CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

Mango Cluster Feasibility and Transformation Study

Planning Commission of Pakistan, Ministry of Planning, Development & Special Initiatives

February 2020

FOREWORD

In many developed and developing countries, the cluster-based development approach has become the basis for the transformation of various sectors of the economy including the agriculture sector. This approach not only improves efficiency of development efforts by enhancing stakeholders' synergistic collaboration to resolve issues in the value chain in their local contexts, but also helps to gather resources from large number of small investors into the desirable size needed for the cluster development. I congratulate the Centre for Agriculture and Bioscience International (CABI) and its team to undertake this study on **Feasibility Analysis for Cluster Development Based Agriculture Transformation.** An important aspect of the study is the estimation of resources and infrastructure required to implement various interventions along the value chain for the development of clusters of large number of agriculture commodities. The methodology used in the study can also be applied as a guide in evaluating various investment options put forward to the Planning Commission of Pakistan for various sectors, especially where regional variation is important in the project design.

Muhammad Jehanzeb Khan,
Deputy Chairman
Planning Commission of Pakistan
Ministry of Planning Development and
Special Initiatives
Government of Pakistan.

FOREWORD

To improve enhance Pakistan's competitiveness in the agriculture sector in national and international markets, the need to evaluate the value chain of agricultural commodities in the regional contexts in which these are produced, marketed, processed and traded was long felt. The Planning Commission of Pakistan was pleased to sponsor this study on the **Feasibility Analysis for Cluster Development Based Agriculture Transformation** to fill this gap**.** The study aims to cover a large number of agriculture commodities spread in various clusters throughout the country.

I truly hope that the policies, strategies, and interventions suggested in this report will facilitate the federal and provincial governments to chalk out and implement plans for cluster-based transformation of the agriculture sector.

Zafar Hasan,
Secretary,
Ministry of Planning Development and Special Initiatives
Government of Pakistan

FOREWORD

This is part of the series of studies on 33 agriculture commodities undertaken for the purpose of preparing a cluster-based transformation plan based on the regional realities in the entire value chain including production, processing, value addition, and marketing. I congratulate the whole team of the project especially the Team Lead, Dr. Mubarik Ali to undertake and successfully complete this monumental study. We are thankful to all commodity specialists who have contributed to this assignment. The CABI Project officers Mr. Yasar Saleem Khan and Ms. Aqsa Yasin deserve appreciation. I truly believe that this study will serve as a basis to make and implement plans for cluster-based agriculture transformation. I hope you will enjoy reading the study and it can help you making your investment decisions along the value chain of various agriculture commodities.

Dr. Babar Ehsan Bajwa
Regional Director
CAB International

FOREWORD

This report is part of the series of studies on 33 agriculture commodities to prepare the agriculture transformation plan by incorporating regional realities at the cluster level. In the report, the clusters of various commodities are identified and characterized, and viable investment options along the value chain of each cluster are proposed. For this purpose, the study team has analyzed macro data, reviewed the literature, and made extensive consultation with stakeholders along the value chain. Foreign and local internationally reputed consultants, Dr. Derek Byerlee and Dr. Kijiro. Otsuka and national consultant Mr. Sohail Moghal were also engaged to understand the cluster-based development approach and conduct cluster-based feasibility analysis. An EXCEL-based Model was developed which was validated by our national consultants. Separate viabilities for individual technologies and products suggested in each commodity are also estimated. This humongous task would not have been possible to complete without the excellent cooperation and facilities provide by CABI, the hard work of commodity specialists and our research team especially Mr. Yasar Saleem Khan and Ms. Aqsa Yasin. The true reward of our hard work is the implementation of the proposed policies, strategies and interventions to develop agriculture commodity clusters in the country.

Dr. Mubarik Ali
Team Leader
Cluster Development Based Agriculture
Transformation Plan-Vision 2020 Project
Planning Commission of Pakistan and
CAB International

ACKNOWLEDGEMENT

It is not possible to mention the names of all those who collaborated with us in completing this report, but my foremost gratitude goes to numerous stakeholders along the value chain who generously shared the information about barley production, marketing, trade and value chain. Without their support, this report would not have reached to the level of present quality.

My sincere thanks go to **Planning Commission of Pakistan** for this initiative and especially financial assistance to complete the project activities. Here I am especially thankful to **Dr. Muhammad Azeem Khan** (Ex-Member, Food Security and Climate Change, Planning Commission of Pakistan), **Dr. Aamir Arshad** (Chief Agriculture, Planning Commission of Pakistan), **Mr. Muhammad Akram Khan** (Project Director; CDBAT project) and other CDBAT project team member **Mr. Muhammad Arif** (Research Associate) and **Dr. Habib Gul** (Research Associate) for successful coordination and support for the project.

I am also grateful to **Centre for Agriculture and Bioscience International** (CABI) and its Regional Director for Central and West Asia, Dr. Babar Ehsan Bajwa and CABI team for selecting me as commodity specialist for this task and offering outstanding cooperation, support and advice during all the stages of this project. However, the research team takes the responsibility of any shortcoming left in the report.

Mr. Shamoon Sadiq

Senior Author

Citation:

Sadiq, Shamoon., Ali Mubarik, Yasin Aqsa, and Yasar Saleem Khan. (2020) Mango Cluster Feasibility and Transformation Study. In Ali Mubarik, (ed.). (2020). *Cluster Development Based Agriculture Transformation Plan Vision-2025*. Project No. 131(434)PC/AGR/CDBAT-120/2018. Unpublished Report, Planning Commission of Pakistan, Islamabad, Pakistan and Centre for Agriculture and Biosciences International (CABI), Rawalpindi, Pakistan.

DISCLAIMER

This report is prepared by using the data from various published and unpublished sources and that obtained during the consultations with stakeholders. The research team took utmost care to arrive at the figures to be used, but is not responsible for any variation of the data in this report than those reported in other sources. Moreover, the views expressed in this report are purely of the authors and do not reflect the official views of the Planning Commission of Pakistan, Ministry of Planning Development and Reforms or the Centre for Agriculture and Bioscience International (CABI).

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LIST OF ACRONYMS

AARI	Ayub Agricultural Research Institute
ACIAR	Australian Center for International Agricultural Research
ADB	Asian Development Bank
AESA	Ago-Eco System Analysis
AGSTAT	Agriculture Statistics
AIARC	Association of International Agricultural Research Centers
AMD	Agriculture Market Development
AMIS	Agriculture Marketing Information Service
AVRDC	Asian Vegetables Research and Development Center
CABI	Centre for Agriculture and Bioscience International
CPEC	China-Pakistan Economic Corridor
DAP	Di-ammonium Phosphate
DPP	Department of Plant Protection
EU	European Union
FAO	Food and Agriculture Organization
FEGs	Farmers Enterprise Groups
FFS	Farmers Field School
FSC&RD	Federal Seed Certification & Research Department
FTA	Free Trade Agreement
FYM	Farm Yard Manure
GAP	Good Agriculture Practices
GPU	Germ Plasm Unit
HACCP	Hazard Analysis and Critical Control Point
HWT	Hot Water Treatment
ICM	Integrated Crop Management
IPM	Integrated Pest Management
ISO	International Organization for Standards
ITC	International Trade Center
IUAs	Infrastructure Up-gradation Agreements
KPK	Khyber Pakhtunkhwa
MRL	Maximum Residue Limit
NGO	Non-Government Organization
NPK	Nitrogen, Phosphorus, Potassium

NPPO	National Plant Protection Organization
NRSP	National Rural Support Programme
PAEC	Pakistan Atomic Energy Commission
PARAS	Pakistan Radiation Services
PARC	Pakistan Agriculture Research Center
PATTA	Pakistan Agricultural Technology Transfer Activity
PBIT	Punjab Board of Investment & Technology
PCSIR	Pakistan Council of Scientific and Industrial Research
PEEP	Punjab Enabling Environment Project
PHDEB	Pakistan Horticulture Development & Export Board
PHDEC	Pakistan Horticulture Development & Export Company
PSIC	Punjab Small Industries Corporation
PTD	Participatory Technology Development
RSP	Rural Support Program
SFA	Sindh Farmers Association
SHARI	Sind Horticulture Research Institute
SIDB	Sindh Industrial Development Board
SIDB	Small Industries Development Board
SMEDA	Small and Medium Enterprises Development Authority
SMGE	Sindh Mango Growers and Exporters Association
SOP	Standard Operating Procedures
SPS	Sanitary and Phyto-Sanitary
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TDAP	Trade Development Authority of Pakistan
TEVTA	Technical Education & Vocational Training Authority
TOT	Training of Trainers
UAE	United Arab Emirates
UAF	University of Agriculture Faisalabad
UK	United Kingdom
USA	United States of America
VHT	Vapor Heat Treatment
VHT	Vapor Heat Treatment
YGR	Yearly Growth Rates
ZTBL	Zarai Taraqiati Bank Ltd.

EXECUTIVE SUMMARY

Statistics revealed that global production of mangoes is over 48 million tonnes showing an increased production with an average growth of 4.4% per annum as compared to 25 million tonnes. In Pakistan, total area under mango cultivation is around 169 thousand ha with the production of 1.7 million tonnes being the second major fruit crop of the country. Pakistan is 6th largest mango producer in the world. The total global export is about 1.7 million tonnes with an estimated value of US$2.1 billion. USA is the leading importer with 28% share in the global market followed by EU countries with 22% share. Pakistan's export to these high-end markets is insignificant.

During the 2000s, the mango production in Pakistan has been increasing at a reasonable rate of 4.1% per annum, comparable to the rate at international level. But all of the increase has been coming from the expansion in its area, while per ha yield has been declining during the period, and the deceleration has accelerated during 2011-16. The decrease in per ha yield along with the poor value chain infrastructure development is resulted a gradual decline in its competitive position in the world market. That is why Pakistan could not benefit from the high growth in the international mango market, both in terms of quantity and value of export. The country is facing a declining export-production ratio while major mango growing countries are bringing higher proportion of their mango produce in international market. Moreover, despite some recent improvements in the mango value chain, the country still earns the lowest per unit price of mango among the leading mango exporting countries of the world.

Realizing the declining competitiveness of mango value chain on one hand and its potential on the other in terms of its consumption preference among the rural and urban communities alike, generating income and employment and earning foreign exchange, the Planning Commission of Pakistan initiated this study to analyse the potential and constraints, and suggest viable interventions along the whole value chain to enhance the competitiveness of mango in the domestic and international market. To incorporate the regional variations in mango production, marketing, and trade, this analysis is undertaken at the mango cluster level in the country. For this purpose, macro data related to the mango sector were analysed, related literature to mango value chain covering its production, marketing, processing and trade were reviewed, and a large number of stakeholders along the value chain were consulted.

Pakistan's mango industry is mainly located in two provinces-Punjab and Sindh, each covering 63% and 37% of the total mango area in the country. Based on the district-level data on mango area and its varieties grown in each province, two mango clusters are identified for the detail analysis in this study: i) Punjab Chaunsa Cluster mainly grows Chaunsa mango variety, consists of Multan, Rahim Yar Khan, Bahawalpur, Muzaffargarh and Khanewal with Multan as its centre point; and ii) Sindh Sindhri Cluster mainly growing Sindhri variety, comprises of Hyderabad, Tando Allahayar, Mirpur Khas, Naushehro Feroze and Sanghar with Mirpur Khas as its centre point. The characterization of these clusters with the help of stakeholders helped to highlight the main production, marketing, trade, and processing feature and identify the potential and constraints in each.

This study is able to identify several constrains at the institutional constraints which include weak mango research and extensions system, poor access to finance, lack of information about the market, lack of supply of modern inputs, poor coordination among stakeholders; production level constraints which include old, bushy-type and tall mango plants with low yield potential, lack of supply of high-yielding and true to type planting material, weak farmers' capacity to understand modern management practices; poor post-harvest handling and marketing which include poor post-harvest management practices like storing, packaging, transportation, etc. poor domestic marketing infrastructure, non-compliance of international quality standards, limited diversity in international market; and value chain and processing level constraint which include weak value chain infrastructure like lack of collection centres, cold storage, hot water treatment plants, etc. and limited processing facilities. These constraints reduce per ha yield, increase post-harvest losses, reduce export-production ratio, and deteriorate quality of the produce for the national and international markets.

In order to address multilevel challenges from production to product and market development, performance targets were set, based on global average for yield, quality and export. To achieve these targets, policies and intervention were designed. The main interventions at the institutional level include social networking of farmers and other stakeholders, strengthening the research and extension system, establishing a Project Management Unit (PMU) at the provincial agriculture departments for each cluster, capacity building of stakeholders along the value chain including farmers, nursery men, traders, trainers, and processors, and improving service delivery system. The main interventions suggested at the production level are promotion of high-density orchards and certified nurseries and establishment of germ plasm unit (GPU) and multiplication blocks at research stations. The marketing level intervention are linking farmer with markets, traders with international markets, and establishment of e-commerce platform containing information of main national and international markets, training modules and technology information. The suggested value chain level interventions are incentivizing the establishment of pack houses, farm-level cold storage, and hot-water treatment plants in rural areas at the FEG levels; and recommended processing level intervention are to incentivize the small-scale mango pulp plants and mango dehydration plants in rural areas preferably under the control of FEGs. These interventions are to be initiated by government and executed in collaboration and participation of the private sector including the Farmer Enterprise Groups (FEGs), exporters, traders and processors. Various institutions and agencies to be involved in implementing these strategies are also identified in the study in each cluster.

A time-horizon of five years has been set for implementing these interventions but a ten-year period is assumed to realize the intended outcomes of the cluster development interventions. These investments shall result in far reaching economic and social impacts, including increased productivity and production, higher quality, value and income and employment, benefiting all the stakeholders of mango cluster in Punjab and Sindh. These interventions are expected to create nearly 14,600 new jobs in total along the value chain and nearly on an average US$ 31.6 million foreign exchange during the last year from the enhanced export-production ratio and improved quality of exports. These cluster interventions are estimated to create positive economic returns. The overall economic, social and environmental impacts of the cluster development program are positive, sustainable and long lasting.

The total estimated investment of this cluster Up-gradation Plan is US$ 91 million for the focal point of Punjab cluster and another US$ 32 million for the focal point of Sindh cluster. Out of the total investment, about 26.8% in Punjab and 27.8% in Sindh will be borne by the Government in terms of strengthening research system, capacity building program, 20% subsidy on value chain infrastructure, and interest free loans. It is expected that these incentives will excite the remaining private investment.

Accounting for all the yearly value chain costs including the production, processing and marketing costs and investments applied over the five years, the estimated Net Present Values (NPV) for Punjab and Sindh Clusters are respectively US$435 million and US$142 million, and the Internal Rate of Return (IRR) for Punjab is 97%; and for Sindh it is 99%. These IRRs are based on respective investment costs is each region and the present value of resulting revenues over a period of ten years. The detailed of cluster level returns, operational costs, and investments can be seen in the Summary Sheet given below with the EXL Model.

Summary Sheet of Mango Clusters

Information	Punjab	Sindh	Overall
Area of cluster focal point (ha)	50,281	29,503	79,784
Production (tonnes)	658,007	190,074	848,081
Yield of the cluster (tonne/ha)	13.09	6.44	10.63
Area of the cluster (ha)	95280	37310	132,590
Production of the cluster (tonne)	1059690	250190	1,309,880
Area on which certified gardens is established (ha)	10,056	5,901	15,957
Area matured for fruiting every year (ha)	10,056	5,901	15,957
Additional production from increased yield (tonne)	67,244	15,724	82,968
Expected additional value at farm gate price (000 US$)	33689.1	7877.8	41566.9
Increase in production - improved practices (tonne)	42,027	29,483	71,510
Additional value of production - improved practices (000 US$)	21055.7	14770.9	35826.6
Increased production - reduced post-harvest losses (tonne)	90,779	24,176	114,955
Additional value of production - reduction of losses (000 US$)	45480.2	12112.2	57592.4
Total production that will have improved value chain (tonne)	79421	18,806	98227
Value of production - improvement in value chain (000US$)	67622.7	15957.5	83580.2
Volume of pulp/puree produced (tonne)	7489	0	7489
Number of processing units required	9	0	9
Number of certified nurseries	9	5	14
Number of collection center required	25	7	32
Number of small-scale cold storage required	56	14	70
Investments (000 US$)			
Investments on Research & Development	240.7	159.3	400.0
Investment for training of farmers for Global Gap	125.2	50.4	175.6
Investment for training of value chain agents	57.0	37.8	94.8
Investment on PMU	1721.0	1721.0	3442.0
Government loans	6781.6	1710.4	8492.1
Investment on new plants for garden renovation	20671.1	12129.0	32800.1
Certified mango nursery establishments	60.7	60.7	121.5
Certification of production processes	712.2	803.3	1515.6
Value chain infrastructure	60622.7	14685.2	75307.9
Pulping/puree Units	255.6	0.0	255.6
Total investment required over five year	91477.5	31557.1	123034.6
Total public sector investment	24502.3	8758.8	33261.2
Total private sector investment	66975.2	22798.2	89773.4
Economic Analysis (000 US$)			
Total production increase in 10th year (tonne)	200,050	69,383	269,433
Gross revenue (undiscounted) in 10th year	187952.8	55778.6	243731.4
Additional operation costs in 9th year	31616.2	8107.4	39723.6
Net cash flow (undiscounted) in 10th year	187952.8	55778.6	243731.4
NPV	435174.8	142179.8	577354.5
Internal Rate of Return	96.57%	98.57%	**97.07%**

1 INTRODUCTION

Amongst the wide array of horticultural crops grown in Pakistan, mango (*Mangifera Indica* L.) holds a prominent position because of its strong production base, domestic demand (95%) and export potential--all of these contribute to the country's socio-economic development. Mango is popularly known as the 'King of Fruits'. It is the national fruit and the second most important fruit crop after citrus grown in Pakistan in terms of area under cultivation and production. Pakistani mangoes are internationally famous for their sweetness, juiciness, nutrition and unique flavor. During the summer season, domestic demand for mangoes is very high. They are popularly consumed both as fresh fruit and in processed forms such as jams, pickles, juices, nectars, squashes, milk-shakes and jellies. Mango from Pakistan is recognized as one of the best of its kind in the world market.

1.1 Mango Production and Trade from Pakistan

Pakistan with a production of 1717 thousand tonnes cultivated on 171 thousand ha is the sixth-largest mango producer country of the world (FAO 2016). The mango production in Pakistan is mainly located in two provinces–Punjab and Sindh–contributing 99.7% of the total mango production in the country; 63% of it comes from Punjab and 37% from Sindh. Punjab accounts for 63% while Sindh 37% of the total mango acreage of Pakistan. The per ha yield of mango in Pakistan is around 10 tonnes per ha. The yield is highest in Punjab followed by Sindh while it is lowest in Balochistan (Table 1).

Table 1:Area, Production, and yield of mango in Pakistan, 2015-16

Province/country	Area (000 ha)	Production (000 tonne)	Yield (tonne/ha)	Share in area (%)	Share in production (%)
Punjab	107.1	1313.6	12.3	62.70	76.51
Sindh	62.7	399.2	6.4	36.71	23.25
KPK	0.4	3.0	7.5	0.23	0.17
Balochistan	0.6	1.1	1.8	0.35	0.06
Pakistan	170.8	1716.9	10.1	100.00	100.00

Source: MNFS&R (2016)

Over the fifteen years, the area under mango orchards in Pakistan has increased from 97 thousand ha in 2001 to 170.8 thousand ha in 2015, an increase of 76% over the period with an average annual growth of 4.4%. The highest increase in area under mango cultivation came from Punjab having a growth rate of 6.0% per annum, while area in Balochistan declined quite sharply (Table 2).

The mango production in the country has increased from 990 thousand tonnes in 2001 to 1717 thousand tonne in 2015, an increase of 73% having an average annual growth rate of 4.1% (Table 2). This increase may be attributed to increasing government attention to the country's horticultural sector, an increase in the area planted to mangoes and rising

consumer demand for Pakistani mangoes in both domestic and foreign markets. The highest growth in mango production came from Punjab with an average annual growth rate 6.0%, while the growth in mango production in Balochistan is negative during the period (Table 2).

The lower growth rate in production than that in area implies that per ha yield of mango has actually been declining over the period with an annual rate of 0.3%. This is true throughout the country in all provinces during the period. In KPK and Balochistan, the per ha mango yield decline is highest (Table 2).

Table 2: Trends in the area, production, and yield of mango by province during 2001-15.

Year	Punjab		Sindh		KPK		Baluchistan		Pakistan	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
	(000) ha	(000) tonne	(000) ha	(000) tonne	(000) ha	(000) tonne	(000)ha	(000) tonne	(000) ha	(000) tonne
2001-02	49.5	634.9	45	340.3	0.2	2.3	2.3	12.3	97.0	989.8
2002-03	50.7	650.3	45.8	371.5	0.2	2.5	2.3	12.8	99.0	1037.1
2003-04	54	684.2	46.5	335.9	0.3	3.2	2	11.3	102.8	1034.6
2004-05	54.3	707.8	47.1	338.4	0.3	3.1	1.4	6.6	103.1	1055.9
2005-06	100.6	1311.9	49.2	349.6	0.3	3.2	1.4	6.5	151.5	1671.2
2006-07	104.9	1391.8	50	352.4	0.3	3.2	1.4	6.5	156.6	1753.9
2007-08	112.1	1356.6	50.7	353.4	0.3	3.4	1.4	5.8	164.5	1719.2
2008-09	112.3	1373.1	52.1	368.1	0.4	4	1.4	8.5	166.2	1753.7
2009-10	112.4	1324.9	55.8	390.5	0.4	4	1.5	8.5	170.1	1727.9
2010-11	112.3	1455.7	59.5	379.0	0.5	3.9	1.4	6.9	173.7	1845.5
2011-12	111.9	1503.2	59.2	381.3	0.3	2.9	0.5	1.1	171.9	1888.5
2012-13	111.4	1304.2	60.1	391.8	0.3	2.9	0.6	1.2	172.4	1700.1
2013-14	109.1	1280.2	60.4	396.1	0.3	3	0.6	1.1	170.4	1680.4
2014-15	107.2	1252	63.1	402.5	0.4	3	0.6	1.1	171.3	1658.6
2015-16	107.1	1313.6	62.7	399.2	0.4	3	0.6	1.1	170.8	1716.9
Annual growth (%)	6.0	5.4	2.7	1.3	3.7	0.9	-10.7	-19.6	4.4	4.1

Source: MNFS&R (2015)

Looking at the trends for the last five years (not reported in Table 2), Punjab shows major negative growth rates in area (-0.9%), production (-4.0%) and yield (-3.1%). However, the Sindh situation is comparatively better during the last five years with positive growth rates of area (1%), production (1.2%) and yield (0.1%).

Pakistan produces many mango varieties, which differ in harvesting time and in their physiological characteristics, especially shape, size, colour, sugar level and acidity. While production is dominated by two major varieties: Chaunsa (*Mangifera india*) and Sindhri (*Mangifera indica*), other varieties such as *Langra, Anwar Ratul, Aman Dusehri, Fajri Kalan, Beganpali* and Saroli are cultivated to a lesser extent. However, the two most popular

varieties are Chaunsa and Sindhri. These two varieties are regarded as best mangoes in the industry because of taste and is demanded both in the domestic and international markets, and are the dominant mango export varieties (Table 3).

Table 3:Main Mango Varieties in Pakistan

Langra	Fajri Kalan	Late Chaunsa
Sindhri	Bangan Pali	Rataul (Anwar)
Aman Dusehri	Sammar Bahisht Chaunsa	Saroli
Alphanso, Bombay	White Chaunsa	

Source: Stakeholders discussion

Sindhri variety is commonly recognized for its aroma and mainly grown in the Sindh province while Chaunsa is famous due to its sweetness and is a popular variety of Punjab Province. Multan Division in Punjab and Hyderabad Division in Sindh are famous regions in Pakistan for these two main cultivars of mango. The mango season extends over five months, starting in mid-May in Sindh and finishing late September in Punjab, with late June to mid-August being the peak production period.

In terms of structure, Pakistan's mango industry is heterogeneous. The country's estimated 387,000 mango orchards range in size from less than two ha to more than 400 ha (PHDEB 2005; Collins et al. 2006; Government of Punjab 2006). The industry's main actors are orchard owners/growers, pre-harvest contractors, commission agents, exporters, wholesalers and retailers. Both production and marketing of mangoes for domestic and export markets is handled by the private sector. The role of the public sector is limited to facilitation through its various research and development, market promotion and extension institutions. The mango industry provides seasonal employment opportunities for the country's rural labor force, with jobs ranging from orchard management and picking to packaging and other pre- and postharvest operations.

During 2016-17, Pakistan has exported 82.7 thousand tonnes of mango worth of US$82.7 million, up from 52.5 thousand tonnes worth of US$16.6 million in 2001-02. This is a 58% increase in quantity with an average annual growth of 2.39. As the growth in the export of mango quantity is lower than that in production, Pakistan is facing a deteriorated export-production ratio over the period.

However, the expansion rate in the value of mango exported is far higher than that in quantity clearly suggesting that Pakistan has improved its mango value chain during the period which enabled the country to earn more from per unit quantity of its export. This is more obvious when the export trend during 2011-16 is analyzed when the mango export quantities has a sharply decline at a rate of 11.3% per annum, while earnings from this export has not decline rather improved at an average growth rate of 3.9% per annum (Table 4).

Table 4: Mango exports from Pakistan during 2001-2016

Year	Quantities	Values
	(000 tonne)	Million US$
2001	52.5	16.6
2002	47.6	14.4
2003	60.4	18.0
2004	82.1	23.8
2005	48.9	15.9
2006	105.6	32.3
2007	62.1	20.0
2008	69.3	25.2
2009	73.6	28.3
2010	85.9	30.5
2011	105.1	44.7
2012	101.2	44.2
2013	98.9	57.3
2014	77.3	41.7
2015	43.7	40.9
2016	82.7	65.8
Annual growth (%) 2001-16 **2011-16**	**2.39** **-11.3**	**9.04** **3.9**

SOURCE: FAOSTAT, Trade, Crops and Livestock Products http://www.fao.org/faostat/en/#data/tp

1.2 Global Context

The global production in 2016 was 50.6 million tonnes, with total cropped area of 5.7 ha translating into yield of 8.9 tonnes/ha. During 2016, Pakistan contributed about 3% of the global area under mango cultivation, and produced 3.3% of the world's total mango production. The per ha yield of mango in Pakistan is about 12% higher than the world average. The mango export from the country contributed about 5% of the world export and only 3.2% in the value of mango exported internationally. This is because Pakistan earns only two third of the world average export price (Table 5).

Table 5: Comparison of world vs. Pakistani Mango Sector (2016)

Item	International	Pakistan	Pakistan share (%)
Area (000 ha)	5681	169.2	2.98
Production (000 MT)	50649	1685.3	3.33
Yield (tonne/ha)	8.92	10.0	111.7
Value of production at farm level (Only mainland) (million US$)	29966	864.0	2.88
Farm gate price (US$/tonne)	592	513	86.65
Volume of trade (000) tonne	1672	82.7	4.94
Value of international trade (US$ million)	2057	65.835	3.20
Export quantity as % of production	3.0%	5.0%	-
Export value as % of production value	7%	8%	-
Average export prices (US$/tonne)	1227	796	64.76

Source: Adapted from multiple sources, as ITC, FAO
FAOSTAT, Production, Crops http://www.fao.org/faostat/en/#data/QC
FAOSTAT, Trade, Crops and Livestock Products http://www.fao.org/faostat/en/#data/TP

Farm gate price of mango in Pakistan is far below (68.8%) the international farm gate price providing Pakistan the competitive edge in competing with the international competitors even by investing in production, exportable quality and value chain infrastructure.

The major mango producing countries of the world are India, China, Thailand (Table 6). While Pakistan's production of 1.7 million tonnes (3.1% share), ranked 6th in global production with cropped area 169 thousand ha translating into average yield of 10.0 tonnes/ha. Although Pakistan's yield higher than the global yield of 8.92 tonne/ha, but still lower than many countries such as Brazil, Indonesia, Egypt, and Mexico with very high yields through better farm management, adaption of GAP/SPS protocols, mechanization, high density plantation and appropriate infrastructure.

Table 6: Top Ten Mango Producing Countries of the World (2016)

Mango Producing Countries	Production		Cropped Area		Yield
	000' Tonnes	% Share	000' ha	% Share	tonnes/ha
1. India	18,779	36.6%	2,237	37.2%	8.4
2. China, mainland	4,664	9.1%	570	9.5%	8.2
3. Thailand	3,432	6.7%	411	6.8%	8.4
4. Mexico	2,197	4.3%	206	3.4%	10.6
5. Indonesia	2,184	4.3%	168	2.8%	13.0
6. Pakistan	1,606	3.1%	168	2.8%	9.6
7. Brazil	1,417	2.8%	79	1.3%	17.9
8. Egypt	1,277	2.5%	113	1.9%	11.3
9. Bangladesh	1,162	2.3%	153	2.5%	7.6
10. Nigeria	918	1.8%	134	2.2%	6.9

Source: FAOSTAT, Production, Crops http://www.fao.org/faostat/en/#data/QC

Globally, mango production has almost doubled from 25 million tonnes in 2001 to 48 million tonnes in 2016 with an average growth rate of 4.4% per annum. Most of the increase in

production came from area expansion at a rate of 3.2% per annum, although per ha yield also improved significantly with an annual rate of 1.2% (Table 7). It is worth noting that rate of increase in mango production in Pakistan is comparable with that at the global level (4.1% per annum). However, all of the increase in mango production in Pakistan came from area expansion, while per ha yield has declined over the period. This implies that Pakistan has maintained its position in the world ranking of mango production, while the country is gradually losing its competitiveness in mango world market as it is not keeping up its pace with the world in the improvement in its per ha yield.

Table 7:Trends in global mango production and trade during 2001-16.

Year	Production			Export	
	Area	Production	Yield	Quantities	Values
	(000 ha)	(000 tonne)	(tonne/ha)	(000 tonne)	Million US$
2001	3560	25102	70.5	654	416
2002	3650	26408	72.4	665	389
2003	3783	29957	79.2	928	564
2004	4158	29854	71.8	913	578
2005	4412	31904	72.3	942	622
2006	4595	34135	74.3	1128	755
2007	4714	35311	74.9	1163	913
2008	4804	36647	76.3	1199	996
2009	5029	35880	71.3	1248	995
2010	5033	38033	75.6	1349	1156
2011	5230	40544	77.5	1439	1372
2012	5480	42999	78.5	1484	1464
2013	5666	45786	80.8	1648	1690
2014	5822	47701	81.9	1637	1932
2015	5450	48226	88.5	1577	1944
2016	5572	48440	86.9	1672	2057
Annual growth (%)	**3.2**	**4.4**	**1.2**	**6.0**	**11**

Source: FAOSTAT, Production, Crops http://www.fao.org/faostat/en/#data/QC

In terms of quantity exported, Pakistan ranks at 7th position after Mexico, India, Thailand, Brazil, Peru, and Netherland. It is worth noting that top exporting countries has much lower ranking in production suggesting high export-production ratio of these countries. Another problem of exports from Pakistan is that it is concentrated in few countries with low-end markets mainly to the Middle East like United Arab Emirates, Saudi Arabia, Oman and Qatar; Afghanistan, and Pakistani expatriates in UK, Canada, and USA. That is why, despite recent improvement in mango value chain as noted earlier, Pakistan receives the lowest export price amongst the leading mango exporting countries.

Table 8:Top Mango Exporting Countries of the World (2016)

s.#	Exporters	Exports Quantity		Value US$		Price
		Tonnes	Share %	000' US$	Share %	US$/Tonne
1	Mexico	369,314	19.1%	378,501	15.9%	1,025
2	India	193,383	10.0%	202,565	8.5%	1,047
3	Thailand	183,290	9.5%	166,367	7.0%	908
4	Peru	161,136	8.3%	199,361	8.4%	1,237
5	Brazil	154,383	8.0%	180,331	7.6%	1,168
6	Netherlands	133,445	6.9%	278,704	11.7%	2,089
7	Pakistan	82,658	4.3%	65,835	2.8%	796
8	Ecuador	63,177	3.3%	45,246	1.9%	716
9	Côte d'Ivoire	37,360	1.9%	21,182	0.9%	567
10	Egypt	35,954	1.9%	53,932	2.3%	1,500
11	Spain	33,758	1.7%	68,161	2.9%	2,019
12	China	29,298	1.5%	56,649	2.4%	1,934
13	USA	29,180	1.5%	37,529	1.6%	1,286
14	Philippines	20,618	1.1%	66,865	2.8%	3,243
15	Others	411,228	21.2%	557,765	23.4%	1,356
16	World	1,938,182	100.0%	2,378,993	100.0%	1,227

Source: FAOSTAT, Trade, Crops and Livestock Products http://www.fao.org/faostat/en/#data/TP

Brazil's major export is to the USA, whereas India and Pakistan main market is the Middle East, while Thailand is supplying to Far East markets. Netherland having the largest port in EU receives most of the cargo that includes mangoes which is redistributed to other EU countries. Pakistan's exports are based upon volumes rather than price due to poor quality and export to low end markets. In 2016, Pakistan's export price was UD$ 796/tonne whereas the world average price in 2016 was US$ 1,227/tonne. The top exporters to high end markets are Philippines with export price of US$ 3,243/tonne is exporting to Japan, Korea and USA. Netherland's export price of US$ 2,089/tonne who is exporting to EU countries, Spain, Peru, and Brazil are also exporting high-end markets mainly to EU. Pakistan's competitor India export price is US$ 1,047/tonne is higher than Pakistan mainly due to better quality and branded mango such as Alphonso. (Figure 1)

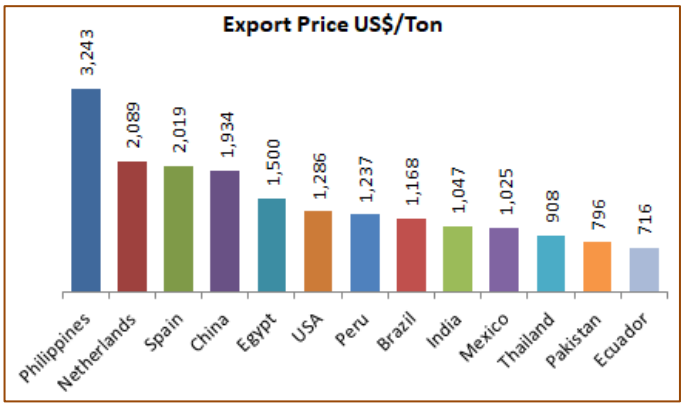


Figure 1. Export price of mango by country **Source: ITC**

USA is the leading import market with 28% share in the global mango market followed by EU countries with 22% share. The major EU countries importing mangoes are Netherlands 10%, UK 5%, Germany 4% and France 3%. Netherland is a redistributor country as most of the sea shipment of mangoes goes through Rotterdam, the largest sea port of Europe, which are then transported to other EU countries. Other leading importers are UAE 6% and China 4%.

Table 9: Top Importing Countries

s.#	Importing Countries	Quantity (tonnes)	Share %
1	USA	464,793	27.6%
2	Netherlands	166,017	9.8%
3	United Arab Emirates	103,417	6.1%
4	United Kingdom	82,937	4.9%
5	Germany	73,649	4.4%
6	China	72,773	4.3%
7	France	58,109	3.4%
8	Canada	57,117	3.4%
9	Saudi Arabia	54,098	3.2%
10	Malaysia	51,158	3.0%
11	Viet Nam	39,877	2.4%
12	Spain	37,938	2.2%
13	Hong Kong, China	32,369	1.9%
14	Belgium	29,210	1.7%
15	Portugal	28,450	1.7%
16	Thailand	26,597	1.6%
19	Others	268,217	15.9%
20	**World**	**1,686,642**	**100.0%**

Source: FAOSTAT, Trade, Crops and Livestock Products http://www.fao.org/faostat/en/#data/TP

International trade of mangoes is more of regional in scope, owing to short shelf life, high transportation cost and quality and SPS compliance requirements. USA-the largest importer of mango-imports most of the mangoes from the neighboring South American countries. EU countries which accounts for 24.40% of the total world imports in quantity draw the bulk of their imports from Brazil, Peru, Spain and Cote D'Ivoire. Pakistan and India compete in UK by supplying mango to the expatriates. India and Pakistan are the major competitor in the UAE and Saudi Arabia which accounts for 9.34% of the world imports in quantity with value of US$ 159 million. These countries are also redistributing countries supplying to its neighboring ME countries. For China, Vietnam, Hong Kong, Korea and Japan, the main exporting countries are Thailand and Philippines. These are considered high-end markets because of the high price they offer compared to the other importing countries of the highest in the world.

The future focus should be towards market diversification, entering the high end markets with high growth rates. The potential countries in Europe are Germany, France and Netherlands. In the Far East there are new emerging markets such as China and Vietnam with growing imports and high growth rates. Export potential to China is enormous due to

very big consumer market, FTA status, its proximity to Pakistan and coming of CPEC project.

1.3 Mango Value Addition and Processing in Pakistan

Most fruits and vegetables are sold in fresh form. Little value is added in the way of sorting, grading, packing or value addition.

Processing: Prior to the requirement of hot water treatment (HWT) for exports to EU countries there was no proper grading facility established in the mango sector. Most of the exporters were grading and packing it manually which were destined to low end market such as Middle East. Since HWT became pre-requite for exporting to EU countries around 10 HWT plants were established by the exporters in Karachi and Lahore. In order to diversify from traditional to high end markets the USAID/FIRMS program took the initiative to establish HWT plants in the production areas. During last five years around eight HWT units in Punjab and five Sindh have been established in the production areas. Few more HWT units are in the process by the private sector. Due to limited number of units with low production capacity it has not yet made an impact in the exports of mangoes to EU.

Value Addition: Horticultural related industries account for some 10 percent of the food, beverage and tobacco sectors and marginally over 2 percent of all industries in Pakistan. The type and size of enterprises engaged in horticulture business can be broadly, though not exclusively, classified as either medium-scale urban-based operations being undertaken by nationally recognized companies, whereas small to medium-scale rural-based industry is largely absent from the sector (Agribusiness Development Project-ADB). With the rise of juice demand including mango drinks in the local market it attracted many large scale branded industries to enter this market segment (Shezan, Mitchell, Engro Foods) which also led to establishment of further fruit pulp industries such as Iftikhar & Co in Karachi and recently established Agro Food Processing Facilities in Multan by the government as a common facility center.

In order to promote medium scale rural-based industry at production hubs, 13 dehydrated units of small-scale have also been installed (8 in Punjab and 5 in Sindh) with the financial support from FIRMS/USAID program. PHDEC in collaboration with PAEC has established an irradiation plant in Lahore with the main objective was to open up USA market for mangoes. But due to security reasons mangoes are not yet being processed for USA destination.

1.4 Need for the Study

Summarizing the above macro-level analysis of the mango sector during 2000s, it can be concluded that although mango production in Pakistan during the period has progressed at a reasonable rate of 4.1% which is comparable with international growth, but the country has failed to improve its competitiveness in international markets. All of the increase has come from the expansion in its area, while its per ha yield has been declining during the period,

and the deceleration has accelerated during the last five years. On the other hand, Pakistan could not benefit from the high growth in the international mango market, both in terms of quantity and value of export. The country is facing a declining export-production ratio while major mango growing countries are bringing higher proportion of their mango produce in the international market. Moreover, despite some improvements in the mango value chain, the country still earns the lowest export price among the leading mango exporting countries.

Realizing the declining competitiveness of mango on one hand and its potential on the other in terms of its consumption preference among the rural and urban communities alike, generating income and employment, and earning foreign exchange, the Planning Commission of Pakistan initiated this study to analyze the potential and constraints, and suggest viable interventions along the whole value chain to enhance the competitiveness of mango in the domestic and international market. To incorporate the regional variations in mango production, marketing, and trade, this analysis is undertaken at the mango cluster level in the country. The whole purpose is to develop a cluster-based comprehensive mango investment and development plan for the purpose of improving its competitiveness in the market. This plan will be the part of the Cluster-Development Based Agriculture Plan for the Vision 2025.

2 GOALS AND PURPOSE

The overall goal of this study is to contribute to *the Cluster Development Based Agriculture Transformation Plan -V2025.* Specific objectives of the study are:

1. To identify the major clusters of mango production in Pakistan
2. To characterize and conduct SWOT analysis of each mango cluster
3. To identify technological, institutional, infrastructure and policy gaps in each cluster
4. Assess the potential of mango production in each mango producing cluster
5. Suggest technological, institutional, infrastructure and policy interventions to achieve the cluster potentials

3 METHODOLOGY

The project was initiated with a workshop organized by meetings organized by project sponsors CABI/Planning Commission in Islamabad. The main purpose was to have a proper understanding of the study to be conducted and expectations from the project sponsors. The meeting led to the development of the questionnaires and survey methodology.

The data and information related to the characteristics, gap, potential and needed interventions to meet the gaps in Mango clusters were collected from three sources:

a) ***Macro-Data*.** Macro data was collected and analyzed from various sources, main source were ITC data, FAO AGSTSAT, UN Comtrade, Pakistan Statistical Year Book 2016, Agriculture Statistic of Pakistan AMIS
   Besides, all the relevant material, concept papers, proposals, baseline survey reports, project/strategy documents were reviewed to reveal the information regarding pre and post project interventions scenario of the mango sector (Detail list in annexure).
b) ***Stakeholders Consultations***. The primary data was collected with field visits, holding interviews and focus group discussions with the stakeholders in the mango supply chain both in Punjab and Sindh. The stakeholders included (detail list in annexure 1):
   - Growers
   - Professional Farm Contractors
   - Provincial Government Agriculture Departments, Research Institutes (Sindh and Punjab)
   - Universities
   - Public Sector Trade Development Agencies
   - Government and Donor Development Programs
   - Input Suppliers
   - **Wholesalers/Contractors**
   - Processors
   - Regulator – DDP
   - Packaging Material Manufacturers
   - Transporters
   - Exporters
c) ***Literature Review*.** The literature related to the functioning, gaps, and interventions in mango value chain is reviewed and synthesized (see annexure 2) for the literature reviewed).

Following generic parameters and indicators are used in collecting the data:

- Global context of mango sector;
- Production potential and review of mango sector;
- Cost of production, harvesting, post-harvest processing of mango from the growers and grower associations;

- Marketing, trading, and processing from traders, wholesalers, retailers, and processors;
- Issues and constraints relating to production, picking, drying, selling, marketing, trading, and processing from all stakeholders;
- Recommendations and benchmarks based on global parameters;

The author then used these data to first identify the mango cluster in the country and then used his subjective judgment in prescribing the characteristics of each cluster, identifying the cluster strengths, weaknesses, opportunities, and threats (SWOT), investigating the functioning of existing value chain, and quantifying the cluster potentials. Based on the above analysis, interventions for improvement in each cluster were suggested. The cost and benefits of each intervention is also estimated to finally work out the Internal Rate of Return of the whole package. A Mango Transformation Plan is also formulated which identifies sustainable cluster upgrading strategies for the development of the Mango sector that can help create significant economic opportunities for producers, processors and all the stakeholders participating at different points of the value chain.

3. LITERATURE REVIEW

Various literatures were reviewed to access the gaps and constraints in mango value chain with special emphasis on the issues prevailing at the production, marketing and infrastructure levels specifically at the cluster level. These issues identified were later discussed and verified by the stakeholders through interviews and meetings. Most of the constraints are common in the two clusters identified in the study so the constraints are compiled under one section.

Reduced unit yields, poor production efficiency in orchards and low quality of fruit produced is all symptomatic of one common problem in tree fruit orchards in Pakistan: lack of reliable young pedigreed fruit trees to the farmers at time of planting. Propagation material used is often of low quality and from uncertain sources resulting in poor quality, uncertain health and not true to type trees. The poor quality of planting materials available in the general fruit tree market in Pakistan is the most important factor affecting the yield capacity of tree fruit crops. (Agribusiness Development Project – ADB 2004).

Kerutagi et al. (2017) analyzed the comparative economics of traditional viz high density mango cultivation in Karnataka and observed that in high density orchard, the average yield obtained was more (7.86 t/acre) than in traditional orchard (3.50 t/acre). (Gaikwad et al. 2017) studied the effect of spacing on growth, yield and quality of mango and observed that highest fruit yield (21.4 MT) was produced in closer spacing of 5 x 5m in cultivar Kesar. (Ragbhar et al. 2016) observed the performance of high density planting of mango (*Mangifera indica* L.,) under mid-western plain zone of Uttar Pradesh and found that after 11 years, the yields of the plots planted at 1111 trees per ha were more than ten times the yields of plots planted at 100 trees per ha (59 t/ha versus 5.9 t/ha). (Majid, Khalil and Nazir (2018).

The high prices of fertilizers and pesticides constrained their ability to ensure timely and adequate applications of these inputs. Mango growers and pre-harvest contractors said they often had to pay high prices for these inputs because of black marketing and artificial shortages. High diesel prices further added to their costs of production. Due to electricity shortages, growers had to use diesel engines to pump groundwater from tube wells for irrigation purposes. Many growers also claimed that inputs were of poor quality because of adulteration. They blamed local companies. Lack of mango specific fertilizers and pesticides that could be more effective in improving tree productivity and mango quality than generalized fertilizers and pesticides (Badar 2014)

There is a lack of use of technology in areas such as the development of high efficiency irrigation systems, pruning machines, rotary tillers and the use of basic tools to harvest crops. Flood irrigation and the harvesting of fruit manually − or in the case of mangoes, by using a metal hook tied to a long stick − are the most common practices followed by farmers (Discussion with Dr. Waqar Ahmed of PATTA project).

Inadequate pest management is detrimental to the expansion of exports, presenting another huge challenge for farmers. Farmers seem to lack sufficient understanding of pest management systems and the deterring effects that ill-managed pest controls have on the

export potential of fruits. Widespread infestation of fruit flies in mango orchards continues to wither the exportability of mangoes. Majority of growers follow traditional management practice of allowing their trees to continue growing until they were very tall some time grows more than 40 feet (Low density plantation). Such height not only makes spraying and harvesting operations difficult, but also affects the quality of the fruit. Modern tree management practices such as pruning and canopy management were less than common. Even those who had opted for these practices were pursuing them crudely and using axes for pruning (Agribusiness Development Project – ADB 2004).

Traditional orchard management in Pakistan perpetuates a variety of diseases that afflict the fruit. Powdery mildew (*Oidium mangifera*), anthracnose (*Glomerella cingulata-Colletotrichum gloeosporioides*) and stem blight (*Diplodia* spp.) are recorded as the most common diseases that impact on all varieties of mango in Pakistan (Jiskani 2017; Malik et al. ud).

Proper (or improper) orchard management is a result of the marketing system, where the contractors gain ownership of the crop at the time of flowering. Some contracts include the use of inputs such as farmyard manure, fertilizer and pesticide sprays as the responsibility of the contractor. In Sindh once the contract is undertaken the owner is totally absent from any farm activity, whereas in Punjab even after verbal agreement (non-contractual) the owner is still active and monitoring the farm management done by the contractor who is responsible for input. In Sindh the duration of the contract is usually more than two years, whereas in Punjab it is year to year (Memon et. al., 2013). This system of divided responsibility for orchard management and risk sharing between growers and contractors which contributes to the prevalence and persistence of disease in mango orchards and compounded by harvesting and post-harvest handling practices.

Traditionally, contractors are responsible for harvesting, sorting, packing and transport of mangoes. These practices include: i) **Strip harvesting** – this involves harvesting fruit with a wide variation of maturity in order to reduce harvesting costs, ii) **Hand picking** – inattention to stem removal causes sap burn, which results in unattractive blemishes on the skin of the fruit. In addition, the sap attracts microorganisms (attached to soil particles) and insects, iii) **In-field sorting and packing** – the fruit is collected, placed on the ground and sorted. This practice exposes the fruit to soil-borne contamination, iv) **Sorting** involves the removal of diseased and damaged fruit prior to packing in wooden boxes, v) **Use of wooden** boxes further exposes the fruit to disease pathogens. The wooden boxes are designed to contain 10kg of fruit however it is common practice for them to contain up to 13kg in order to reduce transport and handling costs. A by-product of this practice is increased physical damage and bruising of the fruit, iv) **Transport** – the over -packed boxes remain in the field until they are loaded onto open trucks for transport to the wholesale markets. The lack of any temperature control accelerates ripening and the development of rot (Medhi, Ahmed and Ahsan, 2017).

The combined effect of these traditional practices is a high level of product waste, and low market prices (Amin et al. 2008). Research indicates that across the two main varieties (Sindhri and Chaunsa), an average 72 per cent of the fruit harvested did not reach the consumer, mainly because of physical damage or breakdown (Collins & Iqbal 2011). In the domestic retail market, research has shown that, 25 per cent of fruit was diseased, 58 per cent of fruit was physically damaged, and 14 per cent of fruit had sap burn, thus leaving only 3 per cent of fruit free of any disorder (Mazhar et al. 2011). This research which was the first

to quantify the losses along the supply chain clearly shows the gains that can made in the development of the Pakistan mango industry if these traditional practices can be improved (Medhi, Ahmed and Ahsan, 2017).

Barring only a few progressive large farmers, the farming community, in general, lacks an understanding of international quality requirements such as SPS. A deficiency of this orientation is believed to be one of the root causes of the poor post-harvest handling of fruit. Most farmers do not acquire Global GAP certification as it's a costly process and they are not sure if the exporter would buy out his orchard at a better price (Agribusiness Development Project-ADB 2004).

Although a few exporters are directly working with growers and farm contractors, it appears that the relationship between the two groups is largely restricted to the purchase and sale of fruits (in addition to the near absence of long-term interactions). One of the most common complaints received with respect to extension services, is that the concerned officers lack both the knowledge and the aptitude, to deal with complex problems, such as the breakout of new diseases. Extension departments lacked horticulturists among their field staff.

The Research, Development and Extension institutions such as the University of Agriculture Faisalabad (UAF), Ayub Agricultural Research Institute (AARI) and provincial extension agencies have an important role to play in this respect. However, these institutions have little capacity, particularly in post -harvest management, to ensure that the relevant knowledge and skills are developed and transferred to the mango industry (Collins et al. 2006). This deficiency is most evident in the provincial extension services, where the lack of a flexible information dissemination system in the wider farming community, is a major impediment to the adoption of improved agricultural systems and practices in Pakistan (Davidson & Ahmad 2002).

Research wings of Provincial Agriculture Departments clearly lack impetus; the limited investigation that takes place in these wings can be categorized as "run off the mill" type of research, focusing only on technical aspects while paying little or no attention to the business and commercial features. The linkage between the research departments and extension departments are also very weak with the result that the flow of information is extremely slow (at best) and often non-existent. Some commonly identified issues responsible for the below par research outputs produced by the public sector include: lack of accountability, inadequate training, political interference, shortage of funds, lack of manpower and delayed release of approved funds. (Agribusiness Development Project – ADB 2004)

Credit from Pre-Harvest contractor/Arthi is the main source of finance in the agricultural sector of Pakistan. Notwithstanding its positive contribution, middleman credit is believed to be the root cause of most of the troubles faced by the agricultural sector of Pakistan. According to a rough estimate, more than 90% of all growers and farm contractors depend on middleman credit (Badar 2014). In the face of the objections raised against the misuse of power exhibited by commission agents, the system in general is providing crucial sustenance to the farming community in a situation where the formal banking system has completely failed (Agribusiness Development Project – ADB 2004). During the auction, the producer or contractor can observe the bidding and know exactly the price offered for their

produce (Khushik & Smith 1996). If the offer is too low the lot can be withdrawn but this option is limited by the short shelf life of the fruit and the lack of storage facilities. As Khushik & Smith (1996) point out, this traditional auction based selling system raises many issues in terms of bargaining power, contract enforcement and information access that establishes exploitation of producers as the norm. Consequently, there is no evidence of a value - oriented approach to supply chain management and due to the systemic impediments to production, postharvest and marketing (domestic and export), the overall performance of the mango industry in Pakistan does not match the potential of the industry (Collins et al. 2006).

Efficiency in production and marketing of agricultural products in modern agri-food industries is attributed mainly to technological innovations such as cold storage, cool chain transportation facilities, shelf-life improvements and preservation techniques. These have not only made food products available off-season, but have also globalized food consumption (Scrinis 2007; Best and Mamic 2008; de Haen and Réquillart 2014), allowing food products to travel around the world to satisfy consumer demand. Pakistan lacks necessary infrastructural amenities such as commercially available cold stores, ripening chambers, packing houses and treatment facilities (Badar 2014 - Value Chain Performance Improvement for Sustainable Mango Industry Development in Pakistan).

Inadequate infrastructure for the handling of fruit, especially at the airports, is one of the biggest impediments to the increase of the exports from Pakistan. There is not a single cold storage facility suitably built for mango storage in the country. Shortage of airspace is another problem that restricts the growth of fruit exports in Pakistan. Many airlines have discontinued their flights from Pakistan and close down their offices across the country. This phenomenon has resulted in a severe shortage of airspace, especially during the mango season. **This has created more serious issues for exporters from Punjab compared to exporters from Sindh as there are more airlines and their frequency at Karachi airport.** Some exporters complain that airlines, in such situations, become exploitative by charging exorbitant freight charges during mango season (Exporter Interview).

Pakistan's export trend for the mango segment makes it obvious that there is an over-dependence on a few markets - particularly those that have a large expatriate Pakistani population. Mango fruit has a fairly extensive geographic coverage; however, the volumes exported to the preferred markets are extremely large and constitute an enormous percentage of the total exports. This puts the entire sector at the risk of collapse, if one of the main markets stops importing from Pakistan for some reason. The exporters are looking at export volumes rather than price.

There are only a few value addition factories in the mango sector using excess fruit or low quality fruit to make value added products like pulp, juices, jams, dehydrated and frozen mangoes and squashes. Some large exporters/processors have acquired certifications, such as the ISO and HACCP but certifications only relate to food safety and the quality of operations, not to the quality of the fruit itself. Therefore, even with these plausible certifications, the issue of inconsistent fruit quality remains unresolved (Processor Interview).

4. CLUTER SPECIFICATION AND CHARACTERIZATION

5.1. Cluster Specification

Based on the district-level data, two main mango clusters are identified in this study for detailed analysis. These are:

I. **Punjab Chanunsa Cluster**: It consists of Multan, R.Y. Khan, Muzaffargarh, and Khanewal districts (Figure 2). These districts contribute about 89% of the mango area in Punjab and 85% of the provincial mango production (Table 9). The main variety of the mango grown in the cluster is Chaunsa. Multan is taken as the cluster point of the cluster which alone contributes 29% in area and 34% of the provincial mango production. Multan also produces the highest mango yield in the country. The cluster has strong institutional and socioeconomic infrastructure to promote interaction among stakeholders' as follows:

- Presence of large number of mango farmers closely interacting with each
- Fifteen hot water treatments plants
- Presence of packaging industry
- Presence of Mango Research Institute and research stations in various cluster districts
- Exporters Associations
- Nawaz Sharif Agriculture University
- Multan Airport

Table 10: Area, Production and Yield of Mango Growing Cluster Districts of Punjab, 2014

Cluster	Area (ha)	Share (%) in provincial area	Production (tonnes)	Share (%) in provincial production	Yield (tonne/ha)
PUNJAB					
Multan	31,241	29.1	425,303	34.0	13.61
R Y Khan	24,384	22.7	226,560	18.1	9.29
M Garh	19,040	17.8	232,704	18.6	12.22
Khandwa	13,759	12.8	175,127	14.0	12.73
Cluster Total	95,283	88.9	1,059,693	84.6	11.12
Provincial Total	107,238	100.0	1,252,000	100.0	11.67

Source: AMIS

Figure 1:Chaunsa Punjab Mango

Moreover, mango related infrastructure spread in the whole cluster enables a strong interaction within the cluster districts and with its focal point, Multan (``)

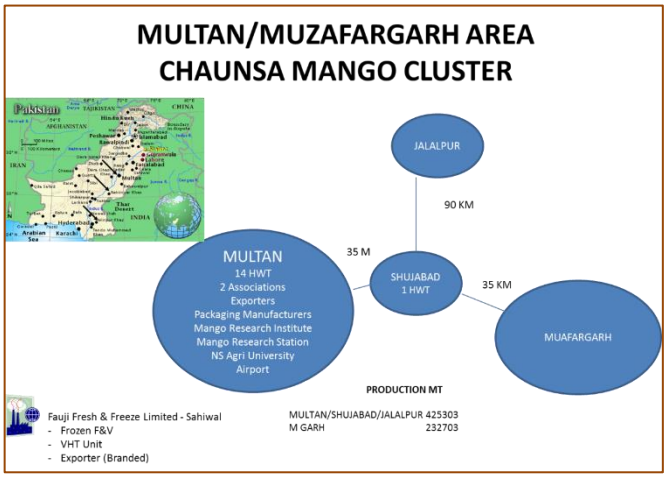


Figure 2: Diagram showing infrastructure in various districts of Punjab Chaunsa Mango Cluster with its focal point Multan

II. **<u>Sindh Sindhri Cluster</u>**: It consists of Mirpur Khas, Tando Allahyar, Sanghar and Hyderabad (Figure 4). These districts contribute about 59% of the mango area in Sindh and 62% of the provincial mango production (Table 10). The main variety of the mango grown in the cluster is Sindhri. Mirpur Khas is taken as the cluster point of the cluster which alone contributes about one fifth of the provincial mango area and production. Mirpur Khas district is located in South Eastern Sindh which is connected with the main highway to the southern port city of Karachi which also have an international airport. The cluster has strong

institutional and socioeconomic infrastructure to promote interaction among stakeholders' as follows:

- Large number of farmers
- 3 Hot Water Treatment plants
- Sindh Horticulture Research Institute
- Exporters
- Association
- Tando Jam Agriculture University

Table 11: Area, Production and Yield of Mango Growing Cluster Districts of Sindh, 2014

Cluster	Area (ha)	Share (%) in provincial area	Production (tonnes)	Share (%) in provincial production	Yield (tonne/ha)
SINDH					
Mirpur Khas	13,159	20.8	79,342	19.7	6.03
Tando Allahyar	9,037	14.3	56,383	14.0	6.24
Sanghar	7,809	12.4	60,113	14.9	7.70
Hyderabad	7,307	11.6	54,350	13.5	7.44
Cluster Total	*37,312*	59.0	*250,188*	62.2	6.71
Provincial Total	*63,144*	100.0	*402,514*	100.0	6.37

Source: AMIS

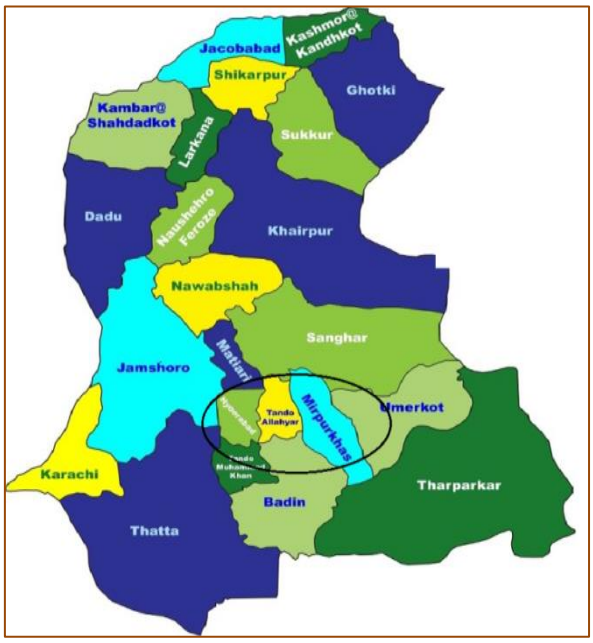


Figure 3:Sindhri Sindh Mango Cluster

Moreover, various mango related infrastructure are present in various district throughout the cluster (Figure 5).

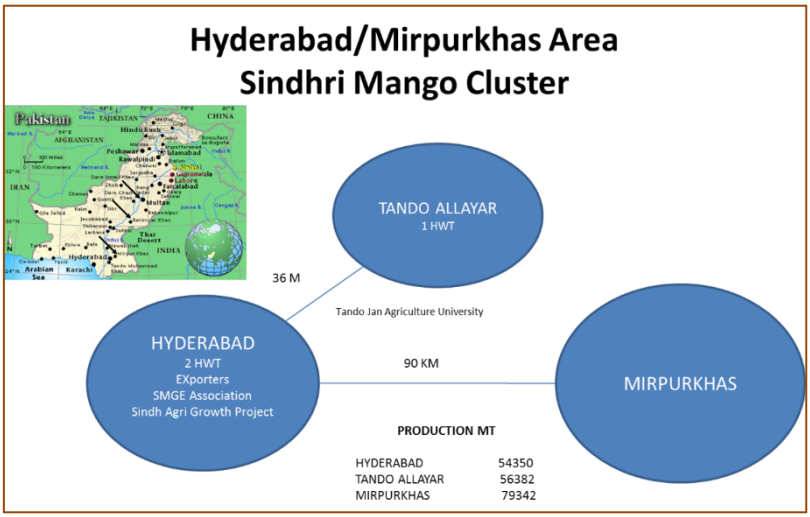


Figure 4: Diagram showing main characteristic of Sindhri mango cluster in Mirpur Khas Division

5.2. Cluster Characterization

The main characteristics of Punjab Chaunsa and Sindh Sindhri Clusters are defined and compared in Table 11, while the main features of each cluster is summarized in below.

Despite the variations in environment, soil and water situation as can be seen in Table 11, both the clusters do have suitable environment for mango cultivation. While underground water is sweet in Chaunsa Punjab Cluster, it is not suitable for irrigation in Sindh Sindhri Cluster. However, extraction costs is increasing becoming costly in the former case, while canal water is getting scarce in the latter case. The Punjab cluster has relatively smaller size and its owner farmers involve in making farm decision, while in Sindh cluster farm size is relatively large and farmers are absentee farmers mainly depending upon their managers.

Although the characteristics of the variety grown in each cluster is different in terms of the maturity period, vigorousness of the tree, fruit size and shape, etc. most of the farm management practices adopted in each cluster are very similar suggesting that research and extension system in each cluster failed to develop and promote cluster specific practices. The plant to plant and row to row distance, input use, irrigation methods and frequency, etc. are very much similar (Table 11).

Average per ha yield in Sindh Sindhri Cluster is lower than that in the Punjab Chaunsa Cluster, despite having similar farm management practices adopted in each cluster. This is due to the variation in micro-climate and the variety adopted. The Sindhri is relatively low yielding variety although its size is relatively bigger. However, low yield of Sindhri is compensated by its earliness character which enable farmers to get significantly higher price than the Chaunsa growers.

Another difference among the two cluster is the level of efforts made to improve each cluster productivity, processing, and markets access (Table 11). The Punjab Chaunsa Cluster received much higher attentions of the policy makers than the Sindh Sindhri Cluster, despite

the fact that the latter has much more access to infrastructure like airport and seaport. However, lately with the opening up of the international direct flight from Multan airport, this advantage of the Sindh Cluster has relatively diminished.

It is a matter of satisfaction that in both the cluster modern technologies and processes have started getting into the mango value chain, like Global Gap certification, hot water treatment, and pulp and juice making. However, the speed of the adoption of these technologies and processes is very slow.

Table 12: Characteristics Differences between Punjab & Sindh Clusters

Feature	Punjab Cluster	Sindh cluster
Product	SB Chaunsa & White Chaunsa	Sindhri
Cluster districts	Multan, R.Y Khan, Muzaffargarh, Khanewal,	Mirpur Khas, Tando Allhyar, Sangher, Hyderabad
Cluster area (000 ha)	95.28	37.31
Cluster production (000 tonne)	1059.69	250.19
Cluster yield (tonne/ha)	11.12	6.71
Focal point	Multan	Mirpur Khas
Focal Point area (000 ha)	31.24	13.16
Focal Point Production (000 tonnes)	425.30	79.34
Focal point average yield (tonnes/ha)	13.42	6.03
Proportion of mango area to total cropped area in the cluster (%)	29.54%	12.00%
Geographical & Environment	• Arid Climate with cold winters and hot summers which damages the branches and leaves due to extreme weather. • Fog during winter and monsoons during summers also cause heavy flower and fruit shedding. • Alluvial soils • Access to canal and tube well Irrigation • Good quality ground water, but the cost is increasing.	• Subtropical Climate with cold winters and hot and humid summers, which may damage the branches and leaves due to extreme weather. • Dust storms in May and June may decrease production by 20-30% and monsoons starts from June till September causes heavy flowering and fruit shedding. • Access to canal irrigation only • Poor Quality Ground Water
Growers	• Farm size: 35% own less than 10 acres, 45% owns 11-30 acres and rest 45% holdings are more than 30 acres. • Majority of owners are uneducated so they lack understanding of new cultivation	• Farm size: 15% owns less than 10 acres, 50% owns 11-30 acres and rest 35% holdings are more than 30 acres. • Majority of owners are uneducated so they lack understanding of new cultivation

Feature	Punjab Cluster	Sindh cluster
	technologies. • Large farmers have the financial capacity to hire technically strong farm managers who makes all farm management decisions. • Abundant availability of labor even women are involved in harvesting of mangoes. • Most farmers do not have contractual farming. • Few farms are Global GAP certified which is costly intervention which deters farmers to adopt it.	technologies. • The large farmers have the financial capacity to hire technically strong farm managers who makes all farm management decisions. Abundant availability of labor even women are involved in harvesting of mangoes. • Most farmers undertake contractual farming. • Few farms are Global GAP certified which is costly intervention which deters farmers to adopt it.
Variety Feature	• Chaunsa is a late season and high-yielding variety; SB Chaunsa harvesting season from 7 July to 30 July, while White Chaunsa from 1 August till 7 September • Local Selection • The mango trees are large, vigorous and well branched and spreading trees. • When the trees are exposed to sunlight during growing season (April-July) they become larger and increase the percentage of pulp.	• Sindhri is an early season and low yielding variety with harvesting time from 25 May to 20 June. • Chance Seedling • The mango trees are large, medium vigorous and round. • When the trees are exposed to sunlight during growing season (March-July) mangoes become larger and increase the percentage of pulp.
Product	• Thick Skin Un-peal able • Chaunsa is famous for its sweetness with TSS of 18-20% and average weight of 300-400 grams. • The SB Chaunsa is of medium size (300-400 gms) very perishable whereas White Chaunsa is medium to large size (300-450 gms) having thick with better shelf life. • The stone size is medium and oblong. • At maturity it is medium to light green color with smooth skin and medium whitish pulp color.	• Thin Skin Peal able • Stone size Medium Long, Thin • The Sindhri mango has sweet sour taste when fully ripened with TSS of 15-17% and average weight of 330-450 grams. • The size of mango is large (330-450 gms) having thin peel able skin, very perishable and suspected to disease and physical injury. • The stone size is medium long, thin, oblong to elliptical and deeply rigged. • At maturity the mango is light green with smooth skin and bloom medium, whitish.
Mango Propagation	• Chaunsa is commonly propagated on variable seedling rootstocks of unknown	• Chaunsa is commonly propagated on variable seedling rootstocks of unknown parentage

Feature	Punjab Cluster	Sindh cluster
	parentage (normally claimed using desi mango rootstock), which is the main reason for clonal differences in the performance of mango variety. • No certified nursery in the whole cluster supplying certified rootstock with defined mother-block. • Most growers have their own nursery plants at their orchard getting seeds from the juice/pulp factories.	(normally claimed using desi mango rootstock), which is the main reason for clonal differences in the performance of mango variety. • No certified nursery in the whole cluster supplying certified rootstock with defined mother-block. • Most growers have their own nursery plants at their orchard getting seeds from the juice/pulp factories.
	• The normal plant distance is 22 (plant) x 27 (row) feet (180 plant per ha) and it takes 9 years to bear fruiting. • Some progressive farmers are adopting high density plantation, with spacing of 15 x 15 feet (473 trees per ha). In this under proper farm management the fruit bears in 4-5 years.	• The normal plant distance is 22 (plant) x 27 (row) feet (180 plant per ha) and it takes 9 years to bear fruiting. • Some progressive farmers are adopting high density plantation, with spacing of 15 x 15 feet (473 trees per ha). In this under proper farm management the fruit bears in 4-5 years.
	When grafting is done. From where the grafting material (scion) is obtained? Who do the grafting? Any scientific method involved and adopted?	When grafting is done. From where the grafting material (scion) is obtained? Who do the grafting? Any scientific method involved and adopted?
Intercropping	Intercropping is common normally growing wheat, cotton, and Barseen (fodder) in mango gardens.	Intercropping is common normally growing wheat, sugarcane banana, and Barseen (fodder).
Pruning	• No scientific pruning method is applied. • Normally dead, diseased and crisscrossed branches are pruned. • In summers after crop harvest thinning out is done by cutting every shoot 2-3 cm from growing point.	• No scientific pruning method is applied. • Normally dead, diseased and crisscrossed branches are pruned. • In summers after crop harvest thinning out is done by cutting every shoot 2-3 cm from growing point. • The knowledge for scientific pruning is lacking.
Management of Orchard	Non-Contractual Orchards	Contractual Orchards
	Owners (present on the farm) better farm management	Owner (Absentee) – Poor Farm Management
Input use	• FYM at the rate of 10-30 kg are used for young plants and 80-	• FYM at the rate of 10-30 kg are used for young plants and 80-100

Feature	Punjab Cluster	Sindh cluster
	100 kg for full grown tree. • Besides using FYM the farmers normally use other fertilizers such as NPK, Urea, DAP, Potash immediately after harvest • Urea is again used in February/March • Besides few big growers the farmers normally use below average and imbalances inputs. • Pesticides are sprayed 1-2 times mostly in March and April. • Quality of pesticides are monitored strongly by Pest Warning and Quality Control, Federal and Provincial Seed Certification departments and DPP.	kg for full grown tree. • Besides using FYM the farmers normally use other fertilizers such as NPK, Urea, DAP, Potash immediately after harvest • Urea is again used in February/March • Besides few big growers the farmers normally use below average and imbalances inputs. • Pesticides are sprayed 1-2 times mostly in March and April. • Pesticides are not monitored well by Sindh government. They do not have Pest Warning and Quality control of Pesticides. DPP is there but are unable to do it due to lack of human resource to cover such a large area.
Irrigation	• During the first six month of plantation irrigation is done at the interval of 4-6 days and during next six months at weekly basis, and after one year, 1-20 days till the plants reaches the bearing stage. • Generally, farmers irrigate their farm through flooding once a month during growing season and twice during fruiting. • Few progressive farmers use drip to irrigate their farms regularly after 10-15 days' intervals.	• During the first six month of plantation irrigation is done at the interval of 4-6 days and during next six months at weekly basis, and after one year, 1-20 days till the plants reaches the bearing stage. • Generally, farmers irrigate their farm through flooding once a month during growing season and twice during fruiting. • Few progressive farmers use drip to irrigate their farms regularly after 10-15 days' intervals.

Feature	Punjab Cluster	Sindh cluster
Harvesting	• Most farmers use bamboo sticks with a net bag attached to it. Ladders are also use to harvest from the upper end of the tree. Harvesting by hand picking is also common causing sap to trickle down on the skin giving poor appearance. • More progressive farmers use modern equipment such as harvesting pole mounted with cutting blade and a bag under the blade. They also use secateurs for cutting stem 2-3 cm away from the fruit. But the knowledge for scientific pruning is lacking. • Trained manpower improves the quality of harvesting • The fruits are harvested when they are still hard and green. • Harvested mangoes are packed in wooden boxes. • In mandi mangoes are ripened by using powder carbide. The exporters use imported ripening sachets. • Typical mango harvesting season is from 7 July till 7 September; Surpluses in July. • Farmers generally arrange the harvesting labor who are dominantly male although women also participate.	• Most farmers use bamboo sticks with a net bag attached to it. Ladders are also use to harvest from the upper end of the tree. Harvesting by hand picking is also common causing sap to trickle down on the skin giving poor appearance. • More progressive farmers are using modern equipment such as harvesting pole mounted with cutting blade and a bag under the blade. They also use secateurs for cutting stem 2-3 cm away from the fruit. De-sapping methods is applied for exportable mangoes. • Trained manpower is in short-supply. • The fruits are harvested when they are still hard and green. • Harvested mangoes are packed in wooden boxes. • In mandi mangoes are ripened by using powder carbide. The exporters use imported ripening sachets. • Typical mango harvesting season is from 25 May to June 20; Surpluses in June • Farmers generally sell their gardens to contractors who arrange for the harvesting labor mainly male. While small farmers arrange their own harvesting labor.
Post-Harvest Management	• After harvest mangoes are laid on the ground in the field or rooms covered with paddy straw to avoid post-harvest losses. • Recently some farmers have started using hydro-cooling with water and fans to remove field heat. • It then transported on open top vehicles. • It is estimated that only 25% of acceptable quality reaches retail	• After harvest mangoes are laid on the ground in the field or rooms covered with paddy straw to avoid post-harvest losses. • Recently some farmers have started using hydro-cooling with water and fans to remove field heat. • It then transported on open top vehicles. • It is estimated that only 25% of acceptable quality reaches retail

Feature	Punjab Cluster	Sindh cluster
	market. • Better trained labor for post-harvest practices	market. • Lack of trained labor for post-harvest. Mostly hire labor from Punjab
Main Insects and diseases	• Infestation of fruit fly affect the quality of fruit and limit its export • Powdery mildew (*Oidium mangifera*), anthracnose (*Glomerella cingulata-Colletotrichum gloeosporioides*) and stem blight (*Diplodia* spp.) are the main diseases • Current status of IPM in pest control in mango in this cluster	• Infestation of fruit fly affect the quality of fruit and limit its export. • Powdery mildew (*Oidium mangifera*), anthracnose (*Glomerella cingulata-Colletotrichum gloeosporioides*) and stem blight (*Diplodia* spp.) are the main diseases • Current status of IPM in pest control in mango in this cluster
Wholesale Market	Multan & Lahore	Hyderabad & Karachi
Technology/Infrastructure	• Around 15 HWT Plants and 5 Dehydration Plants • One Juice manufacturers - SFA • Two Fruit Pulp Unit – SFA • Few farmers have made Global GAP certification	• Around 6 HWT Plants and 1 Dehydration Plant • One juice Unit – Maaza Juice • Few farmers have made Global GAP certification
Export	• Lack of direct flights and inadequate space at Multan Airport • The main markets are Middle East countries and UK to Pakistani expatriates at very low prices. • The packaging is done in corrugated boxes weighing from 2-8 kg with small ventilations (covered with net for EU markets).	• Many international airlines with better flight destinations and better space at Karachi Airport • The main markets are Middle East countries and UK to Pakistani expatriates at very low prices. • The packaging is done in corrugated boxes weighing from 2-8 kg with small ventilations (covered with net for EU markets)
Supply Chain	• De-sapping methods is applied for exportable mangoes at the farm level. • The domestic value chain is dominated by wholesaler. • The price offered depends upon volume, size and variety. • The price fluctuates during the season depending upon the supplies as during glut (June) the prices decreases. • The premium domestic wholesale markets are Multan and Lahore. • Recently the export from Multan by air has been in	• De-sapping methods is applied for exportable mangoes at the farm level. • The domestic value chain is dominated by wholesaler and contractor. The contractors buy the orchard which is financed by wholesaler and obliged to sell it to him. The contractor is responsible to manage the farm till harvest. • The price offered depends upon volume, size and variety. • The price fluctuates during the season depending upon the supplies as during glut (June)

Feature	Punjab Cluster	Sindh cluster
	operation. But due to limited flights and lack of direct flights and shortage of cargo space makes limits exports.	the prices decreases. • The premium domestic wholesale markets are Hyderabad and Karachi. • The exports are mainly done by air but some mango consignments are also being exported through sea shipment. Many airlines operate through Karachi and so there is adequate cargo space for the exporters from this region.
Subsidies/Incentives/Facilities	• Many interventions have been undertaken by government and donor in the promotion of mango sector in this cluster. Some major initiatives are: 1) Mango Pulp common facility center in Multan in collaboration between PSIC and SMEDA, 2) Food Irradiation facility (PARAS FOOD) a collaboration between PHDEC and PAEC, with capacity to irradiate 60,000 tonnes of fruit and vegetable, mainly established to irradiate mangoes for exports to USA, 3) "Model Farms Linked with Improved Supply Chain & Value Addition" project of Punjab government providing incentives through cost sharing programs such as training, certifications, infrastructure and marketing linkages, 4) USAID programs such as AMD, PEEP, PATTA are working towards improving value chains in horticulture sector including mangoes clusters. 5) TDAP is providing 50% subsidy to building exhibition and salary for opening international offices.	• Very few interventions have been undertaken by government and donors in the promotion of mango sector in Sindh. Some major initiatives are: 1) USAID program such as AMD working towards improving value chains in horticulture sector including mangoes cluster in Sindh, 2) TDAP provides 50% subsidy to exporters for opening export offices and the component cover rent and salary, 3) Govt. of Pakistan is providing incentive to horticulture export enterprises by picking up 8% or 50% (whichever is lower) interest on loans obtained to establish cold storage.
Associations	Two Associations Mango Growers Cooperative Multan Mango Growers	One Association Sindh Mango Growers and Exporters Association (SMGE)

5.3. SWOT Analysis

The SWOT analysis was carried out in Group discussions and interviews conducted with the stakeholders in the mango value chain – from growers to middleman, processors, exporters, service providers, relevant government representatives, donors, etc. The results are structured around the value chain functions such as inputs supplies, production practices, cluster interactions, marketing/trade & exports and processing & Infrastructure (Table 12 and 13).

The main strengths of both the clusters are suitable soils, availability of canal irrigation water although it is getting increasingly scarce and costly, progressive farmers adopting modern technologies (like high density garden with drip, Global Gap certification, de-sapping, hot water treatment, etc.), presence of good input supply system through the private sector, and government attention to the horticulture sector in general including available funding for quality infrastructure development and establishment of Mango Research Institute in Punjab Chaunsa cluster, although such attention is at much lower level in the Sindh Sindhri Cluster than in the Punjab Chaunsa Cluster. The presence of both public and private sector extension network in both the cluster is a great strength although currently it fails to address mango farmers issues.

The greatness weaknesses of the mango value chain are varying climate especially temperature, wind and frog that effect the fruiting, little interaction between farmers and research, non-availability of certified, pure variety, and good quality planting and grafting material, sub-optimal use of inputs and sub-standards management practices along the whole value chain including nursery preparation, planting, harvesting, pruning, intercropping, pesticide use, packing, transportation and storage, non-availability of quality inputs, farmers' knowledge and other stakeholders knowledge about quality requirements in national and international markets, lack of quality infrastructure, non-availability of finance for the adoption of modern technologies and processes and if available it is too costly and inaccessible to small farmers, and little processing opportunities.

The main opportunities in both the clusters are availability of soil testing labs which can enable the farmers to adjust inputs according to the micro-environment at the farm-level, and pesticide monitoring labs although both these activities are weak in the Sindh Sindhri Cluster, promulgation of the reformed Seed Act which can help to improve the availability of true-type material by promoting certified mango nurseries in the private sector through truth-in-label nursery supply mechanism, promulgation of the reformed Market Act to reform the existing market infrastructure, learning possibilities from progressive farmers, increased availability of farm manure from fast expanding poultry sector, possibility of starting contract farming by exploiting the present strong relationship between farmers and traders, availability of training modules for capacity enhancement on almost all aspect in the value chain, SOPs and cold chambers for the low-cost sea shipment to Europe, availability of improved packing materials and SOPs for improved packing, international collaboration for the improvement of mango value chain, and huge demand for the value added and processed mango both in the national and international markets. The renewed emphasis of the World Bank Program, called SMART, on horticulture has created a big opportunity to improve the capacity of research an extension of Punjab to address the horticulture issues

along the value chain. In Sindh, Sindh Enterprise Development Fund has created an opportunity to address the horticulture value chain infrastructure issues.

However, the greatest threats to the mango value chain in both the clusters are changing environment, high use and residue of pesticide, substandard and underweight supply of mango in international market, difficulty of training to uneducated farmers, emergence of supermarkets which may exclude farmers from the benefits of expanding mango value chain, inflow of strong Chinese processing firms through CPEC which may exclude Pakistani firms from the benefits of mango processing, and neglect of mango value chin in mango research and extension.

Table 13: WOT Analysis for the Punjab Cluster

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Environment/ Climate Change	Sandy soil texture, hot climate, and well drained land in Chaunsa cluster which are very much suitable for Chaunsa cultivation.	Prolonged winter and sudden rise in temperature affect flowering and fruit setting.		Increase flooding with more intense and frequent rainfalls
	Availability of canal irrigation throughout the year			Drought during winter and shortage of canal water
Input Supplies	Reliable major fertilizer and pesticide supply system with many National / Multinational Companies providing these chemicals	Non-availability of appropriate quality fertilizer and micronutrients	Already established soil testing labs in Punjab can play a major role in matching input with the soil nutrient conditions	Use of adulterated or expired pesticides
		Declining organic matter in soils	Increasing poultry production and poultry manure is an opportunity to halt the declining organic matter	Injudicious use of chemicals
		Limited availability of certified, quality, and pure variety seed/seedlings	Seed Act 2015 which has obligated to Agricultural Departments to establish certified nurseries has created an opportunity to	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
			increase certified mango nurseries	
Cluster interaction	Large number of farmers in Mango cluster	Little interaction among farmers and researchers	Possibility of learning from progressive farmers in the cluster	Infestation of Fruit Fly
		Still most producers have little information about the quality requirements in national and international market.	Strong relation between Commission Agents/Wholesaler and Contractors (each have knowledge about quality demand at least in national market) can be transformed into quality-based supply contract	Pesticide residues
		No contract farming with defined quantities and quality parameter		Exporting of poor quality uncertified Chaunsa has threatened its whole export
		Little credit availability from formal institutes for any actor of cluster		
Production Management practices	Experienced farmers	Lack of certified nurseries and mother block, and traditional method of nursery plantation	Availability of training modules in several national (like NARC, provincial departments, private sector, etc.) and international organizations (AVRDC) to train farmers about latest methods of nursery raising, plant protection, intercropping, harvesting, preparing proper rootstock, efficient	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
			irrigation method, etc. have made the training of farmers and nurserymen a reality	
		Use of rootstock which gives spreading and tall tree with low fruit-leave ratio		
		Low plant population		
		Flooding irrigation wastes water and deteriorate fruit quality		High pesticide and low quality produce may cause heavy rejection in export and threaten the whole export market of Chaunsa
		Intercropping with mango garden		
		Imbalance and sub-optimal use of fertilizer		
		Injudicious use of pesticide	Plant Protection Department of Governments of Punjab and PARC have some capacity (which need to be enhanced) to train farmers on sanitary and phytosanitary (SPS) measures and good agricultural practices	Difficulty of training illiterate farmers about high tech methods and techniques
		Improper harvesting procedure		
		No contract farming with defined quantities		

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		and quality parameter		
		Few farmers adopt de-sapping to lower the mango temperature after harvesting and hot-water treatment to disinfest diseases		
Transportation	Good road infrastructure connecting Mango cluster with all big cities and the port	Wooden packing material used to prepare bags for transportation	Availability of paper boxes in the market already being used in certain other fruits	
		No environment (temperature, humidity, etc.) control during transportation	SOPs for atmosphere control transportation of mango has been developed and atmosphere control chambers are available in the domestic market	
		Improper stacking during transportation	SOPs are available to ship mango to long distances and atmosphere control chambers are available in the domestic market	
		High fuel cost especially diesel used in transportation		
		Limited cargo space and high freight costs		
		Little experience of shipping mango to long distance through sea		
Marketing	Higher price of Chaunsa than other mangoes	Farmers disconnect with the market	Financial support by the commission agents and	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
	and acceptable taste for Chaunsa in both domestic and international markets		wholesalers to harvesting contractors can be converted into quality based delivery contracts	
	Harvesting contracts or collectors pay the price to farmers based on the variety as well as the expected size of the fruit	No grading (rather topping the good quality mango over poor quality) by the harvest contractor		
		Auctioning in the wholesale market with visual and spot grading	New Market Act in Punjab has created big opportunity to reform the old market practices in the province	
		Little capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality product	Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	Supermarkets may exclude small farmers from the quality market
Trade/Export	Due to its unique flavor, sweet with fragrance it is much demanded international markets especially with the South Asian expatriates	Little trade links with high end market	Higher average world price of mango compared to the price Pakistani mango fetch has created big incentive for traders to improve mango quality for export	
	White Chaunsa has higher shelf life than other mango varieties, hence travels long distance without damage.	No weight standards in packing destined for exports. Exporters boxes are underweight.	The collaboration of government of Punjab through "Model Farms" project with AIARC and USAID to overcome constraints in reaching high end export-market may	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
			open up big opportunities for Chaunsa export	
	Established market link in traditional markets, like Middle East.	Little trade links with high end market	"Model Farm" project of Punjab government offers funds to establish farm-level quality infrastructure like cold storage facilities and other infrastructure like Hot Water Treatment plants	
	Few farmers have started exporting white Chaunsa mango to high value Europe market through low cost sea route making direct contract with importers		Recent establishment of few Hot Water Treatment Plant and VHT Plants (which need to be increased) and existence of several registered certification company have created some opportunity to meet the export mango quality requirements	High cost of VHT and certification to farmers
		Lacking mango quality infrastructure for quality maintenance	Rising international demand for mango and opening up new markets like Far East, China, Canada, Central Asia and Europe	
Processing	The products prepared both from ripe and green Chaunsa are highly popular in Pakistan and abroad.		Huge demand for processed mango product within the country and abroad	Big processing firms from China through CPEC with big incentives from the Govt. of Pakistan may grab the whole fruit processing market
		Lack of direct flight services, shortage of air	Government incentives for the import of	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		cargo space and inadequate cargo handling limit the export	agriculture machinery especially cold storage machinery	
	Availability of internationally acceptable processing plants, technologies, and equipment for processing	Very limited time span when Chaunsa is available (from 7 July till 7 September) for processing	Many value added products can be produced from mango such as pulp for use in drinks and ice cream, canned mangoes and dried mangoes.	
		Lack of capacity and resources for small scale stakeholders to get involved in Chaunsa processing		
Research and Extension System	• Mango Research Institute in Shujabad • Strong network of extension spread at union council level	• Lack of capacity to address the emerging issues in such as high-density gardens, IPM, etc.	Recent emphasis of the government to improve the capacity of research and extension to address the horticulture issue through World Bank Program called SMART.	Over-emphasis of the research and extension on major crops, and on the production of mango while ignoring the value chain issues.

Table 14:SWOT Analysis for the Sindh Cluster

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Environment/ Climate Change	Sandy soil texture, hot climate, and well drained land in Sindhri cluster which are very much suitable for Sindhri cultivation.	Prolonged winter and sudden rise in temperature affect flowering and fruit setting.		Increase flooding with more intense and frequent rainfalls
	Availability of canal irrigation throughout the year from Nara and Rohri canals			Drought during winter and shortage of canal water
Input Supplies	Reliable major fertilizer and pesticide supply	Non-availability of appropriate quality fertilizer and	Already established soil testing labs in Sind	Use of adulterated or expired pesticides.

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
	system with many National / Multinational Companies providing these chemicals	micronutrients	can play a major role in matching input with the soil nutrient conditions	
		Declining organic matter in soils	Increasing poultry production and poultry manure is an opportunity to halt the declining organic matter	Injudicious use of chemicals
		Limited availability of certified, quality, and pure variety seed/seedlings	Seed Act 2015 which has obligated to Agricultural Departments to establish certified nurseries has created an opportunity to increase certified mango nurseries	
Cluster interaction	Large number of farmers in Mango cluster	Little interaction among farmers and researchers	Possibility of learning from progressive farmers in the cluster	Infestation of Fruit Fly
		Producers have little information about the quality requirements in national and international market	Strong relation between Commission Agents/Wholesaler and Contractors (each have knowledge about quality demand at least in national market) can be transformed into quality-based supply contract	Pesticide residues
		No contract farming with defined quantities and quality parameter		Exporting of poor quality uncertified Sindhri has threatened its whole export
		Little credit availability from formal institutes for any actor of cluster		
Production Management practices	Experienced farmers	Lack of certified nurseries and mother block, and traditional method of nursery plantation	Availability of training modules in several national (like NARC, provincial departments, private sector, etc.) and international organizations	
		Use of rootstock which gives spreading and tall tree with low fruit-		

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		leave ratio	(AVRDC) to train farmers about latest methods of nursery raising, plant protection, intercropping, harvesting, preparing proper rootstock, efficient irrigation method, etc. have made the training of farmers and nurserymen a reality	
		Low plant population		
		Flooding irrigation wastes water and deteriorate fruit quality		High pesticide and low quality produce may cause heavy rejection in export and threaten the whole export market of Sindhri
		Intercropping with mango garden		
		Injudicious use of pesticide	Plant Protection Department of Governments of Sind and PARC have some capacity (which need to be enhanced) to train farmers on sanitary and phytosanitary measures and good agricultural practices	Difficulty of training illiterate farmers about high tech methods and techniques
		Improper harvesting procedure		
		No contract farming with defined quantities and quality parameter		
		Few farmers adopt de-sapping to lower the mango temperature after harvesting and hot-water treatment to disinfest diseases		
Transportation	Good road infrastructure connecting Mango cluster with all big cities and the port	Wooden packing material used to prepare bags for transportation	Availability of paper boxes in the market already being used in certain other fruits	
		No environment (temperature, humidity, etc.) control during transportation	SOPs for atmosphere control transportation of mango has been developed and	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
			atmosphere control chambers are available in the domestic market	
		Improper staking during transportation	SOPs are available to ship mango to long distances and atmosphere control chambers are available in the domestic market	
		High fuel cost especially diesel used in transportation		
		Limited cargo space and high freight costs		
		Little experience of shipping mango to long distance through sea		
Marketing	Higher price of Sindhri than other mangoes and acceptable taste for Sindhri in both domestic and international markets	Farmers disconnect with the market	Financial support by the commission agents and wholesalers to harvesting contractors can be converted into quality based delivery contracts	
	Harvesting contracts or collectors pay the price to farmers based on the variety as well as the expected size of the fruit	No grading (rather topping the good quality mango over poor quality) by the harvest contractor		
		Auctioning in the wholesale market with visual and spot grading	New Market Act in Sind has created big opportunity to reform the old market practices in the province	
		Little capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality product	Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	Supermarkets may exclude small farmers from the quality market
Trade/Export	Because of higher shelf life than	Little trade links with high end	Higher average world price of	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
	other mangoes, the Sindhri travels long distance without damage.	market	mango compared to the price Pakistani mango fetch has created big incentive for traders to improve mango quality for export	
	Established market link in traditional markets, like Middle East		The collaboration of government of Sind through Sind Agriculture Board with AIARC and USAID to overcome constraints in reaching high end export-market may open up big opportunities for Sindhri export	Slow development of quality infrastructure, lack of stakeholders interest in capacity building to produce and maintain quality, and increasing demand for higher and high may lead to lose the Sindhri export even to traditional markets
	Few farmers have started exporting mango to high value Europe market through low cost sea route making direct contract with importers	Lacking mango quality infrastructure for quality maintenance	Sind Enterprise Development Fund offers funds to establish farm-level quality infrastructure like cold storage facilities and other infrastructure like Hot Water Treatment plants	
			Recent establishment of few Hot Water Treatment Plant and VHT Plants (which need to be increased) and existence of several registered certification company have created some opportunity to meet the export mango quality requirements	High cost of VHT and certification to farmers
		Lack of direct flight services, shortage of air cargo space and inadequate cargo handling limit the export	Rising international demand for mango and opening up new markets like far east, China, Central Asia and	

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
			Europe	
Processing	The products prepared both from ripe and green Sindhri are highly popular in Pakistan and abroad.	Very limited time span when Sindhri is available (from 25 May till 20 June) for processing	Huge demand for processed mango product within the country and abroad	Big processing firms from China through CPEC with big incentives from the Govt. of Pakistan may grab the whole fruit processing market
	Many value added products can be produced from mango such as pulp for use in drinks and ice cream, canned mangoes and dried mangoes.	Unavailability of modern processing plants, technologies, and equipment for processing	Government incentives for the import of agriculture machinery especially cold storage machinery	
		Lack of capacity and resources for small scale stakeholders to get involved in Sindhri processing	-	
Research and Extension System	• Network of extension spread at union council level	• Lack of capacity to address the emerging issues such as proper pruning, harvesting, pest management, input application, etc.	-	Over-emphasis of the research and extension system on major crops, and on the production of mango while ignoring the value chain issues.

5.4. Mango Value Chain Analysis

The value chain backward and forward linkages and relationship are same in both the Punjab and Sindh mango clusters and explained in Figure 6.

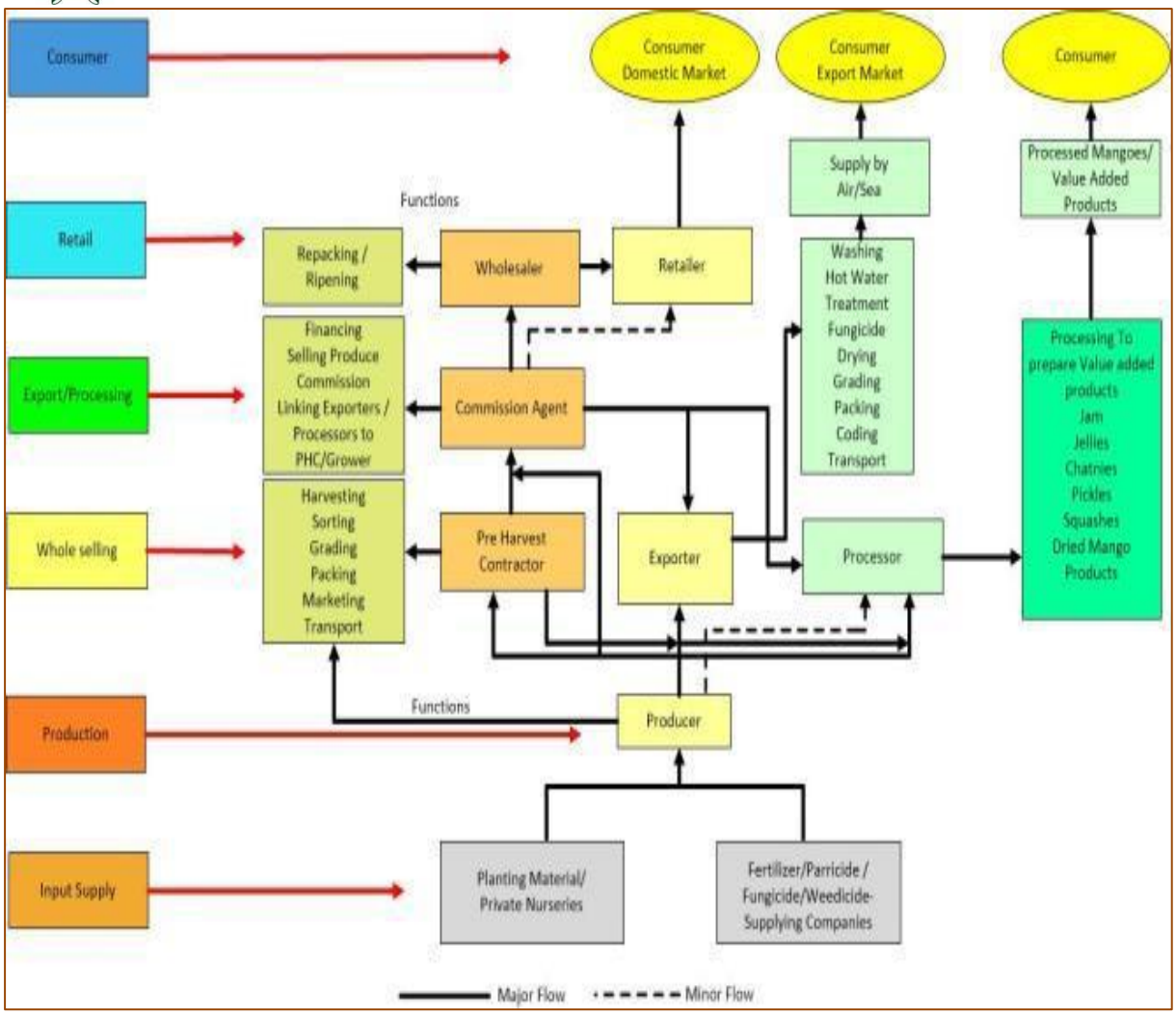


Figure 5:Diagram showing Mango value chain in Pakistan

5.4.1. Input Suppliers

The major inputs at orchard level include nursery seedlings, farm chemicals such as fertilizers and pesticides, packing materials, water and labor.

5.4.2. Mango Nurseries

A majority of the growers raise their own nursery plants in their mango orchards which are not true to variety, whereas some growers buy seedlings from private commercial nurseries. They also source from public sector research institutes such as Multan Research Institute Shujabad in Punjab and Sindh Horticulture Research Institute Mirpur Khas Sindh.

5.4.3. Chemical Suppliers

Growers and pre-harvest contractors purchase these chemicals from local dealers. Large growers and contractors sometimes purchase inputs directly from companies instead of local dealers. Fertilizer & pesticide companies have extensive network presence through their dealership. But there is proliferation of non-branded and counterfeit products selling at

cheaper prices. Small farmers who are financially weak are forced to buy such products on credit. Punjab government has relatively strong monitoring system for quality control of pesticides than in Sindh.

5.4.4. Packing Material

Mangoes are transported in packing of different types and sizes from orchards to domestic and foreign markets. For local market wooden crates were most common because of their relatively low cost and firmness of construction. For exports corrugated packing is used. Recently the industry has started using light plastic crates both for domestic and exports markets.

5.4.5. Structure of Production

There are two stakeholders at the farm level, the owner/grower and the contractor.

5.4.5.1. Growers

Normally the grower manages all the farm activities from raising seedlings, inputs to pruning but does not involve in the marketing activities as it is capital intensive, lack of marketing information and moreover there is market risk. To minimize his risk, he leases out his farm to the contractor mostly on annual basis. Due to annual arrangements the there is no incentive for the contractor to engage in better orchard management practices for sustainable orchard management and fruit quality. The contractor is selected on the basis of price and reputation.

Most of the growers even the large growers irrespective having the infrastructure and financial capacity use traditional practices. Few large farmers use modern farm practices and even acquired Global Gap certification.

5.4.5.2. Contractors

The contractor also locally known as (Beopari) buys out the whole farm at a pre-negotiated price which is paid off in installment, normally in installments, one at the time of the contract and rest during the harvesting period. The contractor either invests his own money or borrows money from the broker on behalf of the commission agent (Arhthi) from fruit mandi. Since the capital is invested by the broker the contractor is bound to sell his crop to him on his terms and conditions. While buying the orchard the contractor assesses the price, looking at the estimated yield, anticipated future price and cost of labor and transportation. Upon entering the contract, the contractor is responsible for farm management including applying inputs until the harvest and then followed by post-harvest activities including harvesting, grading, packing and transportation.

5.4.6. Profit Margins

The profitability across the supply chain stakeholders is very uneven. Although a majority of value chain actors consider the mango business to be profitable, growers complained of

lower returns compared to those of downstream chain actors, who take away a major share of the price paid by consumers. Mango is regarded as a risky business due to its short shelf life, so most of the small growers due to financial, productivity and marketing constraints are forced to sell their produce to the pre-contractor at low price. According to a survey by a mango grower claims that growers earning share is around 10%, middlemen (pre-contractor and arti) around 50% and rest is retailers share. Small growers at Mirpur Khas, in Sindh province, in particular, regarded mangoes as no more profitable than other crops that offered better returns in their area. They said many growers had either cleared mango orchards or were contemplating doing so (Badar 2014).

5.5. Structure of Marketing Channels

Farmers, contractors, commission agents, traders, exporters and retailers are the main players of the market. Farmers and contractors sell the produce to traders through commission agents. The traders of these primary markets target the following market segments:

1) Assembly or village markets
2) Primary wholesale Markets
3) Secondary or terminal markets in other towns of Pakistan
4) Local retailers
5) Fresh fruit processors/ exporters
6) Juice concentrate processors

5.5.1. Main Players in the Wholesale Markets:

There are three main players who manage the fruit marketing in wholesale fruit markets:

1) The Brokers or Commission Agents (Arhtis) are responsible for the auction of the fruit.

2) Resellers (Phariya in Punjab and Mashakhor in Sind)) purchase fruit in bulk at auction through brokers and after ripening and re-packing resell them to the local retailer.

3) Distributors (Ladaniya) purchase fruit in bulk at auction through brokers and distribute it to secondary markets to be sold to resellers and retailers in secondary markets.

5.5.2. Commission Agent (Aarthi)

A broker or a commission agent holds a fruit and vegetable trading license issued by the local market committee and is supposed to facilitate the sale and purchase of the fruit. His clients are the sellers (grower/lease contractors), the buyers/resellers *(Phariya)* and the distributors *(Ladaniya)*. Since a typical fruit auction entails bulk quantities in multiple lots, only the resellers and the distributors participate in the auction. The broker makes a commission as a percentage of the sale price of fruit charged from the seller and fixed fee

per crate from the purchaser. While the maximum commission to be charged from the seller is generally fixed by the market committee in consultation with the brokers (normally 6%), the actual commission charged varies from broker to broker.

Brokers are the major capital investors themselves and therefore dictate the commission terms. More than 80% of the market is driven on credit starting from the broker to the fruit retailer. In addition, credit is extended to the resellers and the distributors. On the supply side of brokers, they often give loans to the fruit contractors and sometimes to the growers who are then bound to sell their produce through them. Growers and contractors who have borrowed from the brokers are charged with higher commissions depending on the amount of money borrowed. These commissions generally vary from 6-15% and are not publicly disclosed. On the selling side, while the broker makes a flat per crate commission from the buyer, any credit sale is sold at higher rate, thereby making a higher margin for the broker. In the absence of a proper credit monitoring system, the brokers are also exposed to the credit risk and default.

Usually middlemen are not very popular in the chain. There is a strong perception in the minds of Value Chain actors that middle men exploit situations for their advantage. Most of the middlemen are expanding their role to become fresh fruit processors, eventually hoping to become exporters themselves.

5.5.3. Reseller (Pharia)

The local re-seller, called *Pharia,* purchases fruit in bulk from the broker (Commission Agent) in open auction lots and ripens the mangoes and repack it for sale to retailers. He tries to get maximum credit from the broker to pass it on to his clients. His profits come from market appreciation and a premium on wholesale fruit prices. Fruit merchants (retailers) buy their daily requirement from re-sellers (*Pharia*) in small quantities. The retailer's margin comes from the type of transaction, cash discounts or credit premiums.

5.5.4. Distributor (Ladaniya) or Beopari

Ladaniya is the distributor of fruit operating between primary and secondary markets. He purchases fruit from the broker in open auction from the primary wholesale market in multiple lots and sends it to secondary markets as a combined load for sale through commission agents of the secondary markets at a higher price. He pays for the transportation costs and takes risks of price fluctuations in the secondary markets. In the secondary markets, the commission agent uses brokers by paying 5% commission for selling fruit to local resellers who sell to retailers.

5.5.5. Marketing Channel # 1: Domestic Retailers

These markets are generally located in big urban locations. Lahore and Karachi, Islamabad and Peshawar are prominent terminal markets in the country. The arhtis get un-ripe mangoes from farm and ripe it with either calcium carbide or imported ripening sachets at mandi before selling it. The wholesaler sells to in the domestic market either to traditional

retailers which includes carts, road side vendors and small shops or to the modern retailers such as super markets and other modern shops who sell higher quality mangoes to the middle and high income consumers.

5.5.6. Marketing Channel # 2: Processors/Exporters

The 2nd channel supplies the exporter. The fruit is purchased by the exporter or processors. It undergoes processing i.e., HWT, grading and packing and then it is stored in the cold storage for some time before it is transported to the airport or Karachi port for the export destination.

There are two supply chains operating for processors and exports. One is comprised of growers, processors along with exporters, importers and consumers in the end market. In a few cases, either the growers have forward integrated into processing and exports, or the other way around, where exporters have integrated backward to have both processing and production of mangoes. By far this is the shortest of all chains and most efficient for its participants. Industry leaders are following this model for its obvious benefit of control over quality for reliability and traceability, etc.

The other supply chain operating for exports is comprised of growers, contractors, commission agents, processors, commercial exporters and importer Normally the commercial exporters get their mangoes processed from the processors who operate as a service provider either by choice or due to availability of excess capacity. Also value addition industry such as manufacturers of jams, jellies, pickles, juices use the same marketing channel.

5.6. International Quality Standards

The table below reflects some of the current phyto-sanitary requirements for mangoes from the key importing countries:

Table 15: Phyto-sanitary requirements for mangoes

Country	Phyto-sanitary Requirements
China, Jordan, Lebanon, South Korea, Mauritius	Hot water treatment (48°C for 60 minutes) against fruit fly infestation applied at the facilities duly approved by the importing country's National Plant Protection Organization (NPPO)
Australia	Irradiation or hot water treatment at 48°C for 60 minutes at the facilities duly approved by the Australia Biosecurity Organization
Japan	Vapor Heat treatment (47°C for 25 minutes) – facility duly approved by Japan Plant Protection Authorities
Iran	Hot Water Treatment (45°C for 75 minutes) to control fruit fly infestation duly approved by importing country National Plant Protection Organization (NPPO)
USA	Irradiation at approved irradiation facility
EU	No process specified, but the product must be free of pests and diseases

6. CONSTRAINTS AND CHALLENGES FACED BY THE CLUSTERS

Pakistan has faced multiple constraints and challenges during last decade in mainstreaming mango sector. Under the given system, Pakistan is currently held-up in a low-quality low profit cycle. Poor stakeholders' capacities resulted in poor quality fruit production, lack of value chain infrastructure have caused a decline in mango export, and poor processing infrastructure at the farm-level has not only resulted in price gluts during the peak mango season but also lowered the competitiveness of the whole value chain. The two mango clusters identified needs to adopt and adapt to new strategies to increase its production capacity to the desired level of quality, safety and international SPS compliant. Following are particular constraints faced by the mango value chain in both the clusters.

6.1. Constraints

With the extensive consultation with stakeholders and literature review, we are able to identify the constraints in mango production, value chain, processing, and institution levels, which are summarized in the following section.

6.1.1. Institutional Constraints

6.1.1.1. Weak Research and Extension System

Although there is a strong extension network entrenched down at the union council level, and Government of Punjab has recently established the Mango Research Institute in Shujabad, the Research and Extension (R&E) System in both the clusters has failed to address the issues of mango production and value chain. For example, SOPs for variety and climate specific input use, Integrated Pest Management (IPM) strategies to manage pests, proper pruning and harvesting methods and techniques, post-harvest handing techniques, etc. are either lacking or could not be promoted at the farm-level. There is no scientific maturing index developed for the farmers to understand the right timing of harvesting. One exhibition of this failure is that despite different environment situation and variety adopted, the management practices adopted in both the cluster are very similar. Most farmers are unaware of modern mango production and post-harvest management practices being used in many mango producing countries of the world. Moreover, protocols for the establishment of high-density gardens are largely missing.

6.1.1.2. Limited Excess to Formal Credit

Existing agricultural financing products (available through the formal banking sector) have multiple structural shortcomings like collateral and complicated paper work. Hence more than 90% of all growers and farm contractors depend on middleman. Notwithstanding its

positive contribution, middleman credit is believed to be the root cause of most of the issues faced by the agricultural sector especially production issues and limiting placed on the farmer's ability to sell his produce to the best paying buyer.

6.1.1.3. Lack of information about market

In Punjab, mango prices in different markets of Punjab are disseminated to farmers on daily basis, while no such facility is available in Sindh. However, this information is limited to major mango varieties without mention of the quality within that variety. Moreover, no information is available about the international markets, especially its changing quality requirements. The information about emerging technologies in production, packaging, transport, and value additions are not provided to various stakeholders in the value chain, thus keeping them disconnected with the international market.

6.1.1.4. Lack of supply of Modern Inputs

Although fertilizer and pesticide supplies are mostly available, but prices of these inputs vary from year to year. Sometime their non-availability constrained farmers' ability to ensure timely and adequate applications of these inputs. Also non-availability of quality fertilizer and micronutrients is causing plant health problems.

6.1.1.5. Weak coordination amongst Stakeholders

There is little effective inter-department and intra-stakeholder coordination such as research, such as extension, research, irrigation, farmers, traders, exporters and processors. Although a few exporters are directly working with growers and farm contractors, it appears that the relationship between the two groups is largely restricted to the purchase and sale of fruits (in addition to the near absence of long-term interactions for the improvement in mango value chain). Quality Constraints in for the Domestic and International Market Requirement

6.1.2. Production Level Constraints

6.1.2.1. Lack of Planting Material

Farmers experience difficulty in getting access to high quality planting material. Lack of reliable young pedigreed fruit trees from the uncertified nurseries leads to reduced unit yields, poor production efficiency in orchards and low quality of fruit produced.

6.1.2.2. Lack of Capacity of Proper Management Practices

Little knowledge about modern tree management practices such as pruning and canopy management were less than common. Even those who had opted for these practices were pursuing them crudely and using axes for pruning. There is a lack of use of technology in areas such as the development of high efficiency irrigation systems, pruning equipment, rotary tillers and the use of basic tools to harvest crops. Farmers lack understanding and knowledge of proper harvesting, high-density garden management, using proper fertilizer

and pesticide in terms of type, quantity and timing. Moreover, little biological and agronomic options are made available to mango farmers to control fruit flies and major mango diseases. Banned pesticides continue to be commonly and excessively used; at the same time, the widespread infestation of fruit flies in mango orchards continues to wither the exportability of mangoes.

No grading is done with regards to sizing, and tolerances of the fruit by class, size, and distance travelled. Normally “topping” practices are adopted where quality and bigger fruits are placed on the top layer of the package. No harvesting index id followed and normally when few semi-ripe mangoes fall from the tree it is considered that the fruit is mature for harvest. So the market is supplied with immature mangoes. All these practices lead leads to marketing issues where it is either sold at lower prices leading to low profitability to the value chain stakeholders.

The system of divided responsibility for orchard management between growers and contractors contributes to the prevalence and persistence of disease in mango orchards which is compounded by harvesting and post-harvest handling practices. In Sindh once the contract is undertaken the owner is totally absent from any farm activity, whereas in Punjab even after verbal agreement (non-contractual) the owner is still active and monitoring the farm management done by the contractor who is responsible for input. In Sindh the duration of the contract is usually more than two years, whereas in Punjab it is year to year (Memon et. al., 2013).

6.1.3. Post-Production Management and Marketing Constraints

6.1.3.1. Poor Post-Harvest Handling

Poor harvesting handling techniques which lead to sap burn/blemishes, soil borne contamination, physical damages and bruises. Weaknesses in packaging (over stuffed wooden boxes) and transport of perishable produce, lead to high losses and in some cases to unattractive presentation of the produce in eventual urban wholesale or consumer markets. Most of packing is done in with over-stuffed wooden boxes with little labeling on it. Transportation is done on open trucks without palletizing which leads to serious quality issues.

6.1.3.2. Lack of Compliance for International Quality

In general, farmers lack an understanding of international quality requirements such as SPS and certifications required for high end markets. A deficiency of this orientation is believed to be one of the root causes of the poor post-harvest handling of fruit. Due to severe structural shortcomings in the supply chains, Pakistan’s mango export industry is incapable of serving the sensitive high-end markets.

6.1.3.3. Poor Local Market Infrastructure

Local markets lack modern marketing infrastructure like for quality auctioning, cold storage, financing, etc. This market infrastructure leaves little incentives for farmers and contractors to make investment to produce quality mango.

6.1.3.4. Dependence on Few Markets

Pakistan's export of mangoes is over-dependent on a few markets and to the low end markets - particularly those that have a large expatriate Pakistani population. There is limited and non-innovative marketing and branding capabilities in export markets.

There are only a few value addition factories in the mango sector, that can use excess fruit or low quality fruit to make value added products like pulp, juices, jams, dehydrated and frozen mangoes and squashes. This induces farmers to discard the low quality fruit that cannot be sold.

6.1.4. Inadequate Value Chain and Processing Infrastructure

Farmers difficulty in handling and maintaining product quality is added because of the poor value chain infrastructure, some of these lacks are highlighted in the following section.

6.1.4.1. Lack of cool chain.

Lack of cool chain system, other appropriate storage and poor-quality facilities at the farm or collection center level for perishable fruits, leads to sales almost exclusively at low "glut" prices at harvest time. There is lack of cold storage facilities and mango being short shelf life leads to high losses. There is also lacks necessary infrastructural amenities such as commercially available ripening chambers, packing houses and treatment facilities.

Similarly, transportation of mango is done in a traditional way by using tractors, open trucks & pick-ups, hardly anybody is using refrigerated transportation. There are multiple other opportunities for storage and transport improvement. Standardized, palletized and containerized transportation would increase the profitability of mango value chain.

Inadequate infrastructure for the handling of fruit, especially at the airports, is one of the biggest impediments to the increase of the exports from Pakistan. There is shortage of airspace problem that restricts the growth of fruit exports in Pakistan. This has created more serious issues for exporters from Punjab compared to exporters from Sindh due to more airlines and their frequency at Karachi airport.

6.1.4.2. Limited processing and value added

Most fruits and vegetables are sold in fresh form. Little value is added in the way of sorting, grading, packing or value addition in the cluster areas. Value added normally use discarded and low-quality mangoes for processing, converting low priced mangoes to high value

products. In the last five years around eight HWT units in Punjab and five Sindh were established under the USAID program. Consequently, few more HWT units were established by the private sector themselves. A very low percentage of fruits and vegetables are processed. Some dehydrated units have also been installed in the private sector and recently four dehydration units have been established with the financial support from FIRMS/USAID program. The existing processing units lack managerial and marketing skills and there is an absence of modern production methods due to which these dehydration units have been unable to substantially market their products both in the domestic and international markets. Government has established a pulp manufacturing plant in Multan as a common facility center which has given boost to many growers in the area of selling or processing their low-quality fruits to pulp which are sold mainly to the juice companies.

6.2. Challenges

The above constraints create number of challenges for various stakeholders in the mango value chain to compete them in the national and international markets. The key of these challenges is discussed in the following section.

6.2.1. Low Yield

The average national yield is 9.5 tonnes/ha is higher as compared to the international average yield of 8.34 tonnes/ha. Looking at the provincial level, Punjab's yield is 13.09 tonnes/ha whereas Sindh yield is far low at 6.44 tonnes/ha. Sindh's yield gap compared to international is 1.9 tonnes/ha.

Despite some of the environmental factors, the major factors responsible for the low mango yield is farmers' capacity to adopt modern management practices as discussed above. Old trees with low fruit-leave ratio, lack of appropriate pruning, use of flooding irrigation, traditional harvesting procedure, and lack of knowledge and understanding on modern farming practices (GAP) are the main factors which have led to low yield. Some international countries such as Brazil adapting best practices under high density plantation have much higher yields reaching 25 tonnes/ha (Voltaire 1999). High density plantation is crucial in enhancing higher yields especially for Sindh cluster with fruit bearing within 4-5 years.

Better orchard management practices and understanding, probably due to donors and government development interventions, contributed towards Punjab's high yield. Punjab cluster yield growth can be maintained approximately 2.48% per year in next ten years through better farm management practices, high density plantation and using modern mechanization.

6.2.2. High post-harvest losses

Due to improper harvesting practices the mangoes incur serious quality issues such as handling injury, fruit latex on the skin of mangoes giving shabby appearance, lack of pre-cooling at farm lead to flesh rotting. Chain-wide analysis of data indicates that overall, between 30 and 40 per cent of Pakistan's mango crop is lost before it reaches consumers because of poor value chain infrastructure and management practices (Sivakumar et al.

2011). At orchard level the growers and pre-harvest contractors reported pre and postharvest losses in the range of 5 to 20 per cent. Mazhar et al (2010) report that "58.8% 'Sindhri' and 87.7% 'Chaunsa' fruit had one or a combination of different disorders (bruising, physical damage, sap contamination) at harvest. It is clear that most of the quality problems within the chain occur at or around the harvest time and are related to harvesting at the incorrect maturity, under or over ripe fruit, poor grading, physical damage. Other major pre-harvest losses are due to severe wind storms and frostbite taking most of the blame. Poor handling during loading, unloading, packing and transportation to mandis cause injuries and damage to the mangoes. Commission agents and wholesalers do not bear the losses as they pass on the closed crates to the buyer. The product is further deteriorated by 10-15% due to poor handling in the mandis and transportation from mandi to retailer point. These losses not only lower consumer value and the profitability of value chain actors, but also represent a substantial waste of resources used in the production and marketing processes. The market efficiency can be improved by the intervention at the post-harvest level by capacity building through training programs, establishing necessary infrastructure, information flow between the stakeholders and most importantly establishing grades and standards and proper enforcement.

6.2.3. Low Quality in Domestic and International Market

Proper value chain infrastructure and processes for quality compliance in the national and international markets are lacking. Pakistan does not export high-quality mangoes because of varying quality, food safety, non-compliance of standards, quality certifications, fruit fly infestation, pesticide residue and marketing issues. Farmers and other value chain stakeholders do not have enough resources and infrastructure are not built to produce and maintain the quality of mango.

A major governance related weakness of mango value chains in Pakistan is a lack of well-defined grades and standards. The current lack of well-defined grades and standards makes price comparisons for mangoes of different qualities difficult for both consumers and value chain actors.

As a result, the price for Pakistani mangoes is very low when compared to that of competitors. Hence, the contribution made by mango exports to Pakistan's foreign exchange reserves is far below its potential. Exporters focus mainly on the volume of their exports and, in doing so, often compromise quality.

6.2.4. Low Exportability of Mango

The country produces mangoes in sizeable quantities and stands among the world's leading mango producers. Although export production ratio of 5.0% is higher than the global of 3.0%, but the country has much more potential to export if risk in export business is improved (ITC 2016). Moreover, proper orientation of Pakistani mango in international markets, and adoption of the weight and quality standards of different countries are lacking, which significantly reduce the export-production ratio of Pakistani mangoes.

7. POTENTIAL OF MANGO CLUSTERS

Pakistan is blessed with unique tasting mangoes liked all around the world. It is 6th largest producer of mangoes in the world. When viewed against other successful developing countries the export performance of Pakistan mango sector has been lackluster. One of the key factors hindering the export performance is the issue of QUALITY production. *Even the research indicated that the local consumers are willing to pay 20-25 per cent premium price for clean, blemish free, fully matured and uniform size of mango (ACIAR, 2007).* It was witnessed that market does exists for such quality fruits at the high end market in the big metropolitan cities.

In this section an attempt has been made to evaluate the potential in both clusters in terms of production, quality and market side of mango value chain, and to establish benchmarks, based on the targets set in chapter 2 for incremental improvements in the cluster performance. In addition, both quantitative and qualitative analyses are presented to explain the nature of active, dormant and inactive segments of the mango value chains in the two main clusters.

7.1. Production Potential

7.1.1. Increase in Yield

During the stakeholders' discussions and in the literature review process, several potentials were identified to enhance the per ha yield of mango gardens. These include replacing the low-yielding low density with high-yielding and high-density mango gardens and improved management practices from planting to harvest. The potential of each are discussed as below.

7.1.2. High-Density Gardens

The research has shown that the yield is way higher in ultrahigh-density plantations due to tight spacing of plants as compared to traditional plantations. For example, the all-India average yield of mangoes in traditional plantations is 2.5-3.0 tonnes per acre per year. In the case of ultrahigh-density plantations, this average increases to 9 to 10 tonnes per acre per year (Adhikary 2017). Although potential of high-density mango garden is very high in Pakistan, it is assumed that it will improve the per ha yield of 40% on such gardens. If we assume 20% of old gardens to be renovated with high-density gardens which will have 40% higher yield, it will bring 33.7 million from the Punjab Chaunsa Cluster focal point and 7.9 million from the Sindh Sindhri Cluster focal point.

7.1.3. Improvement in Management Practices

Similarly, improved management practices especially proper disease management, proper methods, proper and timely use of fertilizer and micronutrient, and proper irrigation management can significantly increase the per ha yield of mango. Our discussion with mango researchers and review of the situation suggest that much higher potential of yield increase due to improved management practices exists in Sind compared to in Punjab. Therefore, we assumed that yield can be improved by 5% in Punjab and 15% in Sindh.

The following table presents situation of supply for both with and without project intervention scenarios. We believe that there is a potential of increasing overall per ha yield by 15% in Sindh and 5% in Punjab if high improved management practices as discussed above are adopted. Using the default growth in yield without intervention and expected increase in yield with improved management practices, it is predicted that there is a potential of increasing 66 thousand tonnes of additional supply just in the focal points of both the cluster in next 5 years which will bring over US$33 million additional revenue to farmers (Table 16).

Table 16:Production Potential in next 5 years

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Punjab Cluster (50281 ha in the cluster focal point)						
Default yield (tonne/ha) without intervention assuming the existing growth rate of 2.58% in the focal point during the last five years	13.41	13.74	14.08	14.43	14.79	
Production without project interventions (tonne)	674,316	691,029	708,157	725,709	743,697	
Increase in yield due to improved management practices (tonne/ha) @5% in five years		0.17	0.35	0.54	0.74	
Increase in production (tonne)		8,638	17,704	27,214	37,185	
Increase in production value (M. US$)		4.32	8. 9	13.6	18.6	
Sindh Cluster (29503 ha in the cluster focal point)						
Default yield (tonne/ha) without intervention assuming existing.0.38% growth in the focal point during the last five years.	6.44	6.47	6.49	6.51	6.54	
Production without project interventions (tonne)	190,074	190,783	191,495	192,209	192,927	
Increase in yield due to improved management practices (tonne/ha) @15% increase in five years		0.24	0.49	0.73	0.98	
Production with project interventions (tonne)	190,074	202,707	215,432	228,249	241,158	
Increase in production (tonne)		7,154	14,362	21,624	28,939	
Increase in production value (M. US$)		3.58	7.19	10.8	14.49	
Production Potential in both Clusters (tonne)	-					66,124

Additional return generated (M. US$)						33.13

Such extra production can be absorbed in the growing domestic and international market. With the improved quality it would cater for exports and the urban population especially through the supermarkets catering to the upper and middle class. By increasing the production, it would create new jobs at the farm level by putting extra manpower in the pre-harvest activities and deploying more staff for extension and support services. It is expected to create 1600 full time jobs at the Punjab cluster and 1200 jobs at the Sindh cluster in the next five years. However, employment generation capacity will be more than double if we considered the yield increase due to renovation of garden.

7.2. Production to Export-Production Ratio

Pakistan is the seventh largest exporter of mangoes with 4% market share globally. Although Pakistan's export production ratio in 2016 was 5.0% which was higher than the global of 3.0% and the competitor countries such as India (1.13%), Egypt (2.82%), Philippines (2.49%), but Pakistan is exporting to low priced countries where the quality and quarantine are less stringent and presence of expatriates and that is a main reason the exports are dependent on few countries and is being over supplied.

The focus of our export should be towards market diversification, entering the markets with high growth rates. The potential countries in Europe are Germany, France and Netherlands with growth rates of 58%, 48% and 79%, respectively. In the Far East there are new emerging markets such as China and Vietnam with growing imports and high growth rates of 72% and 490% respectively. Export potential to China is enormous due to very big market, FTA status, its proximity to Pakistan and coming of CPEC project.

The mangoes are generally exported by air which involves high freight costs which drastically reduces the competitiveness of Pakistani mango. Some efforts were made under donor program but require further urgent work to develop the post-harvest technology so that all varieties mangoes can be shipped by sea. This effort can substantially improve Pakistan's export-production ratio.

There also a distrust among Pakistani mango importers as there are reports that exporters are sending under-weight mangoes. Implementing quality and weight standards regulated by TDAP will evaporate this mistrust thus also help to improve the export-production ratio.

With the opportunities stated above we assume that the production-export ratio can be improved from 5.0% to 8.1% with proper export drive such improving the mango shipment to Europe through sea, exploring new emerging markets such as China and Vietnam, arranging international mango exhibition, attending international horticulture fairs, linking exporters with markets by providing appropriate international market information, etc.. This is expected to generate additional annual revenue of US$ 19.24 million just in the focal point of the Punjab cluster and US$ 5.10 million in the focal point of Sindh cluster in the fifth year respectively.

7.3. Improvement in Quality

7.3.1. Quality for International Market

The export price of Pakistani mango is at US$ 796 per tonne, which is significantly low compared to the international average export price (US$ 1227). Improving the value chain and with proper marketing strategy it will bring this quality at least par to the world average quality thus fetching at least average world average price. Using this higher export price for the existing and additional export will bring US$ 59.2 million to the focal point of Punjab cluster and US$ 15.7 million to the focal point of Sindh cluster.

To enter into the high-end markets, it requires high level of entrepreneurship, awareness of processing & plant technology and packaging techniques, adaption of modern refrigeration methodologies in storage and transportation and conforming to quality standards. Besides it requires infrastructure pertaining to export quarantine requirement such as Hot Water Treatment (HWT) for EU, Iran, China and Malaysia, Vapor Heat Treatment (VHT) for Japan and Korean markets and Irradiation facilities for USA. Although few HWT has been established but there is a need for more plants to fulfill the new export targets. There is one VHT established by Fauji Fresh and Freeze company and have inroads in Japan and Korean markets. There is one irradiation plant established in Lahore (PARAS), while another E-Beam based technology is being established in Karachi. Though PARAS has been approved by US$A but it is not being implemented due to security reasons.

7.3.2. Quality for Domestic Market

The research indicates that the local consumers are willing to pay 20-25 per cent premium price for clean, blemish free, fully matured and uniform size of mango (ACIAR, 2007). Our discussions with stakeholders also suggest that at least 5% of mango can be traded in domestic market in the big metropolitan cities of Pakistan having the quality at par with the international export market thus can fetch at least the world average export price. Interventions which will improve the quality of 5% of the domestic produce to international export standards will generate US$ 89.9 million of net economic returns in the whole value chain.

7.3.3. Reduction in Post-Harvest Losses

Post-harvest losses, one of the major concerns of agriculture in Pakistan, account for nearly 30% of wastage of mango in the country. With improved post-harvest technologies such as better harvesting techniques and packaging, mangoes being processed and moved through cold chain system, these losses can be reduced to 20%. This will generate estimated revenue of US$ 90.9 million and US$ 28.6 million in the Punjab and Sindh clusters respectively at the existing farm gate price. The number of cold storages and processing units to be established has been calculated in the Cost & Benefit section. As per requirements it is expected to create 1,500 jobs in the Punjab cluster and 600 jobs in the Sindh cluster in the next five years.

8. STRATEGIES: PLAN AND NETWORKING

8.1. The Plan

Based on the gaps and potentials identified in previous chapters, following targets are fixed in consultation with stakeholders for a five-year development project to improve the competitiveness of the Pakistani mango in national and international markets:

Table 17:Targets of Mango Cluster Plan

1	In both clusters, replace 20% area of existing mango orchards to certified high-density orchards in the next five years with 40% higher yield.
2	25% Increase in yield of the existing gardens in Sindh and Punjab Clusters from the current base in next five years.
3	Reduce post harvest losses from aproximated 30% to 20% in the next fiveten years.
4	Increasing the export to production ratio from the current 5.1% to 8.1% in five years.
5	Improve the quality of the produce in the domestic market by 5% of the produce to the export standard within next five years.
6	Improve the quality and export price at least equal to the world average from 5.1% to 8.1% over five years.
7	Achieve target of making pulp of one percent of the total production of the Punjab Cluster in the fifth year of the project.

8.2. Policies

The major policy shifts will be required to achieve the above targets. **First**, the farmers will be organized in Farmers Entrepreneur Groups (FEGs) at the union council level in mango cluster and all the incentives including group financing and capacity building will be channeled through these groups. The group member will be monitoring each other to ensure produce quality and get engage in contract farming with traders and supermarkets. The finance can be channeled through triparty arrangement between traders, FEGs, and NGOs/Bank/governments. The banks and NGOs like PRSP should be encouraged to provide loans to FEGs on concessional basis and government should cover the mark up.

Secondly, to ensure the availability of quality rootstock and scion, mango nurseries will be registered and these nurseries will be encouraged to establish the mother-blocks of various varieties by supplying original root stock of different varieties on nominal charges. The tissue culture facilities will be made available for the farmers in major agriculture universities to identify the rootstock and scion of various varieties.

Thirdly, capacity of all stakeholders along the value chain to handle quality produce will be improved. The capacity of policy makers on on GAP/SPS and WTO issues will be enhanced

by engaging RSPs, TEVTA, Agricultural Universities, local and foreign experts, and extension departments.

Fourth, government will improve its extension service delivery by starting the specialized extension program in collaboration with the private sector, and strengthen the capacity of Agriculture Extension, and Department of Plant Protection, and other related services.

Fifth, government will incentivize the improvement in mango value chain infrastructure like pack-houses, cold storage, establishment of special trading platform, reefer trucks, etc., and a special agri-business fund will be earmarked for this purpose both at the federal and provincial level under the Planning Commission and provincial planning departments. In the initial stage the focal points of mango clusters, i.e., Multan and Mirpur Khas will be declared as Export Zones for mango. The Ministry of Commerce will continue the incentives as provided in the Strategic Trade Policy Framework 2015-2018 by the Ministry of Commerce (2016).

Sixth, Government will specify and implement local grade and weight standards in collaboration with appropriate agencies, promote branding of mango and incentivize certification of mango farm and processors. The certification process to be followed is given in Annex 3.

Seventh, logistic issues of mango export will be resolved by improving the management of Pakistan international Airline flights, and establishing cold storage at the airport and seaports,

Eights, A holistic and coordinated approach will be adopted to address constraints and gaps simultaneously along the whole value chain of mango in each cluster, and linkages will be promoted between various actors along the chain through promoting contract farming and establishing e-commerce platforms. Government will also support to organize growers/ processors/exporters associations. The main criteria for access to matching grants for infrastructure development will be formal registration in these associations.

8.3. Interventions

These strategies are aimed at providing comprehensive and mutually supportive solutions to current challenges in developing quality value chain infrastructure and capacities for the mango clusters of Punjab and Sindh to handle quality mango produce for the domestic and international markets. These strategies will be implemented by the PMUs in Punjab and Sindh with the support of multiple partners including Agriculture Department while collaborating with other government and private sector institutions. Major components of the strategies are as follows:

8.3.1. Institutional Level Interventions

8.3.1.1. Social Mobilization & Networking

One of the strategic interventions in mango cluster development is to organize Farmers Enterprise Groups (FEGs) consisting of 30-40 farmers who would be involved in the

implementation of GAP/SPS compliance. The RSP and other NGOs will be engaged in this social mobilization. All experiments and field trials will be organized by FEGs with focus on GAPs application in field. The value chain infrastructure will also be incentivized through FEGs. These FEGs would be able to create economies of scale and can collectively deal with input suppliers, technology suppliers, financial support, contractors, exporters and processors to get better deals. This group will be the key in improving coordination across various stakeholders along the value chain. Traders, exporters, and processors associations will also be organized to promote mango stakeholders' interests.

8.3.1.2. Strengthening Research & Development System

Research should be demand driven which should benefit the stakeholders mainly the grower, trader and the processors. Some of key areas identified through survey and discussion with the stakeholder and experts where the research needs to be initiated on priority basis are:

- **Development of High-Density Mango Gardens**. High density gardens are the future of the mango production in the country. The future development of high-density plantings in mango, however, would be dependent on the use of dwarfing cultivars and/or rootstocks and better canopy management strategies. Lots of research is needed to identify appropriate dwarf rootstock, canopy management, nursery development to establish these gardens, and the garden renovation strategies to replace old with the new high-density gardens. Once these gardens will be in place, many new issues will emerge. Therefore, research on high-density garden should be one of the high-priority areas in future research agenda.
- **Development of Cluster and Site-Specific Appropriate Management Practices**. As noted earlier, despite the variation in variety, environment, and irrigation conditions, the crop management practices remain similar across cluster. The research needs to develop cluster specific planting, input use, irrigation, weeding and other crop management practices which are cheap, sustainable, and optimal in each cluster. The development of optimal irrigation, harvesting and post-harvest management of mango need special attention of research.
- **Developing Integrated Pest Management (IPM) Strategies**. Insects especially thrips and diseases are becoming serious problem in mango production and strategies to control these have impact on the quality of the fruit. Indiscriminate use of pesticide is causing serious high pesticide residue and rejection of export lot problems. Developing integrated biological and agronomic solutions are key to solve these problems. Research in Pakistan has made some progress in develop some Integrated Pest Management (IPM) solutions through the collaboration of CABI, ACIAR, PARC, and universities, but much more need to be done. Developing and implementing the IPM solutions will be one of the major research issues in the future.
- **Protocols for the Sea Shipment.** *T*ransporting mango consignments by sea shipment such is 4-5 times cheaper than by air. Some trial shipments have already been made in Pakistan for Chaunsa and Sindhri variety but still require further research to make it success for commercial shipments.
- **Packaging Materials**. Impact of various packaging material on cost, post-harvest losses, and marketability of mango in different markets along various distance to

travel. Once the “right” types of packaging material for a destined distant market are identified, then it should be incorporated in the grades and standards regulation. Another area where processors have issues is packaging of dehydrated mango in plastic bags where currently they are unable to preserve its shelf life as compared with the international standards Packaging for sea shipment to Europe also needs attention.

8.3.1.3. Establishment of Project Management Unit (PMU)

To implement the entire project activities there is a need to establish two institutional structures - Project Management Units (PMUs), one in Lahore with sub office in Multan for Punjab mango cluster and the other would be based in Karachi with sub office in Hyderabad for Sindh mango cluster to be established. The two PMUs would work in close coordination with:

Directorate of Extension (Horticulture): Activities include designing GAP modules, farmer trainings calendar and plan, and implementation of GAP trainings deploying Farmer Field School (FFS) model. PMUs to utilize services of experienced team of Directorate of Extension (Horticulture) to support as facilitators in FFS. Capacity building of these facilitators will also be key activity under the FFS activity. The Directorate will also be involved in structuring of the inception report, work planning and implementation of other activities.

Directorate of Agriculture (Economics & Marketing): Close functional coordination will be maintained with the Directorate of Agriculture (Economics & Marketing) in structuring of the inception report, work planning and implementation of PMUs activities including capacity building, certification, supply chain infrastructure improvement and international and domestic marketing linkages.

Public sector agencies: Public-sector agencies such TDAP, PHDEC, SMEDA, PBIT SIDB, Commercial Embassies/Consulates, etc. will also be engaged to develop activity-specific synergies; e.g. participation in international trade shows; promotional campaigns; technical support in feasibility studies and business plans for supply chain improvement initiatives; agribusiness certification and capacity building initiatives; establishment of domestic market buyer-seller linkages etc.

Universities and research institutes: PMUs shall make arrangements with a number of universities and research institutes for organization of class-room and on-field trainings, particularly during FFS implementation. These universities and institutes shall also be engaged to host trainings on SPS compliance, food safety, certification audit etc. The universities and institutes include: University of Agriculture Faisalabad, ARID Agriculture University Rawalpindi, University of Agriculture Sargodha, Bahauddin Zakariya University Multan, Ayub Agriculture Research Institute Faisalabad, and Pakistan Council of Scientific and Industrial Research (PCSIR), Sindh Horticulture Research Institute, Agriculture Research Institute (Tando Jam) and Tando Jam University.

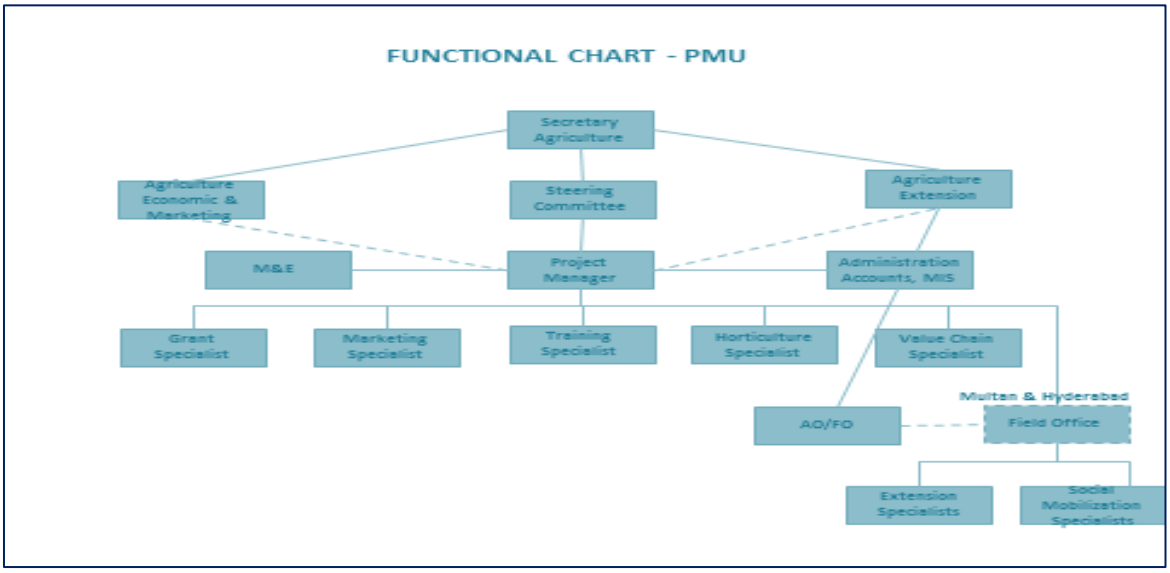
Service providers: A pool of service providers including: certified trainers, auditors, management consulting firms, machinery and equipment vendors, cold storage specialists, legal experts, international marketing specialists, chartered accountant firms, agriculture experts, technical consultants etc. PMUs shall link beneficiaries looking for consulting services, to these service providers during the course of project implementation. Capacity of these service providers will also be built through different training programs.

Two project offices shall be set up one in Lahore as a central project office to implement the project for Punjab Cluster and the other one in Karachi for Sindh Cluster. Both the PMUs would be working directly under the Steering Committees which would be headed by the Agriculture Secretaries. The Project Managers and all other members of core technical team, supporting team including accounting, administration, monitoring and MIS will be deployed in the office the respective offices. Field offices in Multan and Hyderabad would be established which would cover the activities in their respective mango clusters. Depending on the nature of their assignment, short-term experts engaged from time to time will be deployed at any of these two offices. PMUs Project Managers would work closely with Directorate of Agriculture Extension (Horticulture) and Directorate of Agriculture (Economics & Marketing) on ongoing basis. An organogram of the proposed organization structure is shown in Figure 7.

Figure 6:Project management Unit setup

8.3.1.4. Capacity Building of Stakeholders

The prime strategy will be building the capacity of all the key value chain stakeholders (farmers, processors, transporters, exporters, certifying bodies, service providers etc.) with respect to GAPs and SPS protocols, international certifications, investment in supply chain infrastructure, value addition, development and strengthening of domestic and international



market linkages. The Project Management Unit (PMU) agricultural universities, SMEDA, RSP, TEVTA, and foreign consultants shall organize need-based training programs in the next five years for the processors, value addition and exporters, etc. aimed at improving their overall capacity to comply with international compliance requirements.

In order to further build the capacity of PMU extension experts and AD/AO/FO as facilitators, they shall impart training at Agriculture Universities, where staff would be trained (TOT) by Certifying agencies or by **Global GAP Farm Assurer Program** training through Global GAP official trainer, which will also include Global GAP exam to qualify as **Licensed Farm Assurer**. Farm Assurers are independent GLOBAL GAP trained and approved consultants who provide expertise to help producers implement Good Agricultural Practices.

Similarly, trainings on GAPs (crop husbandry, IPM, post-harvest practices, environment, traceability etc.), special topics identified by farmers, participatory technology development (PTD) and non-formal education methods shall also be organized for the facilitators.

Number of universities and research institutes where most of the facilitator trainings shall be hosted. These universities and institutes include: In Punjab: University of Agriculture Faisalabad, University of Agriculture Sargodha, Bahauddin Zakariya University Multan, Ayub Agriculture Research Institute Faisalabad, and Pakistan Council of Scientific and Industrial Research (PCSIR). In Sindh: Tando Jam University, Sind Horticulture Research Institute Mirpur Khas, Agriculture Research Institute Tando Jam. It is recommended that NRSP should be involved in the TOT program.

8.3.1.5. Improvement in Service Delivery

- A product-specific handbook of Good Agricultural Practices (GAPs) and SPS protocols for mango value chain by team of experts represented from PMU, Directorate of Agriculture Extension (Horticulture), R&D institute, and academia.
- Some examples of topics, which shall be thoroughly covered in the modules, include the management of: soil and plant nutrition, insect pest and diseases, pruning and canopy, food safety and phytosanitary, harvest & post-harvest fruit handling, high density plantation and environment. Modules shall be selected and finalized by PMUs in consultation with Directorate of Agriculture Extension (Horticulture) DPP and NARC. Detailed training methodology to be provided in each training module. In order to track effectiveness of the training delivery, a mechanism for evaluation of each training shall also be provided in each module.
- These training courses will be implemented by the private sector awarded on competitive basis with the finance provided by the provincial departments. The Extension Department and PMUs will monitor the implementation of these modules by the private sector.
- FFS sites will be established and operated at the each FEGs level on the sites provided by the group. On average a group of 20-25 member farmers from FEGs shall attend each FFS meeting.
- In coordination of PMU extension experts, AD/AO/FO of Extension Department shall be assigned to each FFS. The farmers shall also be provided with the copies of GAP modules in Urdu language. PMU extension experts and AD/AO/FO shall conduct field sessions based on standard modules.
- At least two field days shall be organized by FFS in a crop season to share experience and results of the application of GAPs at FFS site. The field days shall be completely managed by the farmers. The rest of the farming community shall also be

invited to share learning, experience and overall benefits of application of GAPs in the field.

- Farmers shall continue the practice of GAPs application in their fields and orchards. Facilitators (Licensed Farm Assurers) shall undertake follow-up visits to provide ongoing guidance and to track overall progress by the graduate farmers. Strong interaction among farmers through FEGs will also be encouraged.

8.3.2. Production Level Interventions

8.3.2.1. Promotion of High-Density Plantation

Presently in Pakistan mango trees especially Chaunsa and Sindhri varieties are traditionally established at about 70-100 trees per ha and eventually due to its vigorous growth grows into large trees 10m tall or more, making spraying and harvesting difficult and incurring low production with high input cost. In many countries they have gone into high and ultra- high-density plantation, planting up to 4000 trees per ha (Christopher M. Menzel-2017).

In order to attain higher yield and improved quality produce, high density plantation program will be initiated both in Punjab and Sindh clusters under the supervision of respective research and extension. Although few farmers both in Punjab and Sindh have taken the initiatives towards high density plantation within their existing orchard, but there is a need to promote it extensively by the government through awareness and training programs.

In high density plantation 370 plants per ha will be planted. As discussed earlier, the high-density plantation has significantly higher yield than the old low-density gardens. It is proposed that 20% of the existing mango area will be replaced with the high-density garden. To minimize the impact of old garden renovation, it is suggested that new high-yielding dwarf variety plants will be inserted in the old garden by pruning the old plants, and old plants will be gradually removed when the new plants will be almost ready to bear fruit. For this purpose, scientific pruning methods for the existing gardens will be introduced to create a space for the new plants. As renovations of gardens will require lots of additional cost, new mango plants will be subsidized at 20% rate provided if they are purchased from the certified nurseries. It is conservatively estimated that new high-density gardens will improve the per ha yield by 40%.

8.3.2.2. Promotion of Certified Nurseries

Clean and healthy nursery plants of high varietal purity are a basic requirement for good quality mango producing trees (Rajwana et al. 2013). This necessitates the establishment of certified clean nurseries in Pakistan that can produce genuine mango root stock. Establishment of certified nurseries should be an important component of the introduction of high-density garden program.

Local nursery producers in each province would be encouraged to register with local FSC&RD offices by PMU through local AD/AO/FO and R&D institute to produce certified true to type quality young fruit trees. This would be on a voluntary basis, but would bring with its certain fringe benefits, namely:

- Registration with FSC&RD shall provide the nursery producer with a guarantee of quality and help to raise the business and reliability of the nursery
- They shall get access to propagation materials from the multiplication blocks (on a payment basis) and also access to any new varieties introduced. Non-Registered nurseries will not have access to this material
- These nurseries will become a part of the certification scheme for young fruit trees
- Owners and staff of the registered nurseries will have access to training in improved nursery management and production practices
- participation in the registration and certification scheme will raise the business profile of the nursery and encourage repeat business through certified quality and increased reliability
- Ultimately the nurserymen will attain higher prices for the production, compared to uncertified planting materials.

Price is a big factor that most farmers which drives them either to develop their own nursery or buy them from uncertified nurseries. So it is important that government provide incentive in form of cost sharing for growers buying plants from these registered nurseries. It is suggested that twenty percent of the improved nursery management and registration cost be shared by the government.

8.3.2.3. Strengthening of GPUs and Multiplication Blocks at R&D Institutes

Presently, there are two GPUs pertaining to mango, one is established at Government Agriculture Farm - Khandwa Punjab under the supervision of Mango Research Institute Shujabad where multiplication block has been established where they produce root stock and seedlings for commercial nurseries. The other is in Sindh Horticulture Research Institute Mirpur Khas Sindh. Although protocols and SOPs for GPUs and multiplication blocks have been developed and approved by FSC&RD but is not being implemented in its true spirit due to lack of dedication, capacity of the respective research institutes, and to some extend lack of timely funding.

These GPU's and multiplication blocks shall remain under the strict control of the Agricultural Research System but should be monitored for health, cleanliness and freedom from pest, disease and virus infestation by the FSCRD to keep its varietal integrity and check if the SOPs are being followed.

The roles and responsibilities at the R&D Institutes shall be clearly defined and implemented by Agriculture Research & Extension Department. PMU in collaboration with FSC&RD and NARC shall provide training to the R&D staff officers and the labor working in the multiplication block for managing the health, growth and quarantine. They shall also be trained on nursery management. The R&D Institutes should provide the root stock and budding materials to only those commercial nurseries which are registered with FSC&RD.

8.3.3. Marketing Level Intervention

8.3.3.1. Linking Farmers with Markets

In Pakistan, there is a particular need to create links between growers and markets. This linkage can be developed through Farmers' Enterprise Groups (FEGs) who are GAP compliant. The group monitor its members GAP compliance and ensure quality to traders. They ultimately end up setting predetermined quality-price contract farming with exporters and emerging supermarket retailers within the country. The traders and supermarket retailers also help farmers to provide modern inputs, methodologies, and technologies that can help them to meet the quality requirements of the contract. Such contracts can be built on the current informal arrangements between farmers and commission agents to ensure supplies through pre-harvest contractors.

8.3.3.2. Linking Trader with International Markets

Traders should be encouraged to participate in international events, such as food exhibition, trade shows, trade fairs, international horticulture workshops, etc. Most of the major international exhibitions on horticulture are held on mango off season when exporters do not have excess to their products for display. Those exhibitions have to be identified which are held during mango production time. This does not mean to suggest that the biggest exhibitions should not to be attended. Also, in store displays at high end stores should also be part of marketing promotion so that the consumer is made aware of Pakistani mangoes. Besides, its first step for that retailer to be convinced to import Pakistani mangoes.

Some of the options available for participation in leading trade shows / exhibitions for both fresh and de-hydrated mangoes include AGRAME Dubai, Euro Tier, Fruit Logistica Germany, Fruit Logistica Hong Kong, Gulf Food Dubai, World Food Moscow, etc. Those events will be selected, which are scheduled within the season of product, so that samples of target products can also be displayed at the events for sample tasting. In this regard, collaboration with Trade Development Authority of Pakistan (TDAP), Pakistan Horticulture & Development Company (PHDEC) and Commercial Councilors with respect to identification and participation in the relevant marketing activities shall be sought.

It is proposed while visiting at expos on the side line pre-arrangements shall be made with chain stores to display Pakistani mangoes in a store with taste sampling so that consumer can get awareness of Pakistani mangoes.

International marketing consultants from EU and China and a local marketing company can be hired to support in this endeavor. PMUs and Agriculture Economic and Marketing departments in coordination with these companies would carry out some of the following activities:

1. Mapping of countries and markets for the target products shall be carried out.
2. Specific compliance, customs regulations, packaging requirements and other related prerequisites of exports to these markets shall be identified.
3. Logistics viz-a-viz cost of the products shall be determined.
4. Keeping in view potential international markets and compliance requirements thereof, a detailed marketing strategy with an overall aim to enhance exports to potential

high-value export markets shall be designed. The strategy shall be structured by the PMUs, Directorate of Agriculture (Economics & Marketing) in collaboration with the international experts.

5. An implementation plan shall be the part of strategy and shall include the following details:
    a. Key identified potential high-end international markets
    b. Specific compliance & packaging requirements
    c. Mapping of key potential international trade shows and exhibitions for participation by the program participants
    d. Marketing and promotion program – establishing market presence through branding
    e. Identification of any potential host country partners, facilitators, etc.
    f. Criteria of selection of beneficiaries for participation in events
    g. Tentative costs of participation
6. Participation in 8 international exhibitions and promotional campaigns in next five years will be organized for Punjab and Sindh clusters. The exhibitions will be identified in a mapping process and shall be part of the marketing strategy and plan.
7. In addition to providing grants to beneficiaries for participation in the events, PMUs shall provide a complete package of following support and assistance to them to ensure that they gain maximum benefit from participation in events:
    a. Daily end-of-day briefings
    b. Pre-event coaching sessions
    c. A summary trip briefing which identifies further actions to finalize the business deals initiated at the event
    d. A follow-up interview with participants six months after participation

8.3.3.3. E-Commerce-Portal & SMS-based Training Message Scheme

An integrated innovative tool including e-commerce portal and SMS-based training message schemes in the training delivery mechanism will be introduced by PMUs at the provincial levels. A dedicated web-portal containing information on mango supply, prices, changing quality standards, and emerging technologies in production, value addition, and processing in major mango producing markets, upcoming mango related national and international events, GAP handbooks and training modules shall be prepared to reach the audience at a larger scale. The portal shall provide an option to visitors to subscribe to training messages/tips circulated to registered subscribers on periodic basis. Participants of all trainings will be automatically registered for the SMS tips. A system shall be devised to structure periodic tips in Urdu from the GAP handbooks and training modules, which shall be circulated to beneficiaries and other subscribers on a periodic basis.

8.3.4. Value Addition Level Intervention

One of the key pillars of modern value chain is the presence of appropriate infrastructure such as processing and cool chain system which has become critical for reducing post-harvest losses, promote exports earning valuable foreign exchange, price stabilization in domestic market empowering growers to control as per demand supply situation and avoid quality deterioration due to short shelf life. Processing units such as Hot Water Treatment (HWT) is required as a prerequisite quarantine requirement to most high-end markets so such infrastructure is important to be established for exports. There is also lot of potential to establish mango value added industry such as dehydrated mangoes which requires more detailed analysis for the government to consider in sponsoring such value-added projects.

As mentioned earlier that there is limited level of infrastructure present in the mango value chain. To upgrade the value chain, it is important for the government to promote infrastructure development projects and some of them proposed are mentioned below:

8.3.5. Establishment of Cold Stores

In the fruit and horticulture industry, inadequate cold chain infrastructure means that products have a short shelf life and quickly lose their freshness and quality beyond addressing the cold chain inadequacies. Besides during when there is glut in the market the farmers/contractors have little option to hold the product hence get very low prices. The increased availability of storage would enable farmers to time the release of their produce to periods of higher prices, better transport availability or other more favorable conditions. Standardized, palletized and containerized transportation would increase the profitability of mangoes.

To keep the cold chain intact from production to market there is need for establishing farm-level cold stores at mango production areas at the collection centers. The cold storages would be established under grant mechanism by the government with 20% subsidy on the capital cost and one-year interest free loans. It is suggested that all the export and 5% of the mango output destined for high-end domestic market will be pass through the collection centers. For this purpose, 65 cold storages in Punjab and 15 in Sindh focal points need to be established with a capacity of 14 tonnes of mango every day. The detail costs, benefits, and IRR of the collection center can be seen in with the EXL model in the Value Addition Cost sheet.

8.3.6. Establishment of Collection Centers Cluster

Collection Center can be simple packing house with locally developed washing, drying and manually grading facilities with ripening chamber and a small cold storage for pre-cooling. This would be sufficient for marketing quality mangoes to the local market and exporters would buy it in bulk for further processing as per requirement of the importer.

It is proposed to establish Collection Centers at the production hubs for sourcing quality products direct from the certified farms, washed, grade and pack and cool them as per requirement of the buyer at these Centers. This would not only reduce wastages as it occurs in the traditional value chain but also improve the shelf life and quality of the produce.

Moreover, this market channel would incur numerous benefits to the growers including certified farmers having another market option, saving transport cost and other cost associated with traditional market system and avert price risk of selling at wholesale markets. Also Collection Centers should have access to the Special platforms created at major wholesale markets for branded products conforming to minimum grades and standards established by the Agriculture Economic and Marketing departments. These Centers may also serve as the auction point in rural areas.

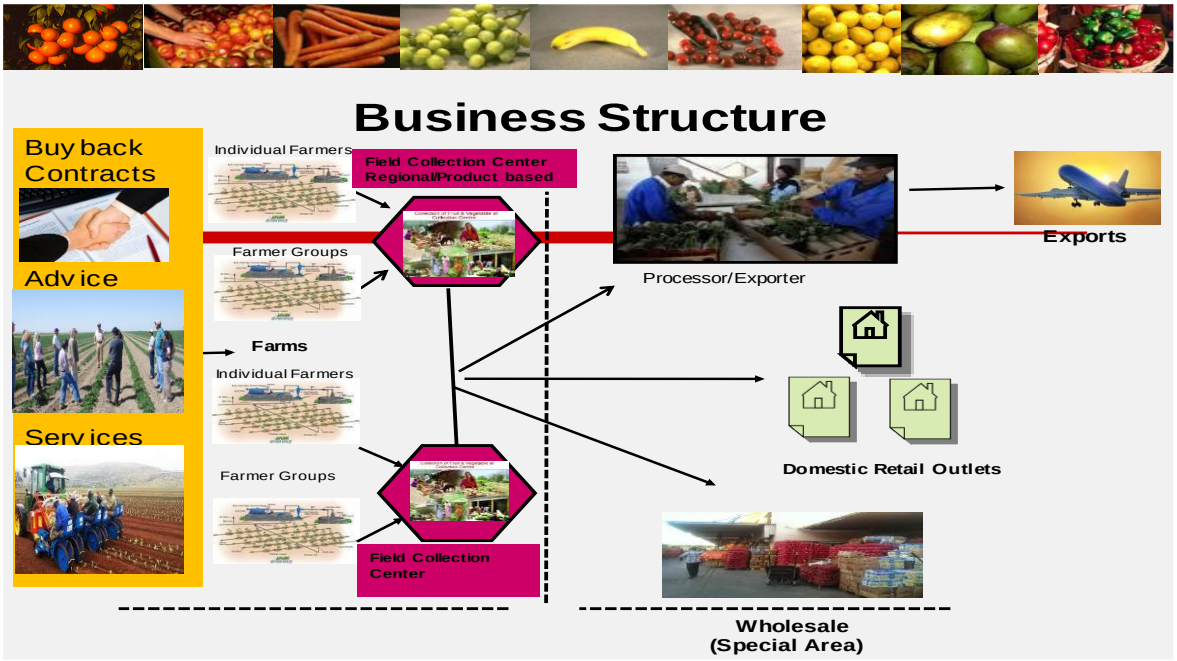


Figure 7: Diagram showing business structure for establishment of collection centers

The Collection Center would be operating under certain minimum grades and standards so that the produce can be sold to exporters, high end local markets and through the special platforms to be established in the existing wholesale markets for branded and standardize produce is auctioned.

As it is a new concept in Pakistan the private sector may feel shy in investing into such a venture. Hence the initiative has to be taken by the government to have a joint venture arrangement with the FEGs with 20% contribution from the government as a grant component, and one-year interest free loans to FEG. The management would be with the FEGs. It is suggested that all the export and 5% of the mango output destined for high-end domestic market will be pass through the collection centers. For this purpose, 29 collection Center in Punjab and 7 in Sindh focal points need to be established. The detail costs, benefits, and IRR of the collection center can be seen in with the EXL model in the Value Addition Cost sheet. This would also ensure that the collection center would have access to the special platforms in the major wholesale markets.

8.3.7. Establishment of Hot Water Treatment Plants

Many of the importing countries especially the high end markets have made HWT mandatory for the mangoes to be imported from Pakistan; this is mainly due to mangoes being highly

susceptible to infestation by fruit flies. Although EU has not specified any process but have strictly followed sanitary measures. In 2014 many consignments were rejected by EU and put a ban on Indian mangoes gave rise to the threat of ban. Department of Plant protection quickly responded to address the issue of fruit fly infestation. Now the export to EU is only exported through HWT process monitored and approved by DPP.

There are already limited number HWT units installed. With the initiation of establishing GAP/SPS farms and efforts to diversify markets especially to the high end markets such as EU and China as per targets of the program it is foreseeable that there would be a need to establish more HWT plants in the mango production/cluster hubs that would fulfill the export volumes. The new units will be incentivized in the production hubs both in Punjab and Sindh clusters as there would be close networking between farmers and processors. It is suggested that all the export and 5% of the mango output destined for high-end domestic market will be pass through the HWT plant. For this purpose, a total of 23 HWT plants will be required in the focal point of Punjab cluster and 5 such plant in the focal point of Sindh. The detail costs, benefits, and IRR of HWT plant can be seen in with the EXL model in the Value Addition Cost sheet. The information sharing would help the farmers to grow exportable produce as required by the processors.

8.3.8. Processing Level Intervention

8.3.8.1. Promotion of Small-Scale Mango Pulp Plant

Fruit pulp is an important value-added product and has a high demand in both local and export markets. The local market of fruit juices, nectars and drinks has been growing at a very high rate, estimated at 7% per year. The major use of mango pulp is in the production of juices and nectars. It is also used for the production of ice creams, toppings, bakery products and jams. It can be repacked as sweetened or single strength pulp in smaller consumer packs and can be consumed as it is or mixed with milk cheese yogurt. It can also be used in mango shake and mango lassi which is a popular drink all over the world. Consequently, the demand for mango fruit pulps has also increased during the last decade. Due to increase in demand for juices many large juice companies have entered the market, supplying to the local and international markets. With the result few new large capacity pulp manufacturing units have been established mostly in the private sector. One unit has been established by the government support in Multan – Agro Food Processing Facility, as a Common Facility Center.

The pulp units offer an attractive opportunity for investors. The establishment of such units can be justified due to the following major facts:

1. Due to large production base there is ample mangoes available for processing

2. Low quality fresh mangoes are sold at very low prices with little profits to farmers. These low grades mangoes are perfect raw material for mango value added products and with value addition it fetches higher profits than selling fresh mangoes.

3. Growing demand creating supply and demand gap in the local market especially by the juice industry

4. It is less risky business than fresh mangoes due to its longer shelf life which can be stocked and sold during off-season

There are many small juice manufacturing factories who have difficulty to access pulp from large pulp manufacturers hence it is proposed that small scale mango pulp units of 10 tonne per day capacity be established with FEGs with the government support with 20% subsidy on the capital investment on interest free loans for one year. It is proposed to establish 10 units initially in southern Punjab in the mango growing areas such as R Y Khan and Sadiqabad, where there are no such value addition projects. The FEGs will gather investment resources from individual members and the profit will be shared based on the proportion of their investment. It is estimated that one unit of pulp processing will cost US$25595, while its operation cost would be US$521,550 for the whole season of 100 days, more than 95% of which will be raw material cost

From economic perspective it will contribute towards reducing the postharvest losses, increasing employment opportunities in the area and maximizing crop value for the farmers.

8.3.8.2. Promotion of Dehydrated Mango Plants in Rural Areas

Dehydrated vegetables and fruits are produced and traded in large quantities around the world. International trade of dehydrated horticultural products has been increasing over the years. In 2015, the total export market of dehydrated vegetables was US$15.4 billion; including trade of US$11.1 billion of dried leguminous vegetables and US$4.3 billion of other whole/cut dried or powdered vegetables. International trade of dried fruits during the same year was US$2.3 billion (Pre-feasibility Dehydrated Fruits & Vegetables Govt. of Punjab). The leading countries exporting dehydration mango are Philippines, Thailand and India. Irrespective of a large mango production base with unique mango varieties, Pakistan has been unable to enter this market segment. The dehydrated mango offers an attractive opportunity for investors. The establishment of dehydration units can be justified due to the following facts:

1. Pakistan is 6th in the global production standing with production base of 1.6 million MT. Less than 5% of the production is exported while the rest is sold in the local market, so ample mangoes are available for processing.
2. Due to pre and post-harvest constraints, 30-40% of the production is wasted; Poor quality fresh mangoes are sold at very low prices with little profits to farmers. These low grades mangoes are perfect raw material for mango value added products and with value addition it fetches higher profits than selling fresh mangoes.
3. It is less risky business than fresh mangoes due to its longer shelf life which can be stocked and sold during off-season. Besides transportation is easy and much cheaper especially in exports as it is by sea freight as compared to fresh mangoes which are mainly transported by air.
4. It is growing market both at international and domestic levels. It would open up new markets internationally and would be differentiated from other competitive products due its unique flavor.

5. SMEs can afford to establish these dehydration plants as the technology is locally available.
6. Exports would generate much more valuable foreign exchange for the country than fresh mangoes.
7. It would increase rural employment especially for women.

Large dehydrated plants are capital extensive and presently the big investors have not yet been attracted. Moreover, these units do not create much employment in rural areas. Through survey it was noted that most of the mango dehydrated plants, even those units established by FIRM/USAID project, are small (1 tonne of mango input per day capacity). The processing units of 10 tonnes per day are suggested to be promoted in this study. Due to limited capacity they have been unable to export. so the government needs to access the situation and see how they can attract large investors into such an attractive sector. Once it shows viability then the private sector would be induced to invest in dehydration plants. Hence establishment of small scale dehydration plants in the clusters have not been incorporated

8.4. Target Related Interventions and the Role of Institutions to Implement Strategies

Following table shows the inter-institution/organization and department collaboration to implement the above mango plan and strategies.

Table 18: Summary of Target related Interventions in Punjab Cluster and the Role of Institutions

Target	key interventions	Key implementing partners
1. Production Level Strategies (increase 25% Yield in the next 5 years)	Capacity building on orchard management especially proper pruning and canopy management, proper dosage and timing of fertilizer and pesticide. Implementation of GAP/SPS through FFS methodology.	PMU, Agriculture Extension Punjab, Academia, Certifying Agency
2. Renovate 20%Orchards' area to garden to High Density Orchards	Training to farmers on High Density plantation in the existing orchards and its management	PMU, MRI, Extension Department
	Supply of true-to-label plants to the farmers through the establishment of certified nurseries at subsidized rates.	PMU, Multan Research Institute (MRI), FSC&RD, NARC
	Training of nursery people for registration, setting mother blocks and supplying true-to-type planting material	PMU, Agriculture Extension Punjab
	Web-Portal & SMS-based Training Message Scheme	PMU, Agriculture Extension Punjab
	Excess to financing to farmers	State Bank of Pakistan
A. Improve quality	Value Chain Improvement which includes:	

5% produce in domestic market based upon international standards in the next 5 years *B. Reduce Post-Harvest Losses from 30% to 20% in the next 5 years*	Capacity building farmers and contractors for post-harvest management which involves proper harvesting, de-sapping, packaging and transportation. Use of proper equipment for harvesting. Implementation of GAP/SPS through FFS model Provide incentive to adapt Certification regimes Establishment of cool chain system to increase the shelf life and quality of mangoes. Government to provide incentive mechanism Regulations such as implementation of grading and standards and establishment of special platforms for sale of standardized mangoes Direct linkages of farmers with the market which includes exporters, processors, collection centers and retailers to bypass traditional value chain. Local expositions are effective way of networking	PMU, Agriculture Extension Punjab, Academia, Certifying Agency PMU, Agriculture Extension, FEG/PMO, Certifying Agency PMU, Agriculture Dept. Punjab, SMEDA, Grant Expert (private sector company) PMU, Provincial Government, Agriculture Departments of Punjab PMUs, Agriculture Dept. (Economic & Marketing)
Increase export to production ratio from 5.1% to 8.1% and improve quality export price in the next 5 years	Market diversification to high end potential markets with high growth rates by attending international exhibitions, B2B meetings and branding National Brand would be established for exports for those mangoes sourced from GAP/SPS farms E-Commerce platform to provide information related international markets Establishing and implementing weight standards Improving schedule of Pakistan international Airlines	PMU, TDAP, Agriculture Dept. (Economic & Marketing) Punjab, Commercial Councilors PMU, TDAP, International Expert PMU, TDAP, Agriculture Dept. (Economic & Marketing) Punjab, Agriculture Dept. (Economic & Marketing) Punjab, Ministry of Commerce
Establish Cool Chain and Processing Industry in the next 5 years	Incentive to be provided by government Enterprises to acquire international certifications, including quality assurance and food-safety compliance certifications such as: Global GAP, IFS, ISO 22000, FSSC 22000, BRC etc. Capacity Building besides production aspects training would be imparted on WTO, Tariffs & Trades Customs Laws, Food Safety	Federal government and Punjab government PMU, Agriculture Department Punjab, Certifying Agency PMU, Academia, relevant government departments

	Standards and Phytosanitary requirement Linkages with domestic and international markets through expos/B2B	 PMU, Agriculture Dept. Punjab, TDAP

Table 19: Summary of Target related Interventions in Sindh Cluster

Target	key interventions	Key implementing partners
1. *Production Level Strategies (increase 25% Yield in the next 5 years)* 1. *Renovate 20%Orchards' area to garden to High Density Orchards*	Capacity building on orchard management especially proper pruning and canopy management, proper dosage and timing of fertilizer and pesticide. Implementation of GAP/SPS through FFS methodology. Supply of true-to-label plants to the farmers through the establishment of certified nurseries at subsidized rates Training of nursery people for registration, setting mother blocks and supplying true-to-type planting material on subsidy Training of farmers on High Density plantation in the existing orchards Web-Portal & SMS-based Training Message Scheme Excess to financing to farmers	PMU, Agriculture Extension Sindh, Academia, Certifying Agency PMU, Sindh Horticulture Research Institute (SHRI), FSC&RD, NARC PMU, SHRI, Extension Department PMU, SHRI, Extension Department PMU, Agriculture Extension Sindh State Bank of Pakistan
A. Improve quality 5% produce in domestic market based upon international standards in the next 5 years B. Reduce Post-harvest Losses from 30% to 20% in the next 5 years	Value Chain Improvement which includes: Capacity building farmers and contractors for post-harvest management which involves proper harvesting, de-sapping, packaging and transportation. Use of proper equipment for harvesting. Provide incentive to adapt Certification regimes Establishment of cool chain system to increase the shelf life and quality of mangoes. Government to provide incentive mechanism Regulations such as implementation of grading and standards Establishment of special platforms for sale of standardized mangoes Direct linkages of farmers with the market which includes exporters, processors, collection centers and retailers to bypass traditional value chain. Local expositions are effective way of networking	 PMU, Agriculture Extension Sindh, Academia, Certifying Agency PMU, Agriculture Extension, FEG/PMO, Certifying Agency PMU, Agri Dept. Sindh, SMEDA, Grant Expert (private sector company) PMU, Provincial Government, Agriculture Department of Sindh PMU, Provincial Government, Agriculture Department of Sindh PMU, Agri Dept. (Economic & Marketing) Sindh, TDAP

Increase export to production ratio from 5.1% to 8.1%and improve quality export price	Market diversification to high end potential markets with high growth rates by attending international exhibitions, B2B meetings and branding National Brand would be established for exports for those mangoes sourced from GAP/SPS farms. E-Commerce platform to provide information related international markets Establishing and implementing wright standards Improving schedule of Pakistan international Airlines	PMU, TDAP, Agriculture Department (Economic & Marketing) Sindh, Commercial Councilors PMU, TDAP, International Expert PMU, TDAP, Agriculture Dept. (Economic & Marketing) Punjab, Commercial Councilors Agriculture Dept. (Economic & Marketing) Punjab) Ministry of Commerce and Trade
Establish Cool Chain and Processing Industry in the next 5 years	Incentive to be provided by government Enterprises to acquire international certifications, including quality assurance and food-safety compliance certifications such as: Global GAP, IFS, ISO 22000, FSSC 22000, BRC etc. Capacity Building besides production aspects training would be imparted on WTO, Tariffs & Trades Customs Laws, Food Safety Standards and Phytosanitary requirement Linkages with domestic and international markets through expos/B2B	Federal government and Sindh government PMU, Agriculture Department Sindh, Certifying Agency PMU, Academia, Relevant government departments PMU, Agriculture Dept. SIndh, TDAP

9. BENEFITS AND COSTS OF CLUSTERING

This section discusses the costs associated with cluster development strategies presented in previous chapter. This also identifies resources and requisite inputs for achieving all the targets given in section 8. An economic and social impact analysis has also been conducted that evaluates the benefits of the Mango cluster development interventions in two target regions of Punjab and Sindh.

9.1. Investments, Costs and Returns for both Clusters

An investment of US$ 91.5 million is needed to support the cluster development efforts in the of the focal point of Punjab, while US$31.6 million for the development of the focal point of Sindh cluster (Table 13) The main investment is in the establishment of processing, value added and cold storages units. This investment would be shared between government and the private sector through incentive mechanism (PMU/government is to develop the cost sharing grant mechanism). Other cost such as establishment of PMU, training, marketing, research, etc. would mostly be borne by the government. 70% of the government share in the investment should be provided by the federal government, by establishing a Cluster Development Fund (CDF) under PCP. The remaining 30% should come from the provincial budgets.

Investment costs are summarized in the following Table 20.

Table 20: Summary of Investment Costs (US$)

Description	Value	Value
Cluster	**Punjab**	**Sindh**
Total Investment (US$)	91,477,539	***31,557,063***
Total ha of land under mango production (ha)	50,251	29,503
Estimated investment per ha (US$)	1,820	1,070
*Currency conversion rates (I US$: 135.0 PKR		

9.2. Economic, Social and Environmental Returns (Punjab Cluster)

Cluster development investments are expected to help generate revenues from the year 2nd. In the Punjab cluster, the gross revenues before mango cluster development are estimated to be ranging from US$ 356.7 million in second years to US$ 433.9million in 10th year. All the six cluster interventions are expected to result in additional gross revenues of US$ 45.4 million in second year and US$ 272.2 million in the 10th year. All the value chain costs

including those related to the production, processing, marketing and selling are applicable from year 1 through to year 5, the total of which ranges from US$ 10.76 million in first year and US$ 45.74 million in 9th year (Table 21).

Offsetting these value chain costs from revenues, net economic benefit in first of interventions will be negative US$ 27.76 million. This amount is exactly equal to the value chain costs in year 1 and cluster investments of 1st year, as no revenues or benefits are expected in first year of cluster development interventions. The net economic benefits in subsequent years are expected to range from US$ 5.46 million in second year to US$ 272.18 million in 10th year (Table 21).

Table 21: Economic Returns and Investments in Punjab Cluster

	A	B	C	D	E	F	G	H	I	J	K	L
4	**Expected Revenues from cluster Development In**		-	-	-	-	-	-	-	-	-	-
5	Intervention-1		-	-	-	-	-	6,109	12,521	19,247	26,299	33,689
6	Expected Additional Revenue from Certified Orchards		-	-	-	-	-	-	-	-	-	-
7	Intervention-2		-	4,328	8,870	13,634	18,630	19,091	19,565	20,049	20,546	21,056
8	Expected Additional Revenue from Increased Yield		-	-	-	-	-	-	-	-	-	-
9	Intervention-3		-	8,655	17,739	27,269	37,259	38,794	40,381	42,024	43,723	45,480
10	Expected Additional Revenue from Reduction in Post Harvest Losses		-	-	-	-	-	-	-	-	-	-
11	**Intervention-4**		-	4,165	8,746	13,764	19,244	19,244	19,244	19,244	19,244	19,244
12	Expected Additional Revenue with Improvement in Export-Production Ratio		-	-	-	-	-	-	-	-	-	-
13	**Intervention-5**		-	10,827	23,723	38,909	56,621	58,682	60,811	63,009	65,279	67,623
14	Improvement in value chain		-	-	-	-	-	-	-	-	-	-
15	a) Bring national export price to international export price		-	-	-	-	-	-	-	-	-	-
16	b) Bring 5% of Production to International Export Price		-	-	-	-	-	-	-	-	-	-
17	**Intervention-6**		-	122	257	404	564	735	765	796	828	861
18	Expected Additional Revenue from Pulp/Puree Processing		-	-	-	-	-	-	-	-	-	-
19	**Total Expected Additional Gross Benefits [TEAG**		-	28,097	59,334	93,980	132,318	142,655	153,287	164,370	175,920	187,953
20	**Expected Costs**		-	-	-	-	-	-	-	-	-	-
21	Renovation of Gardens: Cost of Orchard Establishment		1,378	1,378	1,378	1,378	1,378	-	-	-	-	-
22	Renovation of Gardens: Cost of Orchard during Gestation Period		1,104	2,208	3,312	4,416	5,520	4,416	3,312	2,208	1,104	-
23	Cost of Increase in Productivity (yield)		-	1,488	2,288	3,126	3,204	3,283	3,365	3,448	3,533	-
24	Cost for Reducing PHL		-	3,354	5,155	7,044	7,334	7,634	7,944	8,266	8,598	-
25	Cost of Improve Quality of Produce		-	4,231	6,659	9,311	9,694	10,091	10,501	10,926	11,365	-
26	Operational cost of Pulp/Puree Making		995	2,090	3,289	4,598	5,985	6,230	6,483	6,745	7,016	-
27	**Total Costs [TC]**		3,477	14,749	22,081	29,873	33,114	31,653	31,605	31,592	31,616	-
28	**Cluster Investments**		-	-	-	-	-	-	-	-	-	-
29	***Government***		-	-	-	-	-	-	-	-	-	-
30	Investments on Research & Development		96	72	36	24	12	-	-	-	-	-
31	Training of farmers for Global Gap		50	38	19	13	6	-	-	-	-	-
32	Training of value chain agents		23	17	9	6	3	-	-	-	-	-
33	Investments required on promotion of export (USD)		92	69	34	23	11	-	-	-	-	-
34	Investment on PMU		688	516	258	172	86	-	-	-	-	-
35	Government loans		1,454	1,563	1,686	1,824	254	-	-	-	-	-
36	***Subsidized private sector investment***		-	-	-	-	-	-	-	-	-	-
37	Investment on new plants for garden renovation		1,378	2,756	4,134	5,512	6,890	-	-	-	-	-
38	***Private Sector with government subsidized financial sup***		-	-	-	-	-	-	-	-	-	-
39	Certified mango nursery establishments		24	18	9	6	3	-	-	-	-	-
40	Certification of production processes (USD)		285	214	107	71	36	-	-	-	-	-
41	Value chain infrastructure (USD)		12,860	13,927	15,134	16,426	2,275	-	-	-	-	-
42	Pulping/puree Units (USD)		51	51	77	77	-	-	-	-	-	-
43	***Total investments (USD) [TI]***		17,002	19,242	21,503	24,154	9,577	-	-	-	-	-
44	**Net Benefits [TEAGB]-[TC]-[TI]**		- 20,479	- 5,893	15,750	39,953	89,627	111,002	121,682	132,777	144,303	187,953
45	Estimated Internal Rate of Return [IRR]		97%									-

9.3. Economic, Social and Environmental Returns (Sindh Cluster)

Cluster development investments are expected to help generate revenues from the year 2 of interventions. In the Sindh cluster, the gross revenues before mango cluster development are estimated to be ranging from US$ 98.48 million in second years to US$ 101.46 million in the 10th year. All the five cluster interventions are expected to result in additional gross revenues of US$ 12.66 million in second year and US$ 66.75 million in the 10th year. All the value chain costs including those related to the production, processing, marketing and selling are applicable from year 1 through to year 5, the total of which ranges from US$ 3.50 million in first year and US$ 9.97 million in the 9th year (Table 15).

Offsetting these value chain costs from revenues, net economic benefit in first of interventions will be negative US$ 9.07 million in year 1 as no revenues or benefits are expected in first year of cluster development interventions. The net economic benefits are expected to range from US$ 0.10 million in the 2nd year to US$ 66.75 million in the 10th year (Table 14).

Figure 22 : Economic Returns and Investments in Sindh Cluster

	A	B	C	D	E	F	G	H	I	J	K	L
7	Intervention-2		-	3,584	7,195	10,833	14,498	14,553	14,607	14,661	14,716	14,771
8	Expected Additional Revenue from Increased Yield		-	-	-	-	-	-	-	-	-	-
9	Intervention-3		-	2,479	5,157	8,035	11,115	11,312	11,510	11,710	11,910	12,112
10	Expected Additional Revenue from Reduction in Post Harvest Losses		-	-	-	-	-	-	-	-	-	-
11	**Intervention-4**		-	1,151	2,373	3,674	5,060	5,060	5,060	5,060	5,060	5,060
12	Expected Additional Revenue with Improvement in Export-Production R		-	-	-	-	-	-	-	-	-	-
13	**Intervention-5**		-	2,991	6,430	10,361	14,830	15,053	15,277	15,502	15,729	15,957
14	Improvement in value chain		-	-	-	-	-	-	-	-	-	-
15	a) Bring national export price to international export price		-	-	-	-	-	-	-	-	-	-
16	b) Bring 5% of Production to International Export Price		-	-	-	-	-	-	-	-	-	-
17	**Intervention-6**		-	-	-	-	-	-	-	-	-	-
18	Expected Additional Revenue from Pulp/Puree Processing		-	-	-	-	-	-	-	-	-	-
19	**Total Expected Additional Gross Benefits [TE**		-	10,205	21,156	32,903	45,504	47,530	49,570	51,625	53,694	55,779
20	**Expected Costs**		-	-	-	-	-	-	-	-	-	-
21	Renovation of Gardens: Cost of Orchard Establishment		809	809	809	809	809	-	-	-	-	-
22	Renovation of Gardens: Cost of Orchard during Gestation Period		648	1,296	1,943	2,591	3,239	2,591	1,943	1,296	648	-
23	Cost of Increase in Productivity (yield)		-	1,207	1,818	2,433	2,442	2,451	2,460	2,470	2,479	-
24	Cost for Reducing PHL		-	975	1,519	2,101	2,138	2,176	2,214	2,252	2,290	-
25	Cost of Improve Quality of Produce		-	1,148	1,778	2,448	2,496	2,544	2,593	2,642	2,691	-
26	Operational cost of Pulp/Puree Making		-	-	-	-	-	-	-	-	-	-
27	**Total Costs [TC]**		1,456	5,435	7,866	10,382	11,124	9,763	9,210	8,658	8,107	-
28	**Cluster Investments**		-	-	-	-	-	-	-	-	-	-
29	***Government***		-	-	-	-	-	-	-	-	-	-
30	Investments on Research & Development		64	48	24	16	8	-	-	-	-	-
31	Training of farmers for Global Gap		20	15	8	5	3	-	-	-	-	-
32	Training of value chain agents		15	11	6	4	2	-	-	-	-	-
33	Investments required on promotion of export (USD)		80	60	30	20	10	-	-	-	-	-
34	Investment on PMU		688	516	258	172	86	-	-	-	-	-
35	Government loans		387	396	481	442	5	-	-	-	-	-
36	***Subsidized private sector investment***		-	-	-	-	-	-	-	-	-	-
37	Investment on new plants for garden renovation		809	1,617	2,426	3,234	4,043	-	-	-	-	-
38	***Private Sector with government subsidized financi***		-	-	-	-	-	-	-	-	-	-
39	Certified mango nursery establishments		24	18	9	6	3	-	-	-	-	-
40	Certification of production processes (USD)		321	241	121	80	40	-	-	-	-	-
41	Value chain infrastructure (USD)		3,172	3,343	4,240	3,930	-	-	-	-	-	-
42	Pulping/puree Units (USD)		-	-	-	-	-	-	-	-	-	-
43	***Total investments (USD) [TI]***		5,581	6,266	7,601	7,910	4,199	-	-	-	-	-
44	**Net Benefits [TEAGB]-[TC]-[TI]**		- 7,037	- 1,494.93	5,688	14,611	30,181	37,767	40,360	42,966	45,587	55,779
45	Estimated Internal Rate of Return [IRR]		99%									-

9.4. Conclusion

In conclusion, the overall economic, social and environmental impact of the cluster development program shall be positive, sustainable and long lasting. Accounting for all the fixed costs and variable costs including the production, processing and marketing cost, the estimated Internal Rate of Return (IRR) for Punjab cluster 34%; and for Sindh cluster the IRR is 41%, based on respective investment costs in each region and the present value of resulting revenues over the period of ten years. These estimated IRRs signify the fact that cluster development interventions likely to have positively.

10. Annexures

Annexure 1: List of Stakeholders Consulted

Sr. No	Name	Institution	Location
1	Dr. Shahid Masood	PCSIR - Dehydration	Lahore
2	Malik Ijaz	Sitara HWT processor	Lahore
3	Mujib Arjamand	Grower - JDW	Sadiqabad
4	Tahir Hussain	FSC&RD	Lahore
5	Syed Fayaz Ali	SFA - Value Addition	Kabirwala
6	Kashif Razzak	Grower	Muzaffargarh
7	Mohd Waris Bhatti	Grower	Muzaffargarh
8	Zahis Gardezi	Grower	Multan
9	Nadeem Farooq	Grower	Shujabad
10	Kashan A Chaudhry	Kashan Enterprises - HWT processors	Multan
11	Dr Asif Ali - VC	NS University	Multan
12	Mohd Tariq	NS University	Multan
13	Abid Hameed	NS University	Multan
14	Maqbool Alam	NS University	Multan
15	Allah Baksh	Dir. Multan Research Institute	Multan
16	Abdul Ghaffar	Mango Research Station	Shujabad
17	Shezad Abbas	Dir. Extension Punjab	Lahore
18	Sajid Ahmed	Dy Director (Tech) Agriculture Dept	Lahore
19	Naseer Ahmed	Dy Dir Agri Extension Punjab	Lahore
20	Abid Mahmood	DG (Research) Agri Dept Punjab	Lahore
21	Allah Ditta	TDAP	Lahore
22	Mohd Asif	SMEDA	Lahore
23	Mohd Najeeb Ullah	DIrector AARI	Faisalabad
24	Dr. Atta ur Rehman	AARI	Faisalabad
25	Dr. Mohsin Malik	AARI	Faisalabad
26	Moiz Aziz	AARI	Faisalabad
27	Ghulam Ishaq	PEEP/USAID	Lahore
28	Tariq Qamar	BVC	Lahore
29	Shahid Sultan	Zahid Packaging	Bhalwal
30	Imdad Nazamani	Grower	Sindh
31	Hadi Leshari	Grower	Sindh
32	Abro Sarwar	Grower/Processor	SIndh
33	Shafiq ur Rehman	Sindh Horticulture Research Institute	Mirpur Khas
34	Dr Waqar Ahmed	PATTA	Lahore
35	Shafqat	Model Farms Project Punjab	Lahore
36	Zahoor Alam	Horticulture Consultant	Islamabad
37	Syed Abad Hussaini	Agriculture Economist Consultant	Islamabad
38	Mujahid Ali	Commission Agent	Lahore

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Annexure 3: Process of Product Certification

During the past few decades the reduction of tariff and other trade barriers has resulted in a phenomenal increase in the international trade of agriculture and food products. However, the internationalization and privatization of standards that has accompanied this globalization trend has resulted in grades and standards taking on greater meaning in terms of consumer and retailer demands for quality, safety, authenticity and sustainability. This phenomenon represents new barriers to entry and continued market access in the form of compliance requirements and costs for producers, processors and traders. Unless Pakistan's agribusiness products conform to the increasingly higher standards, the agribusiness sector will not be able to enter, let alone compete, in world markets under a WTO regime. There is, thus, an immediate need to enhance the ability of growers and agribusiness enterprises to respond to sanitary and phyto-sanitary (SPS) and food-quality standards to meet the increasingly stringent international market requirements especially the high end markets. Improved product quality and compliance with safety standards will facilitate the integration of growers and enterprises with supply chains that go beyond the local markets.

Certification especially Global GAP is an expensive undertaking from year to year if it is not rewarded with better price. In past experience shows that many did not renew its annual as they had to sell it in the local market with no price advantage. In order to reduce the certification costs, farmers group (FEGs) shall be formed to undertake certification jointly, such program has been undertaken before in mango sector. Another module is the create Producer Marketing Organization (PMO) where the processors take the lead to implement Certification of the group of farmers they are sourcing produce under contractual arrangement. It is recommended that for next five years the government should pick up the cost of the certification charged by certifying company, all other expenses incurred on the farm improvement would be borne by the farmer.

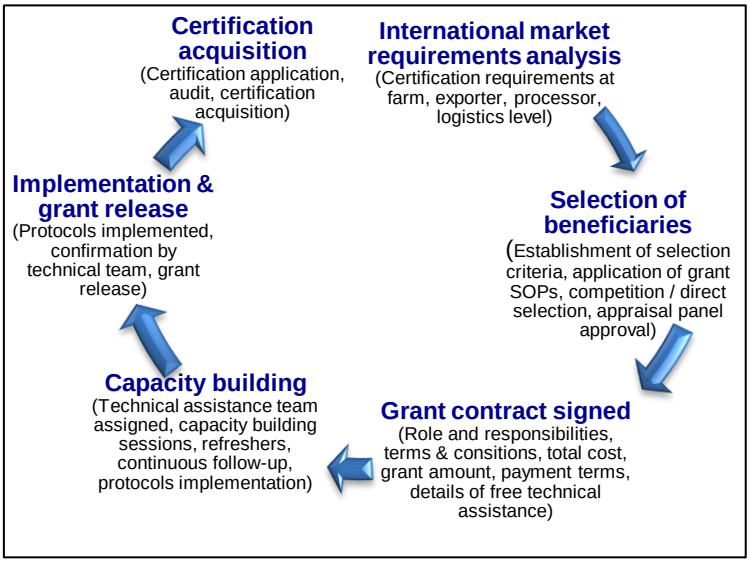

Figure 8: An international certification support model

PMUs would hire the services of a Certifying Agency to support growers and enterprises to acquire international certifications, including quality assurance and food-safety compliance certifications such as: Global GAP, IFS, ISO 22000, FSSC 22000, BRC etc. This program shall be implemented in collaboration with domestic and international certifying bodies and shall play a pivotal role in increasing competitiveness of the target agriculture value chains and enable the participants to integrate into the global market.

An international certification support model (Figure 8), which has been successfully deployed for over a decade in all the international certification support programs implemented in

Pakistan. The model combines the following elements in a single framework: establishment of international markets requirements regarding certifications, target participants of certification program, selection mechanism, mechanism for technical assistance and grants support to acquire certification. The above-noted elements of the model shall be implemented as follows:

Based on the value chain development strategy, a concept note should be prepared for international market requirements for certifications at: (1) farm level, and (2) processors and value addition level. The concept document shall also very specifically identify and describe target participants (farmers, processors, etc.) of the international certifications support program at each of the two levels noted above. Tentative criteria for the selection of participants should also be provided in the concept document. The document should also contain a plan for implementation of international certifications support program. The concept note together with the implementation plan shall be approved by PMUs for further implementation.

Annexure 4. Flow of Costs and Returns at Value Chain Level

Flow of Costs and Returns at Value Chain Actors Level – Domestic Supply (Rs.)

Costs/Returns	Grower	Grower	Transporter	Commission Agent	Wholesaler	Retailer
Cost per Kg	Raw Material	0			34.5	39.5
	Production	8.04				
	Harvest	2.00				
	Packing	4.6				
	Transport	2.5	1.35			
	Others	3.31		1.88	2.5	8.3
Total Cost/KG		20.45	1.35	1.88	37.00	47.80
Cost Flow		18.9%	1.2%	1.7%	34.1%	44.1%
Revenues /KG		34.5	2.5	3.76	39.5	63.75
Gross Margins		14.05	1.15	1.88	2.50	15.95
Return Flow (%)		39.5%	3.2%	5.3%	7.0%	44.9%

https://pdf.usaid.gov/pdf_docs/PA00K812.pdf

Flow of Costs and Returns at Value Chain Actors Level – Exporter (Sea Shipment) (Rs)

	Grower	Grower	Transporter	Exporter - Sea Shipment
Cost per Kg	Raw Material	0		40.5
	Production	8.04		
	Harvest	2.00		
	Packing			16.75
	Processing	6		
	Transport			29.75
	Others	0.5	1.68	
Total Cost/KG		16.54	1.68	87.00
Cost Flow		15.7%	1.6%	82.7%
Revenues /KG		40.5	3.12	150
Gross Margins		23.96	1.44	63.00
Return Flow		27.1%	1.6%	71.3%

https://pdf.usaid.gov/pdf_docs/PA00K812.pdf

Flow of Costs and Returns at Value Chain Actors Level – Exporter (Air Shipment)(Rs)

	Grower	Grower	Transporter	Exporter - Air Shipment
Cost per Kg	Raw Material	0		40.5
	Production	8.04		
	Harvest	2.00		
	Packing			15
	Processing	6		
	Transport			167.85
	Others	0.5	1.03	
Total Cost/KG		16.54	1.03	223.35
Cost Flow		6.9%	0.4%	92.7%
Revenues /KG		40.5	1.9	279
Gross Margins		23.96	0.87	55.65
Return Flow		29.8%	1.1%	69.1%

https://pdf.usaid.gov/pdf_docs/PA00K812.pdf

There are many actors in the mango value chain each having different cost and returns. In order to get a better understanding of the scenario, distribution margins for each market intermediary have been estimated. The distribution margin or price spread is the difference between the price paid and received by each specific market intermediary. The market intermediaries involved in the traditional chain include grower, contractor, transporter, commission agent, wholesaler and the retailer. Another chain is the processor/exporter sourcing mangoes directly from the growers and either he processes and exports mangoes by air or by sea, incurring different cost curves.

There is a general perception that intermediaries involved in the marketing of agricultural produce take away a major share of the total profit. As shown in the tables above, the retailer received a maximum share of 44.9 percent in the distribution margin while the wholesaler, commission agent and transporter received 7 percent, 5.3 percent and 3.2 percent share in the distribution margin respectively. Whereas the growers share is 39.3 percent which provides high returns per kg without any value addition. It may explain here that farmers get better price in unit terms but returns per acre is low, probably due to low yield. The retailer's share in the distribution margin is calculated on the assumption that the total produce purchased by him is sold at a given price. However, in reality the retailer is the last owner of the produce and has to bear all kinds of losses, since produce left unsold fetches a much lower price the next day.

In addition, two scenarios have been developed i.e. structure of supply chain in case of exports by air and through sea shipments. The table above explains the typical export supply chain Distribution Margin (DM) increases at each actor level and the ultimate price reached at optimum value passing through different channels of mango value chain.