Indian Institute of Management, Ahmedabad, 380015, India
E-Mail: srastogi@iimahd.ernet.in

Satish Y. Deodhar

Indian Institute of Management, Ahmedabad, 380015, India
E-Mail: satish@iimahd.ernet.in

Abstract

The gradual elimination of quotas and tariffs from international agricultural trade has given way to non-tariff barriers such as the SPS measures. SPS standards are mostly based solely on agro-biological scientific evidence. However, over-cautiousness in standard setting may lead to trade distortions and lower welfare. We summarise various approaches used to study SPS restrictions, propose a game theoretic approach to assess strategic interaction between two trading partners, and juxtapose the cost-benefit analysis to estimate payoffs of the game. As a topical application of the proposed approach, we pick up the case of potential Indo-US trade in mangoes and wheat. Estimates of the payoffs, which are the net changes in welfare, would suggest whether or not complete ban is justifiable in terms of economic welfare, and, what levels of SPS restrictions may be optimal.

Keywords:

SPS, Phytosanitary Trade Restrictions, US India trade, Wheat Trade, Mango Trade, Game Theoretic Approach

Indo-US Trade in Wheat and Mango: A Game-Theoretic Approach to SPS Standards**

1. Introduction

Under the auspices of World Trade Organization (WTO), agricultural trade has become a lot freer than ever before. This has been made possible through gradual removal and reduction of import quotas and tariffs. As the significance of quotas and tariffs is declining, instances of non-tariff barriers (NTBs), often based on phytosanitary norms are coming to the fore, and are being vehemently contested by the trading partners. In fact, anticipating these kinds of restrictions, WTO member countries have adopted two multilateral agreements, Agreement on Sanitary and Phytosanitary Measures and Agreement on Technical Barriers to Trade, famously known as SPS and TBT agreements. For example, a country can adopt SPS measures to protect human, animal, and plant life and health from the risks arising from invasive species of pests, weeds, disease causing organisms, and toxins present in imported foods and/or agricultural products. These measures have to be non-discriminatory in nature; however, they can be stricter than the norms set out by international organizations such as Codex Alimentarius Commission (CAC), International Plant Protection Convention (IPPC), and World Organization for Animal Health (OIE) if justified scientifically (Deodhar, 2005).

A key feature of the adoption of phytosanitary measures is the role of risk assessment and risk management in determining trade restrictions that provide an acceptable level of risk to an importer and is justified in technical and economic terms (Bigsby and Whyte, 2001). Legitimacy of such restrictions lies in the scientific basis for the likelihood of invasive species entering an importing country and the likelihood of

* We thank Barry Krissoff of Economic Research Services, USDA for his valuable insights.

destruction of its domestic natural flora and fauna, crops, and environment. However, over-cautiousness on technical grounds and inattention to economic considerations may result in trade restrictions quite stringent than necessary, leading to sub-optimal welfare outcomes. Restrictions based on SPS norms have a dual effect – they provide protection to domestic producers from negative supply side externalities, and, at the same time, reduce consumer welfare by isolating domestic producers from international competition. Therefore, it becomes imperative to assess the comprehensive impact of SPS measures on objective and commonly acceptable scientific and economic grounds (Evans, 2003).

A variety of approaches have been used in the past to address the impact of SPS restrictions. We review the existing literature on this subject in Section 2. Following the literature review, in Section 3 we identify topical trade prospect between India and US in two important commodities - mango and wheat. References to possibilities of resuming trade in the two commodities have appeared in news media, for India has placed a virtual ban on import of US wheat and US has placed a virtual ban on import of Indian mango. Importantly, both the restrictions are on SPS grounds. In this context, we present a game-theoretic approach to the possibilities of welfare improving trade between India and US in the two commodities. In Section 4 we lay out the scope for empirical estimation of the model and pinpoint data requirements and its sources. Finally, concluding comments are made in Section 5.

2. Literature Review

As one would expect, the literature on impact of trade restriction due to SPS measures has revolved around the definition, assessment, and quantification of the impact of such measures. Bigsby and Whyte (2001) divide these impacts into two broad

categories - direct impacts reflect the effects of a particular pest or disease on the host and indirect impacts are the general effects that are created by the presence of a pest that could affect public health, ecosystem functions, market access and consumer behavior, research requirements, and tourism and other allied sectors of the economy. FAO (2001) for its part, enlists six types of impacts – impact on production; impact on price and market; impact on trade; impact on food security and nutrition; impact on human health and environment; and impact on financial costs. With such diverse possible impacts, emphasis on method and types of impacts has varied in different empirical studies.

Survey Based Approach

Survey based approach focuses on asking questions directly to the practitioners and traders involved in export operations. Through direct questions, scope of analysis is narrowed down to specific and relevant SPS issues. For example, Mutasa and Nyamandi (1998) conducted a survey through CAC contact points in different countries to assess the degree to which SPS standards impede exports of agricultural and food products from African countries. Fifty-seven per cent of the survey respondents reported that their export consignments were rejected during two years preceding the survey. They opined that their financial constraints limited the effectiveness of their prior inspections and that testing and inspection facilities were found wanting.

Study conducted by Henson, Loader, Swinbank, and Bredahl (1999) involved survey as well as interviews through CAC contact points in developing countries to identify particular problems faced in meeting SPS requirements. They conclude that SPS measures are considered to be the most important impediment to exports from developing to developed countries and to a large extent, it reflects poor access to compliance

resources, lack of expertise, information, and finance. In addition, incompatibility of production and marketing methods in developing countries also contribute to reduced trade flows from developing to developed countries. It is claimed that surveys also bring out issues that are usually left out by economists but felt strongly by the industry. However, such studies have also provided data that can be used for econometric analysis.

Survey based approaches have also offered counter-intuitive assessment of the importance of trade barriers, as it happened in the study by Henson, Lux, and Traille (2001). The study reports that some European exporters consider administrative burden in terms of delays and unpredictability being more trade restrictive than the SPS requirements. Moreover, dependability of these studies for policy formulation is questionable as apart from researcher bias, the responses can also be manipulated by the respondents if they anticipate that the survey is to be used as a basis of future standards.

Inventory Based Approach

This approach is useful for its quantitative as well as qualitative information regarding the extent of SPS standards and their trade restricting impact. There are three sources of information to build the inventory for the analysis – data on regulations, number of detentions at the ports, and data on complaints and notifications from industry against discriminatory regulatory practices. The inventory based approach is comparatively new and researchers have deployed it to take stock of number and severity of standards adopted by countries.

Fontagné, Kirchbach, and Mimouni (2005) assess the impact of environmental regulations and their potential impact on trade by using frequency statistics on the number

of countries that have implemented a trade restrictive regulation for a given product. The underlying idea is that when a barrier is set by a fewer number of countries, it is more likely to be protectionist, and hence, trade distortionary. Caswell and Wang (2001) explore the regulatory barriers imposed on food products exported to US by the Asian countries. They use the United States Food and Drug Administration (USFDA) data on detention and import alert records, which captures the number of detentions of imports to US on a monthly basis. While the authors accept that no dollar value can be attached to the barriers on the basis of number of detentions alone, they conclude that meeting regulatory standards poses a significant challenge to Asian food products entering US. In another study, Wilson and Otsuki (2001) focus their attention on prohibitive food safety standards in the European Union (EU). They employ a direct measure of the severity of food safety standards expressed as the maximum level of aflatoxin contamination in food products permitted in different EU countries. They conclude that adopting international standards (e.g., CAC standards) would substantively increase world trade.

The advantage of this method is the freedom of constructing variables based on the data available on SPS measures. However, despite the ease of availability of data and the freedom of construction of variables, this method necessitates a careful exploration of various dimensions of the food standards before it being used as a basis for policy formulation. The inventory based approach often can be misleading. For example, Barrett and Yang (2001) point out that the US Congressional Research Service found that only 17 of approximately 89000 standards recognized in the United States had international origins (USHR, 1989). However, this information may not be sufficient to conclude that trade is actually restricted by such difference of standards.

Price Wedge Method

This method is based on the idea that SPS measures can be gauged in terms of their impact on the domestic price in comparison to a reference price. The main use of this method is to provide a tariff equivalent of SPS restrictions on imports. Calvin and Krissoff (1998) use the price wedge approach to examine the trade effects of removal of SPS norms on import of Japanese apples into US. They use a two equation partial equilibrium framework for this analysis. Their estimates suggest that the losses due to disease would remain small as compared to value of incremental trade flow.

Beghin and Bureau (2001) analyze a cross-section of studies employing price-wedge method for estimation of tariff equivalents and find that the method may not have a substantial practical validity. Often the domestic product and the imported product have quality differences but these are assumed away in the studies. Also, price wedge due to SPS restrictions is not calculated directly but as a residual after deducting for transportation cost and tariffs. Moreover, such studies do not calculate the welfare gains and losses in terms of changes in consumer and producer surpluses.

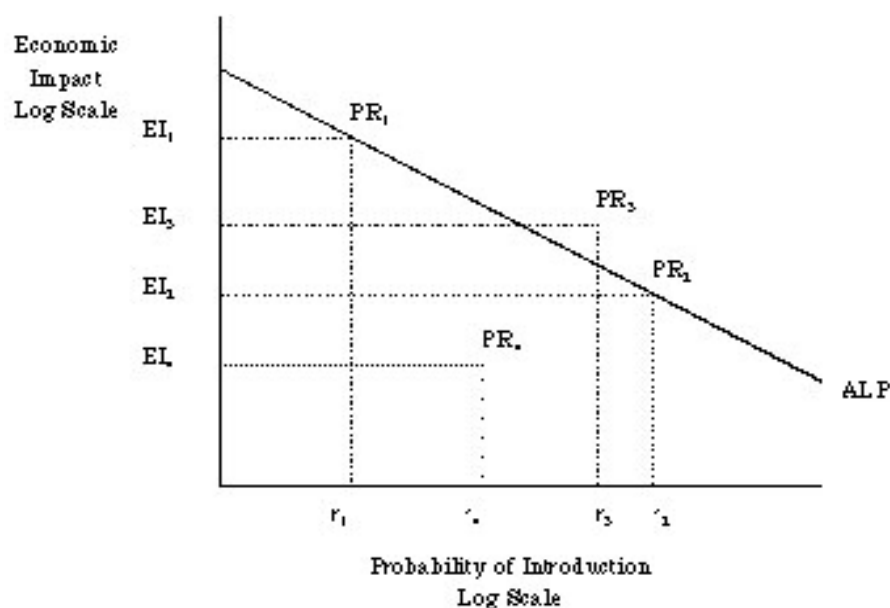
Gravity Models

The gravity equation is a popular formulation for statistical analyses of bilateral flows between different geographical entities. The foundation of gravity models comes from Newton's 'Law of Universal Gravitation.' In 1962, Jan Tinbergen proposed that the equation for gravitational force could be applied to international trade flows. It has since been applied to a whole range of social interactions and bilateral flows including migration, tourism, and foreign direct investment. Head (2003) has summarized the basic principles of gravity model.

Otsuki, Wilson, and Sewadeh (2000) use the gravity equation modeling to estimate the impact of differences in standards implemented by the EU and those recommended by international agencies for aflatoxin levels in food exports from African countries. The study shows that new and more stringent aflatoxin standards in the EU will have negative impact on African exports of cereals, dry fruits, and nuts to Europe. Gravity models quantify the quantum of forgone trade owing to NTBs that cannot be explained by tariffs; however, these models capture only the trade impact and not the welfare impact of NTBs. Therefore, they may undermine some of the effects of the regulations that correct market failures but restrict trade or vice versa (Beghin and Bureau, 2001).

Iso-Risk Framework and ALP

Bigsby (2001) presents risk analysis system, Iso-Risk that combines key elements of risk analysis, namely, probability of occurrence and economic impact. Using the two he provides a quantification of the level of protection associated with an SPS measure. He defines pest risk $PR = EI \times PI$, where PR is the pest risk, EI is the economic impact and PI is the probability of introduction. The term 'introduction' refers to introduction and establishment of a pest. In Figure 1, the variables EI and PI are used to depict the iso-risk line which is referred to as Appropriate Level of Protection (APL) line. There will be a family of iso-risk lines, with rightward shifts indicating higher pest risk. Actual PR that fall on or below the predetermined APL (line) would be acceptable.

Figure 1: Iso-Risk Framework*

*Adopted from Bigsby, 2001.

While there is a problem of converting diverse range of technical and scientific barriers into EI and PI, more importantly, a predetermined ALP that is to be used as the benchmark for decision making is subject to discretion rather than any economic or technical basis. Therefore, there is always ample scope for adopting more stringent measures than necessary. In fact, SPS agreement requires a member country to be internally consistent in selecting levels of protection and avoid any arbitrary or unjustifiable distinctions that would result in discrimination or a disguised restriction on international trade (Miljkovic, 2005). Further, Rodriguez, Heaney, and Beare (2000) point out that the problem becomes more complex over time, and, moreover, specification of locus of iso-risk points varies accordingly to the characteristics of a pest or disease incursion.

Cost–Benefit Analysis

As an alternate to the iso-risk line based analysis, Bureau, Marette, and Schiavina (1998) suggest the use of cost-benefit analysis. The essence of cost-benefit analysis lies in the assessment of risk posed by an SPS hazard and the quantification of regulation impact. The analysis is based on the comparison of costs of compliance under SPS measures, associated gains due to reduction of an externality and prevention of contamination or pest infestation, and the associated losses due to fall in consumer surplus. The efficiency of this approach depends upon finding the appropriate tools of measurement and estimation of risk probabilities. Rodriguez et al. (2000) suggest that using a cost-benefit approach for economic assessment of SPS measures is more appropriate and accepting high risk may be justified when there are net benefits from trade and that benefits from unrestricted imports may outweigh the increase in risk and costs of incursions of pests and diseases.

There have been a number of studies that have employed cost-benefit analysis, e.g., Orden and Romano (1996), James and Anderson (1998), Peterson and Orden (2006). Although all of these studies perform a cost-benefit analysis, there are important variations in their approaches. For example, James and Anderson (1998) study the impact of removal of import ban on bananas in Australia. They perform a simple comparison of changes in consumer and producer surplus to arrive at the net social welfare gain. The study indicates that increase in net welfare for Australia is highest under free trade in bananas. The study, however, does not take into account losses associated with introduction of invasive species and the probabilities thereof. Orden and Romano (1996) study the impact of changes in SPS norms for import of avocados in US from Mexico. They use a framework with various assumptions regarding probability of pest infestation, associated probabilities of crop losses, and the cost of remedial measures.

Their findings show that in most cases there is net welfare gain to US by easing the import restrictions on Mexican Avocados. Peterson and Orden (2006) develop a general framework for incorporating pest risks and costs in an expectation-weighted partial equilibrium market analysis. They consider season specific SPS restriction, state specific SPS measures, and origin and destination specific compliance measures for import of Mexican avocados in US. In all cases they find that the net welfare will go up for US.

3. Commodity Selection and Game Theory Approach

As reviewed above, there have been a number of studies that have addressed the impact of imposition of SPS measures on imports. Some have conducted interviews of various stakeholders involved in agricultural trade and some other have used inventory of recorded of SPS measures adopted by various countries. These studies do not address the impact of SPS measures on trade volumes or welfare of the society. There are a few other studies which have used the gravity models and the price-wedge models. While these studies do consider effects on trade volumes and tariff equivalences, they do not address the economic effects in terms of welfare gains and losses. Such welfare gains and losses are considered in studies using cost-benefit analysis approach. For example, the study on (removal of) ban on imports of bananas in Australia does consider changes in consumer and producer surpluses for Australia. Later studies on US SPS restrictions on imports of avocados from Mexico not only consider changes in consumer and producer surplus but address the issues of risk assessment in terms of pest invasion probabilities, crop damage probabilities, and risk mitigation costs.

However, these later studies are very specific to a single agricultural commodity. Moreover, these studies mostly focus on welfare effects on a single country, namely the

importing country. In reality, however, trading partners may engage in strategic trade policy behaviour, where different levels of SPS measures are used as strategic decisions. The experience of the latest Millennium/Doha Rounds and the earlier Uruguay rounds of the WTO negotiations goes to show that countries engage themselves in give-and-take tactics and strategies to reduce tariff and non-tariff barriers. The alleged yielding to subsidy reduction against claiming geographic indication for champagne can be considered one such strategy. Thus, analyzing the welfare effects in a bilateral framework, where adoption of reciprocal SPS measures on two import commodities for two countries may be more meaningful. One could cast such a scenario in a game theoretic framework where two trading partners play a game where levels of SPS measures on respective countries' imports are their strategies and the sum of producers' and consumers' surplus for the two commodities in the two countries are their respective payoffs. Further, introducing probabilities of pest invasion, crop losses, and cost of risk mitigation may be incorporated to estimate expected payoffs for the two countries. Such exhaustive economic analysis will give the optimal levels of SPS restrictions by the two countries.

We see an interesting application of this framework to the agricultural trade between India and US. With 1.5 million hectares under its cultivation, mango ranks first among the fruits grown in India. In 2006-07, mango production was about 10 million tonnes with exports of about 0.8 million tonnes. Although mango exports constitute significant share in India's horticultural exports, none is exported to US. In 2006, US imported mangoes worth \$ 233 million out of which mangoes worth \$138 million were imported from Mexico. Similarly, in 2006-07 US production of wheat was about 50 million tonnes, half of which was exported. The same year, India on the other hand

produced about 75 million tonnes of wheat and imported 6.7 million tonnes. However, none was imported from US. Thus, although India and US are significant producers and exporters of mango and wheat respectively, they do not trade in them. The reasons for this lie in SPS restrictions applied by both the countries. US banned import of Indian mango in 1989 itself. The reasons cited were the excessive usage of pesticides and the fear of invasion of fruit flies and weevils. India offered to reduce pesticide levels and was ready to give vapour heat treatment (VHT) to eliminate the fear of fruit flies and weevils without compromising the fruit quality and nutritional value. However, USA emphasized on irradiating mangoes and implemented strict inspection norms. The nuclear irradiation and inspection in India by US inspectors has increased the cost of Indian mango manifold and rendered them uncompetitive due to cost escalation (Sen, 2007; Rabinowitz, 2007).

Similarly, India does not permit import of wheat from US due to the fear of invasive weeds, congress grass (*parthenium hysterophorus*) and canary grass (*phalaris minor*), among other weeds. The government stipulated levels of quarantine weeds in the Plant Quarantine (Regulation of Import into India) Order, 2003, are met by most of the wheat-exporting nations like Australia, Russia, Ukraine, Argentina, and Canada (Zarabi, 2007). However, US wheat with 12,000 weeds per 200 kilograms does not match the Indian specifications of only 100 weeds per 200 kilograms. Thus it fails to meet the Indian quality standards (Ramasubbu, 2007). Even with the significant relaxation of the phytosanitary norms in July 2006 to augment domestic buffer stocks by 6.7 million tonnes, US has been unable to meet the Indian standards. It is interesting to note that US president George Bush made a three-day visit to India in March 2006 to boost bilateral trade. At a press conference he is famously quoted to have said, "By the way Mr. Prime Minister, the United States is looking forward to eating Indian mangoes." (Subramani,

2006). Probably what he did not say was that Indian consumers too may want to have a variety in their dinner plates by allowing easier access to imports of US wheat.

Therefore, we would like to cast the prospects of the mango-wheat trade between India and US in a game theoretic context. Consider Table 1 which shows a normal form of game being played between Indian and US. The cells of the table show payoffs to import ban and import liberalization strategies of India and US respectively. If both India and US have ban on imports of wheat and mango, we start with a base scenario of payoffs (0,0). If India unilaterally allows free imports of wheat, India gains by an amount $A-B$, where A is the gain in consumers' surplus and B is the loss in producers' surplus. US wheat producers' surplus goes up by the amount V . Similarly, if US unilaterally allows free imports of mango, US gains by the amount $X-Y$, where X is the gain in consumers' surplus and Y is the loss in producers' surplus. Indian mango producers' surplus goes up by the amount U . Further, if both allow free imports of wheat and mango, the payoffs for India and US would be $U+(A-B)$ and $(X-Y)+V$. If the net welfare accruing to India on account of wheat imports is positive ($A-B$), and, if the net welfare to US on account of mango imports is positive ($X-Y$), then we have a Nash equilibrium in dominant strategies. Free-Trade is the dominant strategy for both the countries and generates optimal payoffs to both the countries. Thus, free trade is Pareto-superior compared to the autarky situation in both the countries.

Table 1: Indo-US Trade in Mango and Wheat: A Game in Normal Form

		USA	
		Import Ban	Complete Liberalization
India	Import Ban	0, 0	U, X-Y
	Complete Liberalization	A-B, V	U+(A-B), (X-Y)+V

Note: A,B,U,V,X, and Y take positive values.

Of course, if the magnitudes of $U+(A-B)$ and $(X-Y)+V$ are negative, then Import Ban by both countries will emerge as the Nash-equilibrium which is Pareto-superior compared to other three outcomes. Interestingly, however, if $U+ (A-B)$ and $(X-Y) + V$ are positive but $(A-B)$ and $(X-Y)$ are negative then we witness the classic case of Prisoners' Dilemma (Tucker, 1950). The dominant strategy Nash-equilibrium is Import Ban by both the countries, although, the Pareto-superior outcome is Free Trade by both - a missed opportunity for both the countries. Unfortunately, if the two markets were studied in isolation, one may legitimize the outcome of the Prisoner's Dilemma (Import Ban by both) if one were to estimate the net welfares $(A-B)$ and $(X-Y)$ as negative (but $A-B+U$ and $X-Y+V$ were positive).

4. Scope for Empirical Estimation

The normal form game presented in the above section does not incorporate partial or intermediate strategies that the two countries can adopt. In reality, the two countries would practice partial bans or partial liberalization in terms of their SPS norms. Hence, we can think of estimating the payoffs of their strategies where a partial ban strategy also exists. The strategy and payoffs in such situation is given in Table 2 below and the definitions of the arguments of the payoffs are spelled out in Table 3. We would like to estimate the payoffs of this normal form game and infer whether or not complete ban on imports of mangoes and wheat is justified. To estimate the payoffs we will also need to conduct pest risk analysis involving probabilities of the pest invasion and crops losses in both the countries. Griffin (2000) gives a thematic framework of pest risk analysis which involves risk assessment and risk management (Figure 2).

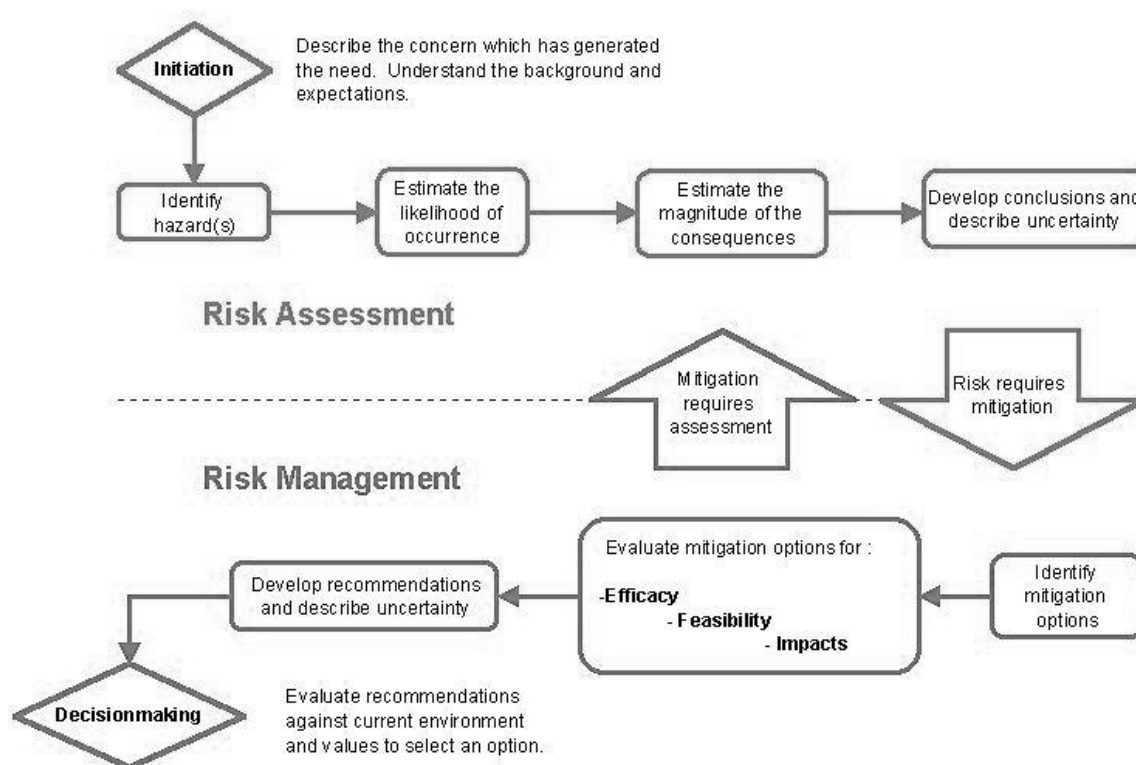
Table 2: Normal Form Game with Partial Ban Possibilities

I N D I A	U S			
		Complete Ban (n=0)	Partial Liberalization $0 \leq n \leq 1$	Complete Liberalization (n=1)
	Complete Ban (m=0)	0,0	$nU, n(X-Y-Z)$	$U, (X-Y-Z)$
	Partial Liberalization $0 \leq m \leq 1$	$m(A-B-C), mV$	$nU+m(A-B-C), mV+n(X-Y-Z)$	$U+m(A-B-C), mV+(X-Y-Z)$
Complete Liberalization (m=1)	$(A-B-C), V$	$nU+(A-B-C), V+n(X-Y-Z)$	$U + (A-B-C), V + (X-Y-Z)$	

Note: n and m are degrees of liberalization of SPS restrictions.

Table 3: Definitions of Payoff Arguments

Policy Change: Autarky to Complete Import Liberalization	India	US
Increase in Consumers' Surplus due to imports	A	X
Fall in Producers' surplus due to imports	B	Y
Spillover effect due to Invasive species due to imports	C	Z
Rise in producers' surplus due to exports	U	V

Figure 2: Overview of Pest Risk Analysis

Source: Griffin (2000).

While we present the game theoretic framework, the actual estimation of the payoffs will involve extending the framework proposed by Peterson and Orden (2006). We will need to estimate or procure demand and supply elasticities, pest control costs in importing country, and compliance and control costs in exporting country.

We also need to get estimates of the probability of pest outbreak. Peterson and Orden (2006) define the probability of pest outbreak for avocados as the joint probability of six steps – pest infecting the fruits, pest passing the inspection undetected at the point of export, pest surviving the shipment, pest passing the inspection at the port of entry, pest finding a suitable habitat, and pest establishing itself in that habitat. We also need to capture the spillover effects, some of which are considered by Peterson and Orden (2006). The possible data sources for making the above estimates may include UNCTAD database on Trade Control Measures, WTO disputes database, International Plant

Protection Convention databases, and International Portal on Food Safety, Animal and Plant Health. In India, the source would be Plant Quarantine Organization of India, agricultural statistics from ministry of agriculture, FICCI Agribusiness Information Center, and, in US information and data could come from US department of agriculture and Animal and Plant Health Inspection Service (APHIS).

5. Concluding Comments

With the advent of WTO led trade liberalization quotas and tariffs are being reduced gradually, and, the focus of trade restrictive practices is increasingly drawn to issues of phytosanitary measures. We discussed various methodologies used to assess the impact of SPS related trade restrictive practices. Some are based merely on stakeholder interviews and inventory of notifications at the international bodies and government agencies. Some have tried to assess impact in terms of changes in trade volumes and others have looked at tariff equivalents of SPS measures. Recent methodologies have tried to estimate expected welfare changes due to the imposition or removal of SPS measures.

While the recent studies address issues mostly for a single commodity and single country, we propose that a game theoretic framework can be used to address a bilateral strategies used by trading partners and their impact on welfare. Such analysis will be very topical in the context of reciprocal trade restrictions imposed on mangoes and wheat by US and India respectively. The payoffs of the game theoretic approach, of course, will be calculated in the spirit of the recent methodologies that have incorporated cost-benefit analyses. Estimation of the payoffs of the normal form game between India and US for the two commodities, mango and wheat, may give clues to what level of SPS measures

may be appropriate for the two countries. We understand that the data requirements for the empirical estimation will be substantial. With some existing data on elasticities, some informed understanding of probabilities involved in pest risk analysis, and data collection on cost of pest risk mitigation and compliance, one should be able to come up with inferences that give valuable insights for policy purposes.

References

- Barrett, C.B. and Yang, Y.N. (2001) "Rational Incompatibility with International Product Standards," *Journal of International Economics*, 54 (2001), pp. 171-191.
- Beghin, J. C. and Bureau, J.C. (2001) "Measurement of Sanitary, Phytosanitary and Technical Barriers to Trade," Consultants' report prepared for the Food, Agriculture and Fisheries Directorate, OECD, 17-18 September, 2001.
- Bigsby, H. (2001) "Quantifying Phytosanitary Barriers to Trade," Workshop on "Risks of Exotic Forest Pests and Their Impact of Trade," Organized online, April 16-29; <http://www.apsnet.org/online/proceedings/ExoticPest/Papers/bigsby.htm> (as on October 15, 2007).
- Bigsby, H. and Whyte, C. (2001) "Quantifying phytosanitary barriers to trade," Chapter 4, *Interdisciplinary Food Safety Research* (2001), (ed.) Hooker, N.; Murano, E., CRC Press, New York.
- Bureau, J.C.; Marette, S. and Schiavina, A. (1998) "Non-tariff Trade Barriers and Consumers' Information: The Case of the EU-US Trade Dispute over Beef," *European Review of Agricultural Economics*, 25 (4), pp. 437-62.
- 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), pp. 351-366.
- Caswell, J.A. and Wang, J. (2001) "Quantifying Regulatory Barriers to Asian - U.S. Food Trade," *Journal of Agribusiness*, 19(2), pp. 121-128.
- Deodhar, S. (2005) "From Quantity to Quality: Need for a Paradigm Shift in the Food Industry," *Productivity*, Vol. 45, No.4, Jan-March, pp. 519-526.
- Dhar, B. and Kullummal, M. (2007) "Taming Non-Tariff Barriers: Can the World Trade Organization Find a Solution?," *Macao Regional Knowledge Hub Working Paper-3*.
- Evans, E. A. (2003) "Economic Dimensions of the Problem of Invasive Species," *EDIS Document FE386*, Department of Food and Resource Economics, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, June 2003; <http://edis.ifas.ufl.edu/FE386> (as on October 15, 2007).
- FAO (2001) "The State of Food and Agriculture 2001," Part III *Economic Impacts Of Transboundary Plant Pests and Animal Diseases*, "III. Economic impacts of transboundary pests and diseases," Rome, Italy; http://www.fao.org/docrep/003/x9800e/x9800e16.htm#P0_0 (as on 17 October, 2007).

- Fontagné, L.; Kirchbach, F. V. and Mimouni, M. (2005) “An Assessment of Environmentally- related Non-tariff Measures,” *The World Economy*, 28 (10), pp. 1417–1439.
- Griffin R. (2000) “Risk Analysis and IPPC,” *Multilateral Trade Negotiations on Agriculture: A Resource Manual*, Part III, ‘Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and Agreement on Technical Barriers to Trade (TBT)’, Food and Agriculture Organization of The United Nations, Rome; <http://www.fao.org/docrep/003/x7354e/X7354e00.htm#TopOfPage> (as on Nov 9, 2007).
- Head, K. (2003) “Gravity for Beginners,” Teaching Note, University of British Columbia, Faculty of Commerce, Vancouver, Canada.
- Henson, S.J.; Loader, R.J.; Swinbank, A. and Bredahl, M. (1999) “The Impact of SPS Measures on Developing Country exports of Agricultural and Food Products,” *The Conference on Agriculture and The New Trade Agenda in the WTO 2000 Negotiations*, October 1-2, 1999, Geneva, Switzerland; [http://wbln0018.worldbank.org/trade/DECagridoc.nsf/cd1d51b0730b98388525657c007c9eb2/f9bf12819fa25cbf852568a300518455/\\$FILE/henson_et+al.pdf](http://wbln0018.worldbank.org/trade/DECagridoc.nsf/cd1d51b0730b98388525657c007c9eb2/f9bf12819fa25cbf852568a300518455/$FILE/henson_et+al.pdf) (as on Oct 2, 2007).
- Henson, S.J.; Lux, N. and Traill, B. (2001) Final Report, Partner 4, FAIR97-CT34-81 program, EU Commission, Agricultural Directorate, Bruxelles (unpublished).
- James, S. and Anderson, K. (1998) “On the need for more economic assessment of quarantine policies,” *Australian Journal of Agricultural and Resource Economics*, 42 (2), pp. 425–44.
- Miljkovic, D. (2005) “Sanitary and Phytosanitary Measures in International Trade: Policy Consideration vs. Economic Reasoning,” *International Journal of Consumer Studies*, 29 (3), pp. 283-290.
- Mutasa, M.P. and Nyamandi, T. (1998) “Report of the Survey on the Identification of Food Regulations and Standards Within the Africa Region Codex Member Countries That Impede Food Trade,” *Workshop on Codex and Harmonisation of Food Regulations*, Harare, Zimbabwe, August 1998.
- Orden, D. and Romano, E. (1996) “The avocado dispute and other technical barriers to agricultural trade under NAFTA,” *Paper presented to the conference “NAFTA and Agriculture: Is the Experiment Working?”*, San Antonio, Texas, USA.
- Otsuki, T.; Wilson, J.S. and Sewadeh, M. (2000) “Saving Two in a Billion: A Case Study to Quantify the Trade Effect of European Food Safety Standards on African Exports,” *World Bank*, Washington D.C.
- Peterson, E. and Orden, D. (2006) “Linking Risk and Economic Assessment in the Analysis of Plant Pest Regulations: The Case of U.S. Imports of Mexican Avocados,” Economic Research Services / United States Department of Agriculture Contractor and Cooperator Report No. 25, October 2006.

- Rabinowitz, G. (2007) "Indian mangoes to hit U.S. market," April 13, 2007, *Boston.com Business*, Associated Press; http://www.boston.com/business/articles/2007/04/13/indian_mangoes_to_hit_us_market/ (As on September 26, 2007).
- Ramasubbu, K. (2007) "Govt Plans to Import More Wheat," October 03, 2007, *The Indian Express*, Ahmedabad Edition.
- Rodriguez, G.; Klijn, N.; Heaney, A. and Beare, S. (2000) "Assessment of benefits and costs under the SPS agreement," Australian Bureau of Agriculture and Resource Economics (ABARE) conference paper 2000.28.
- Sen, A. (2007) "US to miss mangoes in summer of '07," March 06, 2007, *The Economic Times*, Ahmedabad Edition.
- Subramani M. (2006). "Mango Exports to US This Year Likely," *Business Line*, March 10, http://www.thehindubusinessline.com/2006/03/10/stories/2006_031001571200.htm
- Tucker, A.(1950). "A two person dilemma," lecture (handout) at Stanford University, May, reprinted in *Readings in Games and Information*, E. Rasmusen, Ed., Blackwell, Oxford, 2001, pp. 7-8.
- USHR (1989) "International Standardization: the Federal Role," Hearing Before the Subcommittee On Science, Research, and Technology, United States House of Representatives Committee on Science, Space, and Technology, Government Printing Office, Washington.
- Wilson, J. S. and Otsuki, T. (2001) "Global Trade and Food Safety: Winners and Losers in a Fragmented System," *World Bank Policy Research Working Paper* 2689.
- Zarabi, S. (2007) "Phytosanitary Norms Not to be Diluted: EGoM," September 17, 2007, *Business Standard*, VII (137), Ahmedabad Edition.