ECONOMIC IMPLICATIONS OF PESTICIDE RESIDUES IN MANGO'S EXPORT OF PAKISTAN

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Dedicated to My Beloved PARENTS , HUSBAND And Kids (Yousaf, Haleema and Hadia)

My Trust, My Inspiration, My World.

TABLE OF CONTENTS PAGE

LISTS OF FIGURES

LISTS OF TABLES

LISTS OF ANNEXURES

LISTS OF ABBREVATIONS

AEZs	Agro Export Zones
CAC	Codex Alimentarius Commission
DALPMG	Department of Agriculture Livestock Products Marketing and Grading
EU	European Union
EUREGAP	Euro-Retailer Produce Working Group Good Agriculture Practices
ECO	Economic Co-operation Organization
GAP	Good Agricultural Practices
GC	Gas Chromatograph
GDP	Gross Domestic Product
HACCP	Hazard Analysis and Critical Control Points
HPLC	High Pressure Liquid Chromatograms
IPM	Integrated Pest Management
MINFAL	Ministry of Food, Agriculture and Livestock
MRLs	Maximum Residual Limits
NARC	National Agricultural Research Centre
NTTFC	National Trade Transport Facilitation Committe
NPD	Nitrogen Phosphorus Detector
OECD	Organization for Economic Cooperation and Development
PHDEB	Pakistan Horticulture Development and Export Board
POPs	Persistent Organic Pollutants
SPS	Sanitary and Phyto-Sanitary
STC	Special Trade Concern
TBT	Technical Barriers to Trade
TRTA	Trade Related Technical Assistance
UNIDO	United Nations Industrial Development Organization
URAA	Uraguay Round Agreement on Agriculture
WHO	World Health Organization

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Saadia Sheerazi

ABSTRACT

This study assesses pesticide residues in mango samples collected. It finds out pesticide residues in compliance with Joint FAO/WHO Codex Alimentarus Commission maximum residues limits (MRLs) for pesticide residues. This also evaluates the economic impact of sanitary and phytosanitary (SPS) measures (pesticide residues) on the Pakistan's mango export. The study used both primary and secondary data. Secondary data from 1990–2012 for mango production, domestic consumption, domestic price, FER, and export quantity were collected from Pakistan Economic Survey, Fruits and Condiments Statics of Pakistan, Agriculture Statistics of Pakistan, National Trade and Transport Facilitation Committee (NTTFC), and Food and Agricultural Organization Statistics (FAOSTAT, 2001).Whereas the Primary data of pesticide residues data was generated in Ecotoxicology Research Institute, National Agriculture Research Centre (NARC), Islamabad. Mango samples (primary data) were collected from orchards in Multan and Muzafargarh, the main mango growing areas in Pakistan. Data was analyzed through laboratory experiment and regression analysis. It was found that about 78% of the samples being analyzed were containing pesticide residues to varying levels out of which 67% were above the Codex Maximum Residual Limits (MRLs). Three pesticides viz. chlorpyrifos, endosulfan and profenofos were exceeding their MRLs. It has been observed that both domestic consumption and domestic price have significantly negative impact on export quantity of mango by a factor of 0.0017% and 0.00046% respectively. Moreover, every unit increase in mango production lead to 0.0017% increase in export quantity of mango. The co-efficient of FER was found as 0.021 showing that every one unit change in FER in the international market, the export quantity increases 0.021% in the same direction. It has also been observed that mango export is negatively impacted by SPS (Sanitary phyto-sanitary measures) measures. The results show that strict SPS measures are decreasing our trade. Although its coefficient is statistically insignificant this may be due to the relaxed regulations of the current importing countries. However, it can be argued that mango exports to EU countries will be more negatively influenced because of their stringent regulations. Therefore, Pakistan should improve food checking on priority basis, especially in bundles with exporters and promote Good Agriculture Practices (GAP). Pakistan must work seriously to qualify food safety and quality compliance demands. Establishing food testing standard and inquiry infrastructure on significance basis, especially in collabration with exporters. Moreover, the exporters who target high value markets and seeks certifications like ISO 14000, EurepGAP, HACCP and ECO Labeling should be fully sponsored, at least for a specified period of time.

CHAPTER-1

INTRODUCTION

1.1 Statement of the Problem

The agriculture sector in Pakistan contributes 23.3% to the GDP and absorbs 42% of the labour force (Government of Pakistan, 2008). This sector is the largest source of foreign exchange earnings. Fruit and vegetables are desired greatly world wide specially in European countries, Saudi Arabia and Gulf States. Because of appropriate atmosphere and original situation of land these produce are enhanced with nutrient values and flavour. In the country total production of fruits is 5,742 thousand tonnes grown over an area of 652 thousand hectares. Currently only 4.6% of the total production is exported which contributes Rs. 4861 million. The important fruits of Pakistan are citrus, mango, banana, apple, guava, peach, apricot, grapes and dates which are grown over an area of 545 thousand hectares with a production of 4700 thousand tonnes which is approximately 82% of all fruit production (Government of Pakistan, 2009) . Specifically, the horticultural sector contributes about 12% GDP and provides numerous employment platforms mainly the supply chain, specifically in country areas (World Bank and UNIDO, 2006).

Our farmers mostly rely on pesticides for increasing the production and improving the cosmetic value of these commodities. In the year 2010, about 73,632 metric tonnes of pesticides were purchased in the country out of which more than 27% was used in horticulture. Moreover, 25100 hectares and 1224 thousand hectares of fruits and vegetables have received aerial and ground plant protection measures in the form of 1-2 and 1-4 applications, respectively. Quite often un-registered and even banned pesticides are used on horticulture crops. Sometimes pesticides are sprayed on fruits after harvest or prior marketing just to enhance its cosmetic value. Such a tremendous and non-judicious usage of pesticides

can give rise to environmental issues, human health risks and trade concerns (World Bank and UNIDO, 2006).

In International trade the issue of pesticides residues is covered by the WTO-SPS agreement. The Maximum Residue Limits (MRL) set by Joint FAO/WHO Codex Alimentarius Commission (CAC) act as reference in this regard. However, SPS agreement also gives right to the Member States to establish their own standards provided they are science-based and should not represent an unnecessary or disguised restriction on trade (Disdier et al., 2008) . The European Union (EU) has set its own limits, often more stringent than Codex or other countries. A food commodity having higher pesticide residue level than MRL indicates that the commodity has not been grown in accordance to the principles of Good Agriculture Practices (GAP). It is deemed to be unfit for human consumption and cannot enter international market.

There are limited studies (approximately 50) that reported pesticide residues levels exceeding the CAC MRLs in fruits and vegetables consumed locally (Tariq et al., 2007). The situation of exportable fruits and vegetables is also not bright. The Canadian and UK supermarkets targeted by Pakistani exporters are insisting on pesticide residue testing. Since the functional labs in Pakistan are not of international standards hence our commodities are the motif of EU Notifications.According to the yearly details of the EU Rapid Alert System, the total consignments of Pakistan entering the EU rejected were 7 in 2002, 12 in 2003, and 16 in 2004. Pakistan rated 32nd due to rejection of consignments in 2004. All these rejections were not specific to pesticide residues but included Sudan 1 and Sudan 4 colorants, faeces of rodents, aflatoxin, hydrocyanic acid, ochratoxin A and fruit fly (World Bank and UNIDO, 2006) . Rice, wheat and kinow exports were few projects that were rejected by foreign countries. Russia had rejected a consignment of 7,000 tonnes of Pakistani rice and banned on its import in December 2006. In past animal casing consignments were rejected on the basis

of the lindane residues. Sri Lanka has rejected our onion consignment purely on pesticide residues basis (Ahad and Ahmad, 2009). Unluckly Pakistan is that country having neither policy guidelines on GAP (Good Agricultural Practices) nor indigenous MRLs (Maximumum Residual Limits). Furthermore, the legally prohibitted and limited organochlorine pesticides like DDT (Dichlorodiphenyltrichroloethane) also enter the market through illicit ways and are applied in agriculture and public health. Due to absence of GAP, contamination, lack of understanding and also farmers having no opportunity to different plant protection technologies leads to higher levels of pesticide residues in our agriculture products. Currently the prime convience to Pakistan is that our main importing countries are Afghanistan and Middle East, where SPS measures are not severly enforced. However, the rate of consignments rejection or confiscation will be much higher if we want more access to EU markets for fetching lucrative prices as the EU standard are more stringent (World Bank and UNIDO, 2006). To convert the open market challenges into opportunities we should line up our activities with the WTO-SPS requirements. To cope with the contemporary international market we have to assess sensitivity of the pesticide residue issue in our exportable fruits and then accordingly ensure quality, health safety and environment friendly practices.

For this purpose, we have taken mango (mangifera indica) as a case study. Mango is a tasty fruit now growing in most parts of the universe. Mango is one of the tropical fruits, which has experienced vast development in current years. Mango is known as the king of fruits and is an important fruit of the world including Pakistan also. The global annual estimated mango production is above 25-million tones nowadays. In Pakistan production of mango was 1727.93 thousand tones from an area of 167.5 thousand hectares in the year 2008-09 (Government of Pakistan, 2008).

Total world mango export amounted to US$ 1194775729 and Pakistan's share of export is only US$ 33178617 (TRTA Pakistan).[1]

Pakistan is the fifth leading producer of mango (one million tones per year) in the world behind China, India, Thailand and Mexico. As the third biggest mango exporter, with its trade of approximately 80,000 tons per year in the world. Production is based in two regions, the Punjab (mostly grown in districts Bahawalpur, Multan, Rahim yar Khan and Muzzaffargarh) and the Sindh (mostly grown in districts Hyderabad, Thatta and Mir pur Khas) producing 67% and 32% of the total production, respectively (Collins and Dunne, 2007).

It's main export market is Middle East where migrants from the subcontinent are living. The ultimate consumers and thus the importing countries do not urge for strict quality parameters. Thus huge quantity is exported but only on nominal marginal price of about Rs. 36 – 41per kg (Khan, 2010) . On the other hand EU and other developed countries offer lucrative price, but they demand high quality (SPS). Thus we have nominal share in Norway, Sweden, UK, Germany, Switzerland, Canada markets.

In 2008 the export of Pakistani mango is noticed 20% fall exclusively than in 2007 because it paid the minimum price for its mangoes in the globally. The export proficiency decline is reported due to different causes like low yields, quality, local transport, supply chain, packing and processing, absence of infrastructure, cargo space, fierce competition, fragile marketing and the failure to satisfy international quality standard (Khan et al., 2008).

The export of any agriculture commodity depends on following factors such as its production, local consumption, local market rate, foreign exchange rate, bilateral agreements and so many other factors. This study is based on the assumptions that currently we are exporting only 4.25% (73437152kg) of mango production and want to enhance it if all above

[1] (TRTA Pakistan) http://trtapakistan.org/sector-products/horticulture/mangoes

factors were favorable, could we be able to export to EU markets with the current mango production and keep in view only one parameter i.e. pesticide residues.

1.2 Benefits of the Study

In international trade of agriculture produce, two WTO Agreements namely Agreement on application of Sanitary & Phyto-sanitary (SPS) Measures, and Agreement on Technical Barriers to Trade (TBT) are of special importance. These address food safety & quality issues respectively. Most of the work so for done in the country is geared towards TBT as data on SPS, specifically on pesticide residues, is scarce and presently the targeted export market also don't urge for its strict compliance as well.

The impact of chemical contaminants on trade is current field of research in Pakistan, therefore, this study assess the impact of pesticide residues (one of the SPS measures) on Mango export. Taken altogether, the present study gives an important understanding and addition to the efforts as regard to SPS measures. This is the first effort to find out the effect of pesticide residues on mango export. The present study is helpful to boost more research work in the remaining exportable horticulture crops of Pakistan because not much work has not been accomplished with respect to chemical contaminants in horticulture crops and their export.

1.3 Research Questions

This study answers the following questions:

i. What are the pesticide residues levels in exportable mangoes of Pakistan?

ii. Do WTO/SPS measures (specifically pesticide residues) restrict mangos exports?

1.4 Objectives of the Study

1. To find out pesticide residues in mango samples collected from orchards in Multan and Muzaffargarh.
2. To find out pesticide residues compliance with Joint FAO/WHO Codex Alimentarus Commission maximum residues limits (MRLs) for pesticide residues.
3. To evaluate the economic impact of sanitary and phytosanitary (SPS) measures (pesticide residues) on the Pakistan's mango export.

1.5 Hypotheses

1. The pesticides residues in mango exports exceeds the MRLs in Pakistan
2. SPS measures (specifically pesticide residues) affect export of Pakistani mango.

1.6 Organization of the study

The study is organized in to five chapters. In chapter 1 introduction of the study covering statement of the problem, research question, hypotheses and benefits of the study are given. In chapter 2, relevant literature is presented. In chapter 3, data and methodology for the study is given. Chapter 4 comprises of results and discussion. Chapter 5 is based on conclusions and recommendations based on findings of the study.

CHAPTER-2

REVIEW OF LITERATURE

2.1 Introduction

This chapter focuses on detailed overview of studies conducted in the past followed by highlighting the contribution of the present study.

2.2 Review of Previous Studies

Pakistan is an agricultural country. Pakistan's economy is mainly based on agriculture directly supporting 67.5% of total population. This sector contributes 25% to Gross Domestic Product (GDP) and accommodates 44% of the employed labour force (Government of Pakistan, 2007). Fruits and vegetables are integral parts of our agriculture system. Huge quantity of horticulture is consumed locally while a small fraction is exported to different countries like Dubai, India, Afghanistan, Saudi Arabia and United Kingdom to earn valuable foreign exchange (Government of Pakistan, 2008). The environmental condition of the country in terms of humidity, sunlight and temperature favours the insect pest population built-up that causes huge crop losses. To control these losses the farmers rely on the use of synthetic agro-chemicals. The pesticide use in Pakistan was started in 1954 but Pesticide Rules and Ordinance were adopted in 1971 and 1973 respectively. In 1980, the pesticides import, distribution and sale was the sole responsibility of the private sector, as the public sector took itself out of this and this behavior gradually boosted the pesticide consumption many folds. In 2010, the pesticide consumption has been reached to 73632 metric tons amounting Rupees 13855 million. Such a tremendous usage of pesticides in an irrational manner causes human health, environmental and trade consequences (Government of Pakistan, 2011) .There does not exists much research work that estimate pesticide residues in the Pakistani fruits and vegetables. Results from individual pesticide residues monitoring activities showed that MRLs are regularly exceeding.

Masud and Hasan (1995) conducted a survey during 1982-83 in Karachi illustrated that mango and cauliflower samples had residues of heptachlor and aldrin above the MRL proposed by Joint FAO/WHO CAC.

NIH (1984) conducted a comprehensive study in Islamabad on pesticide residues in different food items. Residues of 23 pesticides were detected. The salient findings were that organochlorine and organophosphorus pesticides were present in 100% and 94% composite samples. Individually residues of malathion, diazinon, heptachlor and endosulfan were detected.

Masud et al. (1991) examined a survey during 1988 – 1990 again in Karachi shows that out of 250 samples screened, 37% samples were contaminated with a variety of pesticides in which 48% were exceeding MRLs. In another study, out of 550 samples taken, 39% contained pesticide residues out of which 14% samples were above the MRLs.

FAO (2001) held a study in 2000 around Multan that revealed four vegetables (brinjal, okra, bitter gourd and cucurbits), and cotton seed cake, oil and cattle feed were contaminated with the pesticide residues, and out of them majority ranging to 2/3 were in excess of the Codex MRLs.

Ahad and Ahmed (2009) administered a study in which they collected fruits and vegetable samples from different locations in KP, Faisalabad and Islamabad Markets have been found contaminated with pesticide residue. It has been observed that the percentage of samples containing residues levels exceeding FAO/WHO Maximum Residue Limits (MRL) are increasing day by day.

Zia et al. (2009) examined that fruits and vegetables like other crops are subjected to different pest attacks. For pest control many pesticides are used that include more or less 108 types of insecticides, 30 types of fungicides, 39 types of weedicides, 5 types of acaricides and 6 different types of rodenticides .

Tariq et al. (2007) studied that pesticides are recommended by Department of Plant Protection for use on specific crop, however, due to lack of awareness, some misperceptions and availability of adulterated pesticides in the market, even banned pesticides are also used in horticulture.

Khan et al. (2010) analyzed that in Pakistan, Punjab province uses 88.3% pesticides the highest range as compared to other provinces such as Sindh used 8.2% , KPK uses 2.8% and the Balochistan uses 0.76% of the pesticides consumed. Approximately 30% of different pesticides including organochlorines, organophosphates, carbamates, pyrethroids and fungicides etc. are reported to use on horticulture crops in different parts of the country.

Anwar et al. (2011) noticed that malpractices leave behind objectionable residues on horticulture crops above the Maximum Residue Limits (MRLs) that make them unfit for human consumption and are treated under WTO-SPS agreements in international trade.

Presence of pesticides residues in fruits and vegetables above the MRL is adversely impacting the trade of exportable horticulture crops. Generally trade losses are borne by exporter when importing countries impose stricter regulation.

Drogué and DeMaria (2010) assessed the impact of MRLs on the trade of apples and pears among seven importing (Australia, Canada, Korea, Russia, Japan, Maxico and United States) and seven exporting countries (Argentina, Brazil, China, Chile, The European Union, New Zealand and South Africa). He assumes absolute MRL value is not important but it is the relative differences in tolerance levels between importing and exporting countries that matters. The findings suggest that harmonizing regulations impacts trade differently depending on the exporter.

Akhtar et al. (2009) analyzed that mangoes are a major crop of Pakistan and the Pakistani produce is the fourth largest of the world total produce along its exports. The mangoes are

distinguished by their taste, physical appearance, and environment sensitivity. There are four popular mango varieties of Pakistani mango namely dasheri, chaunsa, ratol and langra produced in Multan, Rahim Yar Khan and Mir Pur Khas. The langra mango shows a lower pH value and has total soluble solids and also shows a relatively high acidity or pungency. The sites that produce this langra mango have no significant difference (except $p < 0.05$). The color of the langra mango was best among the other types of mangoes produced in the same area but the flavor and taste was considered inferior to other types/varieties of mango. There was no correlation among a particular variety of a mango and the region it is produced. We cannot draw a comparision between the regions and the varieties/types of mango for their flavor and taste however the ratol mango has acceptability and consistency in flavor and taste produced in all the three areas mentioned.

Bathan and Lantican (2009) studied the economic aspects of sanitary and phytosanitary (WTO-SPS) measures on the pineapple export of Philippine and their acceptance to importing countries' standards. The SPS standards for fresh and processed pineapple of Philippine are at par with the Codex standards and also satisfies main trading countries standards such as Canada, Japan, Netherlands, South Korea and the United States. Philippine has perfectly managed its export competition in the before and after SPS regulations. The results of multiple regression analysis showed that the foreign exchange rate, the domestic production, and the export price have positive impact on the export value of pineapple while the domestic price has a negative influence on the value of pineapple export. The Australian import of filipino pineapple declined to a small extent because of severe SPS requirements of Australia, however in the overall export of Philippine pineapple it was insignificant.

Ghafoor et al. (2013) analyzed the impact of major variables such as, average purchase prices, the different elements of marketing cost and the sale prices on the mangoes export to UAE from Pakistan. The data was collected from forty randomly selected exporters. The

influence of significant variables such as experience & education of exporters, the average purchase price, the average marketing costs, the average sale prices, the ISO certifications and the government policies on mango export was quantified by employing the double log form of regression analysis. Therefore according to findings the gross margin was measured as Rs.31333/ton, whereas the percentage and the net export margins are found to be 52.3 percent and Rs.11228/ton respectively. The claculated regression model showed that the education, the professional experience of mango exporters, the average marketing costs and ISO certifications, were the important features of mango exports. It is concluded that marketing cost of exporting mangoes to the UAE market from Pakistan should be economized and the quality must be upgraded so that the product sells at good prices. The Pakistani mango in comaprision to other nations have an advantage or you may say comparative advantage in production term over other nations and has great advantages sale in the Middle East Market if exported well.

Khan et al. (2008) conducted a study to forecast production of mango for the years 2005 through 2024. The Log linear and ARIMA (Auto Regressive Integrated Moving Average) models were used to forecast production of mango. The predicted value of production of mango for the year 2024 worked out as 1.43 million metric tons, thus an increased output of mango would be available for consumption as well as for export. This research emphasised the importance for taking steps needed to increase export of mangoes by (1) improving the quality of mangoes, (2) improving the packaging and (3) to conform with the international standard requirements mentioned under the WTO regime.

Deodhar et al. (2008) describes the incremental elimination of the quotas and the tariffs from the international agriculture trade and this has resulted into a non-tariff barriers such as the SPS measures. The SPS standards rather concern human health and are more scientific research oriented. But the over curious attitude in maintanining SPS standards may lead to

distorted trade and less mutual welfare. The authors have abstracted the various types of approach used to study SPS standards, propose a more theoretical approach to estimate strategic interactions between the two trading partners and to place side by side the cost-benefit analysis to estimate payoffs of the game to each partner. A case of the Indo-US trade of mangoes was considered. The policy related to SPS measures and a balance for an economic welfare of both states was measured. The technical and economic data and may be analyzed so that appropriate SPS standards be approved keeping consideration for the welfare of both country citizen .

Gebrehiwet et al. (2007) observed the aftermation of the Uruguay Round Agreement on Agriculture (URAA) that argues on strict sanitary & phytosanitary standards (SPS) used wide spread. The standards have been hindering agricultural trade for developing nations. The developing countries have less say into the formulation of SPS standards especially depending upon their country environment. Also the developing countries have less knowledge, research and expertise that can make their products according to international standards . The max level of aflatoxin in agricultural products of South African food experts is set by five OECD countries namely Ireland, Italy, Sweden, Germany and USA. The results show that strict SPS measures are decreasing trade for developing nations prominently. The aflatoxin standards trade elasticity is around 0.41. If the South Africans opted to the total aflatoxin standards maintained by the five OECD countries as recommended in CODEX then they would have increased their export by US$ 69 million per year from food exports of 1995 to 1999.

Shafaeddin (2007) studied the expenses incurred by the poor countries in order to maintain compliance with the SPS standards. He observed that the cost of compliance is total borne by the exporting country or individual despite their inaptness to modern agriculture norms. He also studies border are inclined in the supply chain of exports and this results in lack of

expanding export network for poor countries. The supply chain of exporting countries in which the cost of losing exports due to wastage or rejection at border of the importing countries is not mentioned clearly.Observing standards of the SPS system by importing countries have significantly increase the cost of compliance for exporting nation. Such stringent SPS standards involves regular policy re-orientation, efficient regulating measures and appropriate supply chain management, research base capacity building and a forseeing strategy opted by the exporting countries.It is also observed that compliance of SPS standards by poor nations have to increase their knowledge, research will take a time period to learn, train and work in collaboration the public & private sector in the supply chain of export. Still the socio-economic cost of lacking to follow SPS standard is vast. It is observed that compliance adherence costs or costs involving to adhere to SPS standard is around 2 to 11 percent of value of African export.The costs also depends on the type of product, the future of the export, the capacity of the country and the size of farm and the exporting enterprises and well managed supply chain.Also in the case of Mozambique it is seen that the investment cost is more than the total food the country exports . This research does not consider delay costs in exports or the rejection cost at border countries that are of significant nature only covers administrative,inspection, testing and certification costs.

Wong (2008) studied the Ecuadorian banana and pineapple farmers and exporters and their non tarrif requirements major markets. Preliminary results based on a survey and interviews with farmers and exporters show that Ecuador indeed complies with SPS and technical standards, but that the level of compliance –and with that, the access to markets, may vary according to the type of farmer. To comply with reasonable SPS and technical standards and to have access to markets in developed countries, it is important that Ecuadorian farmers receive the technical support from developed nations in setting up these processes.

Rickard and Lei (2011) explained that there are number of trade barriers for agricultural and horticultural products internationally. They examined the international markets for fresh apples and oranges and checked the economic implications arising through tarrifs and SPS regulations. They used the price-wedge approach to calculate regional tarrifs and ad valorem equivalents for SPS restrictions. A simulation model was established to analyze the price, quantity, and welfare benefits by ignoring the SPS barriers and also the one called Special Trade Concern (STC) by the WTO.The results suggested that if 36% reduction in global tariffs occur than we achieve greater gains by ignoring SPS measures in apple markets. Wheras in the orange markets where SPS restrictions have greater implications to farmers and consumers a 36% reduction in the tarrifs will lead to a smaller overall welfare if SPS measured again ignored and to some better extent if STC are ignored altogether.

Mustafa and Ahmad (2003) noticed that the Sanitary and Phytosanitary (SPS) agreement are hindering trade in the agricultural and food products. The Pakistani trade is also facing problems in meeting the SPS requirements of the developed countries. This can hinder its potential to export agricultural and food products.Much is being tried to lessen the trade hinder the effects of SPS measures from the platform of the World Trade Organisation (WTO) SPS Agreement, but still current scenario have failed to solve the key problems faced such as connections of Pakistan and other developing countries. This paper probes influence of Sanitary and Phytosanitary (SPS) agreement on the exports of Pakistani agricultural and food products. It also hints the problem areas of Pakistani export faces and how can it be complicated to the SPS measures keeping the available steps done by Govt of Pakistan in the supply chain.

Estes (2003) has mentioned that fresh tomatoes demand has significantly increased in the past decade. Through free trade agreements have lower the borders in monetary terms but a

hurdle of coordinated institutional and competitive market constraints still are challenge for southern U.S. farmers.

Aujla et al. (2007) studies the limitational in the actualization of Pakistan's full production and its exports. It was investigated that wholesale fruits& vegetable markets play important part in producing excess for export. It was noticed that the wholeseller bidded actual exportable fruits and vegetables undercover or in private that was of quality and the rest was bidded activities in open for local consumption. Many commission agents have stake in the fruit export. Most of them purchase the best quality fruits using different names, then export. This secret bidding/auction of fruits hinders the benefits to go directly to the producers or even the contractors that if have knowledge can grow quality produce for export purposes. The profit from the net exports of fruits differentiated with the changes in the season and the distance of the destinating country. The net returns per kilogram of export was higher when produce was exported to Russian States and Middle Eastern States, in comparasion to the European and Far Eastern states; this was due to their distances as more transportation costs involved. The high quality produce is exported to Middle Eastern and Far Eastern countries and a relatively high return/profit is earned. Some around 10 exporters showed a relative high price trend in exporting produce to Middle eastern and European nation,and this predicts that we can increase exporters to these markets gradually and also by bringing the sea freight cost down with in the economies of scale level. The incompetence of the exporters to work in the global lucrative markets for agricultural products is due to absence of hi-tech labartories,for testing food quality and an appropriate certification autharticating food safety on health and environmental safety, Lack of availability of good quality, high technology refregeriated, transportation, lacking better packing material, lack of inputs needed to process the exports and the no availability of credit/loan facility on easy terms & conditions.

Ghafoor et al. (2013) noticed that the mangoes are in excess of local consumption and are feasible to export but lacking appropriate handling and management. Individual exporter may be managing their supply chains whereas little help is extended by centrally organized platforms. They observed that less of appropriate farms produce practices, incapacitable post harvest management, lack of appropriate market identification and inadequate infrastructure hindered Pakistani mango exports. Also the perishable features of the varieties of mangoes is a cause of decline in exports. An extra burden at the Karachi terminal market further deteriorates the behavior of exports and it is suggested to increase the number of exporting terminals that also have the facility of vapour heat treatment at affordable rates, so that the produce can be preserved for long and quality maintained.

Collins and Dunne (2007) mentioned that Pakistani agriculture economy mostly depends upon the horticulture produce. They suggested Pakistan has enormous capacity to inculcate the benefits of the produce.The Pakistani mangoes are cheaper and of norml/average quality when compared to export of other countries. They said many exporters have reasonable influence in the markets such as UAE to export abudantly. The important for Pakistani mangoes included Middle Eastern, European and some Asian countries.The mangoes industry of Pakistan lack appropriate infrastructure and supply chain, lack storage and processing facilities unable to control post harvest produce losses, lack of communication and poor market intelligence. They said that appropriate communicable and cost effective supply chains can increase the export of Pakistani mangoes.

Mustafa et al. (2006) studied the impacts of sanitary and phytosanitary SPS agreements of WTO on the Pakistani export market. They got information from 20 mango growers, 15 pre-harvest contractors and 40 exporters and suggested a loopholes in exporting mangoes from the Pakistani market. They were of the opinion that Pakistani farmers/producers and the exporters were not prepared enough to comply to SPS standards followed globally. Most of

the concerned exporters argued lack of the government facilitation to the mango industry. The exporters proclaimed that existing markets for export and their over indulgence must be avoided any new markets must be explored by introducing some value addidition in compliance to newly introduced international standards like HACCP and EurepGAP.

Pirzada (2006) recommended that Pakistani mangoes produce and trade has a great potential and opportunity internationally as he reffered to Pakistani variety of mangoes are suitable in taste and quality, are very much liked and demanded in Far Eastern and Middle East countries. Pakistani export of mangoes face technical barriers though showing an increase in their exports. He suggested that by overcoming the technical barriers of the supply chain and fulfilling the requirements of the international market. Pakistan can do well in international mango trade.

World Bank and UNIDO (2006) described concerns impeding Pakistani mangoes export. The post harvest management is poor affecting quality and volume of trade surplus. So that, this factor had caused great post-harvest deficits that ranged from 25-40% of overall mango yield in the country. The condition of country's infrastructure was analyzed as an important cause of these failures as framework of national highways were in bad position somewhat estimating transportation expense thus lowering export competition of the country in global market particularly for volatile and unstable produce. Another factor reducing mangoes export from Pakistan in the Middle Eastern markets was short shelf life of Pakistani mangoes. Solely, export to abroad markets was airlifted expanding marketing expenses and decreasing competitiveness of Pakistani mangoes as examined other mango exporting nations. The possible measures to increase export of Pakistan mangoes were to enhance shelf life and develop refined storage techniques recommended.

Haleem et al. (2005) examined factors responsible for the export of citrus from Pakistan.He explained how citrus export volume increase or decrease depending on various features. He

mentioned features such as domestic and export prices, Gross Domestic Product (GDP), foreign exchange rates and national production of a country influence citrus export. A time series data for the period 1975–2004 was used in exploring citrus export from the country considering influence factors, such as domestic and export/international prices,currency exchange and the total gross domestic product (GDP). Changes in volume/quantity of citrus export was observed by keeping above factors in mind and a mechanism of co-integration among each factor and error correction was employed.It was observed that price and non-price factors influence export of citrus. The exporting price of citrus has a considerable impact on the exports,as the 1.48 export price elasticity is observed, as the local /domestic price elasticity is -0.98. The non-price factors that were considered are domestic citrus production , exchange rate and GDP. Their respective elasticities are as follows 1.37 for production, 1.31 for exchange rate and 0.35 for one percent change in GDP. The devaluation of currency is the major cause of variations in exports. The factors in exports that relate to export price and exchange rate dominates internal factors, such as production, domestic price and GDP.

Haleem (2005) observed the Pakistani export of citrus and mangoes for the periods 1975 to 2004 by using Johansen's Cointegration technique. It was observed that export of these fruits overtime declined and average fruit exported in that period was 4.8% and only nominal earnings from exports were reported during first periods and that later on gradually improved. The uncertainty of citrus and mangoes export depends upon the change in domestic produce, non-coherent export policies, currency devaluation, export duties, non-competitive produce and a volatile international market. Observations regarding exports of citrus & mangoes were recorded based on price and non price factors. The elasticity of various factors such as export price, domestic price, domestic production and exchange rate impact was compared in the two types of produce that is citrus & mangoes. It was observed

that export price elasticity of mango is 5.39 while of citrus is 1.48. The domestic price elasticity for mango is -6.73 and of citrus is -0.98. Also for production the elasticity for mango is -2.16 and for citrus is -1.37. The currency devalution is the main factor making export vulnerable.The exchange rate was elasticity for mango was 2.89 and for citrus is 1.31. The GDP elasticity for mango is estimated around 13.63 and 7.15 for citrus crop.

Pakistan Horticulture Development and Export Board (PHDEB) (2005) mentioned that citrus and mangoes are one of the major exportable fruit from Pakistan. In Pakistan production of mangoes is over one million tons but only 60 to 70 thousand tons were exported. The regular import markets are Gulf countries and Saudi Arabia which received paramount volume of fruit from Pakistan. In the Europe the countries that imports Pakistani fruits are UK at the top and than Germany, France, Denmark, Switzerland, Norway . Singapore, Malaysia, and , Hong Kong markets in Asia also imports fruits of Pakistan. Some future markets are also identified as the Iranian & the Chinese. Pakistan fruit export to Middle East markets is around 78%, to Far Eastern markets is 0.7 %, to European markets is 14.8 % and to the rest of the world markets is 6.1 % . Mangoes are priced on their quality classifying as good, average, & poor and prices fluctuate accordingly. The domestic and international customers are demanding tasty and quality mangoes but Pakistani export lack appropriate refrigeration and transportation that reduce the shelf life of the produce.Most of Pakistani produce is shifted by air which is costly. Though export through sea is also being done using refrigerated and non-refrigerated containers and is preferred in most cases as it costs less to the exporters and bulk quantity can be transported easily. Still it is observed that 40% of the mangoes export to Middle East is transported by air and another 30% is transported by sea in containers having refrigerators or not.

Mustafa and Ghafoor (2004) analyzed the grading and standardization norms especially adopted by stakeholders in Pakistan for mangoes and thought that appropriate grading and

improvements raised value of mangoes not only locally but in internationally also . They argued that mangoes were purchased and sold by brand identification in the international markets. This brand identification developed a well accepted global trade language assisting the transactions. An established grading and standard department known as DALPMG (Department of Agriculture and Livestock Product Marketing and Grading) distinguishes Pakistan produce in three catcgories namely Pak Special, Pak Choice and Pak Standard depending on their features weight, taste and quality.The standard and grading procedure maintained by the department in accordance to international standard be implemented in the local markets too, so that quality produce can be exported in abundant quantity after catering the local market with same standard.

Sheikh and Bashir (2003) identified factors affecting export of mangoes from Pakistan. The export of Pakistani mangoes (despite good quality and taste) was much less as compared with other mango producing countries. They observed the major factor affecting export of mango from Pakistan was fruit fly. They interviewed fifty mango growers from Multan and concluded that maximum farmers recorded serious loss to mangoes (greater than 10%) by fruit fly disease in general. They noticed that all prominent mango types especially chounsa, sindhri and other mango varieties in Pakistan were vulnerable to fruit fly disease. They emphased the demand for a broad plan to check fruit fly infestations.

Melle et al. (2007) explained the significant promising advantages for food safety and poverty elimination in West Africa were due to global competitiveness of agricultural products. He used a technique known as value chain in Benin, West Africa to increase the quality and taste of mangoes in local markets along with markets in continent and other markets of the world.. His suggestion for improvement were based on the assumption that trade of perishable fruits among countries shall become difficult as countries shall be more demanding/emphasing on quality.

Vermeulen et al. (2006) assessed the effects on the export of food stuff in the advanced countries coming from growing countries having food protection and quality standards or not. They analyzed that developing countries had complications in the export of fruits exclusively in place of standards demanded by developed countries. The farmers of the developing nations now started to build the farms better and packing houses so that they can compete with world produce in quality and safety standards acknowledged world wide. Many developing nations depend upon their earings from fruits exports such as South Africa.The South African attained benefits by complying to quality standards for their produce and producers. All the supply chain of South African trade of citrus was under question, that is a thorough anylasis from farm produce to end users in Europe was studied. In this regard many shipped containers were observed, to maintain food quality and hygiene standards. It was concluded that fruit citrus from the farm to the packing houses were handled with care but in shipping to international market of Europe was inadequate that was a cause of loss to growers.

Hassan and Ibnouf (2005) studied the time series data of Egyptian exports that include oranges, lemons and mangoes to the Saudi market for the years 1985-2000 and established a model that described competitive capacity determinants such as relative prices, efficiency of export practices in the country and relative stability of production. They made many linear regression equations using the determinants to find out typical relationship among them, some were dependent on each other and others explained the situation/environment of export. The results of the analysis highlight that if Egypt is to increase exports of oranges, lemons and mangoes to the Saudi Arabian markets then they have to increase their production, bring a drastic change in the export supply change and also have to reduce costs contained in the mango exports thereby meeting international standards.

Kleinwechter and Grethe (2005) analyzed Peru mango markets as it working in the EurepGAP environment and discovered that food quality and safety measures are essential to exports. They emphasized that with less restriction of trade barriers among countries, the only standard that is asked is the quality of the product and this has become very essential in case for the import of food items from the underdeveloped and developed nations. By undertaking both quantitative and qualitative socioeconomic research in Peru they described effect of EurepGAP on the mango industry. The compliance process was divided in to three phases such as information phase, decision making phase and the executing phase and it was suggested by them that inadequate information was the barrier that did not let the producers adhere to the international quality and safety measures. The conclusions showed that a small numbers of farmers (except small farms) maintained the measures whereas the growers with less literacy and approach to monetary resources did not achieve so. The results confirmed that organizing such standards caused enormous expenses to growers but also brought advantages at a implication phase. It was furnished by them that only food quality is the number one prerequisite for exporting food items and the local producers bring them in que to the international standard if they want to stay in business with the exporters.

Reddy (2005) revealed that the mango yield as an essential produce of India, reported to about 45 percent part of total global share. Anyhow, exports of Indian mangoes is only 8 percent of the total yield of the world . However growing trend in the export of mango pulp and other processed products from India was found . India had more benefit in exporting mangoes to United Kingdom and Dubai as compared to other countries. He noticed that demands of these importing countries such as strict adherence to the Hazard Analysis & Critical Control Point (HACCP) for assurig quality and hygienics standards were also effecting mangoes export from India. So it was cleared that there was a need to maintain standards to fulfill the great trade demand. Agro- Export Zones (AEZs), developed for

facilitating agro-based export industry, was also considered. He found that efficiency of some mango AEZs in private sector was un satisfactory ,but the efficiency of some of the AEZs which were controlled by Government agencies were found somewhat better. He assured that India would get large part of its products (fresh and processed mangoes) internationally by supporting entrepreneurs to engage in AEZs activities and presenting value added products.

Jamandre et al. (2005) examined Philippine mango industry's price system and trade matters and their stress on exports to arising markets of Asia, China, Europe and Hong Kong. To understand the long run demand and supply an internal model (A distributive lag model) was created.The climate conditions and technological advancements were also considered apart from other factors. The outputs showed that this model was agreeable to the economic theory and the outcome of behavioural relationships. The contributing factors to the supply of mangoes in the markets are the average price of mango flower (a plant cultivated for it blossom), the lagging mango prices, the weighted average of the fertilizers and the workforce for weed control . The department of health in Hong Kong & Guangzhou, China has ordered for food fitness for human consumption if trade is to flow in these areas. A big wholesale market for fruits was Yau Ma Tei market. The exporter and importing agent before actual shipment determined prices for different sizes of fresh mangoes.

Neef (2004) analyzed Belgium trade of apples, strawberries and pears, by using time series data from a period of 1975-2003. The results of study showed that various inner factors such as the production and the per capita availability showed a major role in explaining the changes in total export volumes, whereas other outer factors like foreign exchange rates & prices were found less significant variables.

Jedele et al. (2003) noticed that mango was considered an important exportable fruit for many developing countries of Asia, Latin America and Africa. Mango export was

comparatively less globally as compared to its total productivity. This was mostly accurate for mostly mango-producing countries of Asia, which showed 76 percent share of aggregate mango production internationally. Furthermore, this area supplied only 25 percent of total mango exports. The requirement of fresh mangoes was increasing in the industrialized nations (such as Europe & the United States of America). The rise of fresh mangoes export offered an opportunity for the mango exporting countries to adjust the export system in aspect of importing countries requirements.They made assumptions with the interregional trade model and concluded that an increased produce and exports are positively interrelated or might be correlated with mango-producing nations and their overall wellbeing of the world. Moreover, this model verified that tariff decline leads to an extension in overall trade and raised revenue from trade for developing countries. They ensured that if export revenues of mango trade are used in an effective way it woud participate in the betterment of mango-producing countries.

Choudhry et al. (2001) undertook analysis of mango markets in Brazil, China, Indonesia, India, Pakistan, Philippines,Mexico, Nigeria and Thailand . The data examined the quantity of mangoes merchandised by the following exporting countries such as the Brazil, India, Philippines, Mexico, and the Netherlands and the amount attained by the central importing countries that is China, France, Netherlands, USA and United Arab Emirates from the period 1990, 1994 and 1998 respectively . The price was also compared for the years, 1994-1998. They concluded that bright prospects existed for mango producing and exporting countries in context of increasing demand at global level.

Tambi (1999) employed co-integration technique for analizing the impact of factors affecting Cameroon's exports of coffee, cocoa and fruits. To calculate short and long run effects data about domestic production, export/domestic price ratio and GDP was used. The mixed short term forceful dynamic effect of lagged quantities of coffee and cocoa, domestic and export

price ratios and GDP collectively expressed the changes in the export of cocoa though the lagged quantities of the fruits, coffee and coca did not show an expressive short-run dynamic effect on changes in the export of crop.

Gunawardana et al. (1995) used co-integration and error correction techniques for estimating export of Australian citrus industry. The main variables specified in the model were local production, domestic and international prices of citrus . The outcomes revealed that citrus exports supply was inelastic to relative prices in both short and long run. The local production capability having a positive sign on the export supply whereas 0.73 was noticed as the long-run price elasticity.

Macabasco (1993) examined export achievement and perspective of chosen Philippine horticultural crops for the period 1970-1990. He noticed rising shift in the yield and the exports of fruits such as mangoes, banana and pineapple. The local and export prices of said fruits also raised in the mentioned above time period. He realized that horticulture exported from Philippine increased nearly at the rate of 21 percent yearly. So the regression analysis results promoted this hypothesis that the vegetable and fruit export considerably contributed very well in the economic growth of Philippine. When analyzing the demand side it was seen that importing countries income was a major variable influencing the export demand largely for most of countries. But export price and the exchange rate were not important determinants of export demand. He observed that awareness about fruits and vegetables usage as a mean of keeping good health was rising among people which provoked a grear demand for such produce globally. This growing trend in fresh fruits and fresh vegetables demand has enormous choices for the growers of different horticultural products with in the global market.

Patnaik (1993) analyzed general and future possibilities for the mango exports made by India, India's status in the foreign markets and the present target of the mango exports. This

study showed alot of defects in mango export business which mostly indicated more reliance on specific varieties, high priced tags, rising competitors in the Middle East markets, appearing difficulties in maintaing fruit quality and quarantine laws and hinderance in getting financial assistance for mango exporting business. He assessed export possibilities and outlined strategy for increasing mangoes export to high valued fruit markets of the Middle Eastern countries and European Union.

Islam (1990) noticed different factors impacting on the export of horticultural crops of developing countries. He included 31 countries in this study that reported for about 90% exports of fruits and vegetables from the developing countries. He measured main adjustables or alternateable components such as the production, GDP, the exchange rate, social and physical infrastructure of a country which were affecting export of horticultural from the developing countries. A proxy variable for physical infrastructure was availability of shipping facilities from the ports and also the secondary school enrolment was a delegate variable for human capital. Furthermore, macro economic policies on the exports of these countries was assessed by real exchange rate. In the model explanatory variables are share of manufactured exports to total exports and openness of economy. He noticed these adjustable variables effect by estimating the regression analysis in logarithmic form. In the first case GDP, the production, index of trade dependence and real exchange rate were found to be significantly effecting the exports while in the second case he replaced GDP with physical and human infrastructure variables and found the significance of these variables. The variable manufacturing for export purposes to total exports was also found to be apporoximately affecting in a positive manner. He also examined income and price elasticities for the demand and supply side of horticultural trade, which were estimated to be -0.71, 0.74 and 1.08 saparately. It was observed that horticultural produce were high price favourable than

other agricultural commodities. This was really encouraging for all developing countries who had prospects for horticultural growth.

Peterson and Orden (2008) assessed that developing and least-developed countries (LDCs) may having no financial and technical resources enough to fulfill the SPS requirements in bigger export markets in developed countries. The factual assessments of SPS regulations received no attention in the literature and are usually confined to case studies. Although, few studies showed negative impact of SPS regulations on agricultural trade, specially for developing countries.

Otsuki et al. (2001) examined the impacts of stringent aflatoxin standards used by developed countries on food exports from African countries. They noticed that accepting EU stricter aflatoxin B1 standard (2 ppb) as compared to the standard suggested by the Codex (9 ppb) decreased the exports of cereals, edible nuts and dried fruits from nine African countries to the EU countries by approximately $670 million, while preceding to a reduction in 2.3 cancer deaths per billion.

Gebrehiwet et al. (2007) examined the impact of overall aflatoxin standard followed by Germany, Italy, Ireland, Sweden and U.S on food stuff exports from South Africa. They observed that food safety standards having negative trade effect. Besides, they noticed that if all such countries would adopt the total aflatoxin standard recommended by the Codex, it would lead to an extra $69 million in food exports per year from South Africa during the year 1995-1999.

Chen et al. (2008) examined Chinese exports of fresh vegetables, fish and aquatic products, respectively . They noticed the effects of the pesticide chlorpyrifos MRL and the medicated fish feed Oxytetracycline MRL on the trade during the period 1992-2004. They observed a negative and statistically significant impact of food safety standards followed by importing

countries on Chinese agricultural exports. Furthermore, they noticed a larger trade impact of changes in food safety standards as compared to a allusive change in the import.

Disdier et al. (2008) analyzed the effects of technical regulations on trade followed by Australia, Canada, EU, Japan, Switzerland and US (based on the SPS and TBT Agreements). They noticed a negative effect of SPS and TBT measures on tropical and variety of products export of African, Caribbean and Pacific (ACP), Laten Amercian and Asian countries. Any how, their results deviate by sub-groups of exporting-country. For example, 52 members of WTO are confined to adopt publications of new ordinance on Technical Barriers to Trade under the SPS Agreement in order to give an chance for business partners to argue inquiry or objections to recommended measures since they are followed. Every publication shows, what the proposed measure is, among other things, which product is applied to, if it is based on global standard, and when it is supposed to be applied. ACP countries having more negative impact as compaired to Eight Latin American countries (LA8), whereas the effects on Asian and other Latin American countries aer not significant statistically.They also analyzed that rules implemented by OECD countries having negative impact on foreign export in agricultural produce, particularly trade of developing and LDCs. Their conclusion also recommend that global trade in agricultural commodities among OECD countries also having no significant impact because of these rules and regulations. Moreover, they examined that horticultural imports of EU countries are also negatively affected because of these regulations as to various OECD countries.

2.3 Summary of Previous Studies

The review of literature suggests that several studies have been undertaken both in Pakistan and abroad on the determinants of mango exports. However, only few foreign studies have focused on the issue of pesticide residues in fresh horticulture crops. The situation regarding

pesticides contamination in different food commodities is worst but its impact on trade has not been elaborated in any of the cited literature. This study is going to be the first upto my knowledge in the context of pesticide residues impact on the trade of mango. Therefore the contribution of the study is to find out pesticides residues in mango exports followed by their compliance with Joint FAO/WHO Codex Alimentarus Commision. The study also examine the impact of SPS measures on mango export in Pakistan.

CHAPTER-3

DATA AND METHODOLOGY

3.1 Introduction

This chapter provides details to examine impact of main variables influencing mangoes export from Pakistan. Section I deal with the generation of primary data in analytical laboratory on pesticide residues in mango while section II is retrieval of secondary data and section III deals with econometric modeling respectively.

3.2 Generation of Primary Data

3.2.1 Instruments and Chemicals

The instruments used in this study were Perkin Elmer Autosystem Gas Chromatographs (GCs) equipped with Electron Capture Detectors (ECD), Nitrogen Phosphorus Detector (NPD), two capillary columns of different polarities and Turbochrom data analysis hardware/ software system. Standard grade insecticides were purchased from Riedel-de Haën AG Seelze, Germany. Their stock solutions and required working dilutions were prepared in n-Hexane containing 20% acetone. All other solvents and reagents used in this study were of extra pure GC or HPLC (High Pressure Liquid Chromatograph) grade.

3.2.2 Sampling and Sample Processing

Mango samples were collected from Multan and Muzaffargarh, Punjab as per standards set by Joint FAO/WHO Meeting on Pesticide Residues. Minimum size of each laboratory sample was at least 1-2kg or 5-10 units as per standard. The sample of mango was taken from the fields in Multan and Muzaffargar and the produce is mainly exported from there. Each sample was allotted with a specific code number. The samples were collected as a whole from the fields, transported to laboratory intact and in cool condition to avoid thaw and rot. Each sample was processed separately. These were minced, sub-sampled and kept in a freezer till further

processing. Care was taken to prevent contamination and deterioration of samples at all stages, as they may affect the results.

3.2.3 Extraction and Cleanup

To monitor laboratory practices for avoiding contamination and maintain the reproducibility and accuracy every possible care was taken. All the distillation and cleaning up procedure were regulated and checked for best behaviour and significant improvements and results.

A subsample of 25 gm was taken out and mixed with 50 ml of acetone, 50 gm of anhydrous sodium sulphate and 50 ml of a combination of cyclohexane and ethylacetate (1:1). Allowed the composite to stand for some time till a clear supernatant is formed. Took 30 ml out of the supernatant into a round bottom flask. A few drops of 10% propandiol in ethylacetate and about 4-6 glass beads were combined. The solvent was evaporated to dryness at 40°C under vacuum and nitrogen stream in rotavapor. The contents were amended in 6 ml of cychlohexane and ethylacetate (1:1) and then passed through highflow super cells. Applied 2 ml of this sample on Gel Permeation Chromatographic (GPC) column for further cleanup (Tahir et al., 2001). After passing through GPC column, the samples were dried under vacuum and reconstituted in 1ml n-Hexane for analysis on Gas Chromatograph (GC).

3.2.4 Instrumental Analysis

Two Perkin Elmer Autosystem Gas Chromatographs equipped with autosampler, capillary column, electron capture detector (ECD-Ni^{63}), Nitrogen Phosphorus Detector (NPD) and other accessories were used throughout the study under optimized operational conditions.

Standard of pesticides were run under the above mentioned conditions and multiresidue methods were developed (Figure 3.1 & 3.2). In samples the residues of insecticides were found on the basis of their particular preserving times, determined on the basis of separate peak zones, described on the pattern of sample weight and are given as mg kg^{-1}. A typical GC-NPD chromatogram of the sample having residues of Chlorpyrifos and Profenofos

pesticides has been shown in figure 3.3. Since the recoveries of insecticides being analyzed were optimum at various spiking levels hence no changes were made during calculation of the concentrations in the samples.

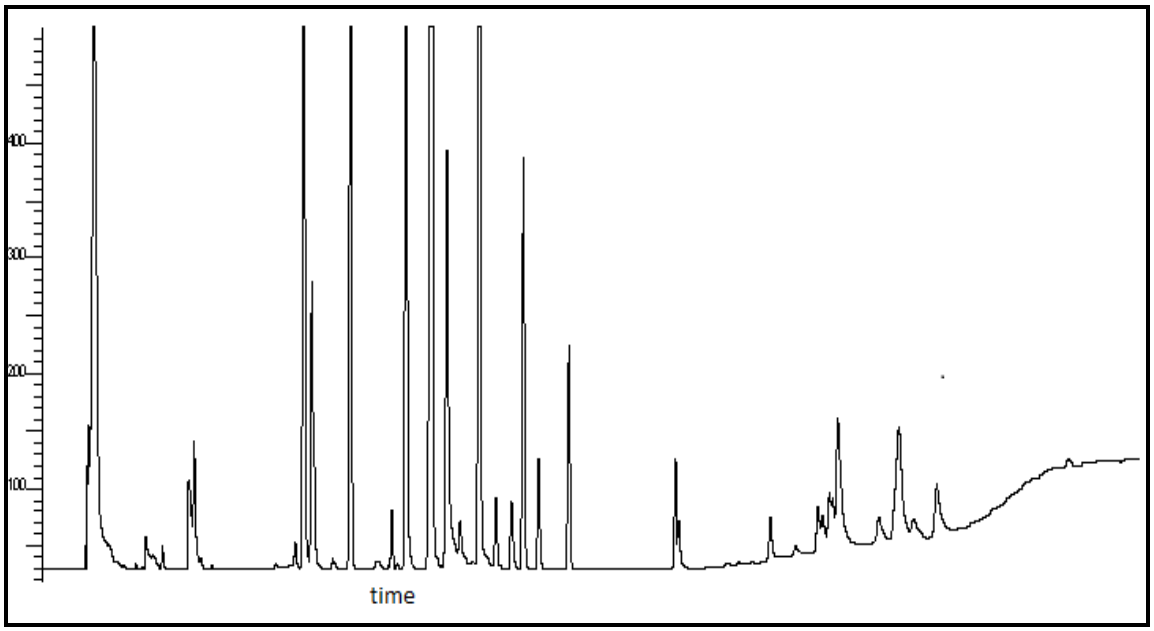

Fig 3.1 Capillary GC/ECD chromatogram of selected standard organophosphate, organochlorine and pyrethroid pesticides under investigation.

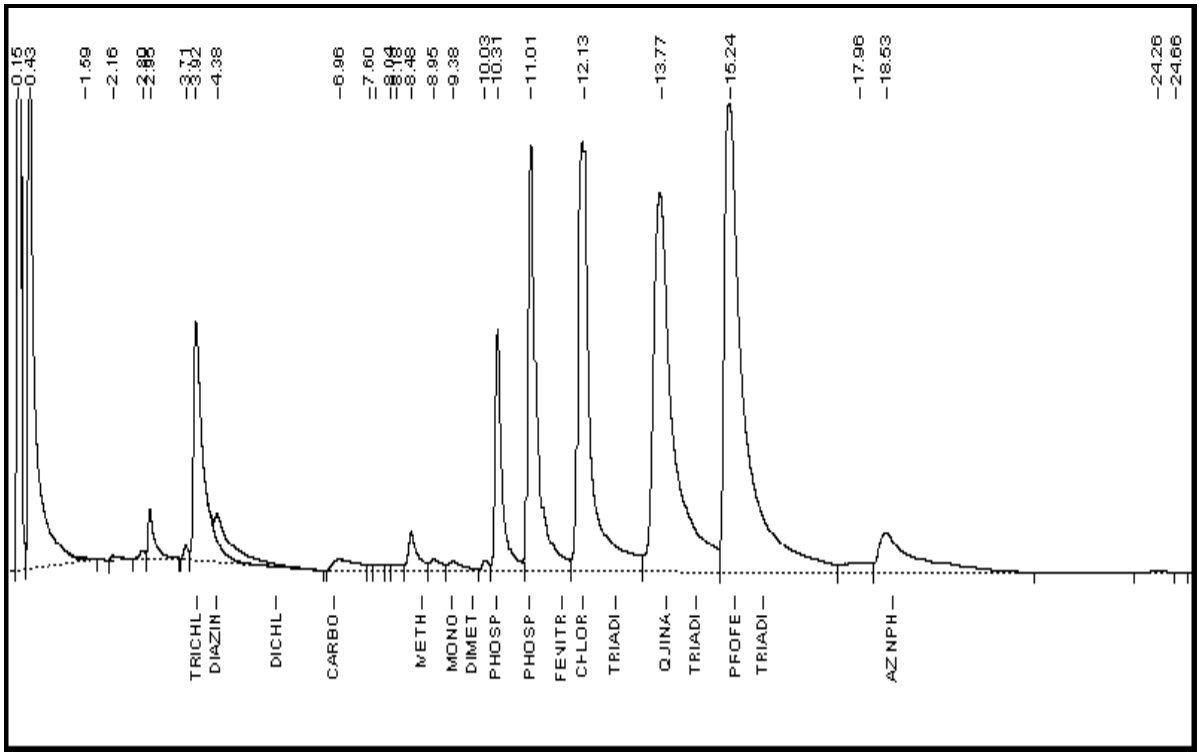

Figure3.2. Capillary GC/NPD chromatogram of some selected organophosphate pesticides

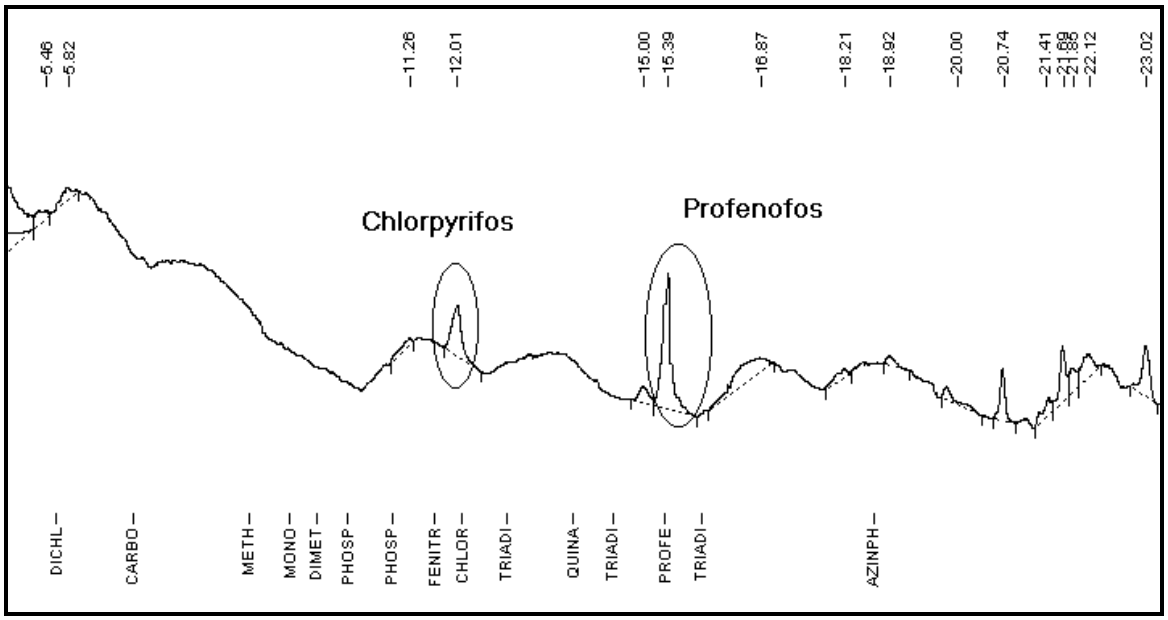

Figure 3.3. Capillary GC/NPD chromatogram (zoomed) of sample showing residues of Chlorpyrifos and Profenofos pesticides.

3.3 Retrieval of Secondary Data

3.3.1 Sources of Data

Secondary data has been taken from Pakistan Economic Survey, Fruits and Condiments Statics of Pakistan, Agriculture Statistics of Pakistan, National Trade and Transport Facilitation Committee (NTTFC), and Food and Agricultural Organization Statistics (FAOSTAT, 2001).[2]

3.3.2 Description of Variables Used

The effect of major variables on export of mangoes were assessed by using time series data for the period 1990-2012 . Because this could not be gained by primary data.The data for the earlier years (1970-1989) were not available from any source. Major variables used in this study are Domestic consumption, Domestic price, Total quantity of mango, Foreign exchange rate, and SPS (sanitary and phytosanitary measures).

3.4 Econometric Modeling

The impacts of different factors and SPS measures on the export quantity of Pakistani Mango exports is determined by using multiple regression analysis. The following log-linear model was estimated by using Ordinary Least Square Method (OLS) as Bathan and Lantican (2009) used this log-linear model in their study.

$$\ln XQ_t = \beta_0 + \beta_1 DC_t + \beta_2 DP_t + \beta_3 FER_t + \beta_4 TQ_t + \beta_5 SPSD_t + e_t \quad \text{----------(3.1)}$$

where

XQ_t = export quantity of mango in year t (tons)

DC_t = domestic consumption of mango in year t (tons)

DP_t = domestic price of mango in year t (rupees / ton)

FER_t = foreign exchange rate in year t (Rs/$)

TQ_t = total quantity of mango production in year t (tons)

[2] FAOSTAT (2001) http:/apps.fao.org/

$SPSD_t$ = SPS dummy variable where "0" is taken for pre-SPS (1990-2003) regime and "1" is for post-SPS (2004-2012) regime; and

e = error term. , β_1, β_2, β_3, β_4 and β_5 are parameters to be estimated.

The overall significance of the the regression model was checked through F-statstics.

CHAPTER-4

RESULTS AND DISCUSSION

4.1 Intrduction

This chapter provides details about current status of pesticides residues,impacts of different variables on export quantity of mango. In this chapter the results of the empirical analysis is discussed and detail of results interpretations along with justification is also given**.**

4.2 Status of Pesticides Residues in Pakistan

This section assess current status of pesticide residues in mango samples collected from Multan and Muzafargargh. These samples were analysed for the residues of 37 pesticides and/or their metabolites namely Dichlorvos, Trichlorfon, Carbofuran, a-BHC, g-BHC, Diazinone, Dimethoate, Heptachlor, Aldrin, Alachlor, Chlorpyrifos, Dicofol, Phosphamidon, Malathion, Fenitrothion, Heptachlor exoepoxide, Quinalphos, Endosulfan, 4,4-DDE, Dieldrin, 2,4-DDD, Profenofos, 2,4-DDT, 4,4-DDD, 4,4-DDT, Mirex, Fenpropathrin, Azinphos methyl, Cyfluthrin, Cypermethrin, Esfenvalerate, Deltamethrin, Metalaxyl, Methomyl, Monocrotoplos, Triadimefon, Triadimenol (I).

The Maximum Residue Limits (MRL) set by Codex Alimentarius Commission (CAC) of Joint FAO/WHO Meeting on Pesticide Residues (JMPR) (Anexure-1) were compared with pesticide residue levels in mango samples collected from Multan and Muzaffargarh (Annexur 2).

The findings have been summarized below:

Table 4.1 Export Volume, Export Market and Sampling Area of Mango.				
Production (000, Ton)	**Export (000 Kg)**	**Export as %age of production**	**Sampling Area (Districts)**	**Export Market (Selected)**
1728.0	73438	4.25	Punjab (Multan, Muzaffargarh)	Middle East, Australia, Belgium, Canada, UAE, UK, Denmark, France, Germany, Netherlands, Italy, Switzerland

Table 4.2 Status of Pesticide Residues in Mango					
Samples analysed (No.)	Samples contaminated (%)	Samples exceeding MRLs (%age)	Pesticide detected (No.)	Pesticide exceeded MRLs (No.)	Pesticide exceeded MRLs (Name)
9	78%	67%	14	3	Chlorpyrifos, Endosulfan, Profenofos

Pakistan exports round about 4.25% of the mango produced in the country to Middle East, Australia, Belgium, Canada, UAE, UK, Denmark, France, Germany, Netherlands, Italy and Switzerland (table 4.1). However, this important fruit is heavily contaminated with pesticide residues. In this study it was observed that 14 different pesticides were detected in 78% of the mango samples analyzed. Out of these contaminated samples 67% samples were exceeding the Codex maximum residues limits (MRL). Three pesticides viz. Chlorpyrifos, Endosulfan and Profenofos were exceeding their permissible limits of 2.00, 0.50 and 0.20 mg kg^{-1} respectively (table 4.2). Endosulfan is a broad-spectrum insecticide which was used from

1950s to control tsetse flies, crop pests and ectoparasites of cattle and used as a wood preservative also. Endosulfan bioaccumulates and has the possibility for long-range transport. Endosulfan exposure may causes congenital physical disorders, mental problems and deaths in farmers. Several countries of Europe have stopped its production. Endosulfan usage is banned or will be diminish in 60 countries that, together report for 45 per cent of current world wide use. DDT and its metabolites have been detected in different samples but their residues limits are within permissible levels. It may be due the historical use of these organochlorine compounds or as an adulteration to some other formulation as DDT is cheaper and readily available in local black market. Due to its persistent and bio-accumulative nature, It has been categorized as one of the Persistent Organic Pollutant (POP) and is banned under Stockholm Convention (World Bank and UNIDO, 2006).

The number of samples exceeding the MRL is of great concern as they may be dangerous to human health and have no place in export market. However, the levels below MRLs may not be taken lightly as low levels may not remain low for ever, if the current trend in pesticide usage is not changed.

4.3 Mango Export Margin

Mango export is a source of foreign exchange earnings. Exports of mangoes from Pakistan increased from 1.16 thousand tones in 1975-76 to 105.21 thousand tons in 2005-06 the highest ever noted in mango export. However, despite increase in exports, share of Pakistan in global exports is only 6 percent (PHDEB, 2005)[3]. This is very low when compared with other mango exporting countries such as Brazil and Mexico which contribute 12 percent and 14 percent respectively (FAOSTAT, 2007)[4].

[3] PHDEB (2005) http://www.phdec.org.pk/
[4] FAOSTAT (2007) http:/apps.fao.org/

If overall performance of the mango sector in the last two periods pre-SPS (1991-2003) and post SPS (2004-2012), is compared separately in terms of average percent increases per year, it is revealed that rate of total production, domestic price and hence domestic consumption has been increased in post SPS. Equivalently the rate of export quantity and hence export values has drastically been reduced more than three and two times respectively in post SPS. Export value, Export quantity and domestic consumption are negatively correlated. In the the pre-SPS (1991-2003) mango export value and export quantity showed a tremendous average increase of 20.4%,and 10.5% per year. However, during the post SPS (2004-2014) this pace could not be maintained and this average increase was reduced to almost half i.e. 10.3% and 1.05% per years.

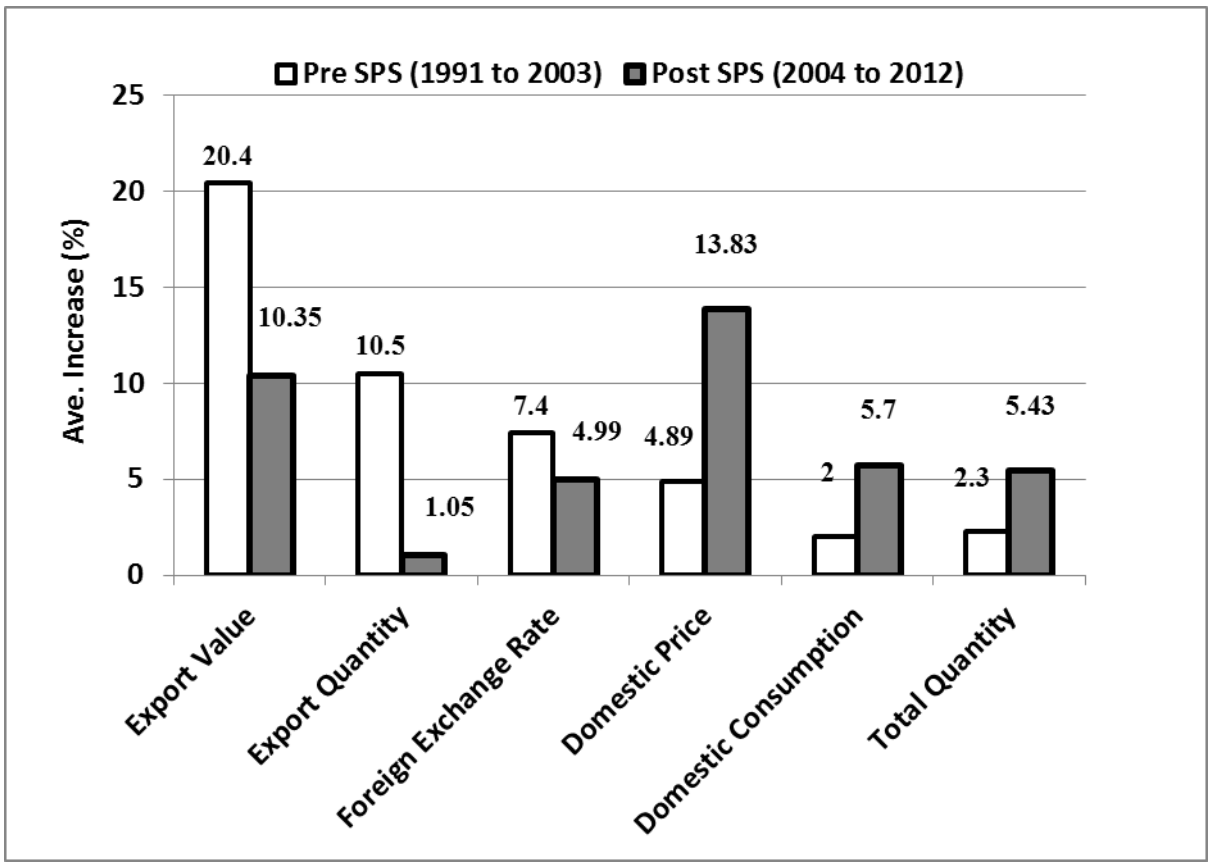

Figure 4.1. Pre and post SPS status of key study variables in Pakistan

4.4 Determinants of Mango Export Quantity in Pakistan

The regression results given in Table 4.3 show that the coefficients of domestic consumption and domestic price are statistically significant for export quantity of mango. Similarly the coefficients of FER and total quantity of mango are also significant for the export quantity of mango, but the coefficient of SPS Dummy is not significant for the export quantity of mango. This may be due to the absence of proper SPS measures.

In this model, R^2 is 0.974 which showed that all independent variables explains 98% of total variations in the dependent variable i.e. mango export quantity. The figure of adjusted R^2 is 0.966 which also shows that the model is good fitted. The higher value of F-statics also favours the overall significance of the model.

Table 4.3 Regression Results of the Determinants of Export Value of Mango

Dependent Variable: Ln(EXPQ)		**Sample: 1991- 2012**		
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	9.057189	0.475044	19.06602	0.0000
DC	-1.70E-05	2.54E-06	-6.690420	0.0000
DPrice	-0.000464	0.000121	-3.850095	0.0014
FER	0.021283	0.004970	4.282089	0.0006
TQ	1.70E-05	2.34E-06	7.262854	0.000
SPSD	-0.018902	0.459107	-0.041172	0.9677
R-squared	0.974424			
F-statistic	121.9173	**Adjusted R-squared**		0.966431
Prob (F-statistic)	0.00000	**Durbin-Watson stat**		1.750132

Source : Author's calculation

4.4.1 Impact of Domestic consumption on Export Quantity of Mango in Pakistan

The increase in export quantity of mango from 1990 to almost 1999 was smooth but afterwards there was an abrupt increase. The export quantity increased from 10 thousand tons to 47 thousand tons. At that time local consumption was more than 936 thousand tons where as it was more than 765 thousand tons in 1990. In 2004-05 the export quantity decreased at that time local consumption was increased. The export quantity at that time was 488 thousand tons but consumption was more than 1622 thousand tons. In 2005-06 the export quantity increased again to 1052 thousand tons and consumption was 1649 thousand tons. Whereas the export quantity was decreased to 616 thousand tons but the consumption was 1658 thousand tons in 2006-07.The export quantity of mango was increased from 2008 to 2012 whereas the local consumption was gradual throughout the year. In 2011-12 the export quantity increased to 851 thousand tons whereas consumption decreased to 1615 thousand ton (Government of Pakistan, 2012) .

Domestic consumption is an important variable showing negative impact on export quantity of mango. The coefficients of domestic consumption are statistically significant for export quantity of mango. The results given in table 4.3 shows that one unit increase in domestic consumption leads to decrease the export quantity of mango by 0.0017 percent. This is because when the domestic consumption increases, less quantity remains for the exports. Therefore, the export quantity decreases. These findings are consistent with the results of (Esteves and Rua, 2013) and (Vannoorenberghe, 2012) who reported a negative correlation (of Value) between domestic consumption and export markets for commodity.

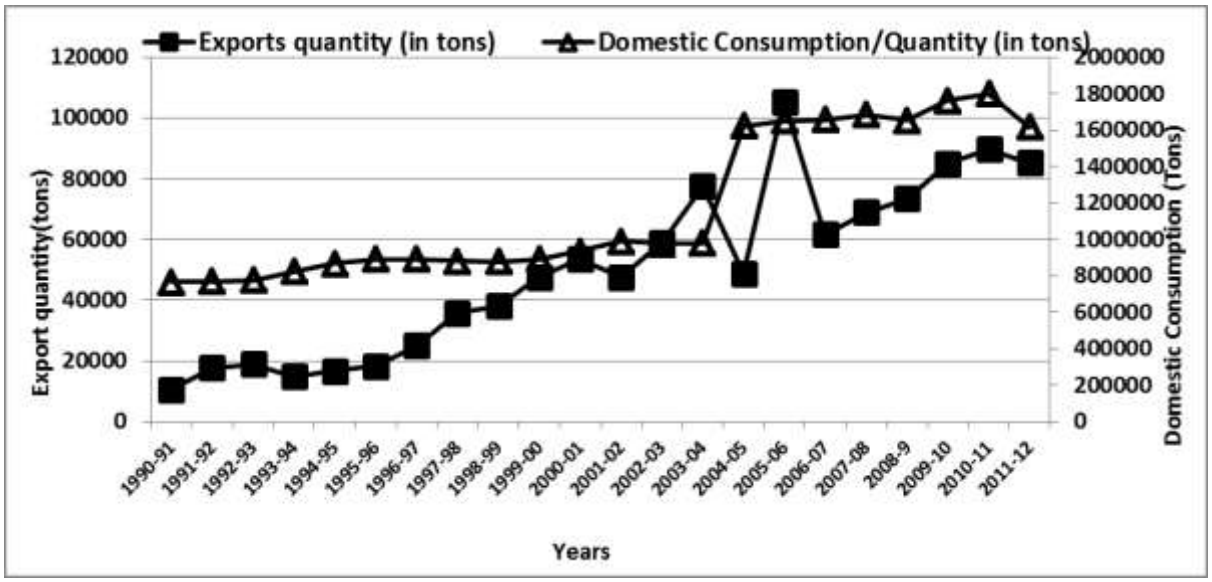

Figure 4.2: Trends in export quantity and domestic consumption of mango in Pak

4.4.2 Impact of Domestic price on Export Quantity of Mango in Pakistan

Economic theory suggests negative correlation between export quantity and domestic price of mango. In this estimated model, co-efficient of domestic price showed negative sign with mango export quantity and is also statistically significant. The co-efficient (0.00046) shows that one unit increase in domestic price leads to decrease the export quantity by 0.0005%.This relationship is because of the fact that with favourable domestic prices, the farmers would sell their mango in local market rather than export it to save energy, labour and avoid risk. In 1990 the local price of mango was Rs. 9.4 per kg that reached to Rs. 16.1in 2000 and then reached to Rs. 50.5 in 2010 respectively (Government of Pakistan, 2009). The estimated relationship is in line with the findings of (Bathan and Lantican, 2009). Moreover, the Canadian and EU sugar conflicts in WTO it was argued that high prices in domestic markets are used to compensate loses in export markets by having exports at lower price than average total cost of production (Chau and de Gorter, 2000).

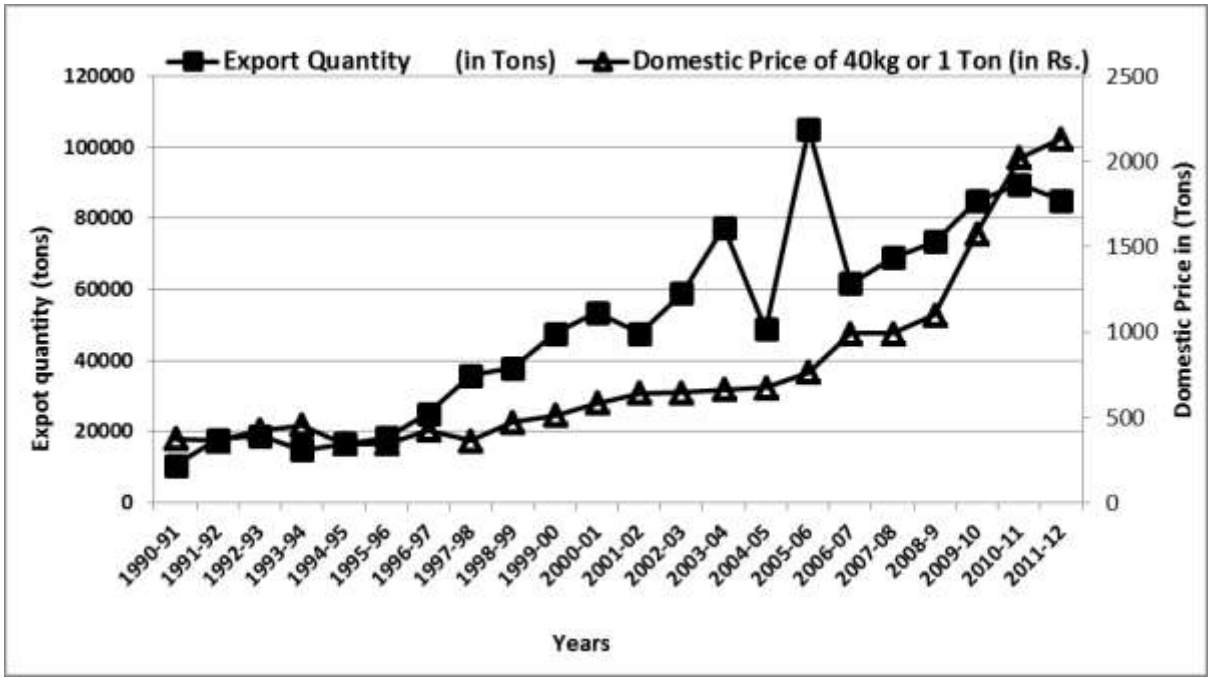

Figure 4.3: Trends in export quantity and domestic price of mango in Pak

4.4.3 Impact of Foreign Exchange Rate on Export Quantity of Mango in Pakistan

Table 4.3 shows that there is a positive relationship between mango export quantity and foreign exchange rate (FER). The co-efficient of FER (0.021) is also found to be highly significant showing that for every one unit change in FER in the international market, the export quantity increases 0.021%. The relationship estimated is in line with (Bathan and Lantican, 2009) who observed a 0.02 unit increase in the pineapple exports by a 1 unit increase in FER.

During decade-I when FER was increasing at an average rate 9% per year, the mango export rate was almost increasing at an average rate of 11.7% per year. But as the FER was brought 4.3% per year in decade-II, accordingly a slow down of export quantity was also observed at a rate of 3.8% per year.

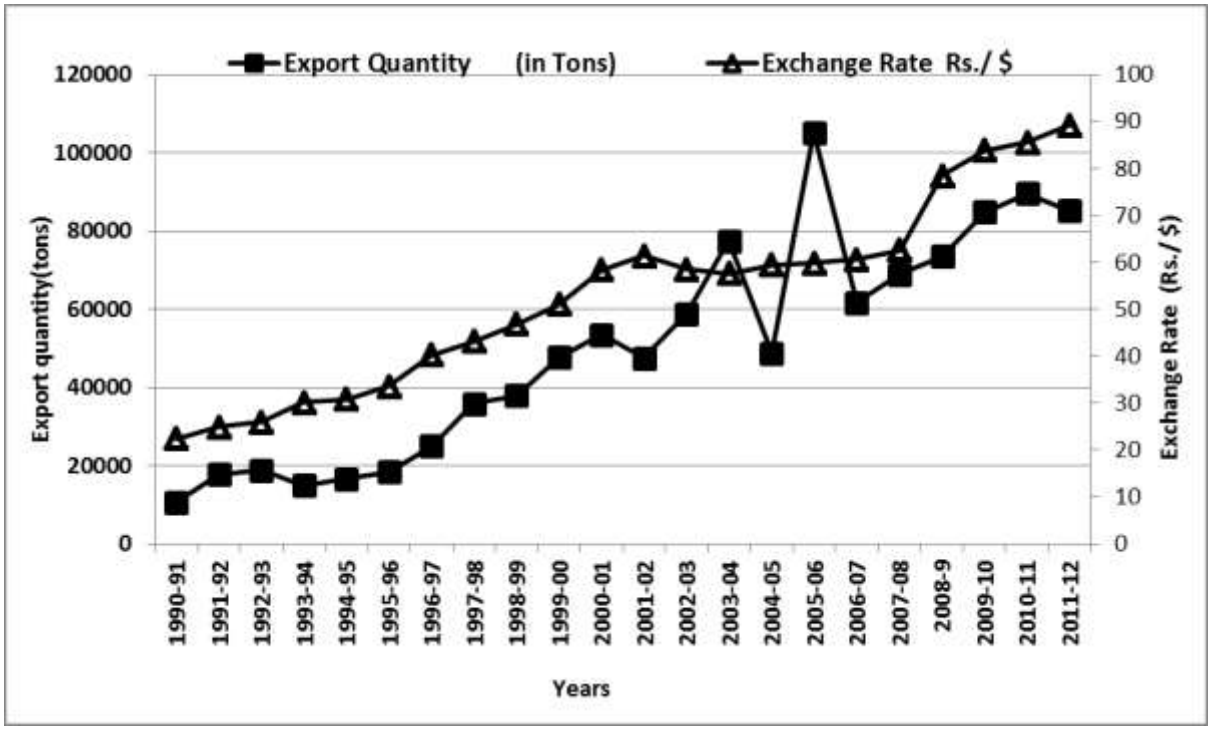

Figure 4.4 Trends in foreign exchange rate and export quantity of mango

4.4.4 Impact of Total Production on Export Quantity of Mango in Pakistan

The total production of mango in 1991 was 776 thousand tons where as in 2000 it was approximately 990 thousand tons and increased to 1700 thousand tons in 2011-12. Whereas the export quantity of mango 10 thousand tons, 53 thousand tons and 85 thousand tons in these years respectively, show a positive relationship between these two variables (Government of Pakistan, 2012).

The impact of total quantity of mango on mango export quantity is also statistically significant. The value of this co-efficient shows that for every unit increase in mango production leads to 0.0017 percent increase in export quantity of mango. These finding are also similar to (Bathan and Lantican, 2009) who found this variable as increasing pineapple exports.

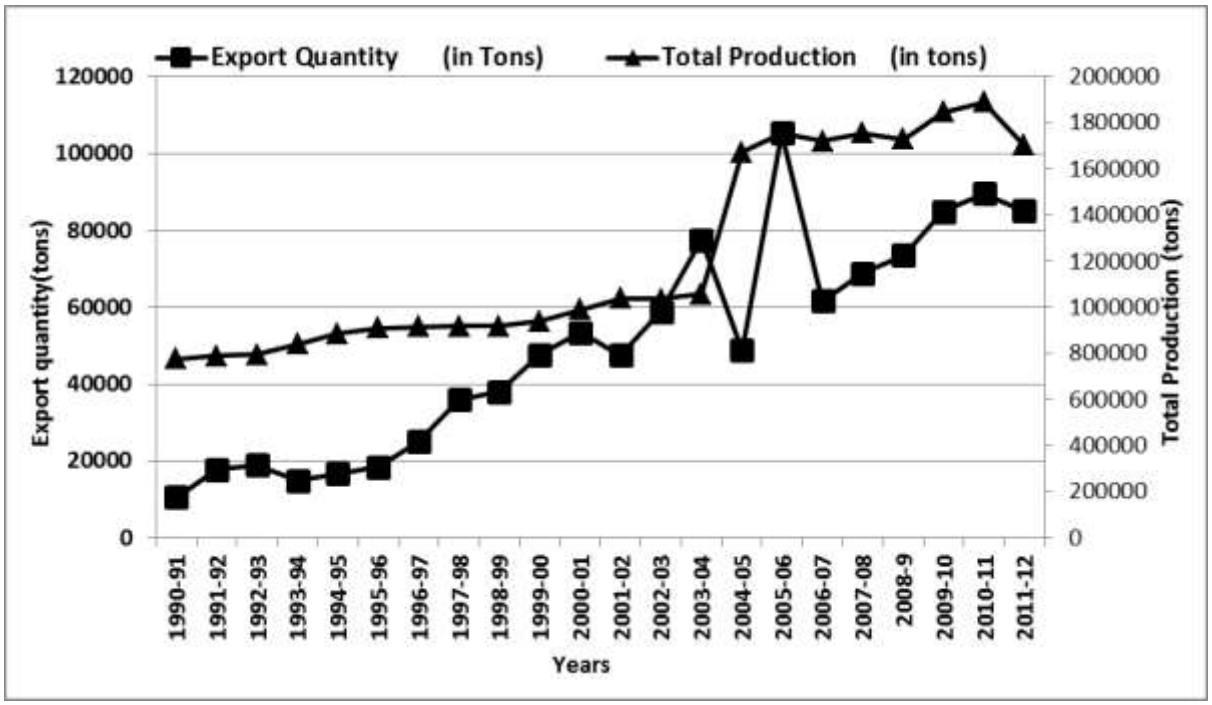

Figure 4.5: Trends in export quantity and total production of mango

4.4.5 Impact of on SPS on the Export Quantity of Mango in Pakistan

Mango is largely used fruit both in immature appearance and in prepared form. Excluding the wastage about 90-94% fruit is consumed regionally (Trade Development Authority of Pakistan (TDAP), 2009). The rest of fruit is exported either in raw form or refined form.The export sector of mango started in the early 1980s, after the establishment of Export Promotion Bureau of Pakistan . During that period small amount of mango was exported to EU and Middle East markets. In the structural modification process in 1990s and response to current WTO agreement on international trade in horticulture sector, small modification has occurred in production technology, harvesting practices, packaging and postharvest care. Hence mango industry has been unable to significantly boost the bulk of productivity. For instance, USA is the biggest market for mango imports in the world; accounting for about one

fifth of the total global mango imports. However, Pakistan has not been able to enter into this market due to quality compliance issues (World Bank and UNIDO, 2006).

Sanitary and Phytosanitary standards (SPS) continue to interrupt market approach. Pakistan is not following SPS standards because of limited SPS management capacity. Thus mango export observed more than 20% downfall in 2007 than 2006 as Pakistan collected the lowest per kg rate for its mangoes in the international market due to bad and cheap quality. This decline in mangoes export due to many factors like quality, supply chain, lack of infrastructure, low yields, cargo space, inland transport, processing and packing, weak marketing, hard competition and standardization (Khan et al., 2008)

The dummy variable SPS was used to examine the status of sanitary and phytosanitary measures on the export of Pakistani mango. As Pakistani mangoes are apparently labeled as SPS infested product in some markets which had closed entry of Pakistani mango in top priced markets like USA, UK, so it was planned necessary to find out the effect of this variable on Pakistan's mango exports. Statistically this variable showed negative sign with mango exports suggesting that mango exports decreases with SPS measures. This variable was found statistically insignificant indicating that exports of Pakistani mangoes were greatly concentrated in markets where SPS measures, specifically pesticide residues, are not strictly observed. This explanation can be augmented by the fact that if Codex MRLs were observed in these markets, about 67% of our mango consignments would be liable to rejection.

Statistical analysis of the data shows that if an SPS measure exists it has negative effect on export quantity of mango. This can be analyzed by the reality that during successive years the export volume of mango has gradually been increased from 17.7 thousand tons to 85.1 thousand tons in the last two decade at an average rate of 8.2% per year. Moreover, in general Pakistani SPS standards, other than pesticide residues, are at par with major target markets

like Afghanistan and Middle East. Basically these are the biggest and historic markets for Pakistani exports of mango. There are several logics which may be intended to explain the importance and influence of this market in mango exports from Pakistan, which mainly comprise presence of a big number of Pakistani immigrants, no hard quality requirements and transportation by road or through sea respectively.

Mostly mango export to these countries is not from a centralized platform but is done on individual bases. This specific framework bring open chances for any person, who has resources and want to export mangoes to this market regardless of his reputation in domestic market or proper identification. Exploiting this opportunity, many seasonal and scrupulous exporters entered in this business in order to earn short term profit. On one hand this approach has increased the mango export to these countries that has been reflected in negative correlation coefficient of -0.0189.

This approach has flooded the target markets with mango with very little marginal profit. To fetch lucrative prices we have to target EU market specifically their Super Markets. Currently Pakistan has a limited/nominal share in this market. These exporters observe GAP and comply with other quality standards. However, if all other business environmental conditions were favourable, we will, even then, not be able to secure a sizable volume in these markets from the current mango produce as EU MRLs are quite stringent (Compare tables and Annexure). If codex MRLs are followed approximately 67% of our mango consignment will be liable to rejection on the other hand if EU MRLs are to be observed then 88% of our consignment may not be allowed to enter EU Super Markets. Currently only Canada and UK Supermarkets strictly enforce MRL tolerance.

Table 4.4 Country ranking in accordance to SPS enforcement

Least Strict	→				Most Strict
Afghanistan	MiddleEast	Malaysia	China	Canada	US Supermarkets
	Russia	Indonesia	Iran		
			UKWholesalemarkets		
			UK Ethnic Importers		

Source: World Bank and UNIDO (2006)

CHAPTER-5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Mango is an important exportable product of Pakistan but its share in international market is very small as compared to its total production. There are several usual factors like Domestic consumption, domestic and export prices, total production and foreign exchange rates affecting export quantity of mango but the recent issue of SPS is another technical barrier. The present study asses the impact of these important factors on the value of mango exports in Pakistan.

Some primary data on pesticide residues were generated in labortary and analyzed . Mango samples were collected from Multan and Muzafargarh. About 78% of the samples being analyzed were containing pesticide residues to varying levels out of which 67% were above the Codex MRLs. Three pesticides viz. chlorpyrifos, endosulfan and profenofos were exceeding their MRLs.

Time Series secondary data from 1990–2012 for mango production, domestic consumption, domestic prices, FER and export quantity of mango was used. Log-linear regression model was used for finding relationship between dependent variable (export quantity of mango) and independent variables (DC, DP, FER, TQ and SPS). Mango export from Pakistan is mainly focused in some markets. It was found that 78% of total commercial excess for export purpose was sent to Middle East, 0.7 % to Far East, 14.8 % to Europe and 6.1% to other countries. The main consumer are Pakistanis and Indians in these countries especially in Middle East . Increased shipping facilities at low rates, elastic and less rigorous food safety requirements are other factors impacting export of mangoes in these markets.

This study exposed that in early years there were small earnings from export of mangoes which raised with the passage of time. It has been observed that both domestic consumption and domestic price have significantly negative impact on export quantity of mango by a factor of 0.0017 % and 0.0004% respectively. Moreover, every unit increase in mango production lead to 0.0017 percent increase in export quantity of mango. The co-efficient of FER was noticed to be highly significant showed that every one unit change in FER in the international market the export quantity increases 0.021% . It has also been observed that mango export is negatively impacted by SPS measures because of the strict regulations of the current importing countries. However, it can be argued that mango exports to EU countries will be more negatively influenced because of their stringent regulations.

5.2 Recomendations

1. In international markets the buyers are becoming more alert for quality and safety. The importing countries have proposed rigid ordinance especially those related to quarantine. Pakistan must work seriously to qualify food safety and quality compliance demands. Establishing food testing standard and inquiry infrastructure, on significance basis, specially in collection with exporters. Favouring such facilities to get certificate from worldwide agencies. EurepGAP (Euro-Retailer Produce Working Group Good Agricultural Practice) and HACCP (Hazard Analysis and Critical Control Points) acceptance should be done on priority basis.
2. Encourage Good Agricultural Practice (GAP) based on reduced use of, reduced risk from, and reduced reliance on pesticides.
3. As agriculture products export to EU and many other progressing markets will be promoted by certification of EurepGAP; cost of certification in addition to several other certifications like ISO 14000, EurepGAP, HACCP and ECO Branding should

be fully supported , at least for a couple of years to fix the trend and enhance image of Pakistan fresh yield.

4. Pesticides are toxic and need to be monitored. An extensive pesticide residues monitoring system should establish to regulate issues in a comprehensive manner .

5.3 Limitations of the Study and Future Research Areas

The main shortcoming of this study is that it only consider the impact of different variables i.e DC, DP, FER, TP and SPS measures on export quantity of mango while ignoring the risks associated with the use of pesticides (especially health and environmental issues), improper orchard management, poor post-harvest handling, constraints in marketing system and lack of compliance to international standards are some major factors which have set limits in the expansion of mango exports from Pakistan.

The study also suggests that further research work should be done for the improvement in market infrastructure, cheaper availability of transport and packing material. The study also proposes research on improving quality, economizing marketing costs, proper presentation for export consignments and good long term relations with buyers. Trade liberalization regime and its impact on production and export of mango from Pakistan. Aspects of value addition in mango's industry of Pakistan. Existential modeling of mango export supply chain in Pakistan. Price transmission of mango markets in world and their impact on Pakistan.

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ANNEXTURE.1:

FAO/WHO CAC and EU MRLs (mg/kg) for mango

Pesticides	Codex MRL	EU MRL
Alachlor	_	0.05
Aldrin	_	0.01
Atrazine	_	0.05
Azinphos methyl	_	0.05
Chlorpyrifos	2	0.05
Cyfluthrin	_	0.02
Cypermethrin	0.7	0.7
DDT	_	0.05
Deltamethrin	0.05	0.05
Diazinon	_	0.01
Dichlorvos	_	0.01
Dicofol	_	0.02
Dieldrin	_	0.01
Dimethoate	1	0.02
Endosulfan	0.5	0.05
Esfenvalerate	_	0.02
Fenitrothion	_	0.01
Fenpropathrin	_	0.01
Heptachlor	_	0.01
Lindane (g-BHC)	_	0.01
Malathion	_	0.02
Metalaxyl	_	0.05
Methamidophos	_	0.01
Methomyl	_	0.02
Mirex	_	
Monocrotophos	_	-
Phosphamidon	_	0.01
Profenofos	0.2	0.2
Quinalphos	_	0.05
Triadimefon	1	0.1
Triadimenol	1	0.1
Trichorphon	_	0.5

JointFAO/WHO Codex Alimentarius Commission

ANNEXTURE .2 : Pesticides residues(mg/kg) detected in mango samples collected from Multan and Muzaffargarh

Pesticides	MA/P-01	MA/P-02	MA/P-03	MA/P-04	MA/P-05	MA/P-06	MA/P-07	MA/P-08	MA/P-09
Dichlorvos	-----	-----	0.01	0.03	0.04	0.01	-----	-----	0.03
Trichlorfon	-----	-----	-----	-----	-----	0.01	0.01	-----	-----
Carbofuran	-----	-----	-----	-----	-----	-----	-----	-----	-----
a-BHC	-----	-----	-----	-----	-----	-----	-----	-----	-----
g-BHC	-----	-----	-----	-----	-----	-----	-----	-----	-----
Diazinone	-----	-----	0.04	0.04	0.03	-----	-----	-----	0.01
Dimethoate	-----	-----	-----	0.05	-----	-----	-----	-----	-----
Heptachlor	-----	-----	-----	-----	-----	-----	-----	-----	-----
Aldrin	-----	-----	-----	-----	-----	-----	-----	-----	-----
Alachlor	-----	-----	-----	-----	-----	-----	-----	-----	-----
Chlorpyrifos	-----	-----	2.15	1.04	1.07	-----		2.21	-----
Dicofol	-----	-----	-----	-----	-----	-----	-----	-----	-----
Phosphamidon	-----	-----	-----	-----	-----	-----	-----	-----	0.05
Malathion	-----	-----	-----	-----	-----	-----	-----	-----	-----
Fenitrothion	-----	-----	-----	0.15	0.17	-----	-----	-----	-----
Heptachlor exoepoxide	-----	-----	-----	-----	-----	-----	-----	-----	-----
Quinalphos	-----	-----	-----	-----	-----	-----	-----	-----	-----
Endosulfan	-----	-----	0.35	0.56	-----	-----	-----	-----	0.53
4,4-DDE	-----	-----	-----	0.01	-----	-----	-----	-----	-----
Dieldrin	-----	-----	-----	-----	-----	-----	-----	-----	
2,4-DDD	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profenofos	-----	-----	-----	-----	-----	0.21	0.25	-----	-----
2,4-DDT	-----			0.03	-----	-----	-----	-----	-----
4,4-DDD	-----	-----	-----	0.01	3870	-----	-----	-----	-----
4,4-DDT	-----	-----	-----	0.02	-----	-----	-----	0.01	0.02
Fenpropathrin	-----	-----	-----	-----	-----	-----	-----	-----	-----
Azinphos methyl	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cyfluthrin	-----	-----	-----	-----		-----	-----	-----	0.12
Cypermethrin	-----	-----	-----	-----	-----	-----	-----	-----	-----

Author Lab experiment results