CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

Cherry Cluster Feasibility and Transformation Study

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

February 2020

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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

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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 Yaseen. 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

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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 especially Mr. Yasar Saleem Khan 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.

Izhar Hunzai
Senior Author

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DISCLAIMER

This report is prepared by using 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 Special Initiatives or the Centre for Agriculture and Bioscience International (CABI).

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ADP	Annual Development Plan
AKRSP	Aga Khan Rural Development Programmer
AQSIQ	Administration of Quality Supervision, Inspection and Quarantine (of China)
CAAS	Chinese Academy of Agriculture Sciences
CDF	Cluster Development Fund
CGIAR	Consultative Groups on International Agriculture Research
CPEC	China Pakistan Economic Corridor
CO	Community Organization
FFs	Farmer Field School
FEG	Farmer Enterprise Group
Ha	Hectare
GAP	Good Agriculture Practices
GB	Gilgit-Baltistan
GI	Geographical Identification
GoP	Government of Pakistan
IPPC	International Plant Protection Convention
ISPMs	International Standards for Phytosanitary Measures
ISO	International Standard Organization
KIU	Karakorum International University
KKH	Karakoram Highway
KPK	Khyber Pakhtunkhwa
MARC	Mountain Agricultural Research Centre
MINFAL	Ministry of Food, Agriculture and Livestock
NARC	National Agriculture Research Council
NGOs	Non-Governmental Organizations
PARC	Pakistan Agriculture Research Council
PCSIR	Pakistan Council for Scientific and Industrial Research
PKR	Pakistani Rupee
PHDEC	Pakistan Horticulture Development and Export Company
R&D	Research & Development
SWOT	Strengths, Weaknesses, Opportunities, Threats
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
US$	United States Dollar
VO	Village Organization

EXECUTIVE SUMMARY

According to the last latest available statistics, the global production of cherries is 3.6 million tonnes from an area of 0.6 million ha having an average per ha yield of 3.6 tonnes per ha. On the other hand, Pakistan produces 6.0 thousand tonnes of Cherries from 2.5 thousand ha of wide spread hilly terrain with an average yield of 2.4 tonnes per ha. The global trade in normal and sour fresh cherries has reached to US$2.3 billion which is expected to reach US$5.0 billion by 2022. Turkey is the leader in global production with 0.48 million tonnes of cherry produce. On the export side, USA leads the world followed by Chile. The top importer of fresh cherries is China followed by Russia and the European Union.

Pakistan ranks 49th among the world's cherry producing countries. Pakistan has made a good start in cherry production since 2001. Starting from a low base, expansion in area under cherry and its production is higher than the world average growth rates, but its per ha yield remains about 60% lower than the world average and the gap is widening because of 27% slower growth in per ha yield than the world average over the period of 2000s. Moreover, cherry production in Pakistan has been contributing almost nil in international cherry market. Whatever little is exported; the export price earned by Pakistani export is only 56% of the world average export price because of the lack of proper value chain.

In this scenario, the Planning Commission of Pakistan has initiated this study to analyze its whole chain, identify gaps and potentials at different segment of the chain, and propose intervention, strategies and policies to improve efficiency of cherry production, value addition, processing, marketing and trade in the country. To incorporate the regional variations in cherry value chain, this analysis is planned to be conducted at major cherry growing clusters in the country. To achieve these objectives, macro data were analyzed, stakeholders along the value chain were consulted and literature were reviewed.

Gilgit-Baltistan (GB) and Balochistan are the main cherry growing regions in Pakistan. Two cluster are identified in this study: i) Northern Cluster in Gilgit-Baltistan province consisting of Gilgit, Hunza, Nagar and Ghizer districts with Hunza as its centre point; ii) Southern Cluster in Balochistan consisting of Ziarat, Quetta, Pishin, Kalat & Zhob with Ziarat being centre point.

As part of this study, several performance gaps were identified in the production, processing and trading components of the value chain, specifically in technology, market structure and availability of input. These included limited access to improved commercial cherry cultivars to produce high quality fruit and the absence of post-harvest technologies such as packaging, cold storage and refrigerated transport for trading in the high-value fresh cherry market. The water shortage especially in Southern Cluster is keeping cheery per ha yield very low.

However, Pakistan has great potential to overcome these constraints because of a number of advantages, including proximity to major cherry market like China, the seasonal difference with the main producers, and favourable production costs, especially labour. Domestic demand for fresh cherries is also growing, especially as the harvest timing in Gilgit-Baltistan coincides with the tourism season.

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In order to bridge these gaps, from production to product and market development, performance targets have been set, benchmarked on global averages for yield, quality and export standards. Based on these parameters and keeping in view the assessed gaps and constraints, specific interventions have been proposed for both the clusters. These interventions include renovation of old low-density gardens with modern varieties, high density gardens with improved management practices and incentivizing value chain and processing infrastructure which will not only improve productivity, reduce post-harvest losses but also enhance quality of cherry for the domestic and international markets resulting higher profit of all value chain actors. These interventions are to be initiated by government and executed in collaboration with, and participation of the private sector, including farmers, traders and their groups/ associations.

The estimated capital investment for the upgradation of both the clusters is US$2.47 million, while also requiring US$ 2.7 million as working capital over the project period of five years. These investments are focused on increasing production, reducing postharvest losses and increasing value-added processing, targeting premium domestic and export markets. This will generate an NPV worth of US$ 9.3 million in different segments of the cherry value chain in both clusters, producing an IRR of 62%. The cluster level details of these costs and estimated economic returns from these investments are summarized in the attached summary sheet.

To achieve these benefits of the upgradation plan, the government has to adopt the cluster approach by understanding and fulfilling the needs of each cluster separately, invest on strengthening research and advisory services and enhance the capacity of stakeholders along the value chain to produce and manage the quality cherry from production to consumption.

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Summary Sheet for Cherry

Information	BL	GB	Overall
Area of cluster focal point (ha)	452	159	611
Production (tonnes)	905	705	1,610
Yield of the cluster (t/ha)	2.00	4.43	2.64
Area of the cluster (ha)	1,065	1,364	2,429
Production of the cluster (tonne)	1,981	3,897	5,878
Annual yield growth without intervention (%)	0.97%	1.33%	1.15%
Percent area renovated in 4 years	30%	30%	15%
Total orchards areas renovated in 5 years (ha)	320	409	729
Increase in yield due to orchards renovated (%)	100%	75%	100%
Increase in production due to orchards renovated (t)	648	987	1,636
Additional production value from renovated area (M. US$)	1.296	1.481	2.777
Production to be processed for domestic market (T)	281	538	818
Income from enhanced value addition - domestic market (000 US$)	842.6	1,612.7	2455.3
Production that will be cold processed for export market (%)	10%	10%	10%
Production to be processed for export market (T)	140	269	409
Income from enhanced value addition for export (US$)	607,821	1,163,298	1,771,120
Production to be dried (T)	47	90	136.4
Income from drying for export and domestic market (US$)	327,691	671,961	999,652
Total number of cold store required	2	4	6
Total number of dryers required	2	4	6
Investment on strengthening research	100000	100000	
Investment on capacity building of FEGs	7888	101037	179,926
Investment on renovation of orchard area (US$)	639000	818400	1,457,400
Investment on cold processing plants (US$)	170000	340000	510,000
Investment on 23 drying units	20000	40000	60,000
Government loans on private investment	20900	41800	62,700
Total investment required year (US$)	**1,028,789**	**1,441,237**	**2,470,026**
Public investment	365,589	482,517	848,106
Private investment	663,200	958,720	1,621,920
Economic Analysis			
Total increase in production due to all the yield increasing interventions (t)	648	987	1,636
Gross revenue (undiscounted) in 5th year	3,075	4,929	8,004
Additional operation costs in 5th year	934	1,763	2,697
Net cash flow (undiscounted) in 5th year	2,140	3,166	5,306
NPV (M.US$)	3,364.77	6,029.36	9,394.14
Internal Rate of Return	53.96%	68.73%	62.56%

1. INTRODUCTION

Cherry (*Prunus avium L.)* is a temperate fruit and grown in the valleys and foothills of the southern and northern mountains of Pakistan. It requires 100-900 chilling hours at flowering and dry weather conditions at the time of fruiting. Sweet cherries contain polyphenolic flavonoid compounds, known as anthocyanin glycosides, which have potent antioxidant and anti-carcinogenic features. These anthocyanins may help against chronic painful conditions, such as gout arthritis, muscle complications and sports injuries. Moreover, Melatonin, the other anti-oxidant found in cherries, is known to have soothing effects on neurons in the brain, calms the nerves, curbs irritability and regulates the sleep cycle (Murtaza 2016).

1.1 Cherry Sector in Pakistan

According to MNFS&R statistics and FAO Statistics, the total production of fresh cherries in 2016 in mainland Pakistan was 2,120 tonnes, with a world ranking of 47th producer. However, these figures do not include production from Gilgit-Baltistan (GB), because it is treated as a disputed area. When GB's production of 3,898 tonnes, grown on 1,363 ha (2014) of land is included, the total cherry production of Pakistan adds up to 6,013 tonnes, and Pakistan's ranking improves to 45th. GB and Balochistan provinces are the main cherry growing regions in Pakistan. The largest producer is GB, with a 64.77% share in the total cherry production in 2014. The second largest producer is Balochistan with a share of 32.92%. The remaining 2.31% is produced in KPK. The total area devoted to cherries in Pakistan is about 2,512 ha. The average yield in Pakistan is calculated as 2.42 t/ha, which comes to about 45% of the global average (Table 1).

Table 1: Major Cherry Producing Provinces in Pakistan (2016)

S#.	Province	Production (Tonne)	Production Share (%)	Area (ha)	Area share (%)	Yield (t/ha)
2	Balochistan[1]	1,981	32.92	1,065	42.38	1.86
3	Other[1]	139	2.31	84	3.34	1.66
	Mainland Pakistan[1]	2120	35.23	1149	4572	1.84
1	Gilgit-Baltistan[2]	3,897	64.77	1,363	54.28	2.86
	TOTAL	**6,018**	**100**	**2,513**	**100**	**2.39**

Source: [1]MNFS&R (2017) and [2]GGB (2015)

Cherry is a high value horticulture product, having potential to increase income and employment opportunities, especially in such marginalized areas as Balochistan and Gilgit-Baltistan.

Table 2: Long Term Production Trends of Cherry in Pakistan by province during 2001-16

Year	Gilgit-Baltistan			Balochistan			Pakistan		
	Area (ha)	Prod. (tonnes)	Yield (t/h)	Area (ha)	Prod. (tonnes)	Yield (t/h)	Area (ha)	Prod. (tonnes)	Yield (t/h)
2001	1,135	2,678	2.36	895	1,555	1.74	2,049	4,263	2.08
2002	1,141	2,692	2.35	873	1,464	1.68	2,038	4,192	2.06
2003	1,157	2,569	2.22	1,092	1,850	1.69	2,325	4,534	1.95
2004	1,168	2,631	2.25	1,121	1,937	1.73	2,341	4,648	1.99
2005	1,197	2,713	2.27	1,134	2,006	1.77	2,378	4,793	2.02
2006	1,217	2,786	2.29	967	1,612	1.67	2,195	4,415	2.01
2007	1,226	2,854	2.33	989	2,292	2.32	2,229	5,175	2.32
2008	1,239	2,901	2.34	979	2,280	2.33	2,234	5,215	2.33
2009	1,247	2,987	2.40	981	1,955	1.99	2,240	4,963	2.22
2010	1,258	3,112	2.47	977	1,944	1.99	2,251	5,085	2.26
2011	1,279	3,231	2.53	982	1,953	1.99	2,272	5,204	2.29
2012	1,286	3,365	2.62	992	1,979	2.00	2,289	5,364	2.34
2013	1,307	3,733	2.86	1,046	1,949	1.86	2,372	5,714	2.41
2014	1,323	3,779	2.86	1,051	1,943	1.85	2,425	5,806	2.39
2015	1,349	3,855	2.86	1,055	1,961	1.86	2,477	5,938	2.40
2016	1,364	3,898	2.86	1,065	1,981	1.86	2,513	6,018	2.39
Average annual growth (%)	*1.23*	*2.58*	*1.33*	*1.44*	*2.52*	*0.97*	*1.45*	*2.47*	*1.04*

Source: MNFS&R (2017)

Cherry production in Pakistan has been expanding at a modest rate of 2.47% per annum during 2001-16, which is higher than the growth in population at 2.24%. This implies that per capita consumption is slowly and gradually improving overtime. Most of the increase came from the expansion in area while per ha yield also improved during the period (Table 2).

Because of its high commercial value, farmers and traders are extremely careful in handling the product at every stage of the value chain. Still, postharvest losses range from 10% in the mainland to 20% in GB, without including the losses during transportation and at the wholesale and retail levels. Fruits that are damaged during harvest are separated at the time of grading, and are dried and sold, separately.

Almost 99% of cherries produced in the country are consumed in the domestic market. As a matter of proximity to nearest consumer markets, cherries produced in GB are supplied and sold in the markets of Islamabad and Punjab, while fresh cherries coming from Balochistan are sold in the urban centers of Sindh, such as Karachi and Hyderabad and Southern Punjab.

1.2 Global Context

Cherry production in Pakistan is far behind the world level in terms of per ha yield, export to production ratio, export and export price (Table 3). For example, Pakistan gets only 40% of the world average yield, it exports a negligible quantity while globally 24% of the production is exported, and its export earns only 56% of the average world export price suggesting that Pakistani cherry does not compete in international market due to its poor quality. However, farm gate price of cherries in Pakistan is far below the international average farm gate price, which shows that Pakistan has a competitive edge over the global cherry value chain at the production level.

Table 3: Comparison of world vs. Pakistani cherry sector (2016)

Parameter	World	Pakistan	Share (%)
Area	605.3	2.5	0.41
Production (000) tonnes	3643	6.0	0.06
Yield (tonne/ha)	6.0	2.4	40.0
Value of production at farm level (Only mainland) (million US$)	5003	3.0	0.06
Farm gate price (US$/tonne)	2181	1500	69
Volume of trade (000) tonne	585	0.007	0.00
Value of international trade (US$ milion)	2318	0.004	0.00
Export quantity as % of production (%)	24	0.32	-
Export value as % of production value	55	0.44	-
Average export prices (US$/tonne)	4328	2429	56.11

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

Global cherry production has increased from 2.9 million tonnes in 2001 to 3.6 million tonnes during 2017 with an average growth rate of 1.6% per annum. This growth in production is higher than the world population growth of 1.19% during the period suggesting international growth in per capita consumption, although relatively slowly. Most of the increase in cherry production came from the expansion in per ha yield under cherry at 5.5% per annum, while area growth during the period is insignificant at 0.2% per annum (Table 4).

In Pakistan, although rate in cherry production during the same period is higher (albeit from a very small base) than the world average but Pakistan attained this growth mainly due to the expansion in area while at the global level main source of cherry production increase is per ha yield. In Pakistan, the per ha yield is already lower than the world average (Table 3) but this gap has been widening as its growth in the country is about 27% lower than the world average. To export cherry internationally, Pakistan has to narrow this wide and increasing yield gap with the world average.

Table 4: Global trends in cherry production by type during 2001-16

Year	Cherry (normal)			Cherry Sour			Total		
	Area (000 ha)	Production (000 tonne)	Yield (tonne/ ha)	Area (000 ha)	Production (000 tonne)	Yield (tonne/ ha)	Area (000 ha)	Production (000 tonne)	Yield (tonne/ ha)
2001	342.8	1815.7	5.30	240.0	1122.5	4.68	582.8	2938.2	5.04
2002	341.9	2094.4	6.13	231.3	972.8	4.21	573.2	3067.1	5.35
2003	349.3	1716.1	4.91	248.5	1133.3	4.56	597.8	2849.4	4.77
2004	347.2	1697.4	4.89	266.4	1239.1	4.65	613.6	2936.5	4.79
2005	355.6	1843.6	5.18	239.0	1154.2	4.83	594.5	2997.9	5.04
2006	378.6	1903.4	5.03	259.5	1142.3	4.40	638.0	3045.7	4.77
2007	378.9	1990.6	5.25	252.7	1192.0	4.72	631.6	3182.6	5.04
2008	378.2	1856.7	4.91	226.1	1221.0	5.40	604.3	3077.7	5.09
2009	394.7	2158.0	5.47	230.8	1339.5	5.80	625.4	3497.5	5.59
2010	396.6	1998.3	5.04	216.4	1130.7	5.22	613.0	3129.0	5.10
2011	404.5	2155.9	5.33	226.7	1252.2	5.52	631.1	3408.1	5.40
2012	403.4	2187.1	5.42	226.1	1160.8	5.13	629.6	3347.9	5.32
2013	416.8	2276.5	5.46	205.8	1385.8	6.73	622.6	3662.3	5.88
2014	406.6	2154.8	5.30	208.2	1332.2	6.40	614.7	3487.0	5.67
2015	394.2	2230.9	5.66	189.6	1339.9	7.07	583.8	3570.8	6.12
2016	418.9	2359.5	5.63	198.0	1402.9	7.08	617.0	3762.3	6.10
2017	416.4	2443.4	5.87	188.9	1199.9	6.35	605.3	3643.3	6.02
Growth rates (%)	1.3	1.8	0.48	-1.7	1.3	3.04	0.2	1.6	1.41

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

The two types of cherry, cherry (normal) and cherry sour, are produced in international market. Although growth in production in both are similar, but cheery sour has much higher rate of increase in yield than cheery (normal), while the area of the former has declined overtime (Table 4).

With an estimated production of 0.48 million tonnes in 2016, Turkey is the top producer of cherry in the world. The per ha yield of cherry is highest in Uzbekistan as well as in Turkey, USA and Iran (Table 5). As Pakistan has close cultural and economic relations with these countries thus can learn about efficient cherry production from these.

Table 5: Top Cherry Producing Countries of the World (2016)

Rank	Country	Production (Tonnes)	Area (ha)	Yield (t/ha)
1	Turkey	480,748	84,746	7.08
2	United States	384,646	37,110	7.77
3	Iran	200,000	28,397	7.76
4	Italy	104,766	29,970	3.17
5	Spain	98,400	25,252	3.73
6	Chile	90,000	24,498	5.03
7	Uzbekistan	84,000	10,808	8.81

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

The largest volumes of cherry are traded and consumed as fresh. As reported earlier, small quantities that are bruised during harvest and separated out during grading, are dried and traded in niche markets. Cherry exports surpassed US$2.3 billion in 2017, an increase from US$383 million since 2001 with an average annual growth rates of 7.8% in its quantities and 11.7% in values (Table 6). The growth rate in cherry export is far higher than that in production during the same period suggesting that cherry is becoming an international commercial commodity where increasing share of its production is consumed in other countries than where originally it is produced. These trends are set to continue over the coming years on the back of advances in postharvest technology, genetics and growing methods, e-commerce platforms and new destination markets.

It is worth noting, however, that growth rates in cherry (normal) both in terms of quantity and values are much higher than those in sour cherry. Therefore, Pakistan in its future strategies should focus on normal taste cherries.

Pakistan could not benefit from the internationally fast-growing cherry market, as its share in global export remains insignificant.

Table 6: Growth in global cherry export during 2001-16

Year	Cherry (normal)		Cherry Sour		Total	
	Quantity (1000 tonne)	Value (Million US$)	Quantity (1000 tonne)	Value (Million US$)	Quantity (1000 tonne)	Value (Million US$)
2001	138.9	348.4	46.0	34.2	184.9	382.6
2002	153.8	382.3	29.3	25.9	183.1	408.2
2003	185.2	485.7	40.2	46.1	225.4	531.7
2004	194.3	600.2	53.8	60.2	248.1	660.4
2005	214.8	647.8	30.0	28.0	244.8	675.7
2006	259.4	727.6	46.1	39.4	305.5	767.0
2007	244.1	812.1	41.6	45.1	285.7	857.1
2008	250.8	972.8	54.9	49.2	305.7	1022.0
2009	304.3	1059.6	41.5	34.4	345.8	1094.0
2010	324.3	1271.1	30.0	32.5	354.4	1303.6
2011	376.2	1528.7	43.2	66.5	419.4	1595.2
2012	394.0	1666.0	58.1	100.9	452.1	1766.9
2013	360.8	1564.5	71.2	103.9	432.0	1668.4
2014	437.4	1951.5	68.1	96.6	505.5	2048.1
2015	479.4	1746.6	83.2	101.3	562.6	1847.8
2016	544.2	2364.7	68.9	87.3	613.1	2452.0
2017	514.0	2189.3	70.5	128.7	584.5	2318.0
Growth rate (%)	**8.2**	**11.9**	**4.6**	**8.5**	**7.6**	**11.7**

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

USA and Chile are major exporters of fresh cherries in the world contributing about 28% of the world export in value term. This is closely followed by Chile with a share of 23% (Table 7). Competing with these countries internationally would be difficult, but Pakistan can capture the

South China market from GB-production if the country can improve its cherry yield and develop value chain.

Table 7: Top Cherry Exporting Countries of the World (2016)

Rank	Country	Export (million US$)	% share
1	United States of America	618.2	28.2
2	Chile	513.2	23.4
3	Hong Kong (re-exports)	301.6	13.7
4	Turkey	159.0	7.2
5	Spain	77.6	3.5
6	Austria	69.8	3.2
7	Uzbekistan	66.7	3.0

Source: http://www.worldstopexports.com/sweet-cherries-exports-by-country/

China remains the top importer of fresh cherries in the world. It imported 102,000 tonnes in 2017, valued at US$ 770 million, followed by Russia. Chile is the top exporter of fresh cherries to China, with a market share of 67.6%, followed by the USA, which had a market share of 26.5% (Global Markets Research, 2018).

Despite being next door to China, Pakistan's export of cherries to China is presently zero. The main reasons are strict phytosanitary standards required by China, which Pakistan presently does not meet. As will be discussed in the subsequent sections, there is good potential for export of both fresh and dried cherries to China from Pakistan.

1.3 Need of the Study

From this macro analysis of cherry at national and international level, we conclude that Pakistan has made a good start in cherry production. Starting from a low base, expansion in area under cherry and its production is higher than the world average growth rates, but its per ha yield is about 60% lower than the world average and the gap is widening because of 27% slower growth in per ha yield than the world average over the period of 2000s. Moreover, cherry production in Pakistan has contributed almost nil in the international cherry market. Whatever little is exported, the export price earned by Pakistan is only 56% of the world average export price because of the lack of proper value chain.

In this scenario, to improve the competitiveness of cherry value chain, the Planning Commission of Pakistan has initiated this study to analyze its whole chain, identify gaps and potentials at different segment of the chain, and propose intervention, strategies and policies to improve efficiency of cherry production, value addition, processing, marketing and trade in the country. To incorporate the regional variations in cherry value chain, this analysis is planned to be conducted at major cherry growing clusters in the country.

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2. GOAL 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 to:

1. Identify the major clusters of cherry production in Pakistan
2. Characterize and conduct SWOT analysis for each cherry cluster
3. Identify technical and investment gaps in each cluster
4. Assess potential for increased production and value-added trade/ export in each cherry cluster
5. Suggest investment strategies to reach the assessed potential
6. Conduct economic and social feasibility of the suggested interventions

2 METHODOLOGY

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

a) *Macro-data*. Relevant macro data were collected from various published and unpublished reports of government and non-governmental organizations and internet search on cherry value chain (see Annexure 1, for the macro data sources)

b) *Stakeholders Consultations*. Primary information was collected through meetings, consultations, key informant interviews, surveys and focus group discussions using structured tools and open-end questionnaires (see Annexure 2 for the list of stakeholders consulted).

c) *Literature Review*. The literature related to the functioning, gaps, and interventions in cherry value chain is reviewed and synthesized (see Annexure 3).

The following generic parameters and indicators are used in collecting the data:

- Global context of cherry sector;
- Production potential and review of cherry sector;
- Cost of production, harvest, postharvest processing of cherry 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; and
- Recommendations and benchmarks based on global parameters.

The author then used these data to first identify the cherry clusters in the country and then used this information to describe 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 potential. Based on the above analysis, specific interventions are proposed for effecting improvements in each cluster.

The costs and benefits of each intervention are estimated to finally work out the Internal Rate of Return (IRR) of the whole package using the EXL model developed in CABI. A Cherry Transformation Plan is also formulated, which identifies sustainable cluster upgrading strategies for the development of the cherry 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

According to a recent report by the Transparency Market Research (TMR, 2018), the expansion in the global fresh cherries' market, as noted earlier, is largely driven by improvements in postharvest technologies and e-commerce.

The Economist (2018) notes that the simmering trade tensions between the world's top two economies (USA and China) are set to erupt into a full-blown trade war. This may create a big space for Pakistani cherries, especially the ones produced in the GB province. Pakistan has formally asked China to encourage its products — mainly agricultural products — into its market to reduce the one-sided expansion in bilateral trade and take a strategic view of the long-term mutual benefits in the China-Pakistan Economic Corridor (CPEC). This should benefit cherry farmers in the southern cluster in Balochistan where China operates the deep seaport of Gwadar, on a long-term lease from Pakistan, and Gilgit-Baltistan, which is physically connected to its western borders. Pakistan and China have agreed in principle to broaden agro-cooperation by adopting a comprehensive approach to fast-track trade in agricultural products (*The News*, 2018). But this is only possible, when Pakistan implements agreed protocols under International Plant Protection Convention (IPPC), which is a major requirement for the export of agricultural products.

With a population of over 200 million people, and rapid growth in urbanization, experts agree that domestic marketing of fresh cherries also has a lot of potential in Pakistan. According to All Pakistan Fruit and Vegetable Exporters, Importers & Merchants Association (PFVA), fruit and vegetable exports from Balochistan can generate US$1billion per year (Reported in Profit, Pakistan Today, 2017). In an initiative to give better access to fruit and vegetables of Balochistan in international markets, PFVA recently completed the consultation process with stakeholders of Balochistan for developing a roadmap for the uplift of the horticulture sector (*ibid*)

Balochistan is rich in all types of natural resources; it is also the "The Fruit Basket of Pakistan" (Samad, 2018). However, fruit production in Balochistan is largely dependent on irrigation, especially on groundwater, which has become a scarce resource. Over extraction, climate change and frequent droughts have created stiff competition for irrigation water among crops, including cherries (UNPO, 2015).

Balochistan has tremendous yield potential that can be exploited through smart planning, including adoption of more efficient irrigation technologies, establishment of crop-specific zones and reducing losses, both before and after harvest. Experts believe that the province should be divided into zones for quality fruit production (Fresh Plaza, 2017).

Gilgit-Baltistan depends largely on fruits and horticulture for its local economy (Daily Dawn, Nov 16, 2017), and there is good potential to increase productivity and enhance value for the local farmers, processors and traders. Enabling policies and smart planning are needed with a focus on establishment of proper infrastructure, transfer of technology and skills, and research and market information. Instead of investing in research and innovation, Pakistan's agriculture sector is focused on increased use of subsidized inputs, including chemical fertilizers, pesticides and irrigation water, which has led to stagnation in productivity," said

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CEO, Harvest Trading and member export Islamabad Chamber of Commerce & Industry, Ahmad Jawad (Dawn November 2017).

A key opportunity is tourism, which can be an important driver for developing the cherry and other sub sectors, especially in GB. Tourism linked with cherry blossoms is a well-known niche in the world (Marshall, undated)

Pakistan as a whole, and Balochistan and Gilgit-Baltistan in particular, are most vulnerable to the effects of climate change, especially new diseases. One aspect of the climate change impact is on the cultivation of early crops, such as cherries, which are most sensitive to slight shifts in weather patterns (Researchgate, 2016). The most devastating effect is that climate change seems to have increased the vulnerability of existing plantations to some dangerous diseases. For instance, the crown gall, which is a worldwide tumor-forming disease in the cherry, cherry and apples plants, appears to have already infected existing plantations in GB (Hussan, 2010).

Therefore, there is a need to identify the diseases present on farms, identify the causal agents and their virulence, determine the severity of the disease and its effect on yield, and seek proper management. There is also a need to develop resistant varieties of cherry against these diseases. Though plant diseases are a major threat to GB's food security, their rapid identification remains difficult due to the lack of the necessary infrastructure (Hano, Ajonok, 2018). Moreover, research capacity is needed to improve food security by reducing the yield losses caused by these diseases (Rasul and Hussain 2015)

4 CLUSTER IDENTIFICATION AND CHARACTERISTICS

4.1 Overview

In GB, cherry production is concentrated in four districts, including Gilgit, Hunza, Nagar and Ghizer which contribute about 71% of the cherry produced in the province (Table 5). These cherry producing districts can be considered as the *Northern Cluster*. This cluster can be developed with the brand name of *Hunza Cherry* as it is well recognized around the world.

Figure 1: Map of Pakistan Showing Cherry Production & Consumption

A key feature of cherry plantations in GB is that they are found along the Karakoram Highway (KKH) and other major road networks, not in the interior of districts, for easy access to transportation. Cherries are harvested in mid-May in the Gilgit district, which is at a lower elevation, followed by Nagar and Hunza districts, which are located in the transitional zone and, lastly, in upper Hunza, near the Chinese border, which is at an altitude of 3,000 m. In this way, the cherry season lasts from mid-May to mid-August, which is a major off-season advantage. The other key advantage is that the cherry and the tourism seasons overlap.

Table 8: Cherry Production in Gilgit-Baltistan (As of 2015)

Sr. No.	District/Location	Area (ha)	Production (tonnes)	Production (% of Total)	Yield (t/ha)
1	Gilgit	145	1,202	30.84	8.29
2	Hunza	160	705	18.09	4.41
3	Nagar	223	470	12.06	2.11
4	Ghizer	189	400	10.26	2.12
5	Skardu	218	231	5.93	1.06
6	Shigar	71	226	5.80	3.18
7	Kharmang	2	1	0.03	0.44
8	Ghanche	87	255	6.54	2.93
9	Astore	62	150	3.85	2.42
10	Diamer	208	258	6.62	1.24
	TOTAL	**1,365**	**3,898**	**100.00**	**2.86**

Source: GB Agriculture Survey Data (2014)

In Balochistan, cherry cultivation is concentrated in the north-western districts of Ziarat, Quetta, Pishin, Kalat and Zhob. Ziarat contributes nearly 46% of the total cherry production in the province, thus rightly remains as the focal district for the southern cluster. The average yield of the Southern cluster is 1.86 tonne/ha (Table 9).

Table 9: Cherry Production in Balochistan (As of 2015)

Sr. No.	Location	Area (ha)	Production (tonnes)	Production Share %	Yield (t/ha)
1	Ziarat	452	905	46	2.00
2	Quetta	249	462	23	1.85
3	Pishin	220	392	20	1.79
4	Kalat	122	222	11	1.82
	TOTAL	1,065	1,981	100	1.86

Source: Ministry of National Food Security and Research
http://www.mnfsr.gov.pk/pubDetails.aspx

4.2 Comparison of Cluster Characteristics

The northern cluster remains the main supplier for the nearest domestic markets from Islamabad to Lahore. The southern cluster supplies to the urban centers of Sindh and South Punjab. For the export window, the northern cluster can position itself for China market, while the southern cluster can target the Middle East. Table 9 below presents an overall comparison of key characteristics in both the clusters.

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Table 10: Characteristic and Comparison of Cherry Clusters

Salient Features	Northern Cluster (GB)	Southern Cluster (Balochistan)
Districts	Hunza, Nagar, Gilgit and Ghizer District (Gilgit Baltistan)	Quetta, Pishin, Ziarat & Kalat District (Balochistan)
Focal point district/Tehsil/Mouza	Hunza (for branding only)	Ziarat
Focal point area (ha)	159	452
Focal point production (t)	705	905
Area of the cluster: (ha)	1,364.00	1,150.00
Production: (Tonnes)	3,898.00	2,975.00
Average yield: (t/ha)	2.86	1.86
% of the crop area that lies in the cluster (Cherry area of the cluster/Cherry area in the country)	45	35
% of the total cropped area in the cluster (Cherry area in the cluster/total cropped area in the cluster)	7	5
Geographical and Environmental Factors	Sandy Loam	Sandy/silty texture
	Steppe and mountainous valleys	Mountainous and flat lands
	Mid-latitude steppe / semi-arid cool climate	The climate of four cherry producing districts is semi-arid (steppe) kalt (cold). It can be termed a “warm summer and cold winter
	Access to snow-melt/glacial water through water channels/ducts	Irrigation is dependent on ground water table level. The irrigation water is extracted from ground using tube wells. The traditional Karez system is also in practice in some areas
	Good quality surface water for irrigation	Poor quality of groundwater, and high costs of umping from ever greater depths.
	Average rainfall 50 to 2000 mm per annum, mostly in the form of snow on the mountain tops	Average rainfall 200–500 mm per year.
	Temperature rises up to 35 °C during summer but drops to -5°C on average during winter	Temperatures frequently rise above 35 °C between May and August. Dry hot days and cool nights are typical during the summer. In winters, temperature goes below zero degree Celsius, particularly during the nights.
	Frost and high precipitation in early spring during March and April impact the flowering and fruiting bearing capacity of cherry trees	Strong winds and dust storms may occur rarely during the month of May and June, causing nearly 20% impact on production capacity
	Mostly dry during the fruiting season of June-August	Dry and hot weather during May through July
Cherry Growers	Small land holding size (<=1 acres) on average	Medium size landholding ranging from 1 to 10 acres

Salient Features	Northern Cluster (GB)	Southern Cluster (Balochistan)
	More than 20,000 cherry growing households across the region	Every household owns at least 3 to 4 cherry trees in the districts
	Farmers Enterprise Groups are functional across the region, though no separate Cherry Growers Associations	No formal Cherry Growers Associations
	Labor is provided by households themselves at the time of harvest	Availability of abundant labor for cherry production practices, especially harvesting
Product Features	Mostly sweet (desert) cherries are grown	Mostly sweet (desert) cherries are grown
	Mature Fruit: Deep red, light red, yellow	Mature Fruit: Deep red, light red, yellow
	A lot of work has been done on cherry value chain in GB and market tested varieties are available to upscale production	Cool climate with good winter rains and dry cool summers of Northern-western Balochistan provide an ideal weather for the good quality cherry production
Variety Feature	Commercial and marketed tested varieties are getting popular. Area under cherry production is increasing. Some cherry varieties grown in the region are Bing, Chelan, Rainier, Lepin and Tulare	Commercial varieties grown in the region are include Bing, Chelan, Lepin and Lambert
	Trees exposed to sunlight during growing season (April-July) become larger. Average yield per tree is 70 to 100 kg	Trees exposed to sunlight during growing season (March-July) are larger. Average yield per tree is 50-70 kg per tree
	Early flowering induces malformation.	Early flowering induces malformation.
	Stone size small with a hard shell	Stone size medium with a hard shell
Nursery and Planting	Propagated on variable seedling rootstocks	Propagated on seedling of unknown rootstocks.
	Most growers have their own nursery plants or get them from other farmers. Government nurseries also provide nursery plants to the farmers	Most growers have their own nursery plants at their orchards and also from government nurseries
	Six-month to one-year old grafts having upright scion growth with 3-4 scion branches are planted	Six-month to one-year old grafts having upright scion growth with 3-4 scion branches are planted usually as compared to scion having too many branches.
	Mixed orchards, random plantation	Row to row distance (E – W) = 15 feet
	Mixed orchards, random plantation	Plant to plant distance (N – S) = 10 feet
	Average number of plants in one acre = 600	Average number of plants in one acre = 500
Inputs/Management Practices	No fertilizers are used for cherry trees	Fertilizers are rarely used
	No pesticides are used for growing cherry in GB	Pesticides are rarely used
	Farmers don't use inputs in any significant manner	Bigger farmers use input such as fertilizers and pesticides
	Normally in one season on average, 8 irrigations are made at an interval of 15 days	Normally in one season on average, 6 to 8 irrigations are made depending on the supply of ground water

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Salient Features	Northern Cluster (GB)	Southern Cluster (Balochistan)
	The major irrigation method used is flooding	The major irrigation method used is flooding
	Intercropping with other fruit plants and fodder crops (such as alfalfa and grass) is a normal practice	Intercropping is done with cereal crops; intercropping with other fruit plants such as apples and pears is also very common
	Weeding is done manually; no weedicides are used	Weeding is done manually and as such no weedicides are used
Pruning/Harvesting	Fruits are harvested by hand-picking or by shaking inaccessible fruit bearing branches	Conventionally the fruits are harvested one by one by a bamboo-pole harvester and collected in a net-bag attached to it.
	Fewer progressive farmers use modern harvesting methods	Few progressive farmers are using long mast with a cutting blade and a small bag under the blade to catch the fruit
	Pre and post-harvest losses are 5% to 7%	Pre and post-harvest losses are 5% to 7%
	When a few semi-ripe fruits fall from the tree, it is traditionally considered that the fruits are mature for harvest. No scientific maturity index is used.	When a few semi-ripe fruits fall from the tree, it is traditionally considered that the fruits are mature for harvest. No scientific maturity index is used
	Summer pruning is done just after crop harvest when the leaves are alive, used as livestock feed	Generally dead, diseased or crisscross branches are pruned.
	Winter pruning is done by cutting the dead branches, used as firewood	This pruning is done just after crop harvest and it is also called as summer pruning
Packaging/Transportation	The fruit is graded and packaged and transported in small vans	The fruit is graded, packaged and transported to other cities by truck
Wholesaler/Retailer	Contractors or wholesalers buy the product from farmers. The price is offered to the farmer based on the size, variety and quality of fruit	Contractors or wholesalers buy the product from farmers as they have connection with the commission agents in the market. The price is offered to the farmer based on the size and variety.
	The auction in the wholesale market is generally based on the variety and weight, but exact grading is not currently followed.	The auction in the wholesale market is generally based on the variety and weight, but exact grading is not currently followed.
	Final grading is done by the retailers. The average market price of cherry is Rs.350 to R.500/kg	Final grading is done by the retailers. The average market price of cherry is Rs.350 to Rs.500/kg
	The commission agents and wholesale merchants do keep accounts of their transactions, but little information is available from their books regarding the quality and the variety sold by them.	The commission agents and wholesale merchants do keep accounts of their transactions, but little information is available from their books regarding the quality and the variety sold by them.
	The prices are high at the commencement of the season and remain stable until the end of cherry reason	The prices are high at the commencement of the season, declining gradually as the supplies increase and decline again at the end of the season
	Mostly sold as fresh in local and national markets	Mostly sold as fresh in local and national markets
	The closest domestic markets are Islamabad, Rawalpindi and northern parts of Punjab	The closest domestic markets for fresh cherry are Karachi and Hyderabad
New Technologies/ Infrastructure	No cold storage facilities are available for cherry or any other commodity in GB	Cold storage facilities are not available

Salient Features	Northern Cluster (GB)	Southern Cluster (Balochistan)
	After harvesting, fresh cherry is packed in boxes and transported directly to local market.	After harvesting, with or without cooling, fresh cherry is transported directly to market in Sindh and Karachi
	Penetration of processing and value addition technologies such as preservation and canning in GB is low	Penetration of processing and value addition technologies is very low
Export/ domestic marketing	Major export market for cherries from GB is down town market in Punjab	Major export market for cherry from Balochistan is the markets in southern Punjab, Sindh and Karachi. A fraction of high-quality produce is exported to Middle East
	Due to recent influx of tourist towards GB, ample demand is growing for selling the cherry to tourists in local market	Cherry produced in Balochistan is exported out of the region; low demand exists in the local market
	Export of fresh cherries is difficult, but potential exists in China on CPEC	Limited quantities are exported to the Middle East
	Due to lack of cold chain storage system, cherry remains fresh for a 8 to 10 ten days. For optimum taste, it has to been consumed within a after harvest.	Due to lack of cold chain storage system, cherry remains fresh for a 8 to 10 ten days. For optimum taste, it has to been consumed within a after harvest.
Supply Chain	Cherry Supply Chain is having various inbuilt constraints and bottlenecks throughout; for example the chain is fragmented and less integrated; price spread is uneven	Supply Chain is having various inbuilt constraints and bottlenecks throughout. There is uneven Price Spread throughout the chain.
	The lack of direct flight services, shortage of air cargo space and inadequate cargo handling limit the export of cherries despite its high demand.	The lack of direct flight services, shortage of air cargo space and inadequate cargo handling limit the export of cherries despite its high demand.
	The typical cherry season is from May to August in GB, with export surpluses available in June/July. Most traders do not follow the recommended handling methods.	The typical cherry season is from May to July, with export surpluses available in June. Most traders do not follow the recommended handling methods.
Certification	Food safety standards and traceability (HACCP, EuropGAP, Global Gap, IFS etc) of Pakistani cherry is another obstacle to enter into high end markets.	Food safety standards and traceability (HACCP, EuropGAP, Global Gap, IFS etc) of Pakistani cherry is another obstacle to enter into high end markets.
	Organic food certification is costly and not affordable by most of the farmers	Organic food certification is costly and not affordable by most of the farmers
Socioeconomic networking/Gender involvement	Cherry in GB is considered to be a women-centric sector in which women play their role in harvesting, picking, cleaning, washing, and packing. They are also involved in selling	Women participation is low in the cherry sector in the province
	On average, a typical cherry grower earns a cashflow of about Rs.10,000/- to Rs.20,000/- per year from sale of cherry. These earnings are spent on education and health	A typical orchard owner earns about R.1.5 million
	Community mobilization and social participation is very high in GB	Community mobilization needs to be fostered for greater participation at grassroots level

Salient Features	Northern Cluster (GB)	Southern Cluster (Balochistan)
Subsidies/Incentives/ Facilities	MARC works in GB for promotion of fruit varieties suitable for growing in mountain areas. It is a research organization that works under PARC. It needs to improve its research capacities	Balochistan agriculture/horticulture department provides extension services in the province
	Govt agriculture/horticulture department extension services that promotes new cultivars and varieties in the region. Govt. nurseries are operating at district level	The government runs nurseries in different districts of the province that provide new cultivars to the growers in the province
	Recently, the GB government in collaboration with IFAD (International Fund for Agriculture Development) has launched a ETI (economic transformation Initiative) project, that exclusively aims to improve the horticulture sector in GB.	Various development programs running in the province are targeting horticulture as one of the potential resource that can improve the incomes of the communities in rural areas
Socioeconomic Networks	Role of development sector in promotion of cherry sector is very crucial in GB. AKRSP has worked on strengthening the cherry value chain in the region. Recently, GBRSP has been started that aims to improve overall development outcomes in the region	The role of BRSP and NRSP is important in improving cherry horticulture in the province
	GB has a rich culture of social organization in the region; Women Organizations (WOs)/Village Organization (VOs) and LSOs (Local Support Organization) actively participating in development initiatives in the region	There is need to focus on social organization of communities with regards to cherry sector in the province

Source: Feedback from different stakeholders and survey of secondary sources

4.3 SWOT Analysis

4.3.1. Overview

The SWOT analysis was conducted in focus group discussions with different stakeholders of the cherry value chains in both the clusters. The results are organized around the value chain functions, including inputs, production, storage, and marketing. Strengths and opportunities are coupled together and likewise weaknesses and threats are combined.

4.3.2. Northern Cluster (GB)

The northern cluster has many strengths and opportunities, including a natural comparative advantage with respect to agro-ecological conditions — water, climate and off-season with major competitors, homogenous farming communities, no tenancy and landlessness, growing tourism and proximity to China. Major weaknesses are poor planning, and policy and priority neglect and inadequate investment in research, technology development /breeding, extension, marketing, etc. Threats include diseases and natural disasters, such as crown gall, climate change, frequent landslides, which are made worse by poor road infrastructure, energy shortages for cold storage and processing, and non-transparent trading practices in local market systems.

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Table 11: SWOT Analysis of Northern Cherry Cluster in Gilgit-Baltistan

Parameters	Strengths	Weakness	Opportunities	Threat
Environment/ Climate Change	Sandy loam soil texture, temperate climate makes the region ideal for cultivating and growing different varieties of Cherry.	In upper parts of the region, frost and precipitation may affect flowering and bearing of the fruit	Starting from south to North, fruit is ready for harvest successively. Fresh fruit is avail round the three months of summers in GB	Severe cold/weather conditions sometimes hamper the fruit bearing capacity of Cherry trees Climate Change induced diseases Landslides
	Availability of abundant snow-melt/glacial water from spring to late summers in GB	Cherry Trees are grown in mixed orchards	Newer and commercial varieties are being introduced in the region	
Input Supplies	Growing demand for input supplies including fertilizers and pesticides	Non-availability of appropriate quality fertilizer and micronutrients in local input market	The private sector can fill the gap by providing input supplies to the growers	Slow uptake of inputs by the farmers
	Traditional varieties of GB are being replaced by commercial and exotic new varieties	Low uptake and usage of fertilizers and pesticides in GB	Local farmyard manure can be used to fertilize the new cherry plants	
		Limited availability of certified, quality, and pure variety seed/seedlings	Government can establish mother nurseries to promote different varieties	
Cluster interaction	Large number, more than 20,000 farmers grow Cherry in GB	Little interaction among farmers and researchers	Possibility of learning from progressive farmers in the cluster	Lack of optimal coordination and integration of Cherry value chain actors
	Cherry value chain is functional in the region, creating high value for the growers, traders and retailers	Producers have little information about the quality requirements in national and international markets	Possibility of collective efforts for achieving the economies of scale	
		No contract farming with defined quantities and quality parameter		
		Little credit availability from formal institutes for the small growers/farmers in GB		
Production Management practices	Farmers having traditional skills in Cherry production	Traditional orchard management practices are faulty (notably pruning, layout and fertility management, and irrigation)	Potential for vertical expansion potential exist; Road infrastructure improving; matching grant from ETI GB	Impacts of climate change, swings in weather conditions
	Possibility of diversification into improved varieties	Unorganized and mixed plantation in orchards		

	Possibility for growth at Cherry production level; current yield is 35Kg/Tree	Sub-optimal and no use of fertilizer and pesticides	Opportunity for expanding extension services in private sector at production and harvesting exists	
		Pre- and post-harvest losses due to lack of skills and infrastructure (i.e., storage facilities); losses/wastages are nearly 7% of total production		
Transportation	KKH connects the region with all major cities in the country	Access roads to remote areas prone to blockages	Availability of paper boxes in the market already being used in certain other fruits and currently has started being used for packing of Cherry	Road blockages due to climatic and natural hazards may hamper the transportation to down the country
		No environmental (temperature, humidity, etc.) control during transportation		
		High fuel cost especially diesel used in transportation; high freight costs	The produce is sold fresh, small quantities are dried and sold. This is particularly the case due to influx of tourists GB	
		No cold chains or cold storage are available		
Marketing	High prices can be earned in local, national and international markets for quality Cherry products	Farmers are disconnected from high value markets	Financial support by the commission agents and wholesalers to harvesting contractors can be converted into quality-based delivery contracts	Supermarkets may exclude small farmers from having access high value markets
		No grading (rather topping the good quality cherry over poor quality) by the harvest contractor		
		Auctioning in the wholesale market with visual and spot grading	Bulk selling can result in better result for growers	
		Little capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality products	Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	
Trade/Export	Few traders/processors are exporting Cherry to other countries; most Cherry from GB is traded within the country	Food safety standards and traceability (HACCP, EuropGAP, Global Gap, IFS etc.) are major obstacles to enter into high end international markets	Growing demand for Cherry products in domestic markets	High cost of certifications and quality standards
		Lack of flight services, shortage of air cargo space and inadequate cargo handling limit the export	Better prices for higher quality Cherry products in domestic/national market	
Processing	The cherry can be consumed as fresh; however, a number of products can be	Fresh Cherry grown in GB has limited shelf-life (7 to 10 days) and hence is	Huge demand for processed Cherry products in national	Processing of Cherry potentially by large may corporations may

	made from it, including the dry cherry	suitable for fresh consumption	and international markets	impact the margins of small processors
		Unavailability of modern processing plants, technologies, and equipment for canning and processing	Government provides incentives on the import of agriculture machinery including the cold storage equipment	
	Cherry can be used in many value-added products such as bakery and confectionary items as an ingredient	Lack of capacity and resources for small scale stakeholders to get involved in Cherry processing		

5.3.1.2. Southern Cluster (Balochistan)

The southern cluster is endowed with a natural comparative advantage with respect to agro-ecological conditions and access to large markets. Proximity to large urban markets, such as Karachi and the Middle East, large farm sizes, opportunities for investment in cold chains, and relatively functioning provincial and national research systems are key strengths. Threats and weaknesses are represented by political instability, militancy and insecurity, climate change, water scarcity, and inadequate research and extension services. Despite these challenges, the cherry value chain in the province is able to create substantial incomes for the actors associated with it.

Table 12: SWOT Analysis of Southern Cherry Cluster in Balochistan

Parameters	Strengths	Weakness	Opportunities	Threats
Environment/ Climate Change	Sandy and silty texture of soil, flat plains, Subtropical climate with hot weather in summer and cold in winter, make the province suitable for cultivating and growing commercial varieties of Cherry.	Wind/sand storms can impact the fruit bearing capacity of Cherry trees	Fresh Cherry is ripe and ready during May, June and July	Lowering water table can pose a serious threat to availability of irrigation water Climate change Water scarcity, militancy
	Ground water is the primary source of irrigation water	Dependence on ground water table	Indigenous varieties adopted to local climate	
Input Supplies	Growing demand for input supplies including fertilizers and pesticides	Non-availability of appropriate quality fertilizer and micronutrients in local input market	The private sector can fill the gap by providing input supplies to the growers	Slow uptake of inputs by the farmers
	The Cherry varieties grown are commercial with higher yield factor	Low uptake and usage of fertilizers and pesticides in Balochistan	The local produced compost and manure can be used to increase the fertilization of soil	
		Limited availability of certified, quality, and pure variety seed/seedlings	Government can establish mother nurseries to promote different varieties	

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Parameters	Strengths	Weakness	Opportunities	Threats
Cluster Interaction	Growers are concentrated in geographical location. Larger orchards owned individual orchards	Little interaction among farmers and researchers	Possibility of learning from progressive farmers in the cluster	Lack of optimal coordination and integration of Cherry value chain actors
	The Cherry value chain has a commercial focus and is trade oriented organized	Producers have little information about the quality requirements in national and international market	Well defined value addition activities can improve the margins of all stakeholders	
		No contract farming with defined quantities and quality parameter		
		The value is loose organized with little focus of value addition		
Production Management practices	Farmers having appropriate skills in Cherry production. Orchard based production management is followed	Orchard management practices followed by the growers need to be further strengthened with new technologies and knowledge	Vast potential for increase in production compared to major producing countries where production has nearly reached maximum levels	Sand/dust storms and wind storms may hamper the production capacity of Cherry trees
	Possibility of diversification into new improved varieties			
	Optimum level of production is achievable(at least 50kg/tree of yield)	Sub-optimal and no use of fertilizer and pesticides	Opportunity for expanding extension services in Cherry sector	
		Pre- and post-harvest losses due to lack of skills and infrastructure (i.e., storage facilities); losses/wastages are nearly 5% of total production		
Transportation	The province is appropriately linked by road with all the major cities in the country	No environment (temperature, humidity, etc.) control during transportation	Availability of paper boxes in the market already being used in certain other fruits and currently is being for packing Cherry	
		High fuel cost especially diesel used in transportation; high freight costs	The produce is sold fresh in Southern parts of the country including Sindh and Karachi	
		No cold chains or cold storage are available		
Marketing	High prices can be earned in local, national and international markets for quality Cherry products	Farmers are disconnected from high value markets	Advance buying of the crop, usually at lower prices can be substituted with contract farming Growing tourism in the area offers opportunities for	Supermarkets may exclude small farmers from having access high value markets
		No grading (rather topping the good quality cherry over poor quality) by the harvest contractor		

Parameters	Strengths	Weakness	Opportunities	Threats
			product differentiation, such as organic cherries	
		Auctioning in the wholesale market with visual and spot grading	Bulk selling can improve the returns for growers and small traders	
		Little capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality products	Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	
Trade/Export	Few traders/ processors are exporting Cherry to other countries; most Cherry from Balochistan is traded within the country	Food safety standards and traceability (HACCP, EuropGAP, Global Gap, IFS etc.,) are major obstacles to enter into high end international markets	Growing demand for Cherry products in domestic markets	High cost of certifications and quality standards
		Lack of flight services, shortage of air cargo space and inadequate cargo handling limit the export	Better prices for higher quality Cherry products in domestic/national market	
Processing	The cherry can be consumed as fresh, however a number of products can be made from it, including the dry cherry	Fresh Cherry grown in Balochistan has limited shelf-life (7 to 10 days) and hence is suitable for fresh consumption	Huge demand for processed Cherry products in national and international markets	Processing of Cherry potentially by large may corporations may impact the margins of small processors
		Unavailability of modern processing plants, technologies, and equipment for canning and processing	Government provides incentives on the import of agriculture machinery including the cold storage equipment	
	Cherry can be used in many value - added products such as bakery and confectionary items as an ingredient	Lack of capacity and resources for small scale stakeholders to get involved in Cherry processing		

4.4 Description of Cherry Value Chain

4.4.1. Northern Cluster (GB)

Commercial cherries were introduced in the northern cluster in the 1990s by Aga Khan Rural Support Programme (AKRSP). Presently, it is one of the fastest growing sub-sectors in high value horticulture, with good potential for higher productivity, production and value-added. About 25,000 small farmers, traders and service providers are believed to be involved in the

cherry value chain, which is then vertically integrated with the larger systems in the mainland Pakistan. Down country traders operate in GB through their local agents, often 'booking' the crop before it is harvested.

In recent years, domestic tourism has provided a new 'premium market' in GB itself. A local company, called Karakoram Natural Resources (KNR) Pvt. Limited has established a modern processing unit at Nomel, near Gilgit town, and attempted to export fresh cherries to the Middle East and Southeast Asia, but faced logistical challenges, and had to abandon its plans.[1] At present, there are no exports of fresh cherries from GB.

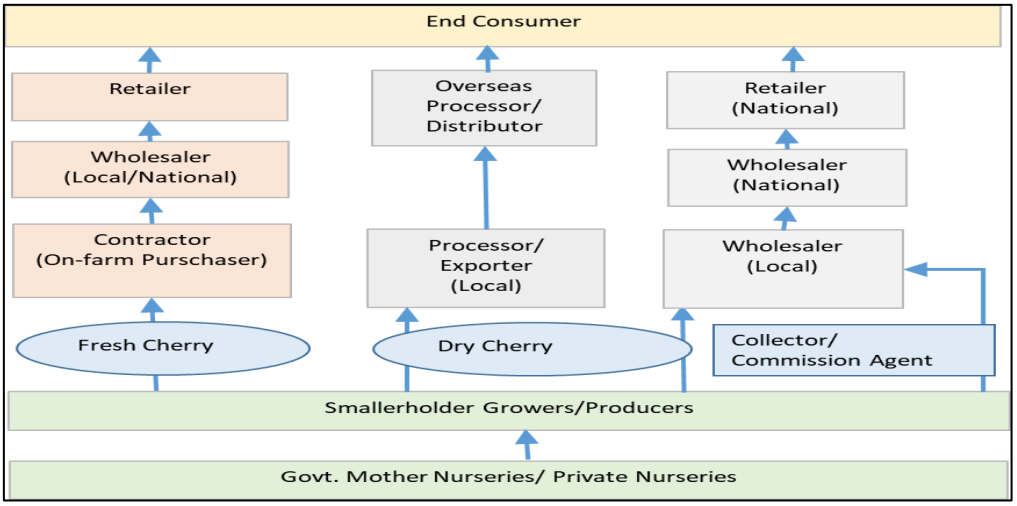
Almost 80% of cherries are sold fresh, small leftover quantities are consumed locally, or sundried and marketed separately. The growing of cherries in GB is increasingly oriented towards newer varieties, which the buyers consider as more valuable than traditional cultivars. The commonly grown varieties in the cluster are Sunburst, Binge and Stella. The quality of these varieties was excellent with higher yields, when they were first introduced twenty years or so ago, by AKRSP, but the world of cherries has evolved and these varieties are now considered as outdated and replaced by newer varieties in the wider world, and the markets in Pakistan, too, want these newer varieties.

In the northern cluster, a large number of small farmers are engaged in generating small volumes of surpluses. Naturally, their transaction costs are high, and that affects their bottom-line. In order to create economies of scale, organizations like AKRSP have created farmers' organizations, and many have evolved into Farmer Enterprise Groups (FEGs) that band together to pool their produce to generate marketable volumes, for collective bargaining with buyers, for bulk procurement of inputs and services such as packaging material, branding and marketing. This is a good base to build on in future to create a more professional and effective cherry growers' association that could provide loans, training, marketing, and other services, thus moving small famers up the value chain. Another interesting development is the proliferation of individual entrepreneurs and small marketing companies that link part-time farmers with traders and market agents.

Whilst there is little horizontal coordination between competing wholesalers, there is a certain degree of vertical coordination in the supply chain. For example, GB wholesalers typically advance cash to smaller traders to source cherry from competing local farmers in advance of the harvest. The following figure depicts the functioning of cherry value chain in GB.

[1] KNR processed and transported fresh cherries to Islamabad airport in refrigerated trucks for air shipment to Dubai, but was forced to break the cold chain at the cargo and customs for hours, because these facilities are not refrigerated. On other occasions, flights were delayed or road was blocked, which led to the spoilage of the product.

Figure 2: Description of Cherry Value Chain in Gilgit-Baltistan



4.4.2. Southern Cluster (Balochistan)

Cherries were introduced in Balochistan by the British Army as far back as in 1920s, along with other high value temperate crops. Balochistan is a mature and well-functioning cherry cluster, with good potential to grow in value. Cherry producers in Balochistan are spread over the northern districts of the province – most of them are large farmers, who grow their crops in proper orchards. Their market is huge, spreading from the metropolis of Karachi to cities in interior Sindh and South Punjab.

There are limits though, on horizontal expansion of cherry value chain in Balochistan, due to the scarcity of irrigation water, but there is scope for vertical expansion through processing, product development and market diversification. Small quantities are presently exported to the Middle East, which can be expanded. There is a good potential for increasing the value-added aspects of the product through improved production, processing, product development and good marketing practices.

In many ways, the value chain is better organized in Balochistan and farmers have been growing improved and commercial varieties for close to a century now. The farmers have moderate levels of skills in orchard management and appropriate technologies are used for harvesting. However, the post-harvest technologies used are not well-developed, especially processing (cold chain) of fresh cherries is not used as a business practice. The following figure shows the description of cherry value chain the province.

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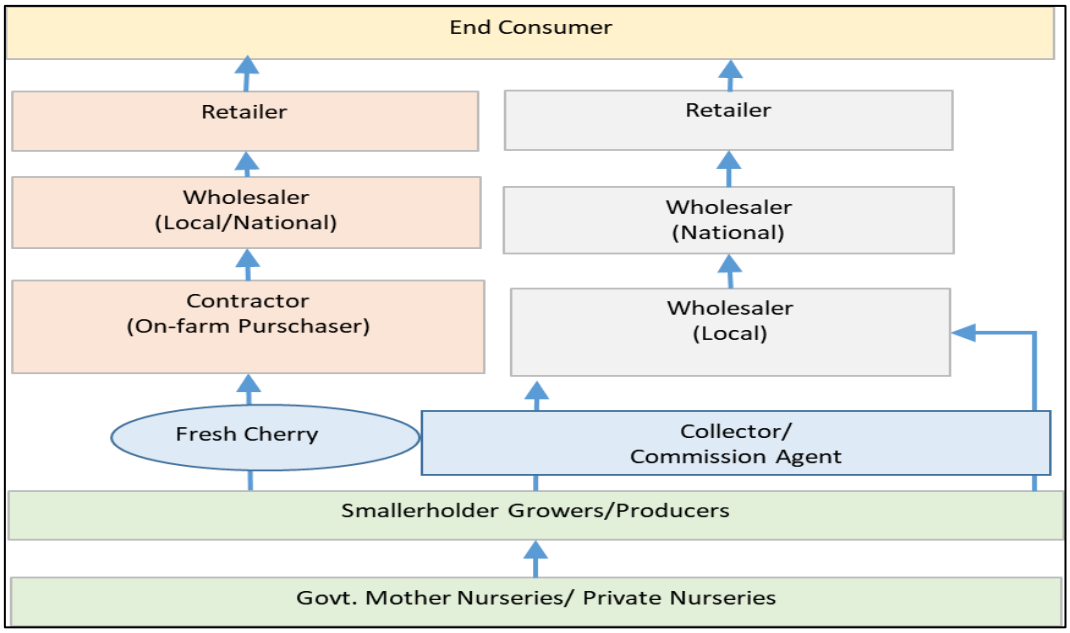
Figure 3: Description of Cherry Value Chain in the Southern Cluster



5 CHALLENGES FACED BY THE CLUSTERS

5.1 Climate Change and Increasing Shortages of Water

Both the southern cluster in Balochistan and northern cluster in Gilgit-Baltistan are similar in many ways, yet very different in many others. One common constraint faced by the farmers in both the clusters is placed upon by the nature itself. Late frost in GB and strong dusty/sandy winds and storms in Balochistan during flowering/ blossoming season greatly impact the yield and quality of production. Climate change related impacts, such as new diseases and shifts in crop cycle are also emerging issues in both the regions. Further research and development efforts are needed to address these threats.

Agriculture in both the clusters is dependent on irrigation. In the southern cluster, water is physically scarce, while in the northern cluster, there is plenty of water supply, but driving it up the vertical mountain slopes is costly. Most of the southern cluster is dependent on groundwater that is being extracted unsustainably through tube wells. As water table falls due to over-extraction or variation in the climate, such as droughts, farmers with elevated lands where cherries are grown are literally, left high and dry. These are some of the conditions faced by the cherry growers in Pakistan.

5.2 Constraints at the Production Level

In GB, most cherry varieties cultivated by farmers originate from a smaller pool of genetic material that was imported a long time ago, which has degenerated and degraded overtime, and there is very little infrastructure to replenish it (Table 13). In GB, Mountain Agriculture Research Center (MARC), a subsidiary of the Pakistan Agriculture Research Council (PARC) is entrusted with the responsibility to carrying out research and varietal development. Since agriculture is now a provincial subject after the 18th Amendment to the Constitution, the GB, DoA feels it has the primary mandate for research. As a result, there is a duplication of effort, and resources are thinly divided. The available resources are spent on buildings, personnel and overheads, and there is no money left for research and development. This means highly qualified scientists are just sitting on their desks, because there is no money for technology transfer, trials in the field, dissemination of results, etc. The varietal development, which is a continuous requirement, is more or less at a standstill.

Table 13: Gaps and Constraints at Production Level

Sr. No.	Parameter	Northern (GB) Cluster	Southern (Balochistan) Cluster
1.	New germplasm	Difficult to access	Difficult access
2.	Mother nurseries	Very few	Available largely in the private sector
3.	Orchard size/type	Small/mix	Large/specialized
4.	Certified plants	Limited availability	Commercial production

Sr. No.	Parameter	Northern (GB) Cluster	Southern (Balochistan) Cluster
5.	Extension services	Weak	Moderate
6.	Commercial inputs	Moderate use	Adequate use
7.	Labor input	Family	Hired

5.3 Constraints at Processing Level

At present, fresh cherries are simply graded and packed in small wooden boxes and sent to the auction markets in major cities, in unrefrigerated vehicle, such as on the rooftop of passenger vans. Obviously, this product fetches a lower price compared to the 'processed product', delivered directly to super markets, under the cold chain conditions. In fresh cherries, processing involves grading and then cooling the fruit to less than 4 degrees centigrade, before packing and loading it to cold containers for transportation.

The technologies needed for processing, packaging, and storage and drying, vary in quality and efficiency. In many cases, traders skip many of the basic processing steps, and just pack a semi-graded product in rudimentary wooden or cardboard boxes, often without any labels or brand names. Many of the processing technologies (Figure 4) for fresh cherries are lacking in both clusters, which is both a problem and an opportunity for improvement. Processing fresh cherries in a central place allows it to separate damaged or undersized cherries, which can be dried, thus eliminating almost all of the postharvest losses before transportation to wholesalers. Sun drying is the easiest way to preserve cherries. Drying technologies are available in both the clusters (see Figure 5). A key advantage is that drying technologies can be used for drying multiple crops, such as cherries, grapes, cherries and tomatoes, etc.

However, despite the availability of these technologies, their uptake and widespread adoption is not automatic, and requires planning, support, and incentives. Moreover, the public sector does not have to take up the entire responsibility upon itself, but seek win-win solutions by working with the private sector and NGO partners. In both the clusters, market linkages are heavily reliant on the tenacity of the individual processor, creating a constricted market structure. However, due to the lack of overseas buyers, processors

Figure 4: Processing Fresh Cherries

information sharing, between processors to fulfil larger orders and access bigger markets.

5.4 Constraints at Trading Level

The handling and storage of cherries is adequate and postharvest and cold storage technologies are available in Balochistan, but not in GB. There are numerous buyers and sellers creating a competitive market environment in big cities. A license is not required for small-scale trading and except access to finance; there are no notable barriers to entry in cherry trading.

Figure 5: Solar dryers

Table 14 below presents an overview of constraints at processing level barriers to entry into cherry value chain.

Table 14: Gaps and Constraints at Processing Level

Sr. No.	Parameter	Northern (Gilgit-Baltistan) cluster	Southern (Balochistan) cluster
1.	Processing and value addition technologies in use	Limited	Moderate
2.	Cold chains	Not available	Available
3.	Drying cherries	Available	Available
4.	Shovel ready investment projects	Available	Available
5.	Access to energy for processing	Limited availability	Available

Traders typically strive to achieve the highest margins by buying at the lowest price and selling at the highest price. Very little attention is paid to product differentiation and quality aspects to achieve price premiums. Communication technologies and internet services are easily obtainable, labor is available on a permanent and seasonable basis and financial services to traders are provided by both formal and informal banking institutions.

Table 15: Gaps and Constraints at Trading Level

Sr. No.	Parameter	Northern (GB) Cluster	Southern (Balochistan) Cluster
1.	Marketing channels	Traditional	Traditional
2.	E-commerce platforms	Not available	Not available
3.	Contract farming	No	Yes

Sr. No.	Parameter	Northern (GB) Cluster	Southern (Balochistan) Cluster
4.	Export readiness	No	Yes
5.	Certifications (phytosanitary)	No	Yes
6.	Branding	Limited	Limited

A shortage of energy (electricity) is a common constraint for the processing segment in both the clusters. Furthermore, if the processing segment is to grow, a diversification strategy is necessary to develop new products and new markets. If in-country trade in higher-value fresh cherries is to develop, facilities for packing, cold storage and refrigerated transport will be necessary. With GB and Balochistan as hubs for temperate fruit in Pakistan, such infrastructure has the potential to benefit the whole horticulture sector, not just cherries.

In summary, an agricultural policy guiding public and private investment and sector support programs to develop the temperate fruit industry is highly desirable both in GB and Balochistan. Improvements are also needed with the provision of up-to-date and useful market information to inform producers, processors and traders what types of cherry products (fresh and dry cherry) consumers want and what they are willing to pay more for. When striving to meet market requirements, the use of ‘standards’ is an effective means of improving quality.

6 CLUSTER DEVELOPMENT POTENTIAL

6.1 Overview

The strategically located clusters, one in the north, bordering on China and Central Asia, and the other in the south, close to the mega city of Karachi and the Middle East, make Pakistan a natural hub for trade, transit and tourism at the crossroads of South, Central, and West Asia. Balochistan is a desert oasis, with abundance of fertile land and grows a variety of horticultural crops. Gilgit-Baltistan is a mountain oasis with plenty of water and slopping alluvial fans, which need terracing for crop cultivation.

In this section an attempt has been made to evaluate the potential in both clusters in terms of production, quality and market side of the cherry value chain, and to establish benchmarks, based on the targets set in chapter 2 (targets) 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 cherry value chains in the two main clusters.

6.2 Establishment and Renovating Orchards

Both the northern and southern clusters can greatly benefit from replacing the old cherry plantations with newer High Yield Varieties (HYVs). This can be done by re-planting HYVs on at least 30% of the existing lands on which cherries are planted in both the clusters.

The new cherry trees planted in year one will become productive after a gestation period of three to four years. The yearly plantation would continue until five years, and in about eight years, all the plantation would reach full fruit bearing stage. A 75% incremental yield can be realized per year from this intervention in the northern and 100% in the southern cherry clusters, respectively, after eight years. The potential of improving the yield in southern cluster is higher because of its existing lower yield.

The question is where to absorb the additional production from this intervention. As noted earlier, the consumption of cherry in Pakistan is gradually and slowly increasing especially in urban areas. With proper market drive through emerging supermarkets in the country, this growth in consumption can be further boosted.

In addition to vast domestic market, as noted earlier, the cherry market has been growing at 7.8% per annum in its quantities and 11.7% in values reaching US$2.3 billion in 2016. China is the major importer of cherry. However, Pakistan remained untouched from this expanding market to its next door. Pakistan has great potential to export cherry to China, especially from its northern cluster. The global fresh cherry market is expected to grow at an annual compound rate of 5%, and China is expected to remain the biggest importer in the near future (Research and Markets, 2020).

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6.3 Export to Production Ratio

The cherry sub sector in Pakistan is characterized by one of the lowest production-to-export ratios. The country only exports a mere 0.007% of its total production. However, new export opportunities have been created, especially to China, which offers premium prices. Pakistan has a comparative advantage, because of its low production costs, as measured by the low farm gate prices in earlier table (Table 3), and can position itself to exporting fresh cherries to China under CPEC.

China is the top importer of cherries in the world, where average import prices were US$7,550/tonne in 2017. Pakistan can also benefit from the seasonal difference with Chile, the main supplier of fresh cherries to China. When cherries are harvested in Pakistan, there are no supplies from Chile, because it's their winter, and cherries cannot be stored. A yet another advantage is physical proximity with China, which means Pakistan can use surface freight, as opposed to air transportation all the way from South America, North America, and Australia who have at least US$ 2,000 /tonne additional transportation costs. Pakistan can do this in US$200 per tonne.

With this opportunity, the northern cluster can significantly increase its export to China and we assume that its production-export ratio can be improved to at least to 5% in both the clusters over five years. Balochistan is well positioned to meet demand in the Middle East and other international markets, including south-east Asia.

6.4 Improvement in Quality

6.4.1 Quality for Domestic Market

One of the areas of concern in the cherry sector of Pakistan is that there exists a wide gap in the export price when domestic prices are compared to the global average. Average global export price of one-tonne of cherries is $4,328 on wholesale, compared to US$ 1,500 for the same in northern cluster, and about US$ 2,000 in the southern cluster in Pakistan. One of the reasons for this difference is the low quality of the produce. Interventions and strategies are proposed, which will improve the quality of at least 10% of the production for high-end domestic market, such as supper and hyper stores. We assume that the cherry can be sold at wholesale level to the super and hyper stores at least at US$3000 per tonne.

6.4.2 Quality for Export Market

The export price of Pakistani cherry is at US$ 2429 per tonne, which is significantly low compared to the international average export price, which is US$4328 in 2017. Improving the quality through cold processing, of at least 10% of the production for export will bring this quality at least at par to the world average quality thus fetching at least world average price.

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6.5 Reduction in Post-Harvest Losses

One of the major concerns of agriculture in the country is high post-harvest losses. For example, these losses account for nearly 20% in the northern cluster, and 10% in southern cluster. With improved post-harvest technologies, we are suggesting in the next section, these losses can be halved.

6.6 Improved Processing

Currently, very small quantiles of cherries are being dried in the country, while internationally, the export value and quantity of dried cherry, as reviewed earlier, is much higher. The technology to dried cherry is very simple, as shown in *Figure 5*. We assume that with the proper incentives, at least half of the post-harvest losses, before transportation; can be saved by drying the product.

6.7 International Standards

To improve the quality and price of cherry to international level, we have to adopt international quality standards at each segment of the value chain. IPPC - the International Plant Protection Convention - is the international treaty under which common standards are developed for pest control in plants and plant products across international borders. The Commission on Phytosanitary Measures (CPM) is the governing body of the IPPC and it has adopted a number of International Standards for Phytosanitary Measures (ISPMs) that provide guidance to contracting parties in meeting the aims and obligations of the Convention (FAO and IPPC 2020). In addition, each country has its own specific standards for each crop.

The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) is the "ministerial administrative organ directly under the State Council of the People's Republic of China in charge of national quality, metrology, entry-exit commodity inspection, entry-exit health quarantine, entry-exit animal and plant quarantine, import-export food safety, certification and accreditation, standardization, as well as administrative law-enforcement." Interested foreign food exporters to China must register under the new AQSIQ registration system, which provides all the guidelines for the export of fresh fruit to China, including cherries.[2] Potential exporters are required to fill out the *Food Exporter application*, whereupon the AQSIQ will grant the exporter an AQSIQ registration number. These requirements are specific to each commodity and country.

[2] http://www.aqsiq.net/importer-register.htm

7 STRATEGIES TO REALIZE THE CLUSTER POTENTIAL

7.1 Plan

Based on the identification of constraints and potentials, and discussion with stakeholders especially researchers, we are able to fix targets along cherry value chain to be achieved through cluster development project five-year project period (Table 16).

Table 16: Targets of Cherry Cluster Plan

S#.	Targets for Cherry Cluster
1.	Establish new or renovate 30% area of existing orchards to increase yield by 75-100%. This can be done by increasing the supply of certified plants of latest varieties, and capacity building of farmers to establish and maintain these gardens.
2.	Reduce postharvest losses by half from the current benchmarks (20% to 10% in the northern and from 10% to 5% in the southern cluster), by drying the low value cherry, processing infrastructure, capacity building of stakeholders along the value chain to adopt postharvest technologies.
4.	Increase the quality and shelf-life of at least 10% of the total cherry production destined for the domestic market by: a) incentivizing establishment of the cold chains and improved drying systems, and training of stakeholders to adopt sanitary and phytosanitary practices.
5.	Increase exports from less than 1% at present to at least by5% of production. Similarly, divert another 10% of production to high-end domestic market

7.2 Policy Reforms

At the policy level, the current practice of providing general subsidies and “export rebates” to selected commodities should be eliminated, as these are incrementally abused. Instead, subsidies and incentives should be specific and results driven. For instance, import duties on all post-harvest technologies should be eliminated, but these technologies should be clearly defined. Moreover, investment incentives for processing industries and storage and cold chains should be carefully reviewed and enhanced. Revenues lost through these measures should be recovered by doubling import duties on value-added agricultural products, and increasing sales taxes on fizzy drinks. A water tax, as recommended by the recent Symposium on *“Creating a Water Secure Pakistan”*, hosted by the Supreme Court of Pakistan on fizzy drink manufacturers should be levied, as they do not pay for the water they use for their products. This change of policy would not only greatly improve Pakistan’s balance of payments, but also reduce public health costs. Moreover, a nationwide program should be developed, in which all rural districts can compete for Cluster Development Grants to specialize in specific high-value crops for export. Another policy recommendation is to include cherries in bilateral/ multilateral trade agreements with friendly countries (OIC, Arab League, and China). At present, China-Pakistan bilateral trade agreement does not include cherries.

At the local level, supporting farmers to organize themselves as marketing groups, such as *Farmers Enterprise Group (FEGs)* would be a key element of the strategy, for achieving economies of scale access to inputs, finance, technology, and market information, especially in the northern cluster where farm size is small and a large number of small farmers are engaged in the cherry value chain. Therefore, we propose that special incentives should be provided to organize these groups in the northern cluster. These FEGs will be established at the union council level. Special loans will be provided on concessional terms to each FEGs to allow them to market their cherries under a brand name, help various stakeholders in adopting best practices, hold trade fairs, competitions, and arrange various training events etc.

A common intervention recommended for both the cluster is to form a national Cherry Association, or the Cherry Association of Pakistan (CAP). This entity should have a website of its own and work to promote best practices, share knowledge, technology and lobby with government for enabling policies, on behalf of its members. CAP should also develop Apps for marketing, and also represent cherry growers and traders in international fairs and events.

7.3 Strategy for Northern Cluster

7.3.1 Production Level Strategies

The primary production strategy is to narrow the yield gap with the global average. The plan is to increase the yields by 30% cluster respectively from the current base of 2.86 tonne/ha to 3.77 tonne/ha in northern cluster; and another 30% yield increase from establishing certified orchards. This shall bring these yields closer to the global average of 5.66 tonne/ha. This will be done by:

a) *Importing high quality germplasm*. The northern cluster needs germplasm having traits of high yields with tolerance to late frost and resistant against crown gall and other diseases. Some of the latest varieties, such as Bing, Stella, and Sunburst, are already tested and available in Pakistan, and only need propagation under controlled conditions. But the technology development is a continuous process that requires establishing a robust breeding program. For this, germplasm can be obtained from China, Chile, Turkey, or USA. So diplomatic and commercial links should be used to get the much-needed germplasm from these countries.

b) *Development and supply of latest and certified varieties to farmers*. A strong breeding program in MARC needs to be established on cherry in the northern cluster. This breeding program will initially rely on the selection of high yielding material from the wide array of germplasm collected, but later it will do some breeding work in developing new varieties. The advance lines (not varieties) will be handed over to the GB research system that will test these in different districts of the northern cluster and finalize the varieties suitable for the district. After finalizing the varieties at the research station by some independent evaluators, the provincial research system will also demonstrate these varieties under the farmers' field and allow the farmers to select the better varieties for propagation.

c) *Wide spread distribution of new Varieties*. Parent blocks will be established at the government nurseries and commercial nurseries will be incentivized to set up mother

blocks and multiply certified plants for sale to farmers under the truth-in-label rules. Encourage the farmers to establish certified orchards by replacing at least 30% of the existing plantation with newer varieties and realize 25% higher yield

d) *Promoting proper orchards certified under* International Standards for Phytosanitary Measures *ISPMs*. In each district, at least 5 commercial gardens each of 0.2 acre should be established at 75:25 cost sharing basis with farmers bearing the 75% cost.

e) *Appropriate training in nursery and orchard management*. The five established gardens above will also be used as demonstration plot where good agricultural practices will also be adopted and farmers will be frequently invited to visit these gardens. It will be highly desirable to invite experts from China to help in putting in place specific phytosanitary standards needed for export to China in these demonstration plots. Moreover, 100 farmers will be provided on-hand training in each cherry growing district. One of the key objectives of this intervention shall be to bring the postharvest losses that are currently 10% of total production down to 5% over five years in southern cluster.

7.3.2 Processing and Value Addition Strategies

By processing and value addition, we mean harvesting at the right time, washing and hydro-cooling the product immediately after harvest, sorting, grading and retail packaging and then establishing a cold chain to deliver the product from the processing center, all the way to super markets in Islamabad, Lahore and other cites, or to the air cargo facilities for export. In this way, not only higher prices are ensured but also the product's shelf life is extended, and transportation and retail level losses are reduced.

Another important processing and value addition method is to dry the product. Typically, dried cherries are considered as a byproduct: when fresh cherries are processed and taken through sorting and grading steps, undersized and bruised fruit is separated and then dried. So, drying can be an efficient way to reduce post-harvest losses. Dried cherries can be used in a variety of ways, such as a flavor ingredient in processed foods, including cereals, fruit bars, cakes yoghurts, ice cream and cheese, etc. Dried cherry can be packaged into small heat-sealed bags as a healthy ready-to-eat snack. Opportunities for product development are largely unlimited, from improving the quality, packaging and marketing of dried cherry, to making new products and seeking new markets, especially in the whole food, organic and ingredients market niches.

Therefore, the main value addition and processing strategy would be both: a) establishing cold chains and, b) drying at least 5% of the production. This will be achieved by:

a) *Incentivizing the private sector to establish cold chains*. At the cluster level, at least one complete cold chain will be established in every cherry growing district, which will include equipment for hydro-cooling, sorting, grading, and packing, as well as short-duration cold storage, and a refer truck. The center will be established in partnership with the FEGs on cost sharing basis. All machinery will be provided on loan to the FEG, which will be recovered in five years provided the FEG share 50% of the cost of the building for the cold chain and remaining 50% costs will be shared by the government.

The farmers' product will be washed, processed, packed and transported in refers through traders and exporters with the brand name of the FGs at a negotiated price with traders/exporters. The revenue from the sale of the produce will be handed over to the farmers after the FGs receive the money from traders/exporters after deducting all costs.

b) *Promoting dried cherries and its use*. The units for processing of fresh cherry to dried cherry will also be established at the cold chain centers under the supervision of FEGs. These processing units, are already manufactured in the local market and are multipurpose, i.e., can be used for drying cherries, grapes, tomatoes and other fruits and vegetables. They will be provided to FEG members on credit by the government and the original cost will be recovered in five years. The number of processors in each FEG will depend upon the demand for processing. The FEG will also provide training to the processors in Sulphur technique for dried cherries. Farmers produce will be processed at the cold chain centers and sold in the domestic and international markets through traders/exporters with the FEG brand name at the pre-negotiated price. The revenue from the sale will be handed over to the farmers after deducting all the costs.

c) *Branding of cherry products*. Each FEG will get its product branded and cost of branding will be initially borne by the FEG and charged from the farmers who will sell their fresh and dried produce through the FEGs. For branding, the 'Mountain Fresh' and 'Organic Food' business models are additional options to improve the value for the farmer groups and other value chain actors. Certifications for IPPC, Phytosanitary, Organic, Fairtrade, and Geographical Indication' can be pursued as other value-added strategies. GI can be used on products that have a specific geographic origin and possess qualities or a reputation that are intrinsically due to that place of origin.

d) *Holding competition and rewards for processors*. Special competition will be held and rewards will be provided for outstanding processors of dried and fresh cherries. These competitions will be held at district-level and then concluded at the cluster level.

e) *Forming a Cherry Association of Pakistan*. This should be a joint activity for both the clusters, which should have a website and develop its own marketing apps.

7.3.3 Marketing and Trading/ Export Level Strategies

Two folds strategies are suggested to improve marketing and trading at domestic and international levels. These are:

a) **Increase the export to production ratio**. Currently, Pakistan exports only 0.006% of its export to the world market while for the world this ratio is 9%. Through proper commercial strategies, we want to bring this ratio to 9% in five years. This will be achieved through following steps:

- *Providing market information*. A small unit will be established in the department of agriculture consisting of three scientists (marketing specialist, economist, and information analysist) with supporting staff. It will regularly provide information to

the stakeholders about international market requirements (i.e., standards, price, potential buyers, etc.).

- *Sponsoring international tours*. Top three best exporters will be sent abroad every year to identify potential markets and new buyers at 50% government expenses.

- *Holding competition and rewards for exporters.* Special competition will be held and rewards will be provided for outstanding exporters of dried and fresh cherry. These competitions will be held at the cluster level.

b) **To improve the quality and export price**. Currently, the export price of Pakistani cherry is around US$2000 per tonne compared to international average export price of US$4,335 per tonne, reflecting a poor quality (in terms of old varieties, smaller size, texture and taste). Meeting international standards is important for the export market and many processor/exporters have faced difficulties meeting these requirements and quality standards demanded by the buyers. It is proposed to provide support in producing quality cherry with international standards at the FEG level, for high end domestic market and for export. To meet these standards, following interventions and mechanisms are suggested.

- **Incentives for adopting best practices and certification regimes.** International best practices and certification regimes are needed to be adopted in all segments of the value chain especially in production, logistic, and marketing to become competitive in national and international markets. For this, special investments are required to adopt and certified these practices. Special tax incentives will be provided to establish certification companies in the northern cluster. The government will also incentivize various stakeholders along the value chain to adopt these practices by paying 25% of the machinery cost recommended by the certification agencies at various levels. However, farmers have to agree to pay for any additional infrastructure, labor, and monitoring costs.

- **Training stakeholders to adopt ISPMs.** International consultants will be engaged by the FG to spell out requirements at production, processing, transportation, storage, and marketing levels and provide training of trainers who in turn will train farmers, processors, traders, exporters, etc. to adopt the ISPMs standards. One hundred farmers and 25 other stakeholders will be trained to adopt the ISPMs in each district every year.

7.4 Strategy for Southern Cluster

The southern cluster is much better streamlined on the production side, compared to the northern cluster. For example, cherries are gown in commercial orchards in the south, compared to mixed orchards in the north, where farmers are going through a transition from subsistence to the commercial farming. Still, there is room for improvement. The following strategies are recommended for interventions related to production and orchard management, product diversification, market segmentation and other value-added measures that are needed to be taken to get maximum value from the cherry cluster.

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7.4.1 Production Level Strategies

The production strategy for the southern cluster would to increase the yield by 30% from the current base of 1.86 tonne/ha to 2.45 tonne/ha. Another 25% yield increase resulting from orchard renovation. This shall include importing germplasm from Chile or Turkey and multiplying it in government facilities. The private registered nurseries will then propagate improved seedlings for distribution to farmers in the medium term. A related intervention would be to provide technical assistance to private nurseries and orchard owners to upgrade production systems and get their farms ISPMs certified for export. To support these interventions, appropriate training in nursery / orchard management will be imparted.

In the southern cluster, a key production constraint highlighted earlier is water scarcity and the threat of prolonged droughts. To address this problem, it is important to select high-yielding varieties that are also resistant to the vagaries of a changing climate, such as droughts. The following specific interventions are proposed:

a) *Importing high quality germplasm*. Balochistan is much ahead in terms of access to new technology and some of the latest varieties, such as Bing, Stella, Regina and Attika, are already available on limited scale (with large farmers), which need propagation and replication on a larger scale, and this is where public sector research and development agencies come in. The southern cluster also needs infusion of new germplasm, having specific traits to suit the prevailing conditions in Balochistan, such as tolerance to drought and pests. Such germplasm can be imported from China, Turkey or USA (Washington State). Bilateral and multilateral agencies can be approached, such as Consultative Groups on International Agriculture Research (CGIAR), FAO or the Chinese Academy of Agricultural Sciences (CAAS) as well as Pakistan's missions overseas, for assistance in accessing the require germplasm.

b) However, the technology development is a continuous process that requires establishing a robust breeding program. For this, germplasm can be obtained from China, Chile, Turkey, or USA. So diplomatic and commercial links should be used to get the much-needed germplasm from these countries.

c) *Development and supply of latest and certified varieties to farmers*. A strong breeding program needs to be established under the Directorate of Agriculture Research, Government of Balochistan. This breeding program can initially focus on the selection of high yielding materials from a wide array of germplasm collected, but later it can undertake long-term breeding work in developing new varieties.

d) *Distribution of new varieties*. Parent blocks will be established at the government nurseries and commercial nurseries will be incentivized to set up mother blocks and multiply certified plants for sale to farmers under the truth-in-label rules.

e) *Promoting proper orchards certified under International Standards for Phytosanitary Measures (ISPMs)*. In Balochistan, commercial nurseries are available, but they are seldom certified under ISPMs, which is why exporters find it difficult to export fresh cherries. Initially, at least 5 ISPMs certified commercial nurseries should be established in the focus district on cost sharing basis with farmers bearing 75% of the cost.

f) *Appropriate training in nursery and orchard management*. The ISPMs certified nurseries should be used for field demonstration and training, where other good agricultural practices (GAP) should also be adopted, and farmers should be exposed to new technologies and practices and innovations. It will be highly desirable to invite experts from China, Turkey or Chile to help in putting in place specific phytosanitary standards needed for export to China, Middle East and Southeast Asia. At least 10 farmers will be provided hands-on training in each cherry growing districts. One of the key objectives of this intervention shall be to bring the postharvest losses that are currently 20% of total production down to 10% over five years in the southern cluster.

7.4.2 Processing and Value Addition Strategies

As in the northern cluster, processing and value addition are missing steps in the southern cluster. Therefore, the strategy would be the same: a) establishing cold chains and, b) drying at least 5% of the production. This will be achieved by: a) incentivizing the private sector to establish cold chains for fresh cherries and drying lower quality grades, both for export and for domestic market, b) promotion of dried cherry use in food within the country, and c) holding competition and rewards for cherry processing and export of dried cherries.

In Pakistan all fresh fruit and vegetables are traditionally traded and marketed in open retail shops and small push-carts, and cherries are no exception. The global trend is supermarkets, where highly perishable items are displayed under cold conditions. Going forward, it is important to establish cold chains, especially for cherries (and strawberries and other berries), to avoid losses, extend shelf life and preserve freshness and obtain a higher price. The plan includes the following interventions.

a) *Incentivizing the private sector to establish cold chains*. In all cherry growing districts of the southern cluster, at least one cold chain will be established, including equipment for cooling, sorting, grading, and packing, as well as short-duration cold storage and a refer truck that takes the product to designated super markets. The center will be established on 50/50 cost sharing basis.

b) *Promoting dried cherries and its use*. The processing of fresh cherries results in separating the fruit by size and grade. For instance, after proper sorting and grading, at least 5% of the fresh cherries will turn out to be bruised or under-sized. This quantity will be destined for drying. This also be established at the cold chain centers under the supervision of FEGs. The drying equipment is very simple and used for drying different products, such as cherries, grapes and some vegetables. Under this plan, the best drying technologies will be identified and demonstration units will be distributed to progressive farmers, or provided as part of the demonstration processing units/ cold chains.

c) *Branding of cherry products*. Balochistan is well known in the Middle East for fresh fruit and vegetables, and it could be a good brand name. Different districts can also develop their own brands. Under the cluster development plan, experts will be hired to develop cherry brands for the southern cluster

d) *Certifications for IPPC, Phytosanitary, Organic, Fairtrade, and Geographical Indication'* can also be pursued as other value-added strategies. GI can be used on products that have a specific geographic origin and possess qualities or a reputation that are intrinsically due to that place of origin.

e) *Holding competition and rewards for Processors*. Special competition will be held with awarded for outstanding processors of dried and fresh cherries. These competitions will be held at district-level and then concluded at the cluster level.

7.4.3 Marketing and Trading Level Strategies

The strategy would be first to increase the export to production ratios through various measures including; *a) the provision of market information* (standards, process and potential buyers) - for this a small unit in agriculture department will be established to regularly provide market information to various stakeholders; *b) Sponsoring international tours* – for example top three exporters shall be sent abroad on exposure visits at 50% government expenses; and c) *Holding of competition and rewards for exporters.*

Secondly, measures are to be taken to improve the quality and export price and in order to meet the international standards. The suggested interventions include; *a) provide incentives for adopting best practice and certification regimes* - for this, special tax incentives will be provided to establish certification companies in the northern cluster. The government will also incentivize various stakeholders along the value chain to adopt these practices by paying 25% of the machinery cost recommended by the certification agencies at various levels. However, farmers have to agree to pay for any additional infrastructure, labor, and monitoring costs. *b) Training stakeholders to adopt ISPMs.* International consultants will be engaged by the FG to spell out requirements at production, processing, transportation, storage, and marketing levels and provide training of trainers who in turn will train farmers, processors, traders, exporters, etc. to adopt the ISPMs standards. One hundred farmers and 25 other stakeholders will be trained to adopt the ISPMs in each district every year.

A common intervention proposed is to establish a Cherry Association of Pakistan. This should be a joint activity for both the clusters, with an interactive website and marketing apps.

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8 BENEFITS AND COSTS OF CLUSTERING

This chapter 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 chapter 2. An economic and social impact analysis has also been conducted that evaluates the benefits of the Cherry cluster development interventions in two target regions of GB and Balochistan.

8.1 Capital Investment Needs

8.1.1 Northern Cluster

A public-private investment strategy is needed to support the cluster development efforts in GB. A capital investment of US$ 1.5 million is needed to upgrade the northern cherry cluster (Table 17). Of this about 33% of the total investment will incur by the government in strengthening research, capacity building of stakeholders along the value chain including farmers, providing incentives (20% subsidy) on value addition and processing infrastructure and renovation of gardens, and providing interest free load for developing infrastructure at rural level. Thirty percent of the total cost will be shared by the PCP, while remaining by the relevant provincial government. For this a Cluster Development Fund (CDF) should be established under PCP and provincial Planning and Development Departments. The seed money for CDF may come from CPEC investments. The private sector will invest on building the value chain and processing infrastructure and renovation of gardens after subtracting the subsidies on these provided by the government.

Table 17:Proposed Investments for the Development of Northern Cherry Cluster

DESCRIPTION	UNIT COST US$	QUANTITY	COST (000 US$)
Strengthening research (Building Cherry Research Station and operational cost)			100.0
Capacity Building and FEGs for improved management practices	74.1/ha	1364 ha	101.0
Cost of renovation /replantation -Plant material cost only (US$/ha)	2000/ha	409 ha	818.4
Cold processing plants (US$)	85,000/unit	5	340.0
4 units for drying	1000/unit	4	40.0
Government loans			41.8
Total			**1,441**

8.1.2 Southern Cluster

Similarly, a combined investment of US$ 1.03 million is estimated for improving the cherry cluster in Balochistan, of which US$ 0.366 million proposed to come from the public sector on

the activities similar in northern cluster, while leveraging the other US$0.663 million from private sources. The private sector will invest on building the value chain and processing infrastructure and renovation of gardens after subtracting the subsidies on these provided by the government.

Table 18:Proposed Investments for the Development of Northern Cherry Cluster

DESCRIPTION	UNIT COST US$	QUANTITY	COST (000 US$)
Strengthening research (Building Cherry Research Station and operational cost)			100.0
Capacity Building and FEGs for improved management practices	74.1/ha	1065 ha	788.9
Cost of renovation /replantation -Plant material cost only (US$/ha)	2000/ha	320 ha	639.0
Cold processing plants (US$)	85,000/unit	2	170.0
Units for drying	1000/unit	2	20.0
Government loans			209.0
Total			1,028.8

8.2 Summary of all Investment Costs

It must be noted that these investments are capital (CAP) investments, not working (WOR) capital (WC) that includes production costs or value chain costs, such as land, labor, raw and packaging material, transportation, distribution, financial costs (the working capital), which are substantial, and borne by the value chain actors. As these costs are expected to increase as a result of new investments, famers and other value chain actors need access to credit, which is typically not available from formal financial institutions. These costs are detailed in Feasibility Model (Annexes 5&6).

In the Table 19 below, we have provided a summary of all CAP investment and WOR capital costs. We propose that 10% of the total costs of the upgradation plan may come from grants, 70% from credit, and remaining 20% as private capital. For grants, international donor agencies like USAID, GTZ, World Bank should be explored, while for loans CPEC and local banks can be tapped. Note: A revolving credit fund can be established in partnership with public sector banks and CPEC. Alternatively, the government can provide loan guarantees to value chain actors to obtain credit from private banks, who will be responsible for due diligence.

Table 19:Summary of Investment Costs (000 US$)

Investments	Northern Cluster	Southern Cluster	Total
CAP Investment	1,535.6	1,028.8	2,564.4
WOR Capital	***11,085.7***	***6,062.0***	17,147.7
Total CAP investment and WOR Capital	12,621.30	7,090.80	19,712.10

8.3 Feasibility Model and Key Assumptions

Annexes 5-6 provide feasibility details for cluster development interventions in both clusters. The results of the model are based on the following key parameters and assumptions.

Table 20:Key Parameters and Assumptions of Feasibility Model

Parameters/Assumptions	Northern Cluster	Southern Cluster
Area under cultivation in focal point (ha)	1,364	1,065
Total baseline production (tonne)	3,897	1,981
Default yield (t/ha)	2.86	1.86
Existing annual yield growth without intervention (%)	1.33%	0.97
Farmgate/wholesale price of (US$/tonne)	2000	2000
Total percentage of area where orchards would be renovated in 5 years (%)	30	30
Assumed yield increased from renovated orchards (%)	75	100
Current post-harvest losses (%)	20	10
Reduction in post-harvest losses after intervention (%)	10	5
Production to be dried/processed (%)	10	10
Price of dried cherry (US$)	7,500	7,000
Current exports to production ratio (%)	0	1
Exports to be increased over five years (% of production)	5	5
Current Pakistani export price (US$/tonne)	2429	2429
Average international export price (US$/tonne)	4,328	4,328
% of domestic production to be improved for high end market in Pakistan	10	10
Gestation period (years)	3	3
Cost of orchard establishment (US$/ha)	2,000	1,750
Cost of production (US$/tonne)	213	213
Cost of local transportation and storage (US$/tonne)	15	15
Cost of national transportation	50	72
Cost of international transportation	200	100
Operation cost of cold processing including raw and packaging material (US$/tonne)	1,916	1916
Cost of dry processing including raw and packaging material (US$/tonne)	1,000	1,000
Marketing costs (% of gross revenue)	1%	1%

8.4 Economic and Social Returns

The investments as proposed for this cluster are expected to generate substantial economic, social and environmental (tree cover) returns. As discussed in the previous chapters, the key objective of cluster development is to improve the overall efficiency of the cherry sector in the country. This efficiency shall be realized as a result of measures taken at production, processing and marketing levels.

Following is a summary of the expected costs and returns for both the clusters. For details, please refer to Annex 5 and 6 in this report.

Table 21:Economic Returns and Investments by Cluster (000 US$)

Parameters	Northern	Southern Cluster	Overall
Undiscounted			
Total Gross Revenue (000 US$)	23,859	13,706	37,565
Total Operating Costs (000 US$)	11,154	6,107	17,261
Total Investments (000 US$)	1,441	1,029	2,565
Net Cash Flow (000 US$)	1,126	6,570	7,696
Economic analysis			
Discount rate (%)	8.5%	8.5%	8.5%
NPV (000 US$)	6029	3365	**9,307**
IRR (%)	68.7%	54.0%	62.0%.0

Based on these parameters, an IRR of 68.7% has been estimated for the Northern (GB) cluster and 54.0% for the Southern (Balochistan) cluster. The Net Present values of both the clusters are positive. This shows a reasonably high potential for returns and profitability in the upgradation of cherry value chain in both the cluster, although it is higher in the former case because of its already higher yield.

Overall the cluster upgradation plan will generate a positive NPV of US$9.3 million with an IRR of 60.0%. The cluster interventions will stimulate the local economy, create jobs, and earn foreign exchange.

8.5 Conclusion

To conclude, the overall economic, social and environmental impact of the cluster development program is positive, sustainable and long lasting. In summary, a lot need to be done to become competitive in international markets. But if the country can invest in R&D, processing and quality infrastructure and capacity building of stakeholders, it can enhance income to farmers, middlemen, and traders, generate foreign exchange for the country and new employment opportunities in the cherry growing rural areas.

9 Programs and Plans

This report presented an overview of the potential of cherry sector in Pakistan. Identified the cherry clusters as part of the V2025 of GoP discussed the gaps and constraints of identified cherry clusters in GB and Baluchistan. Gave recommendations for cluster development in both the regions; and estimated the economic and social impact of the cluster development interventions that shall set new frame conditions at production, processing, and marketing level of cherry value chain in both the regions. In support of the findings and recommendations presented in previous chapters, the following plans and programs are proposed for further value addition.

In support of the strategies and interventions proposed in chapter 8 of this report, the following programs/plans are recommended to further strengthen the interventions and to creating greater opportunities for participation and learning.

9.1 Program for Organization and Networking

The following program is proposed for organization of stakeholders at different levels of value chain.

Table 22:Program for Organization and Networking of Stakeholders

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1. Gilgit Baltistan				
1.1	• Form Cherry Farmer Enterprise Groups (FEGs) at grassroots level. 4 FEGs in total with each having a membership of at least 25 farmers. GB has 4 cherry producing districts, and thus 1 FEGs per district	Organization of Cherry farming community for collective action	Village Organizations (VOs), LSOs, NGOs (AKRPS), DoA GB, Department of rural development GB.	Short to medium term (1 to 2 years)
1.2	• Form Cherry Processors and Traders Association at market/business level. At least 4 processors should be initially involved.	Improve coordination between the stakeholders of Cherry value chain	DoA GB, NGOs, Private Sector	Short to medium term (1 to 2 years)
2. Balochistan				
2.1	• Form Cherry Farmer Enterprise Groups (FEGs) at grassroots level. 4 FEGs in total with 1 FEG in each cherry producing district and FEG each having a membership of at least 30 farmers.	Organization of Cherry farming community for collective action	NGOs, DoA Balochistan, Department of rural development Balochistan.	Short to medium term (1 to 2 years)
2.2	• Form Cherry Processors and Traders Association at market/business level. At least 4 processors (1 processor in each cherry producing district) should be initially involved.	Improve coordination between the stakeholders of Cherry value chain	DoA Balochistan, NGOs, Private Sector	Short to medium term (1 to 2 years)

9.2 Program for Research Reform

The following program indicative areas for further research to strengthen the cherry cluster in the two regions are proposed along with the estimated costs.

Table 23: Program for Research Reform

Sr. No.	Identification of Areas for Further Research	Research Purpose/ Priority	Indicative Research Institutions
1. Gilgit Baltistan			
1.1	• Identify suitable cultivars for mountain areas • Develop strategy for quickly distributing improved seedlings	Cherry production improvement (Short to medium term (1 to 2 years)	MARC, PARC, KIU, DoA Gilgit Baltistan
1.2	• Develop training modules • Develop formats for Farmer Field Schools (FFS) for on-farm training of Cherry producers	Improve Orchard Management and On-farm Processing Skills (Short to medium term (1 to 2 years)	MARC, DoA Gilgit Baltistan
1.3	• Survey for identification of target group of 4 processors	Product Diversification from Processed Cherries (Short to medium term (1 to 2 years)	Private businesses, DoA Gilgit Baltistan, MARC
1.4	• Consultation with processors to assess interest in establishing a Fruit Processor Association • Scoping survey to identify new products and potential buyers	Create market Linkages for quality Processed Cherry (Domestic and Export) Medium to long Term (2 to 5 years)	Private businesses, DoA Gilgit Baltistan, MARC, Export promotion board, Embassies
1.5	• Identify suitable fresh fruit traders to support the cluster • Identify suitable fresh fruit buyers to link with in premium markets through a market survey • Consultation to decide on implementation strategy – wholesale market or individual traders • Identify most suitable cold storage and fresh fruit trading technology	Develop Cold-Chain Infrastructure for Fresh Fruit Trading Medium to long Term (2 to 5 years)	FEG clusters; Farmer Associations; Business associations and cooperatives.
1.6	• Research into Climate change related negative impacts such as new diseases and shifts in crop cycle	Investigate into climate related negative impacts on horticulture Medium to Long term (2 to 5 years)	MARC, DoA Gilgit-Baltistan, KIU, research institutions
2. Balochistan			
2.1	• Survey for identification target group of 4 processors	Product Diversification from Processed Cherries Short to medium term (1 to 2 years)	Private businesses, DoA Balochistan
2.2	• Consultation with processors to assess interest in establishing a Fruit Processor Association • Scoping survey to identify new products and potential buyers	Create market Linkages for quality Processed Cherry (Domestic and Export) Medium to long Term (2 to 5 years)	Private business, DoA Balochistan, Export Promotion Board, Embassies

Sr. No.	Identification of Areas for Further Research	Research Purpose/ Priority	Indicative Research Institutions
2.3	• Identify suitable fresh fruit traders to supporting the cluster • Identify suitable fresh fruit buyers to link with in premium markets through a market survey • Consultation to decide on implementation strategy – wholesale market or individual traders • Identify most suitable cold storage and fresh fruit trading technology	Develop Cold-Chain Infrastructure for Fresh Fruit Trading Medium to long Term (2 to 5 years)	FEG clusters; Farmer Associations; Business associations and cooperatives.
2.4	• Research into Climate change related negative impacts such as new diseases and shifts in crop cycle	Investigate into climate related negative impacts on horticulture Medium to Long term (2 to 5 years)	DoA Balochistan, P&D department, Research Institutions

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10. Annexures

Annex 1: Macro Data Sources

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Annex 2. List of Stakeholders Consulted

The following stakeholders were consulted during this feasibility study exercise

Sr No	Name	Title	Location	Contact
1.	Asghar Ali	Director, DoA	Gilgit	0306 3069900
2.	Melad Karim	COP, Sadpara Development Project	Skardu	0302 5430003
3.	Ahsan Mir	PD, GBTI (IFAD)	Gilgit	0345 5456795
4.	Muzaffar u din	GM, AKRSP	Gilgit	0345 8521990
5.	M. Qurban	SDP	Skardu	0300 7000209
6.	Raza Ali	Member Village Organization Astana	Skardu	0346 8483365
7.	Zulfiqar Ali	Member Village Organization Astana Bala	Skardu	0344 2581350
8.	Mazhar Hussain	Member Village Organization Gamba	Skardu	0340 018912
9.	Ghulam Nasir	Member Village Organization Gamba	Skardu	03435030290
10.	Rehmat Ali	Member Village Organization Hussain Abad	Baltistan	
11.	Mr. Kamal Din	CEO KADO	Hunza	0300 0227770
12.	Malika	Member Village Organization, Katpana	Baltistan	0344 5696969
13.	Sher Ali	Resident of Olding	Baltistan	0341 7722066
14.	Nasir abbas	Resident of Olding	Baltistan	0355 5239534
15.	Balqis	Resident of Hussain Abad	Baltistan	
16.	Zakiya	Resident of Hussain abad	Baltistan	
20.	Mohammad Iqbal	Former, Head of Value Chain, FAO	Balochistan	0300 2361660
21.	Shahishah Khan	Entrepreneur	Balochistan	0334 2408650
22.	Mohammad Yahya Musakhel	Farmer	Balochistan	92 828601034

Annex 3: Literature Reviewed

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Annex 4: Brief Description of the Product, Process and Cost/Benefit

The cluster report on cherries provides the full suite of products, interventions, costs and returns, divided into production, processing and marketing stages. The purpose of this Annex is to highlight one key intervention, the processing part, leading to a finished product.

By processing and value addition, we mean harvesting at the right time, washing and hydro-cooling the product immediately after harvest, sorting, grading and retail packaging and then establishing a cold chain to deliver the product from the processing center, all the way to super markets in Islamabad, Lahore and other cites, or to the air cargo facilities for export. In this way, not only higher prices are ensured, but also the product's shelf life is extended, and transportation and retail level losses are reduced.

It is important to note that this intervention in isolation will not work and not produce the desired results, as it is just one part of the integrated cluster development plan and interventions proposed in the main report. The purpose here is to provide an example of the end product, assuming that all the other steps in the value chain are taken care off, especially the provision of high quality and certified planting material.

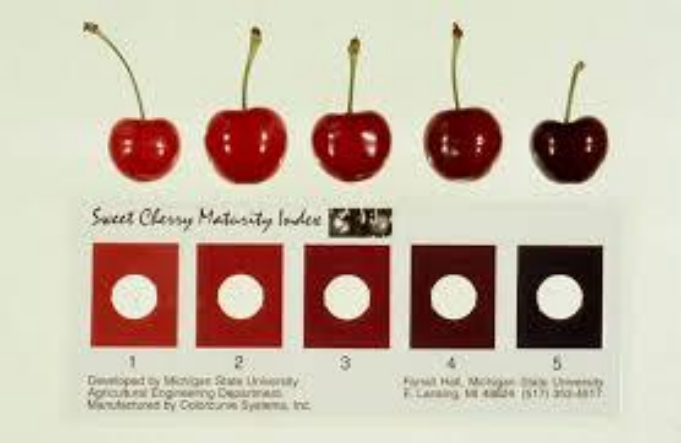
Key parameters

Sr. No.	Description	Details
1	Product	Fresh cherries
2	Process	Sorting, cleaning, grading, cooling down to 4 degree centigrade, packaging, short storage, and transportation in refrigerated vans
3	Technology	Cold processing/ cold chain
4	Number of processing units	One
5	Locations	Balochistan and GB
6	Target markets	Karachi and Punjab
7	Employment generation	1,800-persondays

Process Flow

Picking the fruit

Cherry harvest is best accomplished when they are near-ripe on the tree. Once ready to harvest, the picking season may span 2-3 weeks. The farmer knows when to pick cherries visually once the fruits change from red to dark-red and blackish in color and feel slightly softened, but still firm to the touch. The exact hue varies according to cultivar but regardless of the variety, all fruit soften extremely quickly, making them vulnerable to bruising and subsequent rotting. The recommended method is to gently pick the ripened fruits from the tree.



Storage

The harvested fruit will keep for approximately 2-3 days stored in a cool location and free from damaging factors such as additional weight upon the fruit, which may result in bruises and decay. The fruit is best stored in a single layer to minimize potential damage due to bruising.

Cold processing

Hydro-cooling is a vital step that helps us ensure cherry quality remains high. That's because if cherries are not kept cold, they begin to lose firmness and overall quality very quickly. At hydrocooling, cherries are drenched with icy cold water to bring their internal (or pulp) temperature down. Next, cherries are sorted again, packed and kept in refrigerated rooms until they are loaded on small refrigerated trucks and transported within 24-48 hours of harvest.

Figure 6: 1-2 Precooling Systems and final packaging.

Process Steps

Intervention Cost (US$)

Sr. No.	CAPEX	Units
1	Land	1000
2	Building/ process yard	3000
3	Processing unit/ plant/ machinery (Capacity: 1 tonne/day)	35000
4	Cold truck	40000
5	Office equipment	2000
6	Installation costs	2,000

7	Training costs	2000
	Subtotal Capex	*85,000*
Sr. No.	**OPEX**	**Units**
1	Labour (1,800-man-days per season @US$ 8/day	14,400
2	Raw material (fresh cherries: 90 tonne in three months) @US$ 1/kg	90000
3	Packaging material	2000
4	Depreciation of plant and cold truck (10% per year)	7500
	Subtotal Opex	*113,900*
	TOTAL COST	*198,900*

Revenue Generation (US$)

Description	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Finished goods: 1 tonne/day over a 3-month season per year (tonne)	0	90	90	90	90	90	90	90	90	90
Revenue (@US$3000/tonne ('000)	0	270	270	270	270	270	270	270	270	270

Economic Analysis

Year	Costs (US$)	Income (US$)	Cash flow (US$)
0	-85,000	0	-85,000
1	113,900	270,000	156,100
2	113,900	270,000	156,100
3	113,900	270,000	156,100
4	113,900	270,000	156,100
5	113,900	270,000	156,100
6	113,900	270,000	156,100
7	113,900	270,000	156,100
8	113,900	270,000	156,100
9	113,900	270,000	156,000
IRR		184%	
NPV		813,984	
Interest Rate		10%	

Note:

The calculation does not include income from the sale of low-grade cherries separated after grading, about 5% of the volumes processed, which are typically dried and marketed. The price of dried cherries is nearly the same as fresh, hence no 'loss' or 'waste' during processing.

Annex 5: Analysis for Economic Returns, Costs and Investments in GB

CHERRY CLUSTER	Input value	Yearly %	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9

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Baseline Situation (2016): Acreage, yield, production and value											
Area under cherry cultivation (base year 2016) (ha)	1,364		1,364	1,364	1,364	1,364	1,364	1,364	1,364	1,364	1,364
Production (tonne)	3,897										
Baseline yield (tonnes/ha)	2.86										
Growth in yield (%)	1.33%										
Expected yield without intervention (tonne/ha)				2.93	2.97	3.01	3.05	3.09	3.13	3.18	3.22
Expected production without intervention)t)			-	4,001	4,054	4,108	4,162	4,218	4,274	4,331	4,388
Increase production by renovating/ replanting 30% of total orchard area with HYVs											
		Increm ental									
30% of the orchard area renovated/ replanted in 4 years (%)	30%	6%	6%	12%	18%	24%	30%				
Acreage renovated /replanted per year (ha)	6%		82	164	246	327	409				
Assumed yield increase in renovated/ replanted orchard area (%)	75%						2.29	2.32	2.35	2.38	2.41
Incremental production from renovated/ replanted acreage (tonne)			-	-	-	-	187	380	577	780	987
Value added processing and quality improvement for high end domestic and export markets											
				2.5%	5%	8%	10%	10%	10%	10%	10%
10% of the annual production cold processed for high end domestic markets, from year 3 (tonne)	10%	2.5%		100	203	308	435	460	485	511	538
				1.3%	3%	4%	5%	5%	5%	5%	5%
5% of the annual production cold processed for export, from year 2 (tonne)	5%	1.3%		50	101	154	217	230	243	256	269
				2.5%	5%	8%	10%	10%	10%	10%	10%
10% of the annual production dried from year 3 (1 dry tonne=6 fresh tonne)	10%	3%		17	34	51	72	77	81	85	90
Prices of various products in various markets											
Farmgate fresh cherry price	1,500										
Pakistani average price in high end domestic market (hyper and super stores-slightly higher than current average export price)	3,000										
International export price (high-end international market price)	4,328										
Dried cherry export price	7,500										
				2.5%	5%	8%	10%	10%	10%	10%	10%
Revenue from incremental production (US$/tonne)	2000			0	0	0	280963	569400	865460	1169294	1481057
Revenue from high end domestic markets, i.e. supper stores (US$)	3000		-	150,025	304,040	462,126	652,459	689,607	727,627	766,537	806,353
Revenue from exports (US$)	4000		-	141,423	286,609	435,631	615,052	650,069	685,910	722,589	760,122
Revenue from dried cherry sold in domestic and export markets (US$)	7500		-	125,021	253,367	385,105	543,716	574,672	606,356	638,781	671,961
Total expected incremental returns from all interventions (US$ '000)			-	3,051	3,092	3,133	3,701	4,269	4,837	5,407	5,976
Operating costs											
Production cost (US$/tonne)	381		31,177	62,354	93,531	124,709	155,886	155,886	155,886	155,886	155,886
Cold processing costs (US$/tonne)	1,916				1,553,634	1,574,391	1,651,230	1,728,404	1,805,879	1,883,641	1,961,692
Dry processing costs (US$/fresh tonne)	1,000			33,351	33,807	34,269	34,737	35,198	35,666	36,139	36,619
Local transportation costs (US$/tonne)	15		-	12,503	12,670	12,840	13,448	14,059	14,673	15,289	15,907
National transportation cost (US$/tonne)	72		-	28,807	29,191	29,581	32,074	34,575	37,083	39,596	42,114
International transportation cost (US$/tonne)	100		-	40,009	40,544	41,085	41,634	42,188	42,749	43,317	43,893

Marketing costs (% on turnover)	1%		-	1,770	17,630	18,170	19,290	2,010	20,920	21,740	22,560
Total operating costs (US$ '000)			31	179	1,781	1,835	1,948	2,012	2,113	2,196	2,279
Capital Costs	Unit cost (US$)	Quantity (#)									
30% renovations /replantation of existing orchard area (US$/ha)	7,000	82	574,000	574,000	574,000	574,000	574,000				
6 cold processing plants (US$)	95000	6	190,000	190,000	190,000						
23 units for drying	10000	23	100,000	100,000	30,000						
Total capital costs (US$ '000)			864	864	794	574	574	-	-	-	-
Total Gross Revenue US$'000)	33,465		-	3,051	3,092	3,133	3,701	4,269	4,837	5,407	5,976
Total operating costs (US$ '000)	14,374		31	179	1,781	1,835	1,948	2,012	2,113	2,196	2,279
Total Investments (US$ '000)	3,670		864	864	794	574	574	-	-	-	-
Cash Flow (US$ '000)	15,421		-895	2,008	517	724	1,178	2,256	2,724	3,211	3,698
Discount rate	0.0%										
NPV (US$ '000)	11,751										
IRR (%)	171.2%										

Annex 6: Analysis of Economic Returns – Southern Cherry Cluster, Balochistan

Analysis for Economic Returns, Costs and Investments in Balochistan	Input value	Yearly %	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Baseline Situation (2016): Acreage, yield, production and value											
Area under cherry cultivation (base year 2016) (ha)	1,065		1,065	1,065	1,065	1,065	1,065	1,065	1,065	1,065	1,065
Baseline yield (%)	1.86			1.90	1.91	1.93	1.95	1.97	1.99	2.01	2.03
Growth in yield	0.97%										
Production (tonne)	1,981		-	2,019	2,039	2,059	2,079	2,099	2,119	2,140	2,161
Increase production by rennovating/ replanting 30% of total orchard area with HYVs											
30% of the orchard area renovated/ replanted in 4 years (%)	30%	6%	6%	6%	6%	6%	6%				
Acreage renovated /replanted per year (ha)	6%	64	64	128	192	256	320	320	320	320	320
Yield increase in renovated/ replanted orchard area (%)	25%	0.05					0.05	0.10	0.15	0.20	0.25
Incremental production on renovated/ replanted acreage (tonne)			-	-	-	-	3	13	29	51	80
Incremental production after interventions							2,082	2,112	2,148	2,191	2,240
Value added processing and quality improvement for high end domestic and export markets											
				2.5%	5%	8%	10%	10%	10%	10%	10%
10% of the annual production cold processed for high end domestic markets, from year 3 (tonne)	10%	2.5%		202	204	206	208	211	215	219	224
				2.5%	5%	8%	10%	10%	10%	10%	10%
10% of the annual production cold processed for export, from year 2 (tonne)	10%	2.5%	0	202	204	206	208	210	212	214	216
				1.3%	3%	4%	5%	5%	5%	5%	5%
5% of the annual production dried for high-end domestic and export markets, from year 2 (1 dry tonne=6 fresh tonne)	5%	1%		17	17	17	17	18	18	18	18
Economic Returns: estimate of revenues generated from all streams	Price (US$)										
Revenue from incremental production (US$)	2,000			0	-	0	6,390	25,560	57,510	102,240	159,750
Revenue from high end domestic markets, i.e. super stores (US$)	3000			605,904	611,856	617,865	617,865	624,589	644,414	644,414	672,144

Revenue from exports (US$)	4000			807,873	815,808	823,819	831,907	839,973	848,117	856,340	864,642
Revenue from dried cherry sold in domestic and export markets (US$)	7500			126,308	127,626	128,956	130,298	131,558	132,831	134,116	135,413
Total expected incremental returns from all interventions (US$ '000)				1,540	1,555	1,571	1,586	1,622	1,683	1,737	1,832
Operating costs											
Production costs (US$/tonne)	383		24,468	48,936	73,404	97,873	122,341	122,341	122,341	122,341	122,341
Cold processing costs (US$/tonne)	1,916				781,544	789,219	797,388	806,951	817,814	829,977	843,440
Dry processing costs (US$/fresh tonne)	1,000			16,841	17,017	17,194	17,373	17,541	17,711	17,882	18,055
Local transportation costs (US$/tonne)	15		-	6,312	6,374	6,437	6,503	6,581	6,668	6,766	6,874
National transporation cost (US$/tonne)	50		-	10,098	10,198	10,298	10,410	10,559	10,740	10,955	11,202
International transportation cost (US$/tonne)	200		-	40,394	40,790	41,191	41,595	41,999	42,406	42,817	43,232
Marketing costs (% on turnover)	1%		-	15	16	16	16	16	17	17	18
Total operating costs (US$ '000)			24	123	929	962	996	1,006	1,018	1,031	1,045
Capital Costs	Unit cost (US$)	Quantity (#)									
30% renovation /replantation of existing orchard area (US$/ha)	6,000	64	384,000	384,000	384,000	384,000	384,000				
6 cold processing plants (US$)	95000	3	95,000	95,000	95,000						
23 units for drying	10000	12	40,000	40,000	40,000						
Total capital costs (US$ '000)			519	519	519	384	384	-	-	-	-
Total Gross Revenue (US$ '000)	13,126		-	1,540	1,555	1,571	1,586	1,622	1,683	1,737	1,832
Total operating costs (US$ '000)	7,134		24	123	929	962	996	1,006	1,018	1,031	1,045
Total capital (US$ '000)	2,325		519	519	519	384	384	-	-	-	-
Cash Flow (US$ '000)	10,770		-543	1,021	1,035	1,186	1,201	1,621	1,682	1,736	1,831
Discount rate (%)	0.0%										
NPV (US$ '000)	8,445										
IRR (%)	193%										

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Annex 7: Table of Assumptions and Unit Costs for the Feasibility Model

KEY ASSUMPTIONS	GB	BN
Production costs	*Modern*	*Modern*
Family labour @US$3/day/ha for 320 days (US$)	*960*	*960*
Cost of energy for irrigation @US$ 7 per ha		*7*
Cost of inputs per ha @US$0.35 per tree X 1000 trees)	*350*	*350*
Other costs (US$	*50*	*50*
Total production costs (US$/ha)	*1,360*	*1,367*
Production costs (US$/tonne)	*381*	*383*
Production Assumption		
Cost per plant (US$/plant)	11	8
Plantation density (# of plants) per ha	1,000	1,000
Cost of replanting 1 ha (US$)	11,000	8,000
Unit cost of renovating one grown up tree (US$)	5	5
Current tree density (# of grown up trees) per ha	300	400
Cost of renovating 1 ha (US$)	1,500	2,000
Average cost of planting/renovation 1 ha	7,000	6,000
Processing Plants		
Cost of land (US$)	1,000	1,000
Building/ process yard (US$)	3,000	3,000
Cost of plant with 2 tonne capacity/day US$)	35,000	35,000
Cold truck (US$)	40,000	40,000
Drying unit including trays (US$(	10,000	10,000
Office equipment (US$)	2,000	2,000
Installation costs (US$)	2,000	2,000
Training costs (US$)	2,000	2,000
Total cost per plant	*95,000*	*95,000*
Cold processing costs		
Raw material (US$/tonne)	*1,500*	*1,500*
Packaging material @US$ 0.3 per kg (US$/tonne)	*300*	*300*

Labour cost @100 kg processed per day per worker @ US$ 8.6 wage/day (US$/tonne)	*86*	*86*
Utilities (US$ tonne)	*30*	*30*
Total cold processing costs (US$/tonne)	*1,916*	*1,916*
Dry processing costs		
Raw material (US$/tonne)	*1,500*	*1,500*
Consumables (chemicals etc.) US$/tonne)	*100*	*100*
Labour cost @50 kg processed per day per worker @ US$ 5 wage/day (US$/tonne)	*100*	*100*
Total dry processing costs (US$/tonne)	*1,700*	*1,700*
Transportation cost Local transport (US$/tonne)	*Unit cost* *15*	*Unit cost* *15*
Surface transport to mainland markets (US$/tonne)	*72*	*50*
Transportation on KKH to China (US$/tonne	*100*	*200*
Other assumptions		
Processing plant capacity (tonne/day)	2	2
Average annual processing requirement (tonne)	2	2
Annual (3 month) processing capacity /plant @ 80% capacity (tonne)	144	144
Number of cold processing plants needed (#)	6	3
Average annual dry processing requirement (fresh tonne)	23	13
Capacity of drying unit (tonne/ season/year)	20	20
Number of Drying units required (#)	23	12
Local transportation: total production less postharvest losses at the farm level (%)	95	95
National transportation: total production less 25% local sales and 5% postharvest lose (%)	70	70
International Transportation: production bound for export to China by road	10	10