Trade Standards for Welfare Maximization: A Case of Indo-US Trade in Wheat and Mango

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Abstract

As trade quotas have been eliminated under GATT and tariffs have been rationalized under WTO; the focal point of disputes and negotiations in international trade has shifted to non-tariff barriers, particularly Sanitary and Phytosanitary (SPS) standards. SPS standards are commodity specific standards, adopted by WTO members to protect domestic flora and fauna and environment from the impact of invasive foreign organisms. However, in the absence of any past experience and concrete scientific or empirical evidence, standards are usually kept at prohibitively high levels, thereby inducing sub-optimal outcomes. Therefore, it is imperative to assess the impact of SPS standards on various dimensions and base the policy on expected net welfare gains to the nation as a whole.

Most of the impact assessment approaches in the literature focus on trade gains or level of risk only; however, cost benefit analysis based studies are more flexible, comprehensive, and apt for policy formulation due to welfare oriented outlook. All the studies so far have considered the impact of SPS standards for a single commodity and on the importing nation only. Since unilateral decision on standards leaves out the possibility of choosing mutually beneficial level of standards, it is not in the best interest of the nation. The present research addresses this gap. A negotiation based SPS regime is considered, wherein a country may settle for lower benefits or a loss on trade of one commodity due to lower domestic SPS standards, yet a reciprocal change in SPS standards for another commodity by the trade partner may provide higher net gains. In such a case, unilateral decision making suggests for stringent SPS standards, leading to low or no trade whereas an interactive decision would facilitate trade and augment welfare.

A game-theoretic framework for strategic negotiation on SPS standards between two countries and two commodities is proposed. The framework poses various alternate scenarios and the possible payoffs therein. Analysis of Nash equilibrium under different scenarios is presented with theoretical observations. A range of methodologies for quantifying payoffs is studied and their advantages and disadvantages are analyzed.

To implement the proposed framework for empirical justification, the case of Indo-US trade in wheat and mango is chosen, as it would be more meaningful to compare the welfare implications to developing south with developed north. At present, India does not permit import of wheat from the US due to high weed infestation, whereas mango export from India to USA was banned between 1989 and 2006 due to high pesticide levels and incidence of pests. Since both the countries and commodities are economically significant, this dual trade embargo harms both the nations. With this context, a range of welfare gains to India and US under different SPS regimes is estimated. The policy choices act as strategies and include two ends of spectrum, complete ban and full liberalization. Intermediate strategy for India is to demand Methyl Bromide (MB) treatment of wheat and for US, to demand nuclear irradiation or hot water treatment (HWT) of mangoes.

For estimation, the welfare-representing payoffs are defined as potential gain or loss to the parties affected directly (consumers and producers) or indirectly (by spillover effects). Partial equilibrium framework with stylized microeconomic models for different components is used. Benchmark data of three years (2004-06) is employed in order to avoid the effect of abnormal observations. The principle of conservatism is followed by considering losses on a higher side and gains on a lower side. This ensures that even if there is some margin of error, the outcomes would not change drastically. The estimation process breaks the impact of standards into smaller components and estimates them separately. Change in consumer surplus to Indian consumers due to export of Indian mangoes to the US is captured through Harberger's triangle, whereas the same for US consumers is estimated through a measure of consumers' willingness to pay. The producer surplus is measured by change in value received net of compliance cost. The estimates for loss due to different regimes are quoted and modified from relevant research, whereas the pest invasion probabilities are quoted from literature or collected from relevant specialists. Costs of compliance and transportation are collected from traders, research institutions, and government agencies. The estimates are then summed up over countries for the respective commodities and compared in the game-theoretic framework.

The strictly dominant Nash equilibrium is consistent with the present regime. The payoffs also conform to the policy arguments by the two countries negotiating to maximize own net welfare. The findings justify India's insistence for MB treatment of wheat, as the loss from untreated wheat would be devastating for India. On the other hand, the present policy of nuclear irradiation of mangoes is the best strategy for US; however, the difference in payoff with complete ban and HWT strategies ranges within 2 to 4 per cent of the net welfare gains. This shows that SPS standards are more critical for the developing south. A brief sensitivity analysis is performed to point out that the developed north can afford to be more flexible in adopting SPS standards. The results show that it is more welfare augmenting for both the countries, individually as well as jointly, to adopt moderate level of SPS standards instead of complete ban or complete liberalization. This research assumed linearity and depended upon some binding assumptions due to data constraints. Relaxing such assumptions with more robust data generation, performing similar exercise for more commodities for negotiation, and incorporating transactions cost would be some major directions for further research. As a possibility for future research, a multilateral multi-commodity negotiation process can also be explored in a general equilibrium framework.

Keywords
SPS, India - USA Trade, Wheat Trade, Mango Trade, Cost-Benefit Analysis, Harberger Triangles, Microeconomic Stylized Model.
JEL Classification
F13, F14, F51, Q17

1. Introduction

Initially under the General Agreement on Tariff and Trade (GATT) and then under the auspices of World Trade Organization (WTO), agricultural trade has become a lot freer than ever before. However, as the incidence of quotas and tariffs declined, non-tariff barriers (NTBs) became the focal point of trade negotiations between and among trading partners. WTO member countries have adopted two multilateral agreements to deal with NTBs, namely Agreement on Sanitary and Phytosanitary (SPS) measures and Agreement on Technical Barriers to Trade (TBT). A country can adopt SPS measures to protect human, animal, and plant health and life from the risks arising from invasive species of pests, weeds, disease causing organisms, and toxins present in imported foods and/or agricultural products.

According to the agreement, SPS standards are commodity specific standards backed by scientific evidence and shall be kept at a minimal level. However, near absence of historical basis and over-cautiousness on technical grounds often result in SPS standards more stringent than necessary. The SPS agreement also provides a potent tool for prohibiting trade, protectionism, and discrimination among trading partners. Such stringent standards induce sub-optimal welfare outcomes in two ways – providing unnecessary protection to domestic producers from competition and reducing consumer welfare by keeping the prices artificially higher than a free market level. Such standards adversely affect allocative efficiency within the economy and reduce the comparative advantage of the nation. Roberts (2000) assert that “any SPS restriction that increases the price of an imported good is, in effect, a tax on all exports. Raising the price of a tradable good bids resources away from other industries.”

1.1 Literature Review

SPS agreement is one of the most controversial annexes of the Marrakesh agreement under Uruguay Round (UR) of GATT. SPS agreement is concerned with the issues relating to food safety and plant and animal health. The agreement recognizes the concerns of WTO member nations about providing their subjects safe food and protecting their natural flora and fauna from the damaging or pervasive effects of imported food and related items. Notably, SPS agreement sets broad guidelines to be followed for safer and smoother international trade without distortions, yet it leaves significant scope for countries to develop and adopt their own measures. “Under the agreement, a member has the sovereign right to determine the level of protection it deems appropriate and to institute plant and animal health and food safety measures to protect against bona fide risks” (Rodriguez et al, 2000). According to Annex A of the SPS Agreement (WTO 1), an SPS measure is any measure applied:

a) To protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;
b) To protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs;

c) To protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or

d) To prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests.

For the purpose of these definitions, ‘animal’ includes fish and wild fauna; ‘plant’ includes forests and wild flora; ‘pests’ include weeds; and ‘contaminants’ include pesticide and veterinary drug residues and extraneous matter.

1.2 Research Gaps

There is a range of methodologies, models, and techniques available for assessing the economic significance of SPS measures. As reviewed above, there are a number of studies that seek to assess the impact of SPS measures. However, most of the impact assessment approaches adopted in these studies are either too non-science and/or non-economics driven to form a basis for policy formulation. Further, most of the studies are so restrictive in assessing the impacts of SPS standards that they look at the trade related gains or stakeholders’ concerns only and miss the wider picture; whereas for policy decisions, comprehensive economic as well as social welfare gains and losses shall be taken into account. Although there are few studies that employ CBA that considers impact on social welfare; these studies have focused on the impact of standards for a single agricultural commodity only. Moreover, the studies in literature largely capture welfare effects on the importing country only. Therefore, the existing studies miss on the possible strategic interaction in policy making between/among nations. In reality, however, trading partners engage in strategic trade policy behavior, where different levels of SPS measures are used as strategic decisions. The experience of Doha Round and the earlier Uruguay round of WTO negotiations goes to show that countries engage in give-and-take tactics, thereby tackling trade barriers strategically. The alleged yielding to agricultural subsidy reduction by France against claiming geographic indication for champagne can be considered one such strategy. Thus, this study addresses following research gaps in the existing literature:

- Assessment of impacts of SPS standards in a limited trade or risk context only instead of a comprehensive welfare assessment framework
- Focus on a single commodity and the importing country only, thereby ignoring completely the trade partners’ welfare and possibilities of strategic negotiation
- Standard setting as a purely expectation or scientific evidence based process instead of an interactive strategic decision making process

1.3 Research Objective

So far, the SPS standards have been unilaterally set by countries for each commodity in isolation. This study aims to explore the possibilities of strategic negotiation based SPS standards regime. The objective is to come up with an empirically operational framework, wherein SPS standards are set as a strategic interaction based policy, wherein two or more trading partners adopt SPS policy with consideration to their mutual welfare gains and in the process, enhance individual as well as joint welfare.

1.4 Proposed Framework

This study asserts that the existing regime of unilateral decision on SPS standards is not in best interests of the nation, as it leaves the possibility of setting mutually beneficial levels of SPS standards. This possibility can be captured in a game-theoretic framework; wherein a country may loose on trade of one commodity due to lower domestic SPS standards, yet a reciprocal lowering down of SPS standards by a trade partner may provide higher gains on trade of another commodity. In such a case, unilateral decision making may suggest for stringent and trade hindering SPS standards whereas an interactive decision for lowering down SPS standards mutually would facilitate trade. This would be more welfare augmenting for both the trading partners. Thus, analyzing the impacts of SPS standards in a multilateral framework, where standards are reciprocally modified as welfare based strategic decision, would be more meaningful.

Therefore, a game-theoretic framework is considered, wherein two trading partners as two players engage in a strategic game with levels of SPS standards for respective countries' imports as their strategies. The strategies range from a blanket ban on imports of a commodity to completely free trade, with varying SPS treatments as intermediate strategies. Their respective payoffs comprise the net of the sum of compliance and controls costs and the sum of producers' and consumers' surplus for the two commodities in the two countries. Such analysis will give a comprehensive idea of welfare levels under different policy courses, which, in turn, would suggest an optimal level of SPS standards. This framework can also be extended to multiple nations and multiple commodities at the cost of escalating the number of strategies and costs of calculation exponentially. In light of this framework, our research questions follow.

1.5 Research Questions

1. Would it be more welfare augmenting individually for either or both of the trading partners to lower down their respective SPS standards for a particular commodity?

   1.1 If yes, what is the appropriate level of standards required to maximize the welfare gains?

   1.2 What are the incremental welfare gains attained by respective countries for respective commodities by modifying respective SPS standards?

2. Would it affect the decision of respective countries with regard to the two commodities, if the welfare gains are compared in a game-theoretic framework?

   2.1 If yes, what are the effects and the direction of the same?

1.6 Study Plan

The rest of the study is organized as follows. In Chapter 2, the game-theoretic framework is presented and different methodologies and approaches for empirical estimation are discussed. In addition, the possibilities for an empirical estimation are explored. The empirical estimation for the two commodities for the two countries is discussed in chapter 3 and 4. Chapter 5 combines the estimates for the two commodities and analyzes the same in a game-theoretic negotiation framework. Further, a brief sensitivity analysis is performed and the contextual policies of the two nations are discussed. The final chapter concludes with relevant observations and comments, a brief underlining of policy implications, some policy insights, contributions, significance, and limitations of the study.

2. Analytical Framework and Methodology

The existing literature considers only unilateral decisions on SPS standard, thereby leaving out the possibility of adopting mutually beneficial level of standards. To capture such a possibility, a strategic negotiation based standard regime is considered, wherein a country may loose on trade of one commodity due to lower domestic SPS standards, yet a reciprocal lowering down of SPS standards by a trade partner may provide higher gains on trade of another commodity. In such a case, unilateral decision making may suggest for stringent SPS standards, leading to low or no trade; whereas an interactive decision for lowering down the SPS standards mutually would facilitate trade. Therefore, such a negotiation based standards regime might be more welfare augmenting for both the trading partners, jointly as well as individually.

2.1 The Game-Theoretic Framework

For strategic negotiation on SPS standards between two countries, a game-theoretic framework is proposed[1]. For a simple proposition, consider Table 2.1 that shows a normal form game between any two countries, *M* and *N*, for import of any two commodities, C_M and C_N respectively. The table shows payoffs to M and N for complete ban and full liberalization. While specifying the payoffs for Table 2.1 and subsequent tables proposing theoretically possible frameworks, it is assumed that producers of exporting country gain due to increased trade opportunity but consumers of the same country lose due to higher prices, emanating from sharing domestic supplies with export demand. Similarly, for the importing nation, it is assumed that the producers lose due to increased competition and lower prices but consumers gain due to a larger choice set, increased supply, and reduced prices. These assumptions may or may not stand the empirical testing but for theoretical exposition, they are valid and serve the purpose well.

If both M and N impose ban on import of respective commodities from each other, they attain zero payoff, which serves as a baseline scenario. If M unilaterally permits import of C_M from N, it gains by an amount A-B, where A is the gain in consumers' surplus and B is the loss in producers' surplus. Due to this trade, net impact on N is represented by V, comprising gains to C_M producers and losses to C_M consumers. Similarly, if N unilaterally liberalizes import of C_N, it gains by the amount X-Y, where X is the gain in consumers' surplus and Y is the loss in producers' surplus. For M, the impact is given by U, i.e. - net of gains to C_N producers and losses to C_N consumers. Further, if both the countries permit free import of C_M and C_N, the payoffs for M and N would be U+(A-B) and V+(X-Y) respectively. If (A-B) is positive and if (X-Y) is positive, then there is no rationale for strategic negotiation, as free trade is welfare augmenting for each commodity individually. Therefore, full liberalization by both players is Pareto-superior to any other scenario.

Table 2.1: A normal form game between two countries

	N

[1] This framework was first proposed by Rastogi and Deodhar (2008). Origin and development of the framework was supported by inputs from Barry Krissoff and Ian Sheldon, Economic Research Services, USDA.

		Complete Ban	Full Liberalization
M	**Complete Ban**	0, 0	U, (X-Y)
	Full Liberalization	(A-B), V	U+(A-B), V+(X-Y)

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

If the magnitudes of U+(A-B) and V+(X-Y) are negative, then import ban by both countries emerges as the Nash-equilibrium, which is Pareto-superior compared to other three outcomes. However, if U+(A-B) and V+(X-Y) are positive but (A-B) and (X-Y) are negative, both the countries would want to disown the negative component of the payoffs by banning the trade. Thus, we have a classic case of Prisoners' Dilemma, where the Nash-equilibrium is import ban by both the countries whereas the Pareto-superior outcome is free trade by both. If the two markets are studied in isolation, one may legitimize the outcome of the Prisoner's Dilemma, i.e. - import ban by both, leading to sub-optimal payoffs.

The normal form game presented above does not incorporate intermediate strategies that the two countries can adopt in form of imposing standards and demanding treatment. These strategies are important as they facilitate trade and reduce risk of invasive species at the same time. For such a scenario, the relevant payoff arguments are defined in Table 2.2 and the scenario-wise payoffs are given in Table 2.3.

Table 2.2: Definitions of Payoff Arguments

Policy Change: Complete Ban to Full Liberalization	M	N
Increase in Consumer Surplus due to imports	A	X
Fall in Producer Surplus due to imports	B	Y
Costs of control and spillover effects of imports	C	Z
Net of benefits and losses of exports	U	V

Table 2.3: A Normal Form Game with Intermediate Strategies

		N		
		Complete Ban (n=0)	**Intermediate** 0 < n < 1	**Full Liberalization** (n=1)
M	**Complete Ban** (m=0)	0, 0	nU, n(X-Y-Z)	U, (X-Y-Z)
	Intermediate 0 < m < 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)

	Full 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: m and n are degrees of treatment standards for C_M and C_N respectively.

Based on the framework above, a comprehensive analysis capturing economic as well as social costs and benefits would provide the policymakers with the most welfare augmenting, i.e. - optimal, level of SPS standards for the two commodities for the two countries. Since the analysis is to be based on comprehensive welfare to the nation as a whole, the most appropriate approach is cost-benefit analysis, as reviews in chapter 1. For quantification of the payoffs for empirical analysis and making policy choices, some of the major methodological approaches are analyzed and evaluated next.

2.5 Scope and Basic Details of Empirical Estimation

The purpose of this analysis is to measure the welfare impact of SPS measures through an analysis of comparative statics under different SPS policy regime. Comparative statics is the comparison of two different economic outcomes, before and after a change in some underlying exogenous parameter (Mas-Colell et al. 1995). The impact of SPS standards is decomposed into various smaller components and measured before summing up for comparison in a game-theoretic framework. The SPS policy regime is treated as the exogenous parameter, the change in which initiates a process of change in demand and supply as well as many spillover effects. The comparison is made between the two different equilibrium states with and without the policy change. Notable, the comparison is between different counterfactual equilibria and neither the motion towards equilibrium nor the process of change itself is studied. In that sense, the present analysis focuses more on long-term implications of the policy change, which is more appropriate given the permanence of impact of SPS standards and invasive species that it seeks to control.

The analysis is done in partial equilibrium framework, assuming that a change in SPS regime for mangoes or wheat does not affect other commodities' market substantially. Since mango and wheat are mutually non-competing, non-complementary, and non-substitutable commodities, it is assumed that their markets are also unaffected by one another. Since mango belongs to luxury fruit group and wheat belongs to staple cereals group, the category of both the commodities is very different in nature. Moreover, their pests and diseases as well as the growing conditions are also different from each other. Hence no interaction between the two commodities is a more likely scenario.

The net welfare impact for the respective nations is decomposed into different components and evaluated with stylized microeconomic models. For mangoes, the three-year period from 2004 to 2006, which was just before the ban was lifted, is taken as the benchmark period to avoid the effect of any abnormal observations. For wheat estimates, the three-year period from 2004-05 to 2006-07 is taken as the benchmark period to avoid the effect of any abnormal observations. This particular timeframe is chosen as it significantly coincides with the benchmark years for mango case. Moreover, 2006 is the year, when India began importing the wheat in large quantities; therefore, the dynamics of wheat import are also successfully captured. All the benchmark data years are non-drought, non-calamity, and non-disease normal years, pertaining to the period much before the global financial crisis for both the nations and both the commodities.

All the estimates are conservative in the sense that losses are taken at maximum whereas gains are assumed to be minimum. The conservative approach ensures that even of there is some margin of error, the magnitude and direction of the estimates would not be substantially different. The baseline scenario is taken as trade ban in both the cases, which was the policy prevailing during the benchmark period. Hence, all the estimates are compared to this baseline scenario, the payoffs to which are normalized to zero. All the estimates are converted to US$ figures with the relevant exchange rates.

3. The Case of Mango Trade between India and USA

India ranks first in mango production worldwide, supplying about 40 per cent of world mangoes. With almost two million hectares under mango cultivation, it is India's top value horticulture crop. However, India's mango exports have been about only one percent of the total production (Table 3.1). This is primarily due to huge domestic demand; however, it is more due to lack of export supply chain, high transport costs, and non-exportable quality of Indian mangoes (Mattoo et al. 2007). Mango export is insignificant even in value terms at less than INR 1.5 billion (30 million US$) for 2006-07 (or approximately INR 18 per kg). The top export destinations for Indian mangoes are United Arab Emirates, Nepal, Bangladesh, United Kingdom, and Saudi Arabia. These markets fetch a lot lesser price (Table 3.2) than the US market, which appears to be a much lucrative market, fetching Indian suppliers a price between INR 180 to 240 per kilogram.

On the other hand, US production of mangoes is quite insignificant, not exceeding 3000 MT per annum (Table 3.3). Florida is the major mango producing state of US with over 80 per cent production occurring in Miami-Dade County only (Mossler and Nasheim, 2002). However, US is world's biggest mango importer accounting for 32.7% of the total imports during the 2003 to 2005 period (Evans, 2008). In 2006, US imported mangoes worth $233 million out of which mangoes worth $138 million (or about 60 per cent) were imported from Mexico. The top mango exporters to US are given in Table 3.4. Evidently, India has exported negligible quantity of mango in that period under special permits only. This is due to the ban on mango import from India imposed by US between 1989 and 2006. The ban was lifted in 2006; however, the SPS standards and inspection norms enforced still remain controversial and under negotiation.

Table 3.1: Indian Mango Production and Trade (MT)

Year	Production	Import	Export
2000	10,503,500	6.078	107,015.394
2001	10,056,800	12.958	94,413.198
2002	10,020,200	0.260	121,164.511
2003	12,733,200	90.646	134,110.747
2004	11,490,000	0	60,551.321
2005	11,605,200	38.300	53,480.024
2006	12,663,100	0.799	69,606.603

Source: CMIE Indian Harvest

Table 3.2: Indian Mango Export – Top Destinations

	2005-06			2006-07			2007-08		
Country	**Quantity**	**Value**	**INR/KG**	**Quantity**	**Value**	**INR/KG**	**Quantity**	**Value**	**INR/KG**

UAE	26,533.76	7,30.440	27.53	22,045.51	6,58.102	29.85	22,469.62	6,32.093	28.13
UK	839.97	53.793	64.04	1,883.19	1,14.128	60.60	2,575.37	1,98.166	76.95
B'desh	32,770.90	2,76.636	8.44	42,887.52	3,99.483	9.31	17,063.60	1,59.546	9.35
Nepal	4,116.01	32.298	7.85	8,055.73	70.726	8.78	7,550.89	63.63	8.43
S. Arab	1,564.15	44.22	28.27	1,323.56	42.232	31.91	1,488.95	45.977	30.88

Source: APEDA Trade Junction (2008); Quantity in MT, Value in Million INR.

Table 3.3: US Mango Production and Trade

Year	Production	Import (MT)	Import Value(Mn US$)
2000	NA	235,098.33	164.562
2001	3,000	237,933.97	183.540
2002	3,000	263,347.50	153.009
2003	2,300	278,421.94	192.891
2004	2,600	276,344.91	180.351
2005	2,800	260,841.85	169.117
2006	3,000	292,376.63	209.650

Source: USDA ERS (2008), FAOSTAT

Table 3.4: Top Mango Exporters to USA, 2002-2006 (million US$)

Rank		2002	2003	2004	2005	2006
0	**World**	163.399549	176.139111	168.563694	195.248676	233.053221
1	**Mexico**	82.799812	93.070883	88.279071	107.320673	137.978535
2	**Brazil**	28.692582	28.368441	16.690793	18.222753	18.903762
3	**Peru**	19.885215	16.805038	21.185046	21.522414	23.767997
4	**Ecuador**	10.425287	13.699467	14.409367	13.476137	19.030582
5	**Philippines**	5.363853	8.831806	11.685399	16.685971	12.50469
6	**Haiti**	5.495777	4.477847	5.478889	7.34316	8.649459
7	**Thailand**	3.057433	3.431372	4.230515	4.310713	4.625928
8	**Guatemala**	4.787648	3.644164	2.900569	2.666893	3.398857

9	**Nicaragua**	1.242306	2.005581	1.351129	1.351049	1.735134
10	**Costa Rica**	1.095926	1.141787	1.066	1.083932	1.169677
16	**India**	0.057797	0.075449	0.127856	0.036524	0.040305

Source: World Trade Atlas. Ranking is based on total exports of mangoes by the respective countries to US during 2002 to 2006.

The US banned import of Indian mango in 1989 on account of excessive usage of pesticides and fear of invasion of fruit flies and stone weevils. India offered to reduce pesticide levels and offered Vapor Heat Treatment (VHT) to eliminate the two pests of concern. VHT is the policy demanded only by Japan for import of mangoes, whereas all the other trading partners of India accepted Hot Water Treatment (HWT) as a viable measure of pest control. In 1989, after prolonged negotiations, US permitted import of Indian mangoes with nuclear irradiation and strict inspection. The inspection norms were prohibitively strict as inspection in India by US inspectors increases the cost of mango manifold and renders it uncompetitive (Sen, 2007; Rabinowitz, 2007). However, after further negotiations, US agreed for nuclear irradiation and routine inspection only.

India established its first full-scale nuclear irradiation facility at Lasal Gaon, Nasik in 2003, which was subsequently upgraded in April 2007 and became the first cobalt-60 gamma irradiation facility in the world, outside US, to be certified by USDA-APHIS for phytosanitary treatment of mangoes (IANCAS, 2009). Although the first nuclear irradiation plant in India was established in Vashi, Navi Mumbai in 2003, it was a low capacity demo-plant only. A third plant was commissioned at Hyderabad in 2008, which would start full-scale functioning in the mango season of year 2010 (Hindu, 2008). An irradiation plant requires an initial investment of approximately INR 100 million with a life of 10 years in addition to maintenance, safety, and operation costs.

However, India has tried arguing for HWT as an effective SPS measure reducing probability of fruit fly infestation by 80 per cent (OISAT, 2009). The process includes desapping, washing, immersion in hot water, and fungicide. If coupled with bagging of mango fruit or pre-harvest sanitation treatment, HWT provides a completely fruit fly free crop (Verghese et al, 2006). Initial costs of HWT comes to INR 200 thousand for a life of 8 years, a fraction of irradiation plants with substantially lower operational costs.

3.1 Estimation for Alternative Scenarios

US, as an importing nation, has four policy options to chose from – 1) a complete ban on mango trade, which was in application between 1989 and 2006; 2) HWT, a policy favored by India; 3) nuclear irradiation, the policy favored by US and presently in force, and; 4) free trade, a policy regime with no SPS standards in place. In the nuclear irradiation of mangoes, the fruit cartons are exposed to gamma ray doses of 250-350 Grays (or Gy) for about 10 minutes. However, the US requires mango fruits to be exposed to 400 Gy radiation dose to mitigate the stone weevil (Press Release, 2007). The radionuclide recommended is Cobalt-60, which produces highly penetrating and can be used to treat fully packaged boxes of fresh or frozen food (ICGFI, 1999). After irradiation, the fruit is kept in cold storage for at least a day. The irradiation process delays ripening of fruit, thereby, increasing the shelf-life of the fruit by about a week. The process also inactivates fruit flies and stone weevil, the two pests of concern. However, the irradiation process requires high initial investments. The process is costly and technically sensitive.

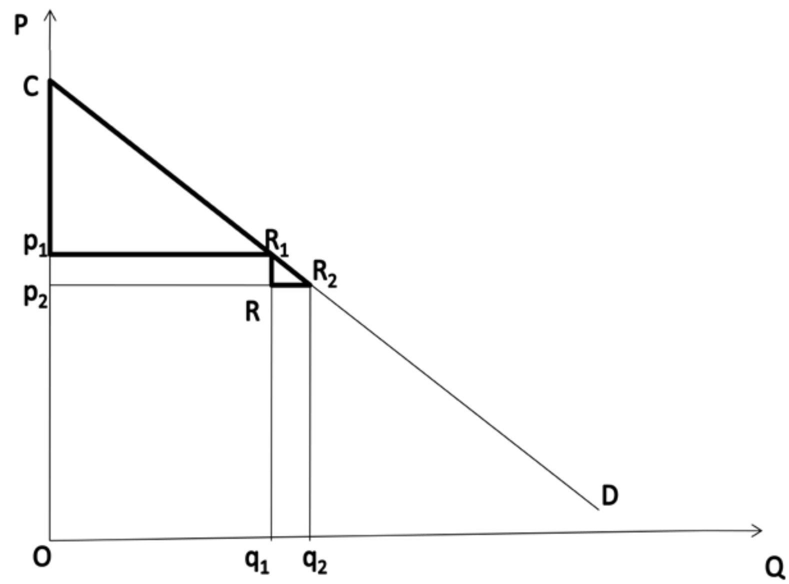
HWT, on the other hand, requires very low initial investments and is a simpler process. The process involves desapping of the fruit, washing, immersion in the hot water, fungicide, and washing again before placing the fruit in cold storage for at least a day. Although countries in Middle-East and EU as well as China, UK, Bangladesh etc. accept HWT as an effective treatment against all mango pests, USA and Japan do not accept it. Japan is the only country in the world that demands Vapor Heat Treatment of mangoes, a process in which mangoes are passed through chemical fumes instead of being washed into hot water, as in HWT. Welfare impact of mango trade on both, India and US, under the four different policy regimes is estimated. Welfare impact is defined as the net of consumer surplus, producer surplus, SPS compliance cost for the exporting nation, and control and spillover costs for the importing nation. In addition to the basic conditions and assumptions, as defined in chapter 2 on framework and methodology, market clearing condition is also imposed. Hence, it is assumed that markets are equipped to supply whatever is demanded and are large and diversified enough to demand whatever is supplied. Given the size, diversity, and long-term flexibility of mango market in the two nations, this assumption shall hold.

3.2 Estimates for Mango Trade – India

The consumer surplus to Indian mango consumers due to export of mangoes to US under different trade regimes is measured by estimating the Harberger Triangles, which gives the lowest estimate for consumer surplus as against the other two measures of consumer surplus, namely equivalent variation and compensating variation (Henderson and Quandt, 2003). The Harberger triangle is depicted graphically in Figure 3.1 and the measurement of consumer surplus under the four scenarios is explained in equation 3.2.

In Figure 3.1, CD is the initial demand curve for mangoes, with demand q_1 at price p_1. If the price changes due to a policy change, the new price and quantity are p_2 and q_2 respectively. The consumer surplus is given by the triangle CR_1p_1, which is similar to the triangle R_1R_2R. The underlying assumption of linear demand is valid as the actual elasticity of demand in this case is -0.98 (Mittal, 2006), which is almost linear.

Figure 3.1: Harberger Triangle Depicting Consumer Surplus



$$(3.1) \qquad e_d = \text{elasticity of demand} = \frac{\Delta Q/Q}{\Delta P/P}$$

$$= \frac{q_1q_2}{p_1p_2} \text{ X } \frac{Op_1}{Oq_1}$$

$$= \frac{p_1R_1}{Cp_1} \text{ X } \frac{Op_1}{Oq_1} \qquad [\Delta CR_1p_1 \sim \Delta R_1R_2R]$$

$$= \frac{Op_1}{Cp_1} \qquad [p_1R_1 = Oq_1]$$

$$=> \quad Cp_1 = \frac{Op_1}{e_d} = \frac{\text{Price}}{\text{elasticity of demand}}$$

Since, $\quad \text{Consumer Surplus} = \frac{1}{2} \ (Cp_1) \ (Oq_1)$

$$(3.2) \qquad \textbf{Consumer Surplus} = \frac{1}{2} \text{ X } \frac{\textbf{Price}}{\textbf{elasticity of demand}} \text{ X } \textbf{Quantity}$$

Table 3.5: Average INR to US Dollar Exchange Rates

	2004	2005	2006
Market Rate	48.302	45.923	44.948
RBI Reference Rate	48.406	45.928	44.95
Average Applied	48.354	45.9255	44.949

Source: CMIE Business Beacon

To measure the consumer surplus, equation 3.2 is estimated for different scenarios. The equation can be estimated easily, if the benchmark dataset includes the three required parameters under all the four possible scenarios - mango demand elasticity of Indian mango consumers, quantity demanded of Indian mangoes, and domestic price of mangoes. With this information, an estimate of consumer surplus of Indian mango consumers under all the four scenarios is derived. The consumer surplus under alternate scenarios is compared with that under trade ban scenario for assessing the impact of the policy change.

The quantity traded under different scenarios is arrived at in different ways. According to the Director of Agricultural and Processed Food Products' Export Development Authority (APEDA), India is expected to export 8,000-10,000 MT of mangoes to the US every year under nuclear irradiation regime (Business Line, 2007). This provides the expected quantity of exports to the US under irradiation regime. For the expected export quantity under free trade regime, it is assumed that the top price export of Indian mangoes would all be diverted to the US, since US is the most premium market. Therefore, all the top quality mango that is presently exported to European or Middle-East countries is expected to be exported to US. This assumption controls for the quality of mangoes as well, which is much inferior in case of export to low price exports to Bangladesh and Nepal. As HWT as a policy stands somewhere in between the two alternate policy regimes of irradiation and free trade, the expected quantity of export under HWT regime would be somewhere in between the two regimes; hence, a simple average of the export quantity under two regimes is taken as a fair estimate of the export quantity under HWT regime.

The elasticity estimate (e_d) for the baseline scenario is drawn from Mittal (2006), which is all India uncompensated elasticity of demand for fruits and vegetables group. Since mango is the largest horticulture crop for India, the number is a close estimation. Since the purpose here is to capture the change in utility as a result of change in consumption, the Marshallian or uncompensated elasticity of demand is considered. Rest of the demand elasticity estimates are derived by a simple linear approximation with demand elasticity under trade ban regime and HWT regime. The mango demand elasticity estimate under the HWT regime is derived by comparing the total available quantity of consumption to the Indian consumers and the price the Indian consumers pay at the beginning and at the end of the benchmark period under trade ban scenario. HWT is used for approximation and thereafter for linear extrapolation and interpolation instead of any other policy regime for the elasticity estimate under the remaining two policy regimes, as that was the prevailing policy for all the other countries during the benchmark period.

Prices under different scenarios are worked out by a simple estimation of equation 3.1, where all the values except that of Δp are known. The baseline price (P) is adjusted for inflation with the Consumer Price Index - Industrial Worker (food group) for four months between April to July (RBI, 2009), which are the four months of mango season in India. All these prices are FOB prices, which are the relevant benchmark for the Indian mango producers. The benchmark dataset thus compiled is depicted in Table 3.6 a, b, and c.

Table 3.6a: Benchmark Dataset for Different SPS Regimes - Prices INR/MT

Year	Trade Ban	Irradiation	HWT	Free Trade
2004	15409.00	15419.38	15425.96	15431.89
2005	16644.66	16656.99	16668.86	16679.55
2006	16680.71	16693.18	16702.46	16710.82

Table 3.6b: Benchmark Dataset for Different SPS Regimes - Quantity MT (Production + Import – Export)

Year	Trade Ban	Irradiation	HWT	Free Trade
2004	11,429,448.68	11,420,448.68	11,413,939.43	11,407,430.19
2005	11,551,758.28	11,541,758.28	11,531,070.13	11,520,381.98
2006	12,593,494.20	12,582,494.20	12,573,262.69	12,564,031.18

Table 3.6c: Benchmark Dataset for Different SPS Regimes – Price Elasticity

Trade Ban	Irradiation	HWT	Free Trade
0.98	1.169	1.234	1.299

The gain to Indian producers is estimated by assessing the value differential between the domestic market and export to US market. The domestic prevailing price, as depicted in Table 3.6a, under different scenarios is compared with the FOB price the Indian producers would get upon exporting to US. A simple estimation of the value gain to Indian mango producers under different policy regimes is compared to the same under the baseline scenario and any excess over and above the baseline scenario is assigned as the cumulative producers' gain to India. The estimates for cost of compliance are collected from the facilities directly. HWT and allied costs were collected through visits to Central Institute of Sub-tropical Horticulture (CISH) in Kakori, Uttar Pradesh and two mango pack-house facilities in Kakori and Lucknow, Uttar Pradesh. The places visited belong to the mango belt of India and make the state of Uttar Pradesh as the biggest mango producing state of India. The irradiation cost estimates were collected from Kay Bee Exports of Mumbai, Maharashtra, one of India's largest mango exporters to USA. All the numbers for both the SPS regimes were cross checked and verified with figures from APEDA. The cost of irradiation is shown in Table 3.7a and 3.7b and that of HWT in Table 3.8.

Table 3.7a: Post-Harvest Irradiation Cost Estimates for Mango (INR per kg)

Expenditure	APEDA	KayBee Fresh
Transport - Farm to Pack House	8.79	2.00
Processing at Pack House (Fungicide)		5.00
Pack House to Irradiation Plant		1.00
Irradiation + Handling	6.59	7.00
Irradiation Plant to Mumbai Airport	1.83	1.00
Clearance Charges at Mumbai Airport		1.00
Air-freight to USA	109.89	110.00
Total	**127.10**	**127.00**

Table 3.7b: Other Costs for Exporting Irradiated Mangoes to USA

Cost of new plant and facilities	INR 100 Million
Life of Plant	10 years
Cost of farm certification (once)	US$ 750
Farm Infrastructure cost (first year only)	US$ 2,500
Cost of farm inspection (per annum)	US$ 300

Source: Hindu (2008), Bourquin and Deepa Thiagarajan (2007)

Table 3.8: Cost of HWT treatment of Mangoes (INR/KG)

Transport (Farm to Pack-house)	2.00
Pack-house(Desapping, HWT, Fungicide)	2.50
Cold storage	2.13
Total per kg	**6.63**
Cost of Plant - (Life – 8 years)	200,000

Source: CISH Kakori, Mango Packhouse Kakori, and KayBee Fresh

The estimates for all the four scenarios were summed up and averaged for annual estimates after conversion into US$ with relevant exchange rates. The compiled results are shown in Table 3.9. The trade ban scenario shows all zeros, as all the other numbers are over and above this baseline scenario. Notably, the cost of compliance under free trade is also zero, as there may not be any standards in force under this scenario. Further, Indian suppliers always gain from access to the high premium market of US. However, Indian consumers also benefit due to overall production rise and probable improvements in quality due to the rush to export to the high premium market of US.

Table 3.9: Estimates for Impact of Mango Trade on India (US$ p.a.)

	Trade Ban	Irradiation	HWT	Free Trade
Impact on Consumers	0	376,550,527	532,432,404	682,715,087
Impact on Producers	0	46,472,628	46,398,347	34,071,311
Cost of Compliance	0	-3,733,295	-2,698,807	0
Total	**0**	**419,289,859**	**576,131,945**	**716,786,399**

The payoff estimates in Table 3.9 clearly indicate that India is forced to abide by the least benefitting standards regime by US. The most well paying strategy for India is the free trade of mangoes; however, India has been demanding for HWT perhaps with the view of minimizing the potential loss to US due to mango pests. Since the negotiation strategy of India would depend not only on its own payoff but also on that of US, an estimation exercise for scenario-wise payoff to US follows.

3.3 Estimates for Mango Trade – USA

According to APHIS (Federal Register, 2006), if the import of mangoes from India is permitted, the effect on US mango producers would be minimal and the benefits of opening up the market to Indian mangoes would outweigh any expected costs to the US' domestic producers. However, going by the conservative principle, we estimate the impact on US producers by assigning proportionate loss of market to them. For example, if Indian mangoes acquire 10 per cent of US mango market share, it is assumed that US producers would lose a proportionate share of their market, thereby pegging the loss to US producers at a higher end. To estimate the loss to US mango producers, the quantity exported from India under different scenarios is compared with the total US mango consumption and the proportionate loss of market is assigned to US mango producers. The US market share of Indian mangoes over the years and the supposed equal share loss to US producers is given in Table 3.10.

Table 3.10: Indian export as a proportion to total US consumption (%)

Year	Trade Ban	Irradiation	HWT	Free Trade
2004	0	3.311	5.707	8.10
2005	0	3.908	8.085	12.263
2006	0	3.814	7.014	10.215

For the impact on consumers, due to data unavailability, an alternate method of measuring the ‘willingness to pay’ is employed. Instead of comparing the reserve price and market price of Indian mangoes for US consumers, the price of Indian mangoes is compared with the prevailing market price of a comparable variety. The prevailing market price of domestic US mangoes and the highest of the prevailing price of other imported mangoes are taken as benchmark to compare the price received by Indian mangoes. The underlying assumption is that if US consumers are paying a premium to Indian mangoes over and above the other available varieties, that premium must denote their gain in satisfaction derived from Indian mangoes. This measure simply captures willingness to pay as an indicator of consumers’ gain in value.

Since irradiation is the most restrictive regime, the exports are subject to strict inspection. As a result, the quantity of export remains low and confined to choicest of mangoes. These mangoes have received a very high premium in US. Therefore, the price received by irradiated Indian mangoes is compared with that of domestically produced US mangoes that fetch the highest price after Indian mangoes. The price of irradiated Indian mangoes is derived by considering the cost escalations over and above the domestic price of Indian mangoes under the irradiation regime. These cost escalations include the cots of transportation, irradiation, other treatments, packaging, export cargo, customs, and a margin for mango importing parties.

Under HWT and free trade regimes, the quantity of export is expected to increase significantly, whereas the quality may not be as consistently high as in the case of mangoes under irradiation regime. Therefore, the price received by Indian mangoes under HWT and free trade regimes is compared with the price of equivalent Mexican mangoes (Gallo, 2009). The Mexican mangoes have about 60 per cent market share in US mango market and fetch the highest price among all imported mangoes barring the Indian premium mangoes. The Mexican mangoes had to compete so far against mangoes from Brazil, Haiti, Peru, and Ecuador (Evans, 2008), which are usually lower in quality but higher in prices due to inefficient supply chains and high transportation cost. With bulk import of Indian mangoes under HWT or free trade regimes, it s expected that a large market share will go to Indian mangoes due to quality as well as preference of the Indian diaspora. The estimates of prices received by Indian mangoes are arrived at by topping the domestic price of Indian mangoes under the respective regime with the costs of transportation, treatment, packaging, duties, and a margin to importing parties.

The highest price received by the benchmark variety of among all the non-Indian mango varieties and the expected price received by Indian mangoes are compared and the difference is multiplied by the quantity traded for an estimate of perceived value gain to US consumers. The price estimates under irradiation, HWT, and free trade also include cost of transportation within India, cost of relevant treatment, cost of transportation between India and USA, charges for customs and duties In USA, and margin for US mango importers. All this information is sought through first-hand interaction with the government agencies (APEDA and CISH) and mango exporters (Nawab Pack House, Kakori and KayBee Fresh, Mumbai). The consolidated price estimate thus derived and the comparable benchmark mango prices are shown in Table 3.11.

Table 3.11: Price of Mangoes under Different Conditions (US$/MT)

Year	US Domestic	Mexican	Irradiation	HWT	Free Trade
2004	7000	5000	10,000.00	5,707.72	4,554.93
2005	5500	3500	9,748.88	5,776.65	4,604.03
2006	7500	5500	9,647.91	5,991.63	4,714.20

The most important estimate for the impact on US is that of potential loss from invasive species and cost of their elimination. Indian mangoes carry twenty pests of concern for US, including fourteen insects, five fungi, and one bacterium (USDA APHIS, 2006). The estimates for cost of control and elimination of pests are directly adopted and adjusted for current prices from Andrew et al. (1978). The study considers loss by pest infestation to the entire citrus industry at the higher end of ten per cent. The loss figure is adjusted with GDP (Gross Domestic Product) Deflator for the benchmark period and taken to be the cost to US in case of free trade. GDP deflator is used instead of other indicators, as GDP deflator flexibly captures changed expenditure patterns. Therefore, by reflecting up to date expenditure patterns, GDP deflator better accounts for price rise as well as the expansion in the size of the industry.

Since, HWT can reduce the potential damage by eighty per cent (OISAT, 2009), the free trade loss figure is reduced by 80 per cent for trade of mangoes under HWT regime. However, since USDA APHIS claims irradiation to be completely effective against all these pests, there is a zero control and elimination cost assumed. The estimates for US thus arrived are averaged for annual numbers and are compiled in Table 3.12. As is evident from estimate of net welfare gains, nuclear irradiation is the only policy regime with positive impact for US. When India was not ready to offer the best choice to US for eighteen years, US chose the second best policy of trade ban. In remaining two scenarios, the loss from pest infestation erodes completely the comparatively small gain to consumers.

Table 3.12: Estimates for Impact of Mango Trade on USA (US$ p.a.)

	Trade Ban	Irradiation	HWT	Free Trade
Impact on Consumers	0	31,038,611	22,674,112	11,546,755
Impact on Producers	0	-687,612	-1,287,436	-1,887,260
Cost of Control	0	0	-41,772,169	-208,860,847
Total	0	30,350,999	-20,385,494	-199,201,353

Although free trade of mangoes is the best policy option for India, as Table 3.9 indicates, in no way it can convince US to choose free trade of mangoes due to high loss figures for US under that policy regime. The US considers its own payoffs and chooses the policy option of nuclear irradiation of mangoes, which is clearly a dominant strategy and exceeds the payoff to US from any other strategy by a substantial margin.

In such a case, India has two options - conventional negotiation approach or strategic negotiation as per the framework proposed in this study. Under the conventional approach, India would either take the positive but sub-optimal payoffs of nuclear irradiation or it would keep negotiating for a less restrictive SPS regime, probably in vain. However, if the proposed framework is valid, India would be able to induce the US to accept some negative payoff from mango imports in lieu of allowing trade in another commodity with higher gains. Further, since these estimates are conservative in nature, there is a possibility of some margin of error while passing the estimates. Therefore, a sensitivity analysis is performed in a later chapter on analysis of the results. As a possibility, US may have greater gains or lower losses from the strategies enumerated; however, it is unlikely to observe greater loss or lesser gain figures due to already conservative estimates.

4. The Case of Wheat Trade between India and USA

Wheat is cultivated in almost all the climates and regions of the world. Wheat is used as the main staple food worldwide and its production leads all other crops, including maize and rice (Curtis, 2002). Wheat is also used for making cakes, cookies, pasta, noodles, and fermenting beer, vodka, and alcohol. The production of wheat has witnessed almost constant rise over past few decades. However, most of the production is shared among top producers, with only three countries, namely China, India, and USA, accounting for more than a third of total wheat production worldwide. Major wheat producing nations are shown in Table 4.1.

India is world's second largest wheat producer with 11 per cent contribution after China, which contributes about 15 per cent. However, owing to huge domestic demand, both the nations consume most of their wheat domestically. USA is world's largest wheat exporter, supplying almost a quarter of exports worldwide. Other prominent wheat exporting nations are Australia, Ukraine, EU, Russia, France, Argentina, Canada, and Turkey (USDA FAS, 2007). Although India exports some insignificant quantity of wheat to neighboring countries like Nepal and Bangladesh (Table 4.2); notably, it has sought to import wheat in large quantities in recent times. This is a change marked as the end of the era of self-sufficiency that emanated from green revolution in Indian food-grain production.

Table 4.1: World's Top 15 Wheat Producers, 1996 – 2005

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
China	18.84	18.89	20.10	18.49	19.38	17.00	15.91	15.72	15.45	14.56
India	12.12	10.61	11.31	11.18	12.13	13.03	11.81	12.67	11.63	11.49
USA	10.95	10.59	11.01	11.68	10.65	10.37	9.03	7.67	11.40	9.37
Russia	5.55	5.96	7.22	4.55	5.27	5.88	7.96	8.81	6.09	7.24
France	5.69	6.14	5.52	6.71	6.30	6.37	5.35	6.78	5.44	6.33
Canada	4.60	5.09	3.96	4.06	4.58	4.53	3.50	2.82	4.21	4.12
Germany	3.27	3.23	3.23	3.40	3.34	3.69	3.87	3.62	3.44	4.05
Turkey	3.32	3.16	3.04	3.54	3.06	3.58	3.22	3.40	3.39	3.35
Australia	3.04	4.05	3.13	3.72	4.21	3.77	4.12	1.76	4.59	3.25
Pakistan	3.13	2.89	2.71	3.15	3.04	3.60	3.22	3.17	3.43	3.15
Ukraine	3.00	2.31	3.00	2.52	2.31	1.74	3.62	3.58	0.64	2.79
UK	2.42	2.72	2.54	2.61	2.51	2.82	1.96	2.70	2.41	2.65

Argentina	1.76	2.75	2.46	2.12	2.63	2.75	2.61	2.14	2.59	2.36
Iran	2.07	1.71	1.64	2.01	1.48	1.38	1.60	2.17	2.40	2.23
Poland	1.60	1.47	1.34	1.61	1.54	1.45	1.57	1.62	1.40	1.51
Total	**81.35**	**81.57**	**82.20**	**81.34**	**82.44**	**81.96**	**79.35**	**78.62**	**78.51**	**78.46**

Source: CMIE IES; All figures in Percentage, Data arranged in descending order on the year 2005 values

Table 4.2: Wheat Production and Trade – India (MT)

Year	Production	Import	Export
2002-03	72.76	0	4.9
2003-04	65.10	0	5.7
2004-05	72.06	0	2.1
2005-06	74.00	1.3	0.8
2006-07	74.89	5.5	0.2

Source: CMIE Indian Harvest

After decades of dependence on wheat imported under P.L. - 480, India began gaining self-sufficiency in food grain production during late-70s as a result of green revolution. Thereafter, India did not involve in import of wheat for long except for meager quantities and successfully sustained this self-sufficiency for almost two decades. However, despite steady rise in production as well as acreage and productivity, supply shortfalls are witnessed in Indian domestic market over past few years. There are several reasons cited behind this shortfall including a shift of taste and preference in southern and north-eastern India for wheat based products as opposed to traditional rice based products and increased demand for end use of wheat as a result of rising demand for pasta, macaroni, noodles, bread, and other bakery products etc. The Indian union minister for Food and agriculture, Sharad Pawar, was quoted (Asian Age, 2007), “Dietary habits are changing. Three years ago, I used to pursue southern states to off-load more wheat. Today, chief ministers of seven states are demanding more wheat. Demand for wheat from the north-eastern states is also on the rise.” Amid supply shortfalls, risk of price inflation, and worries of stock-out for Public Distribution System (PDS), India imported about six million MT of wheat in 2006 and 1.95 million MT in 2007. All the countries exporting wheat to India in recent years are shown in Table 4.3.

Table 4.3: Countries Exporting Wheat to India, 2001-2005 (Million MT)

Country	2001	2002	2003	2004	2005	2006
World	0.010062	0	0	0.003343	0	6.079555
Russia	0	0	0	0	0	2.081393
Canada	0	0	0	0	0	1.306751
Australia	0.006697	0	0	0	0	1.093582
Ukraine	0	0	0	0	0	0.333029
France	0	0	0	0	0	0.265145
Hungary	0	0	0	0	0	0.257772
Romania	0	0	0	0	0	0.250196
Bulgaria	0	0	0	0	0	0.237907
Argentina	0	0	0	0	0	0.15222
Czech Rep.	0	0	0	0	0	0.0706
Kazakhstan	0	0	0	0	0	0.02987
Nepal	0	0	0	0.003343	0	0.00009
Bangladesh	0.003365	0	0	0	0	0
USA	0	0	0	0	0	0.001

Source: For 2006 Figures: COMTRADE; APEDA Trade Junction

For all other years: DGCI&S

Table 4.3 suggests that USA, despite being the largest exporter worldwide, exported only a thousand MT of wheat to India in the said period. This wheat must have been imported into India under some special arrangements or special permit, as India does not permit commercial import of wheat from US. India has borne substantial losses on account of the weeds that came with P.L. 480 wheat during 1950s, most notably 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 other wheat-exporting nations like Australia, Russia, Ukraine, Argentina, and Canada (Zarabi, 2007). However, US wheat with 12,000 weeds per 200 kg fails to meet the Indian quality standards of only 100 weeds per 200 kg and (Ramasubbu, 2007). Although India relaxed SPS norms significantly in July 2006 to augment domestic buffer stocks by more than six million MT, the US has been unable to meet the Indian standards.

The US, as the world's third largest wheat producer and largest exporter, has a share of almost a quarter in world wheat exports. In the last few years, US exports of wheat have always exceeded 25 million MT (Table 4.4). US wheat may prove to be important for Indian needs, as India is expected to import up to 5 million MT of wheat every year over next few years till 2017, roughly amounting to US$ 1.5 billion p.a. (Koo and Taylor, 2008). Moreover, participation of US in bidding would significantly increase the competition and would tilt the prices in favor of India, leading to substantial financial and welfare gains for India. For a meaningful negotiation on wheat trade between India and USA, it is important to quantify the welfare effects of such a trade possibility that may or may not be moderated with different SPS standards.

Table 4.4: Wheat Production and Trade - USA (Million MT)

Year	Production	Import	Export
2002-03	44.062	1.958	22.384
2003-04	63.813	1.760	32.295
2004-05	58.737	1.946	28.464
2005-06	57.280	2.309	27.424
2006-07	49.316	3.395	25.025

Source: CMIE IES

4.1 Estimation for Alternative Scenarios

India, as an importing nation, has three policy options to chose from – 1) a complete ban on wheat import from US, which is the case at present; 2) Methyl Bromide (MB) treatment of wheat, a policy demanded by India, and; 3) completely free trade of wheat with no SPS standards in place, which is often advocated by the US. MB is one of the most effective and affordable fumigants to neutralize weeds and fungi. In the treatment process, the wheat shipment containers are fumigated with the MB and an appropriate concentration of MB is contained inside the container for about 24 hours. According to NPIC (2009), as a property of MB, the gas fills air spaces in enclosed areas and penetrates cracks, crevices, and pores in soil, commodities, and structures. Although MB is a toxic substance, it leaves the application site after the treatment is complete. Complete erosion of the gas takes about five days, till when the treated wheat seeds are not deemed for consumption.

Welfare impact of wheat trade on both, India and US, under the four different policy regimes is estimated. Similar to the estimation for mangoes, welfare impact is defined as the net of consumer surplus, producer surplus, SPS compliance cost for the exporting nation, and control and spillover costs for the importing nation. The welfare gains are assessed for both the nations on the premise if there is wheat import into India from USA vis-à-vis any other nation. This distinction is important to understand the impact on wheat suppliers and retail consumers. Given the excess supply of wheat the US carries at any given point in time and relatively small quantities that India has ventured to import, market clearing conditions are implicitly assumed and shall easily hold to good.

4.2 Estimates for Wheat Trade

During the benchmark period, India imported different quantities of wheat through seven international tenders (Modi, 2007). The initial two tenders were for smaller quantities but in June 2006, when India invited tenders for more than two million MT of wheat import, no country was able to meet the SPS standards demanded by India. Therefore, India relaxed wheat import standards substantially in the beginning of July 2006 (Order 1, 2006) and the same relaxed norms were extended in December 2006 (Order 2, 2006) and again in April 2007 for the period till December 2007 (Order, 2007). Notably, this relaxation in norms strengthened the US claim that the Indian standards are set arbitrarily high despite the fact that US was not able to meet these relaxed standards as well; however, most other major wheat exporting nations, including Australia, Russia, Ukraine, Argentina, and Canada were able to meet India's requirements (Zarabi, 2007).

If India were to permit US participation in the competitive bidding for exporting wheat to India without any SPS standards in place, the impact on India would consist of two parts; first, the saving on import bill, if US offers a lower price than the import price actually paid by India, and; second, the loss incurred by India on account of potential pest infestation. During the benchmark period, India imported a total of 6.806 million MT of wheat at different prices. The price actually paid by India is shown in Table 4.5. The same is compared with two weeks lagged prevailing price in Chicago Board of Trade (CBOT) for Soft Red Winter (SRW) wheat. A lag of two weeks is important as this is normal lead time, when the tender prices are quoted; however, the prices even at the immediate dates are closely the same. Similarly, SRW is the variety closest to the one imported by India. Both the CBOT and actual prices are comparable, as insurance and oceanic freight would be in addition to these prices.

Table 4.5: Wheat Import by India and Prevailing Price in CBOT

Date	Quantity (Million MT)	Import Price (US$/MT)	CBOT Price (US$/MT)
10-Feb-06	0.5	178.75	148.44172
8-May-06	0.8	191.39	142.19541
12-Jun-06	2.2	197.82	156.52518
27-Jul-06	0.33	210.72	146.23714
30-Aug-06	1.67	228.94	145.13485
26-Jun-07	0.511	325.59	196.94248
23-Aug-07	0.795	389.45	256.09871
	6.806		

Source: CBOT Price - US Wheat Associates weekly price reports

Rest of the data – Modi (2007)

As is evident from Table 4.5, the prevailing price at CBOT is always substantially lower than the price actually paid by India. Therefore, it can be safely assumed that the US would have won the tenders for exporting wheat to India, had the SPS standards had not prevented US participation in the import process. This would have saved India substantial amounts. Similarly, US would have benefitted to the extent of the export bill issued to India. The price differential between CBOT price and price paid by India, the actual import bill borne by India, the possible export bill issued by US, and the potential saving thereby occurring to India are shown in Table 4.6.

Table 4.6: Wheat Import Price and Value Differentials (US$)

Date	Price differential	Import Bill (Actual)	Import Bill (US)	Potential Saving
10-Feb-06	30.30828	89,375,000	74,220,860	15,154,140
8-May-06	49.19459	153,112,000	113,756,328	39,355,672
12-Jun-06	41.29482	435,204,000	344,355,396	90,848,604
27-Jul-06	64.48286	69,537,600	48,258,256	21,279,344
30-Aug-06	83.80515	382,329,800	242,375,200	139,954,601
26-Jun-07	128.64752	166,376,490	100,637,607	65,738,883
23-Aug-07	133.35129	309,612,750	203,598,474	106,014,276
Total		**1,605,547,640**	**1,127,202,121**	**478,345,519**

On the other hand, imports from US with watered down SPS restrictions would entail some losses to India on account of control and elimination of new exotic pests. However, there are no studies or estimates available on the potential loss amounts to India due to absence of any historical experience with these new and so far un-established exotic pests. Therefore, the exotic pests associated with wheat and potential losses were explored through first-hand interaction with plant pathologists, agricultural scientists, and wheat economists at the GoI’s consulting organizations, namely National Bureau of Plant Genetic Resources (NBPGR), New Delhi; Directorate of Wheat Research (DWR), Karnal, and; National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.

According to a GoI study, total agricultural loss associated with existing exotic pests is valued at INR 600 billion per annum with 57 per cent of the same originating from wheat pests only (DPPQS, 2006). If it is assumed that all the new wheat pests would entail equal amount of loss as that entailed by the existing ones, a fair estimate can be passed for the potential loss to India. There are total 32 pests associated with wheat that are pest of concern for India, as these are presently not found in India. 19 of the 32 pests of concern are associated with the US wheat. Hence, a loss figure is estimated as shown below.

(Total loss amount from existing pests) (Share of loss originating in wheat) (Proportion of pests associated with US wheat)

=> (INR 600 billion) (57 per cent) (19 / 32)

= INR 67.687 billion per annum

On the other hand, if the US agrees to provide the MB treatment as demanded by India, it would have incurred an additional cost of compliance. This would have reduced the gain to US producers by the amount of cost of compliance. The cost of MB treatment comes out to US$ 3.94 per ton and is worked out based on the interaction with a chemical supplier, Mulji Mehta Pharma, Mumbai and an importer, Bishnoi Trading Corporation, Gandhidham. As claimed by the Indian side, the MB treatment would render all the weeds ineffective for spread, thereby entailing no control or elimination cost to India.

The total welfare impact of wheat trade on both the countries, as derived above, is summarized in Table 4.7a and 4.7b. Most importantly, the retail consumers and wheat producers in the two nations are not affected by the wheat trade between the two nations, albeit for different reasons. As shown in Table 4.4, about a half of the US wheat produce is exported annually. This is the amount in excess supply of the domestic demand, hence US consumers are unaffected by the export of wheat to India. Similarly, the US heavily subsidizes domestic producers and their produce is taken off at heavily incentivized farm-gate prices. Therefore, for the US wheat producers, it does not matter to which buyer their produce is exported, as long as they are able to produce and sell it. Indian wheat producers, on the other hand, remain unaffected by the wheat import from US, as the import takes place only after the domestic market supplies prove to be inadequate for meeting the domestic demand. Therefore, the US wheat does not compete against the Indian wheat but serves as a contributor to the same end. The effect on Indian consumers is not accounted for, as wheat is one of the heavily controlled commodities in India. Moreover, the question that Indian producers and consumers face is not whether there is an import of wheat, which in any case happens. They rather face the question that whether wheat is imported from US or from any other country. The US wheat vs. other nation's wheat is an irrelevant question to retail consumers and producers, as long as there is a wheat import from any country. By not accounting for the consumer and producer surplus as a result of wheat trade, the only effect that is foregone is that of rent-seeking due to excess or shortage of wheat. From a policy point of view, elimination of rent seeking is totally justified and even desirable.

Table 4.7a: Estimates for Impact of Wheat Trade on India (US$ p.a.)

Trade Ban	Benchmark	0.00	0.00
MB Treatment	Low import bill	478,345,518.57	478,345,518.57
	no weeds	0.00	
Free Trade	Low import bill	478,345,518.57	-981,507,882.48
	Weeds cost	-1,459,853,401.05	

Table 4.7b: Estimates for Impact of Wheat Trade on USA (US$ p.a.)

Trade Ban	Benchmark	0.00	0.00
MB Treatment	Gain in Revenue	1,127,202,121.43	1,100,386,481.43

	Compliance cost	-26,815,640.00	
Free Trade	Gain in Revenue	1,127,202,121.43	1,127,202,121.43
	No costs	0.00	

The estimates of welfare impact on India are consistent with the policy adopted so far, as permitting imports without treatment would be fatally devastating for the Indian side, with losses as much as about a billion US dollar per annum. However, the question arises that if the US stands to gain substantially with exports to India even after incurring the cost of MB treatment, why does it not chose the second best policy option? There answer is found at two levels. First is that US wheat is accepted without any treatment to over 110 nations and Indian standards are arbitrarily high (US Consulate, 2007). Second, the US is one of the signees of the Montreal Protocol, which aims to reduce or eliminate the chemicals contributing to depletion of ozone layer. However, Indian demand of MB treatment is justified on several grounds. India, being a developing nation, is permitted to use MB till 2015 (Subramani, 2006). Secondly, no technically or economically feasible alternative to MB treatment is available (Toth, 2005). Finally, US has successfully lobbied for Critical Use Exceptions (CUEs) of the MB chemical and the usage of MB chemicals is permitted under section 604(d) of the Clean Air Act of USA. The CUEs include 1) the quarantine and pre-shipment exemption to eliminate quarantine pests, and 2) CUEs, designed for agricultural users with no technically or economically feasible alternatives (USEPA, 2009). Therefore, the continued refusal of US to provide MB treatment for wheat exports to India can be termed as impractical policy adamance and complete disregard for the potential pest infestation losses to India.

It would be critical for India, given the payoff matrices above, to persuade US to alter its policies with regards to the MB treatment of wheat. Evidently, the US is not willing borne small cost of MB treatment but wants India to accept the pest infestation costs. India may choose to show a mutual welfare gain by a change in policy regime in either or both of the countries, if a meaningful comparison can be made. Therefore, a composite assessment is made in the next chapter within the proposed framework for strategic negotiations in international trade standards.

5. Combined Results and Analysis

For a meaningful negotiation on SPS standards, it is necessary to combine the scenario-wise payoffs and analyze them in the proposed game-theoretic framework. Therefore, welfare payoffs from mango and wheat trade to the two nations under different SPS regimes, as derived in previous chapters, are combined in Table 5.1a and 5.1b. In Table 5.1a, first bracket in each cell indicates payoff to India and the second bracket shows payoff to USA. Within each bracket, first figure depicts the effect of mango trade and second figure depicts the effect of wheat trade. This table depicts the effects of the trade of two commodities separately and underlines the behavior of the countries involved, which prefer positive parts of the payoff only and evade form the negative components of the same.

Table 5.1a: Combining Payoffs of Mango and Wheat Trade between India & USA

		USA			
		Trade Ban	Nuclear Irradiation	HWT	Free Trade
INDIA	Ban	(0+0), (0+0)	(419+0), (30+0)	(576+0), (-24+0)	(716+0), (-199+0)
	MB T	(0+478), (0+1100)	(419+478), (30+1100)	(576+478), (-24+1100)	(716+478), (-199+1100)
	Free	(0-981), (0+1127)	(419-981), (30+1127)	(576-981), (-24+1127)	(716-981), (-199+1127)

Table 5.1b: Combined Payoffs of Mango and Wheat Trade between India and USA

		USA			
		Trade Ban	Nuclear Irradiation	Hot Water Treatment	Free Trade
INDIA	Trade Ban	0, 0	419, 30	576, -20	716, -199
	MB Treatment	478, 1100	(897, 1130)*	(1054, 1080)**	1195, 901
	Free Trade	-981, 1127	-562, 1157	-405, 1106	-264, 928

* Nash Equilibrium in Strictly Dominant Strategies represents current regime

** Kaldor-Hicks Efficient Payoff Strategies, the SPS regime demanded by India

From Table 5.1a, it is amply clear that both the nations want to disown the negative part of their payoffs. India chooses trade ban or MB treatment to escape the negative values posed by unrestricted imports of wheat. Similarly, USA chooses trade ban or nuclear irradiation but ignores the other two options due to associated negative values. According to scenario-wise summed up payoffs in Table 5.1b, both the nations have a strictly dominant strategy. There is a Nash equilibrium in dominant strategies with the strategies being nuclear irradiation of mangoes for US and MB treatment of wheat for India. This implies that the present SPS regime of both the countries is consistent with their respective best payoff strategies. The payoff matrix clearly explains US' emphasis on twin strategies of nuclear irradiation for mangoes and free trade for wheat, as these two together provide US with the maximum welfare gains. However, India's policy emphasis on MB treatment of wheat and HWT of mangoes, although less lucrative for India than the free trade of mangoes, is Kaldor-Hicks (Kaldor,1939; Hicks, 1939) efficient to all the other policies. Under the twin policies advocated by India, the extra loss to USA is about US$ 50 million, which India can easily compensate from the additional gains of US$ 157 million. In this sense, India's approach to negotiation is seemingly grounded in mutual gain rather than that of US, which is seemingly driven by the maximization of self-interest.

The payoff matrices above fully explain the present policy regime and negotiation trends. India has been pitching for HWT of mangoes and MB treatment of wheat; whereas USA has emphasized upon nuclear irradiation of mangoes and almost free trade of wheat. In addition, Table 5.1a clearly conforms to the framework proposed in Table 2.1, in which the players look at a single commodity's payoff at a time. Therefore, they tend to disown any negative payoffs; thereby, subjecting themselves to a suboptimal strategy set. However, in the present case, the players retreat to one of the partial liberalization strategies, which is different from the retreat to trade ban strategy, as hypothesized in the proposed framework.

Although the payoffs to India under different scenarios are clearly distant in magnitude, implying that even some margin of error in estimation may not affect the direction of the payoffs. However, such is not the case with the payoff estimates to the US. The payoffs to US under MB treatment as well as free trade strategy of India (i.e. - the two bottom rows of Table 5.1b) fall within a small range and permit small margin of error. Since all of the above payoffs are conservative in nature, it is unlikely that the direction or magnitude of the payoffs would change to the extent to affect broad conclusions. However, all the above payoffs are akin to point estimates, whereas an interval estimate would be better for the situations with a reasonable amount of doubt about the accuracy of the way the events are expected to unfold. Therefore, a brief sensitivity analysis is performed next. The analysis is performed only for those scenarios only, where the degree of certainty is less due to claims contrary to the assumptions taken for this study or any change in the value of outcomes attached may affect the decision on SPS standards to any significant degree.

5.1 Sensitivity Analysis

As discussed above, the payoffs to India from wheat as well as mango trade are decisively clear with huge differences of magnitude across scenarios. Further, there is not any theoretical basis to suggest that the value or the direction of these payoffs might substantially differ from the value derived above. As can be easily observed from Table 5.1a and 5.1b, the difference in payoff values exceed US$ 140 million at least, which provides a huge cushion and a substantial margin of error. Similarly, the payoff values to the US from wheat trade are large in magnitude. These values might be reduced by a small margin due to some additional profiteering or extra transportation costs; however, it is unlikely to affect these estimates by any significant degree. Therefore, the payoffs to US across scenarios would remain consistently similar to the ones derived above. However, the impact of mango trade on US is not substantially different under different scenarios. Therefore, an assumption that is in conflict with the actual scenario or a partially correct observation may affect the outcomes to such a degree, where a change in magnitude or direction of payoffs is possible. Hence, a sensitivity analysis for impact of mango trade on USA is in order to bring more robustness to the results of this study.

The payoff to USA is within a small range under three of the four scenarios, namely trade ban, irradiation, and HWT. This is seemingly valid as the first strategy was a US policy for 18 years, the second strategy is a US policy for the past 3 years, and the third strategy has been a request by India during all these years; whereas the fourth policy option of free trade has not been the case so far. For the sensitivity analysis, the values that may actually be different from the ones assumed for this study include the pest risk estimate under different scenarios and the impact on US producers. These are the two variables for which there exists some theoretical justification or claim, which is different form the assumptions taken for this study so far. Therefore, only these two variables are discussed under varying possibilities for alternate values.

While urging and negotiating with the US to adopt HWT as the applicable standards for import of mangoes, India has maintained that HWT is an effective control measure. Due to emphasis on conservative estimation, the analysis above assumes that the pest losses can be reduced by 80 per cent with HWT. However, there are various studies to suggest that the risk is completely mitigated even with HWT. According to OISAT (2009), HWT is an effective treatment against fruit fly damage, anthracnose, and stem-end rot infestations. According to Waskar (2005), HWT coupled with post-harvest fungicidal treatment reduces disease risk as well as increases shelf life. According to a study commissioned by National Mango Board of USA, few improvements in the mango HWT process maximize the mango quality, such as - hydro-cooling the fruit after HWT and immediate packaging of the fruit without breaking the cold-chain (Mitcham and Yahia, 2009). However, the study distinctly notes that HWT is not effective against the mango seed weevil, which is one of the pests of concern to US. Buganic et al. (2005) suggest pre-harvest bagging of mango fruits and post-harvest HWT accompanied by fungicidal treatment effectively cures all the disease of mango and reduce the fruit-fly damage by 80 per cent. Most importantly, Dr. Hernani Golez of National Mango Research and Development Center, Guimaras, Philippines, suggest that HWT can be made more effective by extending the treatment time till the pulp reaches a temperature level of 46 degree centigrade, which effectively cures all the problems faced by mango crops (ABW, 2009).

Since the estimate of potential losses to US stands on the leanest grounds, the same is changed first for the sensitivity analysis. If it is assumed that there are no losses from HWT (accompanied with pre-harvest bagging, fumigation, and appropriate cold chain maintenance), the loss to US of US$ 41 million is nullified. Therefore, the gain to US under HWT regime increases by the same amount. The total payoff to US from mango trade under HWT regime now stands at a positive figure of US$ 21 million. Since this figure is still lower than the comparable numbers under nuclear irradiation regime, irradiation remains the dominant policy option for the US, albeit with a much smaller margin if US$ 9 million only.

As a logical next step to the above, the 'no loss to US' under nuclear irradiation regime is put to test. A study by Iowa State University distinctly notes that "as in the heat pasteurization of milk, the irradiation process greatly reduces but does not eliminate all bacteria" and that irradiated food helps the product only when all other protocols are followed in the most appropriate manner (Iowa, 2006). If irradiation is not a perfect and leak-proof policy option, it may lead to some losses to US. Therefore, as the next adjustment, the US is assigned a small loss figure of a tenth of the normal loss figure under the free trade regime. This implies that although irradiation is an effective process, there remains a chance of 10 per cent that the pests of concern may affect US. This leads to assigning an additional amount of loss to the US to the tune of US$ 20 million. In isolation, this adjustment would not affect the policy choice and irradiation still remains the preferred policy choice of the US with over a US$ 30 million positive margin over HWT regime. However, if this second adjustment is taken into account in continuation to the previous one, the policy choices are seriously affected. With an additional loss of US$ 20 million from irradiation regime and an elimination of the loss of US$ 41 million under the HWT regime makes the latter a more attractive policy option for the US.

If the above line of argument is further extended and the study by APHIS is fully accepted, there would not be any loss of market share to US mango producers (Federal Register, 2006). The study comments that if the import of mangoes from India is permitted, the effect on US mango producers would be minimal and the benefits of opening up the market to Indian mangoes would outweigh any expected cost to the domestic producers. This would further increase the gain to US under different regimes by the respective figures of loss to US producers. However, since the loss to US producers is so small in magnitude, not crossing a US$ 2 million mark under any circumstances, this is almost insignificant in the decision making scheme.

If all of the above three adjustments are assumed to be valid, the policy choices for US may completely change and may not remain as clear as before under the conservative approach. The effect of these adjustments is represented in a summarized tabular form in Table 5.2a through d. The payoffs affected by the respective adjustments are shown in bold.

Table 5.2a: Total Payoffs to US - No Loss from HWT

	USA				
I		Trade Ban	Nuclear Irradiation	HWT	Free Trade
N D	Trade Ban	0	30	**21**	-199
I	MB	1100	1130	**1121**	901
A	Free Trade	1127	1157	**1148**	928

Table 5.2b: Total Payoffs to US - Marginal Loss from Irradiation

	USA				
I		Trade Ban	Nuclear Irradiation	HWT	Free Trade
N	Trade Ban	0	**9**	-20	-199

D I A	MB T	1100	**1109**	1080	901
	Free Trade	1127	**1136**	1106	928

Table 5.2c: Total Payoffs to US - No Loss to US Producers

	USA				
I N D I A		Trade Ban	Nuclear Irradiation	HWT	Free Trade
	Trade Ban	0	31	-19	**-197**
	MB T	1100	1131	1081	**903**
	Free Trade	1127	1158	1108	**929**

Table 5.2d: Total Payoffs to US - All Adjustments Simultaneously

	USA				
I N D I A		Trade Ban	Nuclear Irradiation	HWT	Free Trade
	Trade Ban	0	**10**	**22**	**-197**
	MB T	1100	**1110**	**1123**	**903**
	Free Trade	1127	**1137**	**1149**	**929**

If all the three adjustments are made simultaneously, or as noted earlier, only the first two adjustments are considered as valid due to the insignificance of the loss amount to US producers, the policy choices demand a substantial rethink. If the payoffs in Table 5.2d are considered to be valid, the US has a clear case of deviating fro the present policy regime of nuclear irradiation and opting for HWT. Although the difference in magnitude of payoffs is again low, these payoffs represent the lower limit of gains and imply that the difference in payoffs cannot be squeezed any further. So far, all the tables and estimation results have been presented in the point estimate form only; however, it would be important for the policymakers to know the extent to which the payoffs may change. Therefore, a range estimate is presented in Table 5.3a and b with the conservative estimates representing the lower bound of gains (or upper bound of losses) and the estimates after lenient adjustments representing the estimates for the upper bounds of gains (or the lower bounds of losses). Post-adjustment combined comprehensive payoffs for both the countries and both the commodities are shown in Table 5.4.

Table 5.3a: Range Payoffs to the US from Mango Trade (Thousand US$)

	Trade Ban	Irradiation	HWT	Free Trade
Impact on Consumers	0	31,038	22,674	11,546
Impact on Producers	0	*0 to -687*	*0 to -1,287*	*0 to -1,887*
Cost of Control	0	*-20,886 to 0*	*0 to -41,772*	-208,860
Total	0	*10,152 to 30,351*	*22,674 to -20,385*	*-197,314 to -199,201*

Note: Range is shown wherever applicable.

Table 5.3b: Range Payoffs to the US from Wheat and Mango Trade (Million US$)

USA				
	Trade Ban	Nuclear Irradiation	HWT	Free Trade
Trade Ban	0	10 to 30	22 to -20	-197 to -199
MB T	1100	1110 to 1130	1123 to 1080	903 to 901
Free Trade	1127	1137 to 1157	1149 to 1106	929 to 928

Note: Range is shown wherever applicable.

Table 5.4: Combined Payoffs of Mango and Wheat Trade between India and USA – After Sensitivity Adjustments

	USA				
INDIA		Trade Ban	Nuclear Irradiation	HWT	Free Trade
	Trade Ban	0, 0	419, 10	576, 22	716, -197
	MB T	478, 1100	897, 1110	**1054, 1123**	1195, 903
	Free Trade	-981, 1127	-562, 1137	-405, 1149	-264, 929

If the adjusted payoffs are held as valid for policy consideration, the policy choices may drastically alter. According to Table 5.4, US shall adopt HWT for mangoes as the strictly dominant strategy, whereas India shall stick to its choice of MB treatment as the strictly dominant policy regime. The game-theoretic payoff matrix again provides a Nash Equilibrium in strictly dominant strategies for both the nations. However, as against the case with conservative estimates previously, the Pareto Optimal policy choices coincide with the Nash equilibrium. Therefore, the policy choice as well as negotiations would be direct and simple with clear agreement in the interest of both the trade partners.

6. Conclusion

Although SPS agreement of WTO has become one of the major points of dispute among member nations, there are few studies that assess the welfare impact of standards in a comprehensive manner. Due to near absence of empirical studies, standards are usually kept at prohibitively high levels, thereby inducing sub-optimal outcomes. Therefore, it is imperative to assess the impact of SPS standards on various dimensions and base the decision making on expected net welfare gains to the nation as a whole. Cost-benefit analysis based studies are more flexible, comprehensive, and apt for policy formulation due to the welfare oriented outlook.

All the studies so far have considered the impact of SPS standards for a single commodity and on the importing nation only. The present research addresses this gap as such unilateral decision on standards leaves out the possibility of choosing mutually beneficial level of standards. A negotiation based SPS regime is considered, wherein a country may settle for lower benefits or a loss on trade of one commodity due to lower domestic SPS standards, yet a reciprocal change in SPS standards for another commodity by the trade partner may provide higher net gains. In such a case, an interactive decision would facilitate trade and augment welfare as against unilateral decision making, which suggests for stringent SPS standards, leading to low or no trade.

A game-theoretic framework for strategic negotiation on SPS standards between two countries and two commodities is proposed. The framework poses various alternate scenarios and the possible payoffs therein. Analysis of Nash equilibrium under different scenarios is presented with theoretical observations. A range of methodologies for quantifying payoffs is studied and their relative assessment is made.

To implement the proposed framework for empirical justification, the case of Indo-US trade in wheat and mango is chosen due to the relevance of North-South divide. At present, India does not permit import of wheat from the US due to high weed infestation, whereas mango export from India to USA was banned between 1989 and 2006 due to high pesticide levels and incidence of pests. A range of welfare gains to India and US under different SPS regimes is estimated. The policy choices act as strategies and include complete ban and full liberalization with a set of intermediate alternate standards.

The estimation process breaks the impact of standards into smaller components and estimates them separately. The estimates are then summed up over countries for the respective commodities and compared in the game-theoretic framework. The strictly dominant Nash equilibrium is consistent with the present regime. The payoff matrices fully explain the present policy regime and negotiation trends. The payoffs also conform to the framework proposed where the players look at a single commodity's payoff at a time; thereby, subjecting themselves to a suboptimal strategy set. The results show that it is more welfare augmenting for both the countries, individually as well as jointly, to adopt moderate level of SPS standards instead of complete ban or complete liberalization. A brief sensitivity analysis confirms that there is ample scope for policy negotiations and testing of assumptions. Notably, in conservative estimates as well as in the estimates of sensitivity analysis with relaxed assumptions, it is clearly underlined that the developing south is more prone to the impact of the level of SPS standards as compared to the developed north.

6.1 Policy Implications

As observed through detailed estimation process, the policy choices of both the nations are consistent with their respective payoff estimates. However, the policy emphasis and demands are not in sync with the best outcomes possible. The request by India for HWT regime in mango import by USA is not the most lucrative option for the US and entails small losses. The demand of India for HWT can be justified only in the case if India may undertake to compensate the US for any losses emanating from a policy change in favor of India. This shall not be much difficult for India; as the regime change increases the benefit to India by over US$ 157 million, whereas the consequential loss borne by US is about US$ 50 million only. Therefore, India may offer to compensate the US mango producers directly in lieu of a more favorable policy regime. This would keep the US at the same welfare level and at the same time, would increase the gain to India by more than US$ 100 million. Through this exchange, both the nations may reach a Kaldor-Hicks efficient outcome.

The policy demanded by US for wheat trade with India, on the other hand, is not so mutually benefitting. By moving from MB treatment to free trade of wheat, the gains to US would increase by over US$ 26 million; whereas the consequential losses to India would exceed US$ one billion and would be too high to be compensated by any consequential gains. The potential pest infestation would be devastating for Indian flora, fauna, and ecology. Therefore, the US emphasis for free trade of wheat may not be justifiable on any economic grounds. Given the amount of damage India may have to borne as a result of untreated wheat, it is surprising to witness continued demand for free trade of wheat by US. As a possibility, India may choose to buy the untreated cheap wheat from the US and treat it on Indian ports at own cost. Given the huge payoff gains and small costs of MB treatment, this exercise seems more plausible than tedious negotiations. However, the cost of keeping imported wheat in the bay for five days and repackaging wheat after treatment etc. would entail some additional costs and inconveniences. More importantly, given the history of invasive species, it may be a risky proposition. The invasive pests often spread through air, water, and ride over other species. Therefore, the chances of spread of invasive species cannot be completely mitigated, if wheat is treated at Indian ports rather than being treated by the US before exporting to India or over international waters.

However, the US policy emphasis of free trade of wheat shall not be particularly surprising given the past experiences of negotiation behavior of the developed north and particularly that of USA. Although the US wants to preserve its mango fruit industry from mango stone weevil, which is negligible in size and economic importance by its own admission, the US does not hesitate in enforcing highest level of standards on India without consideration of costs attached. At the same time, The US wants India to ignore the huge potential losses on account of pest infestation from free trade of wheat. Ironically, upon disagreement, Indian standards are termed as arbitrarily high and unnecessarily prohibiting trade by the US. However, India can claim to have crystal clear choices for both the commodities.

6.2 Contributions

The present study has two significant contributions. At a methodological level, the proposed framework aims to take the SPS standards setting to a different plain; i.e. - from unilateral decision-making to mutually welfare augmenting strategic standards. Analyzing SPS standards as a strategic decision in a game theoretic framework would strongly affect the policy choices and would dictate for less restrictive SPS standards. The robustness, generalizability, and policy applicability of this framework can be further enhanced by taking other disputed commodities into consideration.

Empirical contribution to the literature is in the form of putting an economically rational value at the welfare impact of various SPS regimes in case of Indo-US trade of wheat and mango. The present study is the first of its kind, which seeks to attach an economically justifiable value on the welfare impact on the two nations as a result of the trade of two commodities. Both the contributions together suggest whether negotiations can be fruitful at all or not and if at all there is a possibility of making a Pareto-improvement over the prevailing policy regime.

This study underscores another important point; i.e. - the impact of risks arising out of invasive species cannot be studied in terms of science alone but it has to be wedded to the economic implications. This is underlined with a clear separation of direct impact on consumers and producers from indirect impact on environment and other indirect stakeholders. By spelling out the pest losses specifically as purely environmental externalities, the separation of direct and indirect impact of SPS standards is clearly underlined. As shown in the estimation process, the major costs of trade are not the market shares but the costs of pest infestation and control, it is clear that SPS standards is the central issue in these disputes. Therefore, a traditional analysis with enumeration of trade gains or losses would not suffice.

6.3 Limitations

Although the framework proposed in the present research is extendable to multi-country multi-commodity framework without the loss of generality, the empirical estimation is highly contextual in nature. If there is a change in the measurement or behavior of any of the variables or if there is an additional variable for consideration, it would entail a fresh analysis, as any change in the context may lead to a cascading effect over the outcomes. A basic assumption throughout this study has been that of linearity, and by extension, non-interaction. It is assumed that a linear summation of various payoff estimates is possible, as the two commodities are orthogonal and their consumer, producers, and spillover effects do not interact at any level. In the estimation process, the Armington assumption (Armington, 1969) for mangoes has not been given due importance and various varieties of mango have been clubbed together for easy comparability. This distinction, however, does not hold in case of wheat, as only the comparable varieties have been considered.

From a policy perspective, this research assumes that a Coasean negotiation is possible, where all the stakeholders would reach an efficient policy paradigm, if left unto themselves. This is an easy and efficient way of distributing welfare gains optimally at the level of two trading partners; however, individual targeting within national boundaries may be an inhibitor. Reaching a Kaldor-Hicks efficient solution may be difficult due to systematic errors that inhibit redistribution of welfare gains. As indicated by Scitovszky (1941), it is more of a theoretical exercise to reach a Kaldor-Hicks efficient equilibrium, whereas it may not be possible in most of the cases to operationalize it. This is most aptly underlined by Abla and Nugent (1996) by underlining the role of transaction costs. These transaction costs include role of externalities, role and complexity of laws and procedures, and the cost of information dissemination.

In addition, the empirical estimates are subject to data availability limitations and are as strong as the assumptions made. This study indicates many levels, where more systemic efforts are required for robust data generation. These areas include precise estimation of economic impact of all the relevant pests of concern for both the countries and for both the commodities. Finally, introduction of economies of scale and scope can also alter some of the assumptions. To explain further, since India is a large country, Indian demand of wheat with US among the bidders may affect the prevailing price scenarios. However, since the previous excess Indian demand for wheat imports has constituted less than a percent of world excess supply, this remains a remote possibility. Similarly, although Indian mangoes do not get substantial premium from top price importers, the demand competition from the US may lead to increased price offers from other countries as well, thereby reducing gains to India from US trade but enhancing overall gain from mango exports to other countries.

6.4 Future outlook

Since this study is a first in its scope, more elaborate estimates would make the policy decisions more robust. It would be a good extension of this study to find more robust data estimates for the cases presented. However, in a different dimension, some other commodities can also be explored for bundled negotiations. Performing similar exercise for more commodities for negotiation may bestow more bargaining power in the hands of developing southern hemisphere countries. Few such commodities, on which there has been a dispute between India and USA over SPS issues, include almonds, pulses, and shrimps.

Although this research has paved the way for empirical analysis and economic valuation of SPS standards, there are some binding assumptions made through out the study. This research assumed linearity in the sense that all the estimates can be summed up linearly and therefore, the possible interaction effects were assumed away. Although these assumptions were necessary due to data constraints, relaxing such assumptions with more robust data generation would greatly enhance the scope for further research. This research has tried to account for spillover costs of the trade; however, many of the roundabout effects have been ignored. For example, the gain to USA due to the supply of machinery for irradiation has not been taken into consideration. From a policy point of view, incorporating transaction costs would be critical for policy decisions and a value add dimension for future research, as suggested by Abla and Nugent (1996).

As a possibility for methodological extension of this research, a multilateral, multi-commodity negotiation matrix can be explored in a general equilibrium framework. However, this may remain a theoretical possibility only due to the fact that negotiations, give and take relations, and payoff matrices would inflate exponentially with the addition of every subsequent commodity or country. Further, policy utility of such a study would also be doubtful since many countries would be involved.

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