CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

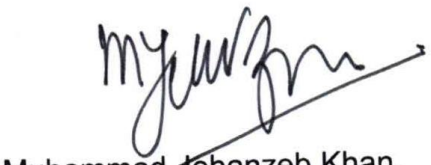
Almond Cluster Feasibility and Transformation Study

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

February 2020

FOREWORD

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



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

FOREWORD

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

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

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

FOREWORD

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

Dr. Babar Ehsan Bajwa
Regional Director
CAB International

FOREWORD

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

Dr. Mubarik Ali
Team Leader
Cluster Development Based Agriculture
Transformation Plan-Vision 2020 Project

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 almond 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, Ministry of Planning, Development and Special Initiative), **Mr. Muhammad Akram Khan** (Project Director; CDBAT) and the team from Planning Commission of Pakistan **Mr. Muhammad Arif** (Research Associate) and **Dr. Habib Gul** (Research Associate) for successful coordinating the project activities and preparation of this report.

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

Dr. Muhammad Javed Tareen
Senior Author

Citation:

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DISCLAIMER

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

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LIST OF ACRONYMS

ADP	Annual Development Plan
BRSP	Balochistan Rural Support Program
CABI	Centre for Agriculture Biosciences
CPEC	China Pakistan Economic Corridor
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practices
GB	Gilgit-Baltistan
GoP	Government of Pakistan
ha	Hectare
IRR	Internal Rate of Return
IPPC	International Plant Protection Convention
Kg	Kilo gram
KP	Khyber Pakhtunkhwa
M.	Million
MINFAL	Ministry of Food, Agriculture and Livestock
MIS	Market Information System
MNFS&R	Ministry of National Food Security and Research
NARC	National Agriculture Research Council
NGO	Non-Governmental Organization
NPK	Nitrogen, Phosphorous & Potash
NRSP	National Rural Support Program
PARC	Pakistan Agriculture Research Council
PCSIR	Pakistan Council for Scientific and Industrial Research
PFVA	All Pakistan Fruit & Vegetable Exporters & Importers Association
PHDEC	Pakistan Horticulture Development and Export Company
PKR	Pakistani Rupee
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

EXECUTIVE SUMMARY

The almond fruit is very popular and 2nd largest nut after peanut grown worldwide mostly in the temperate zones. Globally it planted at 1.92 million hectare (ha) with an estimated production of 2.24 million tonnes. The USA is at the top position by supplying more than 2.0 million tonnes of almond. Pakistan ranks 17th among the top almond producing countries of the world by cultivating almond on about 10 thousand ha and producing 22 thousand tonnes. The global export of almond has reached to US$ 5.17 billion in 2017. The USA has also attained top position in almond export during 2016 by exporting more than US$4.3 billion. Pakistan exported about 185 tonnes of almonds with an estimated worth of US$1.07 million during the same year contributing 1% of total production of the country, and 0.02% of the world export.

Almond production in Pakistan is found to be in serious crisis as its production has plummeted at a rate of 1.6% per annum during 2001-16 mainly because of the deterioration in its productivity, although area also disappeared in KP. This resulted in increasing imports, and the trade deficit in almond of the country has ballooned over the period. On the other hand, globally both area and per ha yield is on the rise indicating Pakistan's deteriorating position as well as its competitiveness in international almond market. The rising global exports, however, has created a great opportunity for Pakistan to expand its export.

In this scenario, Planning Commission of Pakistan has sponsored this study to look into the whole value chain of almond and identify gaps and potentials for investment so that the competitiveness of almond can be improved in the domestic and international market. Recognizing the variation in geophysical and socioeconomic conditions, the analysis is designed to focus on major almond growing clusters.

As 95% of almond is cultivated in Balochistan, the Western Balochistan districts of Loralai, Zhob, and Killa Saifullah are recognized as the main almond growing cluster in the country with Loralai as its focal point. The study identified a number of development challenges in the Balochistan cluster through its end-to-end value chain development. The foremost challenge is the climate change, resulting in serious shortage of irrigation water. Policy neglect, low productivity of old gardens, archaic garden management, poor harvest and post-harvest practices, poor capacity of farmers to undertake proper varietal selection and harvesting methods also pose serious constraints. However, the SWOT analysis of the cluster revealed that great potentials exist for the development of almond value chains in the area including proper climatic condition for almond harvesting, growers experience in almond cultivation available of high-yielding varieties, description of standard garden management and harvesting practices, and availability of almond processing technologies and processes.

The interventions proposed for the improvement in almond competitiveness are: renovation of existing orchards with late blooming high yield varieties; diffusion of improved orchard management practices through mobilizing provincial agricultural extension department and agricultural advisory services; introducing improved value chain practices like fruit picking,

grading, sorting, packing, etc. for the purpose of controlling post-harvest losses and improving almond value in domestic market; installation of almond shelling and oil extraction units.

Total estimated investment required for the Almond Upgradation Plan in the focal point of the existing cluster in Balochistan is US$9.5 million, out of this 40% born by the public sector, whereas the net-cash flow (undiscounted) after deducting all direct and indirect costs during the 5th year of the project shall be US$18.0 million. However, to achieve these benefits would require, beyond the direct investment, US$5.4 million as an operational cost to be incurred by various stakeholders along the improved value chain. Net present value of the Almond Upgradation Plan after deducting all costs and investments is positive at US$56 million, whereas the Internal Rate of Returns (IRR) for the Plan is 136% clearly indicating an economically viable project (see attached Summary Sheet for the details of the impacts of interventions, investment, and operational costs). The upgradation plan also includes policy recommendations and strategies to effectively implement the interventions. Strengthening of research, organizing farmers into groups, and capacity building of stakeholders will be the key for the success of the upgradation plan.

Summary Sheet of Almond Cluster

Information	Cluster Loralai
Area of cluster focal point (ha)	4,557
Production (Tonnes)	10,195
Yield of the cluster (tonnes/ha)	2.24
Annual yield growth without intervention (%)	-2.91%
Percent area renovated in 5 years	20%
Total orchards areas renovated in 5 years (ha)	1,139
Increase in yield due to orchards renovated (%)	50%
Increase in production due to orchards renovated (tonnes)	3,017
Expected additional value of production due to orchards renovated (US$)	6,704,404
Increase in yield due to improvement in management practices (tonnes/ha)	0.19
Increase in production due to improvement in management practices (tonnes)	879
Additional value of production due to improved management practices (US$)	1,953,215
Reduction in post-harvest losses after intervention (%)	20.0%
Increased in production due to reduced post-harvest losses (t)	1,099
Expected additional value of production due to reduction of losses (US$)	2,441,519
Additional production that will be processed (%)	50.00%
Production to be processed drying/processing (t)	2,347
Total volume of palm oil produced (tonnes)	44
Additional income through enhanced processing (US$)	17,375,612
Total number of Almond oil units required	2
Total number of Shelled Almond units required	7
Total investment required for processing (US$)	1,226,050
Almond R&D Program	1,111,111
Capacity Building of Farmers' Organization for improved management practices	297,893
Orchard renovation cost-plants and drip irrigation (US$)	4,527,312
Investments (US$)	
Investments required on establishment of certified almond nurseries (US$)	1,679,187
Investments required on almond oil processing units (US$)	65,522
Investment on almond shelling (US$)	875,750
Value chain level training	200,000
Government Loans (One year interest free)	818,054
Public Investment (US$ Million)	**3.850**
Private Investment (US$ Million)	**5.691**
Total investments (US$)	**9,540,567**
Overall benefits and rate of return	
Total increase in production due to all the yield increasing interventions (t)	**4,995**
Expected additional value of production due to all interventions (US$)	**23,428,466**
Additional operational cost due to improvement in value chain during 5th year (US$)	**5,390,076**
Total net benefits of all the interventions in 5th year (after offsetting all costs) (US$)	**18,038,390**
NPV (M.US$)	**56,310,887**
Internal Rate of Return	**136%**

1 INTRODUCTION

1.1. Almond Sector in Pakistan

Almond (*Prunus amygdalus*) is deciduous fruit and is grown in temperate and colder climates of the world. Almonds are found to be grown in temperate countries. Almond is high nutritional and rich source of calcium, vitamin E, manganese, phosphorous and iron. It also pack other minerals such as selenium, zinc, niacin and copper[1]. When compared with other nuts, almonds are denser in beneficial components and nutrients. Almond health benefits include preventing heart attacks and heart diseases, improving bone health, strengthening immune system, enhancing the skin, reducing inflammation, increasing energy production and preventing cancer. Other benefits include supporting healthy pregnancy, promoting weight loss, help control blood sugar levels, preventing constipation, improves brain health and supply the body with antioxidants. Ancient Indian Ayurveda practitioners even believe that almonds had the capability to boost brain capacity, longevity and intellectual ability. Being rich in fiber, like most other fiber-rich foods, almonds help prevent constipation. However, it is also important to drink a significant amount of water when eating almonds to speed up the digestive process and beneficial effects of the nut. The taste of almond varies from bitter to sweet and both can be easily found in the market[2]. Traditionally, sweet almonds are edible, while bitter almonds are used to make almond oil, common that is used to add flavor to food.

Since almond have a high fat content, it is important to store shelled almond in a tightly sealed container in a cool dry place away from exposure to sunlight in order to protect them from being rancid. Keeping them cold further protects them from rancidity and prolong their freshness. Refrigerated almonds can be kept for several months, while if stored in the freezer, they can be kept for a year. Shelled almond pieces will become rancid more quickly than whole shelled almonds. Almonds in the shell have the longest shelf life[3].

Almonds are usually eaten as raw, in roasted form and also as an important ingredient in various traditional cuisines and salads. Its presence is considered necessary in sweet dishes, like, *zarda*, *halwa* (of suji & carrot), vermicelli/*sawayyan*, kheer, *qulfi* and ice cream etc. "*Badam ka halwa*" is very famous dish in Indo-Pak subcontinent. Arabs have special liking for this fruit, which is extensively used in their dishes also. It can also be used for culinary purposes, e.g. making

[1] One hundred grams of almond contains 575 calories, a good amount of fiber (12.2 g), an excellent source of vitamin E (26 mg), total fat (949 g), monounsaturated fat (31 g), total omega-3 fatty acids (6 mg)), total of omega-6 fatty acids (12065 mg), protein (21 g), potassium (670 mg), magnesium (268 mg), phosphorus (484 mg), calcium (265 mg) and iron (3.5 mg). They are low in saturated fat and contain many other protective nutrients. Calcium and magnesium are good for bone health, vitamin E and so-called phytochemicals are an excellent base for protection against cardiovascular diseases and even cancer. Almonds have a favorable effect on the level of cholesterol in the blood (Berryman et al., 2011).

[2] [https://www.naturalfoodseries.com/13-benefits-almond/]

[3] [http://www.whfoods.com/genpage.php?tname=foodspice&dbid=20]

'*qorma*'. In Indo-Pak subcontinent, it is thought to have a strengthening ability on nervous system, so mostly advised to children to take almonds in early morning in order to increase their cognitive ability. Several products of almond are available like almond butter, almond oil, crushed almonds, almond milk, almond biscuits and cakes, etc. Almond oil is a strengthening agent for hairs and causes them to be bright, healthy, strong and long. Its massage on the body strengthens the muscles and relieves pain. Since ancient times, it has been widely employed in beauty tips. It reduces the risk of cancer and must be included in the diet, especially in children's diet[4].

During 2016-17, almond gardens in Pakistan were present on 10.3 million hectare (ha) supplying 20.7 thousand tonnes of almonds (Table 1). The province of Balochistan is main almond producing area of Pakistan where 95% of production is concentrated while the remaining 5% is produced in KP province of Pakistan. The average yield of almonds in Pakistan is about 2.01 tonnes/ha, while it is highest in KP. Almond is also grown in Gilgit-Baltistan on an area of 1.16 thousand ha from which 2,361 tonnes of almonds are produced (GGB, 2015), however, these production figures are not included in the Pakistan statistics data. In most areas of the GB almond are not grown as commercial gardens due non-availability of big piece of lands. Almond trees in GB are planted in the backyards or just for the sake of shade purposes. The chilling requirements range from 300 to 800 hours for dormancy break and quality almond production.

Table 1: Provincial distribution of area and production of almond in Pakistan

Year	Area (000 Ha)			Production (000 ton)			Yieldper ha (kg)		
	K.P.K	Balochistan	Pakistan	K.P.K	Balochistan	Pakistan	K.P.K	Balochistan	Pakistan
2000-01	0.4	10.6	11.0	3.00	30.10	33.20	7.5	2.8	3.0
2001-02	0.4	9.2	9.6	3.90	22.50	26.40	9.8	2.4	2.8
2002-03	0.4	8.8	9.2	3.60	20.10	23.70	9.0	2.3	2.6
2003-04	0.3	9.8	10.1	3.10	20.80	23.90	10.3	2.1	2.4
2004-05	0.4	9.9	10.3	1.40	21.70	23.10	3.5	2.2	2.2
2005-06	0.4	10.0	10.4	1.40	21.90	23.30	3.5	2.2	2.2
2006-07	0.3	10.5	10.8	1.40	21.90	23.30	4.7	2.1	2.2
2007-08	0.3	10.8	11.1	0.90	25.70	26.60	3.0	2.4	2.4
2008-09	0.3	10.7	11.0	0.90	25.60	26.50	3.0	2.4	2.4
2009-10	0.3	10.6	10.9	0.70	21.20	21.90	2.3	2.0	2.0
2010-11	0.3	10.5	10.8	0.60	20.90	21.50	2.0	2.0	2.0
2011-12	0.3	10.5	10.8	0.60	20.80	21.40	2.0	2.0	2.0
2012-13	0.2	10.5	10.7	1.70	20.50	22.20	8.5	2.0	2.1
2013-14	0.2	10.4	10.6	1.10	20.50	21.60	5.5	2.0	2.0
Year	Area (000 Ha)			Production (000 ton)			Yieldper ha (kg)		

[4] PAR Agriculture Education Portal. "Almond Crop in Pakistan"
[https://www.opia.cl/static/website/601/articles-58898_archivo_01.pdf

	K.P.K	Balochistan	Pakistan	K.P.K	Balochistan	Pakistan	K.P.K	Balochistan	Pakistan
2014-15	0.2	10.4	10.6	1.10	21.00	22.10	5.5	2.0	2.1
2015-16	0.2	10.3	10.5	1.00	20.50	21.50	5.0	2.0	2.0
2016-17	0.2	10.1	10.3	1.00	20.70	21.70	5.0	2.0	2.1
Growth rate (%)	**-5.0**	**0.5**	**0.4**	**-8.4**	**-1.0**	**-1.6**	**-3.5**	**-1.5**	**-2.0**

Source: MNFS&R (2018); PAR Agriculture Education Portal. "Almond Crop in Pakistan" [https://www.opia.cl/static/website/601/articles-58898_archivo_01.pdf].

In the last decade, the almond production faced a serious crisis. Although area under almond remained almost stagnant at around 10.0 ha, its production plummeted at annual rate of 1.6% per annum. It is unfortunate that despite the highest per ha yield in KP, the highest percentage decline in almond production also came from KP where it declined at an annual rate of 8.4% per annum from 3.0 thousand tonnes in 2001 to only 1.0 thousand tonnes in 2016-17 (Table 1). The steep decline in almond production in KP during 2001-17 can be attributed to both decrease in area as well as per ha yield because of the civil war in the almond growing areas in the province. However, yield also declined in Balochistan during the period indicating a general negligence to the crop.

1.2. Almond in Global Perspective

According to FAO-Stat (2017), the annual production of almond in the world is estimated at approximately 2.24 million tonnes from 1.93 million ha, making average yield as 1.16 tonnes per ha. On contrary, the total production of almond in Pakistan is 21.0 thousand tonnes from 11.1 ha. Per ha yield of almond was 1.9 tonnes, which is about 62% higher than the world average. The total almond production of Pakistan is little less than one percent of the world (Table 2).

Table 2: Comparison of world vs. Pakistan's almond industry (2016)

Parameter	World	Pakistan	Share (%)
Area (000 ha)	1926	11.1	0.58
Production (000) ton	2240	21.0	0.94
Value of production (Million US$)	13524	55.1	0.41
Yield (ton/ha)	1.16	1.9	162.55
Farm gate price (US$/ton)	6039	2624	43.45
Quantity of international trade (000 ton)	755	0.2	0.02
Value of international trade (Million US$)	5168	1.075	0.02
Export-production ratio (% of production quantity)	15%	1%	-
Export-production ratio (% of production value)	38%	2%	-
Average export prices (US$/ton)	6845	5811	84.89

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

Internationally the almond production is increasing at an annual rate of 1.65% per annum, higher than the population growth of 1.19% implying that per capita availability of almond is increasing globally. This annual increase in production is contributed almost equally by the expansion in almond area with 0.79% as well as yield by 0.86% per annum (Table 3).

Table 3: Trends in world almond production and yield during 2001-2017

Years	Area (Ha)	Production (tonnes)	Yield (tonnes per ha)
2001	1665	1542	0.93
2002	1675	1839	1.10
2003	1596	1760	1.10
2004	1622	1594	0.98
2005	1699	1825	1.07
2006	1660	2062	1.24
2007	1683	1667	0.99
2008	1674	1812	1.08
2009	1757	1823	1.04
2010	1717	1900	1.11
2011	1728	2099	1.22
2012	1767	2027	1.15
2013	1823	2018	1.11
2014	1730	1937	1.12
2015	1730	2020	1.17
2016	1851	2145	1.16
2017	1926	2240	1.16
Annual growth (%)	**0.79**	**1.65**	**0.86**

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

Because of the increasing production trends, per capita annual consumption of all nuts and their products (in which almond is the major nut) has globally increased from 1.43kg in 2001 to 2.34 kg in 2013 (FAO Food Balance Sheets), which is about 64% increase in 12 years, thanks to the awareness about health benefits of nuts in general and almond in particular. In Pakistan, however,

per capita annual consumption of nuts has declined from 0.83kg to 0.76kg during the corresponding period.

A more interesting fact is that almond is becoming an international commodity as its trade (exports quantities and value) are increasing at quite an impressive rate. Though Pakistan's export in almond has impressive increase from 0.02 thousand tonnes in 2001 to 0.19 thousand tonnes in 2016 and touched the highest of 0.72 thousand tonnes in 2014, Pakistan except two years generally remained a net-importer of almond during 2001-16, (Table 4). The trade deficit has ballooned over the period and reached at US$21.7 million during 2016. However, because of favorable temperate environment in Balochistan and KP significant, potential exists in improving almond productivity if world-recognized almond varieties are grown. This could save a significant amount of foreign exchange spent on import and become its net-exporter.

Table 4: Trend in world trade of almond in comparison with Pakistan 2001-2016

Years	World		Pakistan					
	Quantity Exported (000tonnes)	Export value (Million US$)	Quantity Imported (tonnes)	Import value (000 US$)	Quantity Exported (tonnes)	Export value (000 US$)	Trade Deficit (tonnes)	Trade deficit (000 US$)
2001	303.6	783.3	119	65	19	57	100	8
2002	367.3	1033.6	117	64	23	73	94	-9
2003	356.2	1240.3	1080	703	1	2	1079	701
2004	348.0	1587.0	5358	4287	1	1	5357	4286
2005	347.8	2297.2	3128	3767	31	105	3097	3662
2006	405.5	2272.4	3358	4446	227	1346	3131	3100
2007	458.1	2312.2	3902	6076	221	1093	3681	4983
2008	473.1	2214.1	5269	8127	280	1232	4989	6895
2009	547.4	2142.1	2833	5459	102	388	2731	5071
2010	559.4	2628.8	2915	5910	172	653	2743	5257
2011	627.8	3066.1	1621	4329	90	396	1531	3933
2012	657.3	3564.5	2117	5253	83	613	2034	4640
2013	687.7	4669.1	1373	3685	391	1483	982	2202
2014	694.1	5498.0	666	1867	717	2497	-51	-630
2015	663.5	6203.6	4352	14497	266	1174	4086	13323
2016	755.1	5168.3	8929	22759	185	1075	8744	21684
Annual growth (%)	**6.21**	**12.15**	**12.70**	**24.92**	**28.31**	**33.51**	**16.75**	**29.9**

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

Almond is produced to various extents in more than 45 countries of the world, but United Sates of America and Spain are the leading countries of the world in almond area and production (Table 5), while Pakistan ranks 17th in the world in area and 18th in production

Table 5: Area, production and yield in top almond producing countries of the world

Rank	Country Name	Area (Ha)	Production (tonnes)	Yield (kg/ha)
	World	1925.9	2239.7	***1162.9***
1.	USA	404.7	1029.7	2544.3
2.	Spain	633.6	255.5	403.3
3.	Morocco	170.9	116.9	684.3
4.	Iran	50.9	111.8	2199.2
5.	Turkey	34.1	90.0	2643.2
6.	Italy	58.5	79.6	1361.3
7.	Australia	38.0	75.4	1983.5
8.	Syrian Arab Republic	110.8	71.8	648.3
9.	Tunisia	182.0	67.0	368.2

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

The highest per ha yield producing countries of the world are Israel obtaining 22.5 tonnes per ha remotely followed by Jordan who obtains 11.3 tonnes per ha (Table 6). These countries are temperate and their environment is comparable with Pakistan. Still average of Pakistan at 1.9 per ha is only less than 10% of Israel and 20% of the Jordan yield.

Table 6: Top almond yielding countries of the world

Rank	Country Name	Area (Ha)	Production (tonnes)	Yield (kg/ha)
	World	***2,239,697***	***1,925,887***	***1162.9***
1.	Israel	396	8903	22482.3
2.	Jordan	333	3756	11279.3
3.	Lebanon	5703	30381	5327.2
4.	Chile	8099	32979	4072.0
5.	China	15583	51953	3334.0
6.	Uzbekistan	1302	4271	3280.3
7.	Kyrgyzstan	569	1857	3263.6
8.	Turkey	34050	90000	2643.2

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

The total volume of global exports of almond during 2016 was at 755 thousand tonnes with an estimated value of US$5.168 billion. USA is the leading almond exporting country of the world by exporting almond worth of US$3.2 billion followed by Spain having the export of US$479 million almond during 2016 (Table 7). On the other hand, Pakistan could export only 185 tonnes of

almond worth of US$ 1.08 million during the same year, which is only 0.02% of global export quantity and values. Pakistan has large suitable land in Balochistan and KP that can be brought under almond cultivation thus its exports can be enhanced many folds but the main constraints is the non-fulfillment of Sanitary and Phytosanitary and other certification requirements of developed markets because of the poor quality.

Table 7: Top ten almond exporting countries of the world (2016)

Rank	Country	Quantity exported (000 tonnes)	Value (Million US$)
1.	USA	499	3238
2.	Spain	75	647
3.	Australia	41	243
4.	UAE	29	192
5.	China	25	124
6.	Germany	14	122
7.	Netherlands	13	108
8.	Italy	10	108
9.	Belgium	10	76
10.	Chile	7	66

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

The world's top almond importing countries during 2016-17 were Spain, Germany, Italy, and France (Table 8). Being nearest market, Pakistan should explore China and UAE markets who also import significant quantities of almond,

Table 8: Top almond importing countries of the world (2016)

Rank	Country	Quantity (000 tonnes)	Country	Value (Millin US$)
1.	Spain	101	Spain	675
2.	Germany	87	Germany	655
3.	Italy	42	France	303
4.	France	37	Italy	294
5.	China	37	Japan	241
6.	UAE	35	China	233
7.	Canada	29	Canada	207
8.	Japan	29	UAE	204

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

Pakistan's mainly export shelled almond although a large quantities of almond in shell are also exported (Table 9). Germany I the main buyer of shelled almond while UAE was the main buyers

of almond in shell during 2016-7. There is a significant increase in the export of both shelled almond as well almond in shell during 2016-17 as compared to 2015-16 (Table 9).

Table 9: Export of almond by Pakistan to different destinations of the world

Country / Commodity type	2016-17		2015-16	
	Quantity (Kgs.)	Value (000 Rs.)	Quantity (Kgs.)	Value (000 Rs.)
Almond in Shell	**59320**	**15895**	**17124**	**5784**
Australia	9528	2440	5615	1818
Bahrain	1655	542	1520	486
Canada	-	-	1400	438
Malaysia	-	-	509	230
Netherlands	672	229	414	146
Saudi Arabia	4374	1672	5186	1897
South Africa	1200	597	2480	770
Sweden	300	89	-	-
United Arab Emirates	40824	10016	-	-
United Kingdom	767	311	-	-
Almond Shelled or *Giri*	**184008**	**127487**	**237845**	**118780**
Australia	2160	1455	13963	6684
Denmark	-	-	5000	2415
Germany	152280	105880	153500	71753
Kenya	-	-	11080	6703
Malaysia	-	-	65	42
Netherlands	128	123	-	-
Saudi Arabia	13149	9676	25465	12762
U.S.A.	1355	890	-	-
United Arab Emirates	210	219	-	-
United Kingdom	14726	9244	28772	18422

Source: MNFS&R (2017)

On the import side, Pakistan also imports mainly shelled almond 96% of which comes from USA. Almond in shell is also imported mainly from USA (Table 10)

Table 10: Import of almond by Pakistan from different countries of the world

Country/Commodity type	2016-17		2015-16	
	Quantity (Kgs.)	Value (000 Rs.)	Quantity (Kgs.)	Value (000 Rs.)
Almond in Shell	**3198601**	**997640**	**3277601**	**755452**
Afghanistan	325248	89614	830511	177435
Australia	58634	12633	--	--
Canada	10000	1850	--	--
Table 10, Cont…….				

Country/Commodity type	2016-17		2015-16	
	Quantity (Kgs.)	Value (000 Rs.)	Quantity (Kgs.)	Value (000 Rs.)
China	29023	7385	--	--
Germany	4	2	--	--
Iran	4200	889	--	--
U.S.A.	2771492	885267	2412730	570225
United Arab Emirates	--	--	34360	7792
Afghanistan	12101	2417	34966	7314
Australia	435579	101370	1462552	368133
Canada	79685	15966	--	--
Chile	1053	201	--	--
China	20158	4058	--	--
European Union	--	--	15400	3107
Hong Kong	19958	5220	--	--
Iran	25798	5202	3200	995
Spain	--	--	76912	23821
U.S.A.	8331721	2312086	6834848	2052351
United Arab Emirates	653	162	62641	21963
United Kingdom	15500	3717	--	--

Source: MNFS&R (2017)

Concluding the analysis of macro data, almond in Pakistan is found to be in serious crisis as its production has plummeted at a rate of 1.6% per annum during 2001-16 mainly because of the deterioration in its productivity, although area also disappeared in KP because of the civil war in the almond growing areas in the province. This resulted in increasing almond imports, and the trade deficit of the country in almond trade has ballooned over the period. On the other hand, globally both area and per ha yield is on the rise indicating Pakistan's deteriorating position as well as its competitiveness in international almond market. The rising global export of almond, however, has created a great opportunity for Pakistan to enter into the world rising almond market.

In this scenario, Planning Commission of Pakistan has sponsored a study to look into the whole value chain of almond and identify gaps and potentials for investment so that the competitiveness of almond can be improved in the domestic and international market. Recognizing the variation in geophysical and socioeconomic conditions, this analysis is designed to focus on major almond growing cluster(s).

2 OBJECTIVES

This study has been conducted to contribute in the Cluster Development Based Agriculture Transformation Plan –Vision 2025. The following objectives of the study are given as under:

a) To identify major almond clusters of Pakistan based on their production.

b) To characterize and conduct SWOT analysis of each almond cluster.

c) To identify infrastructure, institutional, technological, and policy fissures of each cluster.

d) To evaluate the real potential of almond crop in each cluster.

e) To recommend infrastructure, institutional, technological and policy interventions to benefit economically from the recommended cluster potentials.

f) To conduct economic and social feasibility of the suggested interventions.

3 METHODOLOGY

The macro data, field-level situation and other related information regarding characteristics, loopholes, potentials and required measurements for development of almond cluster were gathered from following sources:

1. **Macro data**. Macro data related production, trade, prices, etc. were collected from various sources including internet searches See Annexure 1.

2. **Stakeholders' discussion**. The primary data were gathered from field visits of farmers, individual and group discussions with farmers, researchers, extension agents, exporters, office bearers of farmer's associations, NGOs, and higher authorities See Annexure 2.

3. **Literature Review**. Literature related to almond production, marketing, distribution, value chain development, and processing was extensively reviewed See Annexure 1 for the list of data sources used in this study.

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

1. World almond's industry perspective.
2. The almond industry analysis and its potentials.
3. Almonds cost of production, harvesting, postharvest and processing of almonds data was collected from farmers and other stakeholders.
4. Data was also collected from government directorates of Economics & Marketing, Postharvest & Food Technology, Wholesalers, Retailers and processers.
5. Production constraints, harvesting, transportation of almonds, marketing issues, trading export failures, and processing data was obtained from all the stakeholders.
6. The recommendations made on the basis of local and national yardsticks and international parameters.

4 REVIEW OF LITERATURE AND SUMMARY OF CONSULTATION

The per unit area yield of almond is the most promising aspect of this industry which results in more production with less inputs that enhances the benefit proportion as compared to cost. The

highest yield per unit area can be achieved by putting the essential ingredients crop management. For example, Israel is the world's top per unit almond yielding country (Table 6) country which is achieved through scientific almond tree management interventions, a testimony to persistent innovation of both science and industry.

The bilateral trade between China and Pakistan is quite imbalance and in favor of China. That is why Pakistan has asked China to encourage its agricultural products into Chinese market which will enhance one-sided contracted volume of trade from Pakistan side. In this respect China-Pakistan Economic Corridor (CPEC) is a potential platform for both countries to benefit from. Therefore, China and Pakistan have principally agreed to widen agro based cooperation and adoption to fast-track trade in agricultural products (The News, 2018). But to meet the export targets, Pakistan must have to apply the protocols under International Plant Protection Convention (IPPC), which is a major requirement for the export of agricultural products.

The CPEC is one of the great opportunities for the destination of Pakistani products especially fruits, vegetables and dairy and poultry products. According to All Pakistan Fruit & Vegetable Exporters & Importers Association, Balochistan can export US$1 billion worth of fruits and vegetables annually (PFVA). The PFVA in the start of this year visited Balochistan and held a series of meetings with the stakeholders for paving the way for the agricultural products of Balochistan including almond marketing in international markets. As Balochistan is called "The Fruit Basket of Pakistan" due to its five different agro-ecological zones which enable it to produce variety of quality crops (around 75 different crops), and 95% of almond production in the country comes from Balochistan. Only one Zone out of the five is irrigated with canal system while the rest are dependent on precious quality ground water but the persistent drought for the last 3 decades has played havoc with the agriculture sector of the province. On the other hand, untrained and illiterate farming community has further aggravated the situation by over extraction and injudicious use of this precious source.

However, it is matter of satisfaction that most of the almond farmers of Pakistan expressed their satisfaction over existence of major road network for access of their produce to the main markets of the country. However, roads from farm to main roads are in poor condition all over the country.

Despite the miseries created by the climate change, Balochistan is still land of tremendous opportunities that need to be tapped through wise planning, introduction of super/high density fruit trees, introduction of low water requiring crops and modern production technologies, including improved local and exotic varieties. The experts are of the view that the current situation can be improved by introduction of high efficiency irrigation systems which will increase the agriculture both vertically and horizontally i.e., improvement in productivity and expansion in area, respectively.

During the consultation process the farmers of almond expressed the concerns that besides water scarcity, major pests of this crop are also posing great threat. Tip borer, shot hole borer, aphids and scale while, blight, wilt and root rot are the almond major pests of almond in Balochistan, which sometimes cause major havoc and force the farmers to apply several sprays on this precious crop. Thanks to dry climate of most of almond growing areas during recent years, no

major disease has been mentioned by the almond farmers. Nevertheless, measures on biological control of major pests of almond crop are being taken in Balochistan. These interventions are in progress at Balochistan Agriculture Research Institute, Quetta with the collaboration of Center for Agriculture and Bioscience International (CABI). Their research work on these major pests has resulted in many successes which will indeed minimize the use of chemical sprays on almond crop.

5 CLUSTER IDENTIFICATION AND CHARACTERIZATION

5.1. Introduction to the Almond Cluster

As noted earlier, almond 95% of almond comes from Balochistan, while the remaining 5% comes from KP. The almond area in KP has declined because of the civil war during early 2000s in almond growing districts of the province. Besides, Gilgit-Baltistan also produce a small quantity of almond which is not reflected in national production statistics. Although, GB almond plantation has an advantage of its proximity to CPEC main highway which leads to Gwadar from the border of China, its cultivation is scattered throughout the region as backyard individual tree plantation, not as commercial garden. Therefore, in this study we consider that plantation in KP and G-B does not form almond cluster. However, because of its favorable environment for almond cultivation and its proximity to the CPEC, we recognize G-B as future potential cluster if almond commercial gardening technologies are introduced there.

Based on the district-level almond production statistics, the main almond producing areas in Balochistan are Loralai, Zhob, Killa Saifullah districts (Table 11), therefore these are recognized as the only almond cluster in the country with Loralai as its focal point (Figure 1). This cluster, named as Balochistan cluster, supplies about 87% of the total provincial almond production. The focal point alone contributes more than one half of the total almond production in the province.

It is worth noting that per ha yield of almond is highest in Ziarat and Khuzard, although the area under almond is very small. Moreover, surrounded districts also have very small area of almond thus this does not make a reasonable size almond cluster. However, if properly promoted, the northern Balochistan can also be a potential future almond cluster.

Table 11: Production areas of almond in Pakistan

S#.	District/Location	Area (ha)	Production (tonnes)	Production (% of provincial total)	Yield (tonnes/ha)
Balochistan cluster					
1	Loralai	4,206	10,195	51	2,424
2	Zhob	1,543	4,202	21	2,723
3	Killa Saifullah	1,150	2,924	15	2,543
	Total Balochistan Cluster	6,899	17,321	87	2.5107
Non Cluster districts and regions					
4	Barkhan	451	1,088	5	2,412
5	Kalat	178	471	2	2,646
6	Ziarat	124	390	2	3,145

S#.	District/Location	Area (ha)	Production (tonnes)	Production (% of provincial total)	Yield (tonnes/ha)
7	Khuzdar	72	288	1	4,000
8	Pishin	139	257	1	1,849
9	Mastung	100	204	1	2,040
	Non-cluster districts of Balochistan	1064	2698	13	2.536
	Total Balochistan	7,963	20,019	100	2.514
10	Gilgit-Baltistan	1,164	2,361	10.08	2,028
	Total	**9,127**	**22,380**	**100%**	2,707

Source: MNFS&R (2017) and GGB (2015).

Figure 1: Map of Pakistan showing almond production & marketing areas

The reason of selecting Loralai as focal point of almond cluster is that it is the top almond producing area of Pakistan, contributing alone 48% of almonds of Balochistan province and 60% of the almond cluster. The said district is also surrounded by other almond producing districts i.e., Killa Saifullah, Zhob and Ziarat.

5.2. Characteristics of Almond Cluster

The height of almond growing areas in Pakistan is from 1.4-25.5 thousand meters from sea level, which is considered quite suitable for almond cultivation. However, each level of height is suitable for the cultivation of different almond varieties.

The proposed Balochistan Cluster is geo strategically lying in West of the country and near to the Western route of CPEC. Therefore, the almond can easily be transported to any market of the country. This cluster has the access to Karachi and Gwadar ports therefore Middle East markets can be focused. While, in north almond export to Central Asia and adjacent potential markets of Islamabad and Lahore is viable. The climatic conditions of the cluster suit best to almond crop and that is why several varieties thrived well and became cultivars. In this cluster wild almond are also found on hills and mountains.

In the Balochistan Cluster, many small farmers are engaged in almond cultivation and they produce considerable volume of almond while, their marketing cost is very high and no platform is available for collection of fruit in bulk and presented or marketed the small volumes of small farmers. No farmers' cooperative group exists to manage inputs in bulk like pesticides, fertilizers, packaging materials, branding, transportation of their produce, and marketing (Table 12).

Although, most farmers irrigate their fields, but water is getting scarce due to prolonged drought in Balochistan. Almond is mostly intercropped with other fruits, cereals, and fodder. Little grading is done at the farm-level and primitive methods of transportation and marketing is used (Table12)

Table 12: Characteristic of Balochistan Almond Cluster

Salient Features	Balochistan Cluster
Districts	Loralai, Zhob, and Killa Saifullah
Area of the cluster (ha)	6,899
Production (t) of the cluster	17,321
Average yield of the cluster (kg/ha)	2511
Focal point district/Tehsil/Mouza	Loralai
Focal point area (ha)	4,206
Focal point production (t)	10,195
Focal point yield (kg/ha)	2424
Percentage of the crop area lies in the cluster (almond area of the cluster/almond area in the country)	75.6%
Percentage of the total cropped area in the cluster (almond area in the cluster/total cropped area in the cluster)	6.12%

Geographical and Environmental Factors	• (allium pidmont soil (Sandy Loam and sandy clay loam)) Calcareous soil and gravely in nature.
	• Plains and mountainous valleys
	• Climate is mild to very warm in summer and very cold in winter. Some areas come in monsoon range. Some areas are arid.
	• Mostly almond orchards are irrigated with ground water, but water is scarce due to prolonged drought.
	• Ground water is pumped and the water is fit for irrigation.
	• Average rainfal 50-300 mm. Most of the rain occur in winter and only Zhob area receives monsoon rainfal.
	• Temperature rises up to 35-40 °C during summer but drops to -5°C during winter. Dry hot and cool nights are typical in summer.
	• Dust storms do occur in late summer.
	• Mostly dry during the fruiting season of July-August
Almond Growers	• Small land holding size (<=2 ha) on average
	• No almond specific growers association however, Farmer's Association do exist.
	• Availability of abundant labor for almond production practices, especially at the time of harvesting.
Product Features	• Mostly sweet and some bitter almond also grow.
	• Hard Shell and soft shell varieties, sweet and bitter varieties.
	• Pls. Tell the crack-out ratio (i.e., kernel-shell weight ratio) for various almond variety grown in Balochistan. It would be better if this ratio is compared with the imported vrieties.
	• Small size nuts are used in ice cream or dreessing other food items.
Variety Feature	• Around 10 almond varieties are available in the cluster out of which 5-6 have become main commercial vrieties. • Area under almond is increasing in the cluster. • Main almond varieties cultivated in this cluster are Talwar, Patasa, Spin Patasa, Kaghazi, Tor Mongphali, Katta, and Mongphali.
	• Average yield of almond per tree is 15-20 kg

	• Some almond farmers raise their own nursery plants. Almond saplings are also available from private nurseries and government nurseries.
	• During the early almond orchards plantation, inter cropping is normal. Normally orchards are properly laidout.
	• Average number of plants are 108 per ha.
Inputs/Management Practices	• Fertilizers are used. Fresh cow dung is used as FYM which is very harmful for trees as trees become vulnerable to the attck of termites
	• Mostly pesticides are used against insects while rarely used against diseases.
	• The use of micro nutrients is not practiced in almond orchards, macro nutrients N:P:K are used.
	• Normally in one season on average, 8 irrigations are applied at intervals of 10-12 days.
	• Mainly orchards are flood irrigated.
	• Intercropping with other fruit plants and fodder, cereal crops (such as alfalfa, wheat etc.) and vegetables are normal practice.
	• Weeding is done manually, no weedicides are used
Pruning/Harvesting	• When harvesting is done? • How, who, and where drying of kernnel is done to bring the required humidity level? What is the required humidity in almond (6% in Australia)? • How many days remain in field after harvesting? • What is normaly almond (in shell)-debris ratio when sweeped from the field? • How it is separated from debris? • When and who dry it to bring the moisture content to 6%? **These are important questions and must be answered.**
	• Almond fruit is harvested manually by hand-picking or beating the tree branches with stick. No mechanised harvesting exist.
	• Pre-harvest losses are 5-10% while, almost no post-harvest losses occur.
	• No exact know how about proper stage of maturity of almond fruit for its harvesting. Farmers do not use any scientific maturity index.
	• No concept of tree and fruit pruning.
	• Winter pruning is done by cutting the dead branches, used as firewood but generally pruning is considered loss to tree vigor.

Packaging/Transportation	• After harvesting fruit is not graded and packed in sacs and placed in the seperate room then transported in vans, pickups and through trucks by big farmers.
Wholesaler/Retailer	• Contractors or wholesalers buy the product from farmers. The price is offered to the farmer based on variety and quality of fruit.
	• The auction in the wholesale market is generally based on the variety and weight, but grading standards are not followed.
	• As per market demand re-grading is done by commission agents, retailers and exporters. The average price of almond is Rs. 800-1200/kg.
	• Auction at the wholesale level is not done in front of farmers.
	• The prices remain high in the begining of the season and after that remain unstable until the end of the reason.
	• Mostly sold shelled in local and national markets while, unshelled in international markets.
	• The major portion of almond fruit is consumed within country.
New Technologies/Infrastructure	• No ware house facility for almond is available in the cluster.
	• No shelling facility is abailable in the cluster.
	• No value addition, preservation, and prominent industrial processing is done with surplus almond.
Export/ domestic marketing	• Almond are mostly marketed in Faisalabad, Quetta, Karachi, Lahore, and Islamabad markets.
	• Presently more than 200 million population of Pakistan will be increasing year by year and CPEC will also be in full swing therefore, pressure for increase in production and quality of almond is very much there and farmers are aware of it.
	• Although most of the almond are destined to markets of other provinces but still export potential in the commodity exists but very small quantity is exported.
	• Almond remain fresh for at least two years at room temperature and can be exported whenever market is high.
Supply Chain	• Due to variation in quality no sustainability in prices. There is uneven Price Spread throughout the chain.

	• Unfit packaging and imporper storage at farms and markets decrease the qualilty of almond. • Complex procedures for shipment of almond limit its exports.
	• Majority of farmers and traders do not follow the almond handling precautions and protocols.
Certification	• SPS, Food safety standards and traceability standards such as HACCP, EuroGAP, Global Gap, IFS are not followed which cause major obstacle to enter into high end and export markets.
	• Organic food certification is costly and not affordable by majority of the farmers despite most of the fruit is organic.
Socioeconomic networking/Gender involvement	• Women role in almond industry is very limited.
	• A typical orchard owner earns more than Rs. 0.7 million from an acre.
	• Community mobilization needs to be fostered for greater awareness about the importance of modern production technology of almond.
Subsidies/Incentives/Facilities	• Balochistan Agriculture Department,.Agriculture Research, Extension, BARDC, FAO and other Non Governmantal Organisations are working on horticulture production including almond crop through different projects and interventions but still a lot need to be done. • Several projects on different aspects of horticulture has been implemented inclusive of almond crop
Socioeconomic Networks	• The role of FAO, BRSP and NRSP is important in improving almond husbandry in this cluster. These organisations can involve every walk of life for promotion of almond industry in the cluster.

5.3. Almond value chain in the Cluster

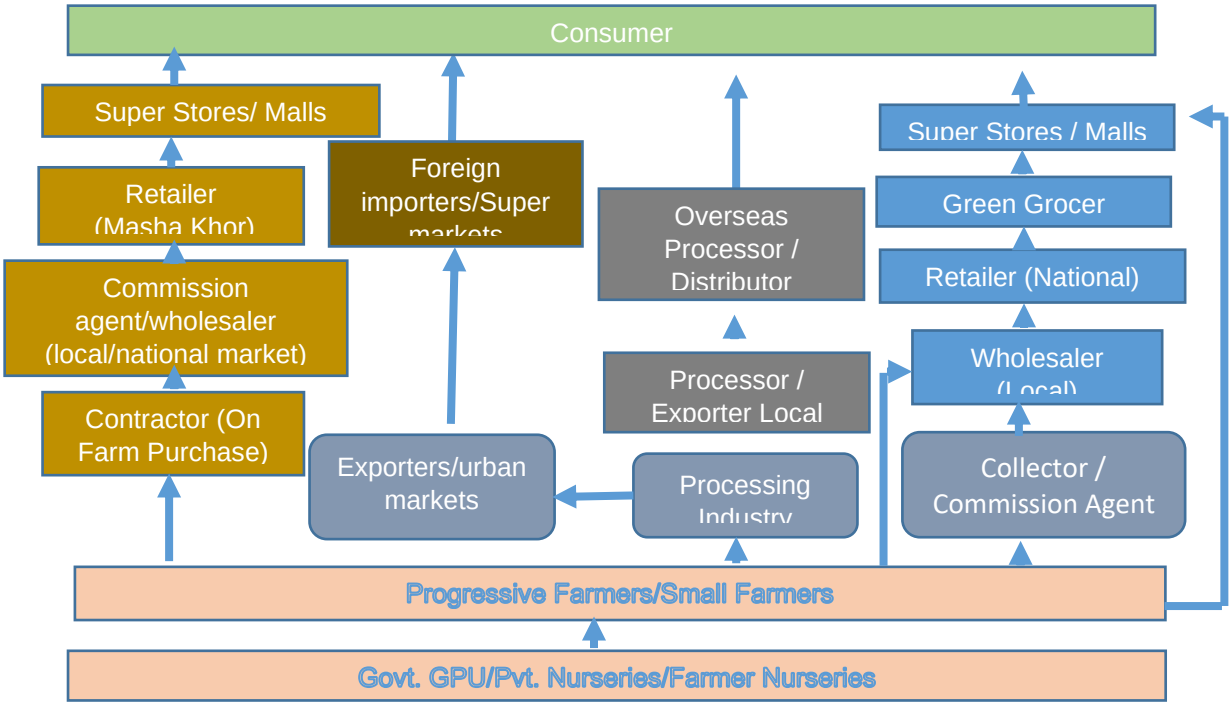
Almonds were introduced in the Balochistan cluster some 80 years ago. But this crop was given special attention due to its great potential, in the beginning of 1980s by execution of a project entitled “Deciduous Fruit Development Project” by the Balochistan Agriculture & Cooperatives Department through Agriculture Research Institute, Quetta and Food and Agriculture Organization (FAO). Now, this crop has become an industry which has engaged thousands of farmers, laborers, traders and relevant allied service providers. The almond growers always have the leverage to dispatch their produce to any part of Pakistan due to their central geo positioning. This crop is main source of living to the people engaged in it but for last few years of persistent drought resulted in a looming fear over farmers. The effects of drought can be seen in dried or dead almond orchards of the cluster.

The cultivation method is still conventional in the cluster. Even the irrigation methods have not changed i.e., still flooding method is applied, farmers have no soil testing ideas, nor do they have such facility in the area. Fertilizers are used injudiciously, and the quality of fertilizer is also compromised. Fresh cow dung is used in almond trees to make soil pulverize but instead of any benefit from this practice tree roots get polluted and an enemy insect emerges that destroys the roots of the trees which results in loss of young bearing trees.

Mostly almond fruit is marketed right after harvesting without storing. Farmers indicated that say normally do not store almonds. However, if needed, it is stored in a separate room without proper storing measures. Almond can be stored for several months with simple arrangements. Mostly almonds are packed in sacks and transported through open trucks and pickups and marketed in big cities of Pakistan. The quality almond is manually graded and packed.

Most of the produce of Balochistan is destined to other parts of Pakistan and a negligible quantity is exported. Almond is generally packed in jute sacks after simple sorting. Such produce does not attract the consumer and results in low returns to farmer. Harvesting may be done by contractors or farmers themselves. The contractors use the hired casual labor, while farmers harvest the crop normally using combined family and hired labor. The harvested almonds are brought to the wholesale markets by the producers/contractors and sold to the commission agents/wholesalers. The commission agents/wholesalers also buy directly from farmers. Very little if any shelling activities prevails in the cluster. The auctioning is done based on the variety and appearance of the produce. Some of it goes to the processing industry who simply remove the shell, and send it to the urban centers or exporters, from where it reaches to the consumers (Figure 2).

Figure 2: Almond value chain in the Balochistan cluster



Grower still plant old varieties which prevail in the cluster for last more than 40 years. The potentials of these varieties have deteriorated overtime. To regain productivity, it is essential to renovate these garden through new cultivars. Introducing new almond varieties is even more important for export purpose so that export can be match to the demand of the targeted international markets.

5.4. SWOT ANALYSIS

5.4.1. Overview

The SWOT analysis was conducted during the consultation meetings in major almond producing areas in presence of different stakeholders of almond crop. These results are based on the consultative discussions with almond farmers, researchers, extension agents, commission agents, traders, exporters, and all the other stakeholders of different segments of value chain; inputs, production, storage, and marketing. The strengths and opportunities were also looked at and in similar way weaknesses and threats have also been combined.

5.4.2. SWOT Analysis of Balochistan Cluster

The Balochistan Cluster has many strengths and opportunities for the cultivation of variety of almond (Table 13). The experience of growing of almond by the farmers of this cluster is one of the great strengths which is needed to be exploited by employing the modern production technologies of almond crop. The conducive climate for almond production, especially low humidity, is one of the advantages that do not allow diseases to proliferate. This cluster lies in the west of the country and at liberty to market its product in either ends of the Pakistan. Major weaknesses are lack of planning, no familiarity with modern production technologies, availability of natural pollinizers, and post-harvest handling of almond. No or little investment on almond research and development was made. Indigenous technology development, breeding programs, extension work and marketing have almost completely been neglected. The biggest threat is persistent drought coupled with worst energy shortage, insect attacks, absence of value addition, and unfair trading practices. These all factors hinder the development of this very important crop which is livelihood and mainstay for the farmers and other stakeholders.

Table 13: SWOT Analysis of Balochistan Cluster

Parameters	Strengths	Weakness	Opportunities	Threat
Environment/ Climate Change	Temperate and dry climate makes the cluster ideal for cultivation of different cultivars.	In uplands of this cluster, late spring frost affects flowering and fruit set.	Almond fruit is ready for harvesting simultaneously in whole cluster and ends at same time as well. Dry climate favors	Less precipitatation cause less production and small sized

			clean cultivation of almond.	shrivelled kernal.
	Less chances of occurance of severe diseases. Disease resistant varieties are one of the potentials.		New and commercial varieties can be introduced in the region which are reslient to adverse climate change and require quite less water than the local germplasm.	Strong winds with dust storms occur frequently.
Input Supplies	As plantation area is expanding, demand for input supplies including fertilizers and pesticides is growing.	Non-availability of quality fertilizers and micronutrients in local input market	Conducive environment for private sector can fill the gap by providing input supplies to the growers. Well rotten compost can improve the soil condition and water holding capacity.	Lack of awareness regarding use of inputs, slow uptake of inputs by the farmers.
	Demand for high or Super High Density and exotic germplasm is inreasing.	New germplasm is expensive, out of reach of farmers and can hinder increase in quality almond production.	High density germplasm is an opportunity for increased and quality almonds production.	Absence of certified nurseries and skill of nursery manageme nt in private sector.
		Limited availability of certified, quality, and true to type saplings and absence of certified nurseries.	Government farms can be a good opportunity for establishment of mother nurseries for provision of different varieties.	
Cluster interaction	Agriculture is main sector of the cluster and almond is one of the major crops in the cluster.	Little interaction among farmers and researchers and no platform for interaction.	Small and new farmers have good opportunity to learn from progressive farmers of almonds in the cluster.	There is lack of coordination and integration among almond value chain

	Existing almond value chain is fully functional in the cluster, producing high value almonds for the growers, traders and retailers. Farmers have the desire for adoption of medern production technology.	The almond growers have little information/awareness about the quality requirements in national and international markets.	There is possibility of collective efforts for achieving the economies of scale.	actors which has negative effect on the cluster. Research and Extension departments do exist but outreach is limited.
		Little or no credit availability from formal institutes particullarly Zarai Taraqiati Bank for the growers of the area.		
Production Management practices	Thousands of Farmers having traditional expertise in almond production which can be used for production and quality enhancement.	Traditional orchard management practices are faulty. Presently most of the management practices are not increasing productivity and quality.	There is great potential for both vertical and horizontal production existing for almond crop.	Present drought spane, existing poor irrigation system and out dated cultivars and rootstocks.
	Possibility of diversification into improved varieties.	Without any plantation system or unorganized and mixed plantation in orchards.		
	Existing yield per unit area can be increased many fold.	Lack of soil health improvement or less than optimal dose of fertilizer and little know how about composting.	There are opportunities for private sector to provide extension services. Service Poroviders can also be an opportunity.	
		Pre- and post-harvest losses due to lack of skills and infrastructure (i.e., storage facilities); losses/wastage are nearly 15% of total production.		
		Non practicing of bee keeping for cross pollination		
Transportation	The cluster has the strength to supply the	Existing access roads to main high	No packing issues however,	Floods during

	produce to any part of the country.	ways condition is not good.	for good marketing and export quality improvemnt is necessary. In future CPEC is a big opportunity.	monsoon season cause blockage of roads which hamper produce supply and destroy the produce as well.
		No proper value chain exists. No proper transportaion system exists.		
		High transportation costs and fluctuation in transportation fares.	Quality almonds are produced and presentation improvement is necessary.	
		The cluster is in almond producing center but without any value chain and proper storage.		
Marketing	Better marketing environment can fetch good prices for quality almond of the cluster.	Almond growers sell their produce at throw away prices due to unawreness of high value market. No Market Information System (MIS).	Contract system has the potential to manage quality produce flow in the market with the help of commission agents‘ financial support.	Competition for quality and marketing with Afghanistan and Iran. Small farmers have reservations against high value markets.
		No grading system exist and fruit is packed with mixed grade almond fruit.		
	Market has demand for good quality almond to meet consumer demand.	Weak market information system, depriving grower of their due return. Absence of on spot grading causes losses to growers. Non-transparent auctioning of almond produce cause low returns.	Capturing the growing demand of almond in Middle East and South Eastern countries. Sale of almond in big lots can be beneficail for growers.	
		Absence of capacity building of farmers and traders hinder improvement in produce quality and presentation.	The emerging super markets trend in Pakistan and abroad is a good opportunity for almond growers which is direct business mechanism with the farmers and	

			narrows the trading channels.	
Trade/Export	Most of the produce is traded within the country due to high demand and very small quantity is exported. More than 200 million of Pakistani population is itself big market and existing cultivation area and production do not fulfil the demand.	Quality almonds have no food safety standards and traceability (HACCP, EuropGAP, Global Gap, IFS etc.) certifcates which are major obstacles to enter into high end international markets.	Growing urban population of the country is one of potential opportunities for almonds marketing. China and India are the leading importers of almonds.	High cost of quality standards and its continuity. And also high costs of certifications. Competition with Afghan almond which is improving its quality and quantitiy.
		Lack of transportation, airports, and port facilities, no cargo flights, shortage of air cargo space and inadequate cargo handling limits the export.	Better prices for higher quality almond products in domestic and national markets.	
Processing	Mostly almonds are consumed in raw form while, several byproducts can be made even industrial use potential also exist.	Almond can be stored for longer period but better storage facility is not available therefore, processing industry is one of the options.	Huge demand for processed almond in national and international markets.	Absence of proper processing industry is resulting in less export and wastage of fruit.
		Unavailability of advanced processing units, technologies, and equipment for preservation and processing.	There is tax holiday on import of agriculture machinery including field implements and processing machinery.	
	Almond nibs have the potential for use in many bakery items and confectionary. Roasted almond is one of the examples.	Small stakeholders have no capacity and financial support to process the produce.		

6 CHALLENGES FACED BY THE CLUSTER

6.1. Climate Change and Shortage of Water

The almond cluster of Loralai area is facing very serious problem of water shortage and with the climate change, these effects are intensifying over time. On average, most of the areas of focal point (Loralai) cluster has been growing almond for last 80 years. But after such long time cultivation experience, this cluster still could not overcome the issues of ground water shortage faced by the almond industry production. The ground water is extracted from more than 800 feet depth which has increased the cost of production. To upgrade the almond cluster, it is imperative to introduce drought-tolerate high yielding and best quality, and disease resistant rootstocks. New varieties combined with introduction of the solar system for water extraction along with high efficiency irrigation system can ensure better production of almonds. Due to climate change, the almond cluster may face the challenge of new diseases and shift in crop phenology in future. Low returns to almond farmers will discourage the cultivation of almond in this cluster.

6.2. Production Level Constraints

In Pakistan, almond is facing serious problems from production to its post-harvest management and export marketing. Due to lack of proper irrigation, access to high yielding germplasm and cultivars, adoption of primitive methods of cultivation, almonds are not giving the yield as per the potential of the available cultivars. Besides several other factors affect like poor management practices, lack of modern state of the art technologies and lack of awareness of almond's farmers. Furthermore, the other reason for low productivity of almond is the pollination issue. Almond yield is significantly affected by the cold injury and pollination problem (Table 14).

This implies that the production management practices and technologies for improving almond cultivation has not been adopted properly, which results in decrease of the yield whereas the decrease in area was due to the shortage of irrigation water. Almond growers in Balochistan cluster are facing serious problems from production to marketing such as non-availability of high yielding almond varieties to the farmers, insect insurgence, shortage of irrigation water, poor pollination, and sever damage to the crop due to long harsh winter.

The provincial Agriculture Department has introduced several new and exotic almond varieties in this cluster (and in other almond growing areas), and a few of have succeeded in the field. With the passage of time, varieties loose or degrade their yielding and quality potentials. To replenish the yield potential, while introduction of new germplasm becomes essential, currently almond industry lacks any such mechanism. After the 18th amendment in the Constitution of Pakistan, agriculture has become a provincial subject. Therefore, the Agriculture Department of Balochistan has the responsibility and mandate to prioritize the research and development for the existing glooming almond industry. But the provincial research institutes receive very little budget for R&D

(research and development) purpose. There are highly qualified researchers doing work in the Balochistan Agriculture Research Institutes, but lack of funds makes them ineffective.

Table 14: Gaps and Constraints at Production Level

S#.	Parameters	Loralai Cluster
1.	Research on almond	Some qualified staff is available but no credible program on almond due to lack of operational money
2.	New drought-tolerate germplasm	Reseaerch institutes have secured limited germplasm, but much more need to be done.
3	Mother nurseries or GPUs	Very few in government and non in the private sector
4	Orchard size/type	Large scale/standard without adoption of scientific managment practices, like spacing, pruning, etc.
5	Certified plants	Limited availability
6	Cold injusry	Sometime sever
7	Polination	Poor due the diasappearane of polinating insect with high pesticide use on crop and long drought
8	Cold injuries	High
9	Extension services	Poor
10	Commercial inputs	Moderately available
11	Labor input	Hired

6.3. Constraints at Value Addition and Processing Levels

Large portion of almond produced in the cluster is traded without processing and any value addition, Use of improper packing materials, improper transportation, high charges of transportation and improper storage are the major value addition constraints (Table 15). Lack of knowledge about almond processed products and skills and technology for processing of various products like almond oil extraction, non-availability of small industry for processing like non-availability of proper hulling and shelling facility, energy shortage, and narrow focus of extension services and research on farm production are the major processing level constraints.

Normally almonds are marketed without processing, grading, proper packaging, and transported without proper transportation protocols and labeling or trade mark. While, in the absence of these technologies it is not possible to maintain the quality and standards of almond. Most of the farmers of Pakistan are very poor and illiterate as well so, adaptation of modern production technologies is very difficult in the existing almond industry of Pakistan. Therefore, it is imperative to incentivize this industry for adoption of such technologies. The public sector cannot do this alone thus it is also necessary that NGOs and private sector should also come forward for win-win solution by investing and developing infrastructure for introduction of these technologies. Marketing and processing of almond is confined to individuals which steer the marketing of this very important

crop at their will. As mostly almonds are not exported due to bad presentation of the product therefore, processors compete for customers within the country but still no collaboration, horizontal integration between the growers and processors to meet the big orders or capture big or potential markets.

Table 15: Gaps and Constraints at Value Addition and Processing Level

S#.	Parameter	Loralai Cluster
1.	Potential demand for value added product	Exist
2.	Potential demand fro processed product	Exist
3.	Availability of nut-variety for processing	Exist
4.	Technologies for processed products	Available and can be made accessable
5.	Availability of energy	Needed for processing, but its availability is scanty and highly unrelaible
6.	Availability of funds to invest on processing set up	Could be available from formal and informal sources.
7.	Information about the almond product markets, required quality, prices, etc.	Not available to potential processors
8.	Advisory services for processing, such as knowledge and training for processing standards, etc.	Not available

Like many other agricultural commodities, unavailability of electricity is a common and big obstacle for the processing of almond. For the development of processing segment, a diversified strategy is necessary to develop new products and markets. For in-country or export trade in higher-value almond, it will be necessary to develop almond cluster inclusive of facilities for shelling, processing, quality packing, and labelling will be very necessary. Such infrastructure is vital and will be fully utilized to its capacity for serving not only almond but the entire horticulture sector where needed.

6.4. Constraints at Trading Level

Exploitative role of commission agents/*arthies*, unexpected/unnecessary import during the peak local production, uncertainty in prices due to their fluctuations, disconnection with international markets, unavailability/inaccessibility of the necessary infrastructure such as storage and lack of quality assurance and certification mechanisms are the major trading level constraints (Table 16). Formal regulated marketing centers do exist in the almond cluster, where traders are bound to carry on their businesses under the licenses issued by the authorities, but exploitations of farmers are rampant in these centers. The indigenous almond industry also faces problem of imported almonds which influence the market prices.

Naturally traders strive to earn the highest margins by buying at the lowest prices and selling at the highest prices, however, very little attention is paid to product differentiation and quality

aspects to achieve premium prices. Communication technologies and internet services are easily obtainable but no Marketing Information System (MIS) exists. Labor is available on a permanent and seasonal basis and financial services have been made available for traders by both formal and informal banking institutions but still the almond industry is not benefitting from these facilities and investment of trading infrastructure is poor.

Table 16: Gaps and Constraints at Trading Level

S#.	Parameter	Loralai Cluster
1.	Marketing channels	Traditional/some areas regulated
2.	Trade financing	Limited availability from formal sources
3.	Information about international markets	Not available, except about neighboring countries and that is also through word of the mouth.
4.	E-commerce platforms	Not available
5.	Contract farming	Limited to pre-harvesting contracts
6.	Export readiness	Not ready, but can be achieved with little investment
7.	Certifications (phytosanitary)	No
8.	Branding	Limited

7. CLUSTER DEVELOPMENT POTENTIAL

7.1. Overview

The strategic location of the cluster, particularly it being on the CPEC route, is very important and must be exploited. The almond crop in this cluster has the potential to expand both vertically and horizontally because of experienced almond growers, existence of main high ways and road network, round the year availability of labor, clean and diseases free environment, etc. These are the basis for establishment and development of any cluster. In this section, attempt is made to evaluate the potentials of this cluster in terms of enhanced production, improvement in quality for domestic and international markets, import substitution, etc. In this attempt of potential evaluation, benchmarks are established. Both quantitative and qualitative analyses are presented to explain the nature of active, dormant and inactive segments of the almond value chains in the said cluster.

7.2. Expanding Almond Productivity

As discussed earlier, the current yield of almond 2.1 tonnes/ha in the cluster which is far lower than many other countries of the world like turkey (2.6 tonnes/ha), USA (2.54 tonnes/ha) having similar temperate environment like the one in Balochistan cluster. This yield is rapidly declining overtime. Moreover, the quality of almond produced in Pakistan is much lower in terms of grain size and other attributes mostly liked by the world. On the other hand, both the provincial and federal Agricultural Research Institutes do exist in Balochistan and are working for setting the technologies aimed at increasing productivity of almond in the province. Many advanced production technologies, such as pruning of existing garden, and improved almond varieties such as *Talwar*, *Pathasa* and *Kaghazi* already exist which can easily double the yield. The renovation of the existing orchards with late blooming varieties coupled with adoption of improved management practices can not only reverse the overtime declining trend but also enhance its productivity. Based on the discussion with the researchers in horticulture and agricultural extension worker in the area, it is anticipated that through consistent efforts, 50% improvement in yield can be brought through orchards' renovation with late blooming varieties along with the application of water saving technologies, and about 20% improvement in productivity can be brought through the adoption of improved orchards management practices, such as proper irrigation, harvesting, pesticide application, etc., on the old gardens where renovation is not done. If we renovate only 25% of the gardens, it will generate US$16.8 million after the renovated gardens start bearing fruits in eight years. The new plants of new varieties can be inserted in between the old plants after proper pruning of the old trees, which will not only create space for the new pants but also improve yield of the old trees. Moreover, improving the management practices of the farmers in the cluster area will generate US$4.8 million. This will also generate lots of additional employment at the farm and market level in handling about 48% additional production that will come through these interventions.

7.3. Reducing Post-Harvest Losses

Producing a good crop of high-quality almond requires time, skill and money. To gain full benefits from the crop, it is important to sustain the quality of the almond until they are reached to the consumers. Proper harvesting and post-harvest handling can prolong the shelf life during which they remain consumable and marketable, thus reduces the losses along the value chain. These practices have been properly defined elsewhere in the world but some fine tuning may be required under the Balochistan cluster situation. The researchers believe that with the adoption of appropriate harvesting and post-harvest technique, the post-harvest losses can easily be reduced from 20% to 10%, which will generate US$6.1 million, resulting in extra income to various stakeholders along the value chain. In addition to handle the 10% additional production will also generate additional employment at the value chain level mostly in peri-urban areas.

7.4. Harnessing the Demand Potential

The question is where to absorb the additional supply generated through garden renovation, improved management practices, and reduced post-harvest losses? There is strong potential to absorb these supplies within the country. Enhanced almond production in the country will, at first, substitute the increasing imports and at least halt the declining per capita consumption within the country, as noted earlier. The above interventions in the focal point can substitute about 50% of the total almond imports in the country and save over US$13 million in foreign exchange. This will have positive impact on the health of the people. Moreover, in the long-run, Pakistan can benefit from the strong positive global trends in per capita consumption and export of almond when its production becomes competitive through the suggested innovations.

7.5. Enhanced Processing

Very little domestic production is shelled or processed into products like almond oil. Despite thousands of tonnes of almond production, no significant almond processing units has been established in the Balochistan cluster. Moreover, whatever little shelling is done, the technologies used are primitive and unhygienic. While technologies for shelling, roasting of almond kernels, and oil extraction are commonly available, the promotion of processing these within the cluster will minimize the postharvest losses considerably, provide off-farm jobs, and stabilize its prices. The processing of almond in rural area will also generate employment for the youth of the cluster. The feasibility of almond shelling and oil extraction plant has placed in a separate sheet in the EXL Almond Economic Analysis File and briefly explained in Annexure 3.

Currently 75% of the imported almonds are shelled suggesting higher demand for shelled almond. However, only 5% of the almond produced in the country is shelled and even less percentage of it is roasted. The stakeholders believe that if facilities are available, 40% of the almond produced in the focal point can be shelled and absorbed in domestic market. Moreover, our assessment with consumers suggests that there is high domestic demand of almond oil used in cooking, body message, etc.

8. CLUSTER DEVELOPMENT PLAN, POLICIES AND STRATEGIES

8.1. Plan

Looking at the constraints and opportunities and after the discussion with stakeholders, following plan with quantitative target is suggested for the cluster development five-year project.

Table 17: Targets of almond cluster plan

S. No.	Targets for Almond Cluster Development
1.	Increase per ha yield of almond by at least 40% on the 25% targeted area through orchard .renovation
2.	Increase per ha yield of almond by at least 15% through improved management practices on non-renovated gardens.
3.	Improved value chain to reduce post-harvest losses from 20% to 10% during the five years project period and improve its quality so that it can compete with the imported almond in the country.
4.	Increase shelled almond processing up to 40% and almond oil processing up to 6% of the total production.

8.2. Policies

Almond is very important crop for the poor farmers in Balochistan. It is grown on about 10,000 ha, mostly by farmers having less than 2 ha of land. But there is no policy attention on the crop, thus no credible research activity in the province. So the **First** and most important policy shift should be to establish a Stone Fruit Research Center in Balochistan having a major focus on resolving the almond value chain issues.

Secondly, the consumption of local almond should be encouraged and imports of almond, especially during the almond harvesting season, should be discouraged. Government should impose duty on almond import and the money should be used for almond R&D and providing support for developing value chain infrastructure which can improve the quality of local almond production.

Third, Almond growing farmers in almond cluster of Balochistan should be organized into Farmers Entrepreneur Groups (FEG), who can collect necessary investments to build almond processing and value addition infrastructure and can be trained in groups. Moreover, FEGs as a group can ensure almond quality and can start quality-based price contracts with traders.

Fourth, farmer's capacity especially on proper varietal selection, harvesting, storing and grading technologies, and other stakeholders on handling almond quality value chain and processing is required to successfully implement intervention suggested in the next section.

Fifth, MIS for provision of information on market trends is very important both for farmers and stakeholders. This will create competitive environment among the almond industry stakeholders which will lead to enhance the production, quality and value chain of the product.

Sixth, there is a need to sign a Memorandum of Understanding with the countries like USA, Spain and Australia to import high yielding almond germplasm and exchange of researchers/scientists for learning from their experiences.

8.3. Strategies and Interventions

Following strategies and interventions are suggested to achieve the plan targets.

8.3.1. Strengthening Almond R&D

The Stone Fruit Research Center should be established in the private-public partnership mode run by an autonomous Board. The Board members should be taken from the stakeholders along the value chain. The money for the research center should come from a cess fund on the export and imports of almond. The center should have the following functions:

- Collect the germplasm and varieties from major almond growing countries, especially from those regions where almond is grown under dry condition. It should also develop crop management and post-harvest efficient management practices. The Center should work with the private sector to develop processing technologies to produce different almond products.
- Importing the late blooming almond nursery plants, high yielding improved almond varieties from countries like USA, Spain and Australia.
- Conduct research on almond processing and value addition.
- Establish an e-commerce portal containing information on the almond prices with quality in major national and international markets, export requirements, almond emerging technologies in the whole value chain, etc.

8.3.2. Renovating the Orchards

The existing almond cultivars bloom early and get affected from cold injury, which results in low or no yield. It is proposed to replace these early blooming cultivars with more productive trees of improved varieties which bloom late and are resistant to cold injury. Twenty-five percent of the old gardens will be replaced with cultivars will be established on high efficiency irrigation systems to increase the almond area. We believe that with proper incentives, encouraging response to

this intervention shall come from the farmers' side. For the purpose, the following measures needs to be taken:

- Establishing mother orchards at provincial agriculture research institutes and private nurseries having good business experience and reputation.
- Providing financial support to private nurseries for propagation of certified nursery plants of improved imported varieties for provision to the farmers.
- Providing financial support to the farmers in renovation of their orchards with late blooming plants on 50:50 cost sharing basis under project approach.

8.3.3. Improved Management Practices

At present, farmers of the area are following decades old orchard management practices. Demonstrating and educating farmers about the yield impacts of following improved management practices by activating public agricultural extension department and the agricultural advisory services shall result in adopting modern improvement management practices. For this, the following measures needs to be:

- Educating farmers for applying decomposed farm yard manure and recommended doses of fertilizers on regular basis for soil health.
- Organizing trainings of the farmers and service providers in facilitating pollination through natural pollinizers in the almond orchards.
- Applying sprays of recommended chemicals, when and wherever needed and biological control of some major pests.
- Developing schedule of drip irrigation based on the soil, climate, etc.

8.3.4. Improved Harvest and Post-Harvest Management Practices

Selection of appropriate variety at different altitude and harvesting at the correct time using appropriate harvesting techniques are essential to produce good quality almonds. Although, storage life of the almond is more than the perishable fruits, to ensure enhanced storage life, almond should be harvested with optimum moisture content. If harvested late with low moisture the almond will shrivel and lose attraction, harvesting almond too early will lead to fungal diseases i.e. aflatoxins. The almond kernel should be kept in an environment so that it can avoid excessive moisture evaporation and also reduce excessive moisture when needed.

Almond is normally transported and stored in bulk after filling in jute of plastic sacks in the orchard. These jutes are not resistant to moisture and insect attack. The almond should be packed after proper drying in open air to remove excessive moisture. At present, almond is harvested manually by beating the branches with stick. This practice damages the tree and affects the nut quality as well. All this result into the loss of a notably high proportion of fruit in the supply chain.

Under the improved post-harvest management practices, the harvesting labor will be trained in better harvesting methods by educating them about the signs of appropriately mature nut and the payment method shall also be changed from quantitative to qualitative & graded harvesting method by raising their harvesting remunerations. The fruit packaging method shall be changed from jute sack to air tight and gas tight bags. Moreover, improvement in grading (size and maturity based) shall also be practiced. It is assumed that market shall also positively respond to these practices by offering relatively higher prices for the better sorted, graded and packed almond than those packed in conventional jute sacks. The plastic sacks should be avoided.

In this regard, the specific measures that need to be taken are:

- Organizing trainings of the almond harvesting labor to teach them about the stages at which the almond should be harvested.
- Ensuring the availability of almond packaging material at reasonable rates.

8.4. Encouraging Almond hulling/shelling as Cottage Industry

The potential markets for shelled almond have been identified in the previous section. The feasibility of the hulling/shelling is given in the EXL Model sheet. The following strategies are suggested to promote processing of in-shelled almond into shelled almond as a cottage industry in rural areas:

- The cottage level almond processing activity shall be consisted of establishing small units of 50 shelling/hulling machines along with due gadgets (e.g. sorter, cracking machine etc.) for storing/cracking the almond, and shelling process.
- Collection of almond kernels processed in rural areas and its packaging shall be encouraged at small scale industry in peri-urban areas which will collect the shelled almond from many manufacturing points in rural areas. The established firms will market the shelled almond and distribute it to various destinations of the country throughout the year and abroad under its own brands.
- For this the due financial support shall be provided to the Farmers Entrepreneur Groups to establish the almond processing units in the form of interest free loans and 20% subsidy in the fixed capital needed for the purpose.
- Training and certification of almond processing in food safety and quality management system so that SPS certified almond kernel is available from the cottage industry in the almond cluster areas.
- Introduction of GI (Geographical Identification) registration and certification in the almond cluster areas of Balochistan.

8.5. Import Substitution

Pakistan is importing almond worth of US$21 million, and it is blooming at the rate of 12.7% per annum. If the trend continued, the import value can reach US$75 million over the next ten years. It is assumed that adoption of above described interventions and value chain improvements shall result in availability of higher quantities of better quality almond, which can compete with the import quality. It is anticipated that in eight-year period, when the impact of all the intervention will be in place, the additional quantity of almond can substitute about 22% of the almond import. Under this, in addition to policy support as explained above, following specific measures suggested are:

- Improving almond value chains to match with the international standards of product quality by providing due information like, variety, nutritional information, certifications about non-usage of harmful chemicals in production and processing, child labor, etc.
- Link the imports of almond with the investment on the development of almond value chain and marketing within the country.
- Introduction of Pakistani brands of almond with attractive names and packaging in the international food exhibitions.

9. ECONOMIC ANALYSIS OF CLUSTR UPGRADATION PLAN

9.1. Baseline Status

The baseline status of the almond production in the cluster has been shown Table 14. At present, total almond orchard area in the cluster is about 4.56 thousand ha produced nearly 10.20 thousand tonnes of almond in 2015-16. The mean almond yield per ha falls at 2.24 tonnes with decrease in average annual growth as -2.91% per annum and farm gate price as US$2222/ton. It is feared that if the currently prevailing negative annual yield growth rate shall continue in coming five years, the present total value of output at farm gate price estimated as US$20.656 million, shall decline to US$ 19.532 million at 5th year from now (Table 18).

Table 18: Yearly Baseline Status of the Sample Almond Cluster in Balochistan

Items	Inputs	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Total almond areas in the cluster (ha)	4,557								
Total almond production in the cluster (tonnes)	10,195								
Baseline yield (tonnes/ha)	2.24								
Annual yield growth in past 10 years (%)	-2.91								
Average farm gate price (US$/ton)	2222								
Average gross value of output (US$/ha)	12100.0								
Almond yield growth w/o interventions (tonnes/ha)		2.24	2.11	2.05	1.99	1.93	1.87	1.82	1.77
Annual expected prod. w/o intervention (tonnes)		10,195	9,602	9,323	9,053	8,789	8,534	8,286	8,045
T. value of cluster output at farm gate (Million US$)		**22.656**	**21.339**	**20.719**	**20.117**	**19.532**	**18.965**	**18.413**	**17.878**

9.2. Interventions and Benefits

Intervention-1: Orchards' Renovation with late blooming plantation

The first intervention proposed is increasing almond productivity through renovating the current orchard with high density plantation in the cluster. It is assumed that in coming 5 years, 50% of the total orchard area of the cluster shall be renovated with late blooming almond plantation and the mean almond yield from these high density orchards shall increase by 30% attributed to more number of plants per ha and of timely blooming nature. In this way, 2,279 ha of almond orchards shall be renovated in 5 years. As the gestation period of almond is 3 years, the additional plants inserted shall start fruit in 4th year. Therefore, the almond production from the 1st year renovated orchard shall be 30% higher than their sister non-renovated orchards. The total value of additional

almond produced from renovated orchards at farm gate price shall be US$ 0.604 million and US$ 1.172 million in 4th and 5th project years, respectively (Table 19).

Table 19: Yearly Returns from Orchards Renovation with Late Blooming varieties in the Focal Point of Balochistan Cluster

Items	Input	Increment	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Almond orchards renovated with late blooming orchards in coming five years	25.0%		-	-	-	-	-	-	-	-
Percent area of orchards renovated		5%	**5%**	**10%**	**15%**	**20%**	**25%**	**25%**	**25%**	**25%**
Orchard area that would be renovated (ha)		228	228	456	684	911	1,139	1,139	1,139	1,139
Assumed yield increase from renovated orchards (%)	50.0%									
Additional production from increased yield (t)			-	-	-	679	1,318	1,920	2,486	3,017
Expected additional value of produce at farm gate price (Million US$)			**-**	**-**	**-**	**1.5**	**2.9**	**4.3**	**5.5**	**6.7**

Intervention-2: Raising Productivity by Better Management Practices

For the second intervention pertaining to the adoption of better management practices, the farmers shall be educated through demonstrations and organizing farmers' days in the area. Based on the results of such experiments on farmers' fields, it is anticipated that the mean almond yield in the areas shall improve by 30% during 5 years of project period. Since, this intervention shall be operational in the entire cluster, therefore, its benefits are expected to be started and realized by the farming community in 2nd year of the project period. In this way, the average improvement to the tune of about 0.58 tonnes/ha shall be realized in the 5th year of the project period. The additional production achieved from adoption of improved orchard management practices in 5th year shall be 2037 tonnes resulting additional remunerations going in the pockets of the farming community shall be more than US$5.859 million (Table 20).

Table 20: Yearly Returns from Better Orchard Management in the Focal Point of Balochistan Cluster

Items	Input	Increment	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Percent increase in yield over five years	10.0%	2.50%	2.5%	5.0%	7.5%	10.0%	10.0%	10.0%	10.0%
Increase in yield after intervention (tonnes/ha)			0.05	0.10	0.15	0.19	0.19	0.19	0.19
Addition production achieved from enhanced yield (tonnes)			240	466	679	879	879	879	879
Expect value of additional production at farm gate price (Million US$)			0.53	1.04	1.51	1.95	1.95	1.95	1.95

Intervention-3: Controlling Post-Harvest Losses

This intervention is aimed at realizing the farmers' community that instead of paying on quantity of almond collected by weight, the harvesting labor should be paid on the basis of quality of almond of desired grade harvested. Their charges shall be adjusted in a way that their daily based earnings are not affected. Similarly, instead of packing the harvested almonds in large jute or plastic sacks, without proper sorting, air tight hermetic bags will be introduced. It is assumed that by adopting the recommended harvesting, grading and packaging measures, the post-harvest losses shall be halved from current 20% of the produce to 10% in 5-year period. By this way, more than 1,195 tonnes of additional marketable surplus shall be achieved in the 5th year of the period, valued at US$ 2.656 million (Table 21).

Table 21: Yearly Returns from Controlling Post-Harvest Losses in the Cluster Focal Point

Items	Input	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Current post-harvest losses (%)	20.0%	-	-	-	-			
Expected reduction in post-harvest losses after interventions (%)	10.0%	2.50%	5.00%	7.50%	10.00%	10.00%	10.00%	10.00%
Addition production achieved due to reduced post-harvest losses (tonnes)		258	536	852	1,195	1,195	1,195	1,195
Expected value of additional production at farm gate price (Million US$)		0.55	1.09	1.74	2.44	2.44	2.44	2.44

Intervention-4: Almond Processing and Oil Extraction

This intervention involves establishing almond hulling and de-shelling industry as cottage industry at the union council levels and collecting the processed almond for oil extraction at tehsil or district level**.** The detailed feasibility of almond shelling is produced in Annexure 4. It is presumed that in

5-year project period, it is assumed that the current level of almond shelling will increase from 10% to 50% of total almond produced in the cluster. Assuming that this intervention is implemented successfully, then by 5th year, about 2347 tonnes of almond shall be shelled. It is assumed that 7% of the shelled, up from 1%, almond will be processed for extracting almond oil. During the 8th year, about 44 tonnes of almond oil will be produced with an estimated value of US$0.39 million. The value of almond cake will be around US$0.47. The total value of shelled almond, almond oil, and almond cake would be around US$17.38 during the 8th year of the intervention, along with generating rural employment opportunities in the cluster area (Table 22). In the EXL Model, the feasibilities of the almond shelling and oil extraction are also produced which gives respective IRR of 87% and 49%.

Table 22: Yearly Returns from Almond Processing in the Cluster

Items	Inputs	Increment	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Almond shelling									
Current percentage of almond shelled (%)	10.00%								
Additional percentage of production to be processed over 10 years (%)	50.0%	5.00%	10.0%	20.0%	30.0%	40.0%	40.0%	40.0%	40.0%
Production that will be used in shelling (t)			454	925	1,511	2,175	2,238	2,295	2,347
Conversion factor from unshelled almond to hulled almond 2 tonnes almond = 1 tonne kernel]	1 to 0.45	0.45							
Quantity of shelled almond (T)			454	925	1,511	2,175	2,238	2,295	2,347
Price of shelled almond (@Rs. 950 per kg)	7,037								
Value of shelled almond (Million US$)			3.19	6.51	10.63	15.31	15.75	16.15	16.52
Almond oil processing									
Current shelled almond processed into oil (%)	1.0%								
Additional percentage of shelled almond to be processed into oil (%)	7.0%	1.50%	1.5%	3.0%	4.5%	6.0%	6.0%	6.0%	6.0%
Shelled Production that will be used in processing (t)			7	28	68	131	134	138	141
Reducing water content	1 to 0.95	0.95							
Conversion factor from hulled to oil	1 to 0.32	0.33							
Total conversion factor		0.15							
Total volume of almond oil produced (t)			2	9	21	41	42	43	44
Total volume of almond cakes produced (t)			304	620	1,012	1,458	1,499	1,538	1,573

Price of the almond oil @Rs.2500/kg (US$/ton)	7,407								
Price of almond straw (@Rs. 80 per kg)	593								
Total value of oil produced (Million US$)			0.02	0.08	0.19	0.36	0.37	0.38	0.39
Total value of almond cakes produced (M.US$)			0.09	0.18	0.30	0.43	0.44	0.46	0.47
Total value of output (oil + cakes) (M. US$)			0.11	0.26	0.49	0.80	0.82	0.84	0.86
Total value of output (shelled oil + cakes) (M. US$)			3.30	6.77	11.12	16.10	16.57	16.99	17.38

9.3. Almond Import Substitutions

With the above production enhancing interventions (Intervention 1-3), the additional almond production during the 8th year would be 4995 tonnes. If the import increased as a conservative rate of 5% (currently it is 12.5%), the almond import during the period would be 23238 ton. Thus the additional production through intervention would substitute about 25% of the imports, saving about US$12.73 million during the 8th year.

9.4. Summary of the Benefits

Table 23 summarizes the yearly benefits stream from the interventions introduced in the almond cluster. It can be observed that the total returns from above described interventions in the cluster shall start fromUS$4.38 million in 2nd year of the project, shall increase to US$ 28.47 Million in 8th project year.

Table 23: Yearly Expected Gross Returns from Almond Cluster Development Interventions

Items	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Intervention-1: Orchards renovation	-	0.00	0.00	1.51	2.93	4.27	5.52	6.70
Intervention-2: Improved orchard management	-	0.53	1.04	1.51	1.95	1.95	1.95	1.95
Intervention-3: Controlling post-harvest losses	-	0.55	1.09	1.74	2.44	2.44	2.44	2.44
Intervention-4: Introducing almond oil extraction	-	3.30	6.77	11.12	16.10	16.57	16.99	17.38
Total =	-	**4.38**	**8.89**	**15.87**	**23.43**	**25.23**	**26.91**	**28.47**

9.5. Operational Cost Associated with Interventions

Intervention-1: Orchards Renovation with Late Blooming Plantation

The late blooming orchards plantation involves investment at two fronts. On farmers' side, it involves incurring expenses on purchasing certified nursery of improved varieties and sowing these plants in the large spaces available between the existing trees, plus caring these plants till they start fruiting and later on expenses on improved management practices of renovated orchards started bearing fruit. On agriculture service providers' side, it involves upgradation of available nurseries available in the area for the production certified plants of modern improved varieties. For this purpose, they would be first registered and then the mother plants of modern improved varieties shall be provided. Meanwhile, they shall be provided bud-wood for grafting on the rootstock plants available with them. The yearly details about the costs of renovating and maintaining the orchards in the cluster is given in Table 21 below. In the post-project period, the cost declines because of the reduction in orchard renovation costs after the termination of the project (Table 24).

Table 24: Yearly Costs of Orchards Renovation with Late Blooming Plantation in the Focal Point of Balochistan Cluster

Items	Input	Increment	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
New late blooming orchards renovated (%)	25.0%	5%	5%	10%	15%	20%	25%	-	-	-
Av. cost of renovating orchard (US$/ha)-Labor plus manure	1308	-								
Total orchard area annually renovated (ha)-labor+manure		-	228	228	228	228	228	-	-	-
Total cost of orchard establishment (M. US$)[1]		**-**	0.30	0.30	0.30	0.30	0.30	**-**	**-**	**-**
Total acreage in gestation period (ha)		-	228	456	684	911	1,139	911	684	456
Orchard mgmt. cost in gestation period (Million US$)	200	-	0.16	0.32	0.48	0.64	0.80	0.64	0.48	0.32
Acreage in fruiting (Ha)		-	-	-	-	228	456	684	911	1,139
Mgmt. cost of new orchard in fruiting (US$)		**-**	**-**	**-**	**-**	0.16	0.32	0.48	0.64	0.80
Total cost of orchard renovation (Million US$)		**-**	0.46	0.62	0.78	1.10	1.42	1.12	1.12	1.12

Intervention-2: Raising Productivity by Better Management Practices

For exploiting the productivity potential of the almond orchards of the area, the farmers of the area shall be trained for adopting improved management practices, e.g. regular pruning of the orchards, applying recommended doses of fertilizers and the micronutrients, spraying the orchards on regular basis to protect from various insects and diseases, etc. This involves investment from the farmers. From the farmers' perspective the yearly costs of adopting better orchard management practices is given in Table 25 below.

Table 25: Yearly Costs of Better Orchard Management in the Focal Point of Balochistan Cluster

Items	Input	Increment	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Input cost with traditional practices (US$/ha)	200									
% increase in management cost from the current level (%)	352%	88%		88%	176%	264%	352%	352%	352%	352%
Additional mgmt. cost due to improved management practices (M. US$)[1]				0.80	1.60	2.41	3.21	3.21	3.21	3.21

[1] For details about management costs, See Annexure-5.

Intervention-3: Controlling Post-Harvest Losses

Controlling post-harvest losses involves new investments in harvesting, sorting, grading, packaging, transport and loading/unloading methods. This requires investments from the farmers, pre-harvest contractors and value chain stakeholders is given in Table 26.

Table 26: Yearly Costs of Controlling Post-Harvest Losses in the Focal Point of Balochistan Cluster

Items	Input	Increment	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Current cost of controlling post-harvest losses (US$/Ha)	33									
Incremental costs of adopting new post-harvest management practices to reduce losses (%)	68	17%		17%	34%	51%	68%	68%	68%	68%
Total increase in cost of controlling post-harvest losses (Million US$)[1]				0.026	0.05	0.08	0.10	0.10	0.10	0.10

Intervention-4: Almond Shelling and Oil Extraction in the Area

As already mentioned that an individual shelling/hulling unit shall be consisted of 50 household level shelling/hulling machines operated by local women folk of the area. The average processing cost is estimated at US$200/ton. In this way it will generate employment opportunity for the poor village women, who will work indoor in their native villages. The necessary training shall be provided to these working women. Yearly distribution of processing and raw material cost is given in Table 27 below. It can be observed that total cost of oil extraction shall begin from US$ 1.292 Million in the 2nd project year and shall attain its peak in 5th by costing the cluster as US$6.496 Million.

Table 27: Yearly Costs of Almond Processing for Oil Extraction in the Focal Point of Balochistan Cluster

Items	Input	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Shelling cost per tonne (US$/ton)	2418							
Total cost in shelling (Million US$)[1]		0.02	0.07	0.16	0.32	0.32	0.33	0.34
Oil extraction cost per ton	**2457**							
Cost of almond oil extraction including raw material (Million US$)		0.02	0.07	0.17	0.32	0.33	0.34	0.35
Total Cost of processing (Million US$)		**0.04**	**0.14**	**0.33**	**0.64**	**0.65**	**0.67**	**0.69**

9.6. Summary of the Operational Costs

Table 28 summaries the yearly costs stream associated to various interventions introduced in the almond cluster. It can be observed that the anticipated costs associated with the development of almond cluster shall begin from US$ 0.46 Million in the 1st project year, which shall increase on regular basis till 8th year of the project to the extent of US$ 5.14 Million in the 8th year of the project.

Table 28: Gross Expected Costs (M. US$) of Almond Cluster Development Interventions in the Focal Point of Balochistan Cluster

Items	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Intervention-1: Orchards renovation	0.46	0.62	0.78	1.10	1.42	1.12	1.12	1.12
Intervention-2: Improved orchard management		0.80	1.60	2.41	3.21	3.21	3.21	3.21
Intervention-3: Controlling post-harvest losses		0.026	0.05	0.08	0.10	0.10	0.10	0.10
Intervention-4: Introducing almond processing	0.00	0.02	0.07	0.18	0.34	0.35	0.36	0.37
Total =	0.46	1.48	2.57	3.93	5.39	5.11	5.13	5.14

Table 29 pertains to the yearly stream of net-economic benefits after offsetting the direct value chains costs incurred for the development of almond cluster in Balochistan. It can be observed that initially, the net-benefits of the introduced interventions shall be negative, which shall turn into positive by 4th year of the project and onwards its positivity shall sustain. By the 8th year since the inception of the project, the net-benefits shall be to the tune of US$ 10.421 Million.

Table 29: Net-Economic Benefits after Offsetting the Direct Value Chains Costs in the Focal Point of Balochistan cluster

Items	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Total expected gross returns from cluster development interventions (Million US$)		4.38	8.89	15.87	23.43	25.23	26.91	28.47
Gross costs to be incurred on cluster development interventions (Million US$)	1.03	2.05	3.14	4.48	5.94	5.09	5.10	5.12
Net-economic benefit (Million US$)	-0.46	2.90	6.33	11.96	18.06	20.14	21.80	23.36

9.7. Investments Cost

In order to improve the sample almond cluster, public and private sector investment under project approach is needed. As all the above calculations are made on the basis of a 5-year project, therefore, the yearly distribution of investments required for all the six proposed interventions is given in Table 30 below. The total investment required for all the interventions would be US$ 10.1 Million.

Table 30: Public Investment (Million US$) Needed for Almond Cluster Development in the Loralai Focal Point of Balochistan Cluster

Items	Total	Year-1	Year-2	Year-3	Year-4	Year-5
Almond R&D Program	1.111	0.44	0.33	0.33	-	-
Capacity Building of FEGs for improved management practices	0.298	0.12	0.09	0.04	0.03	0.01
Orchard renovation (plants and drip irrigation)	4.527	0.91	0.91	0.91	0.91	0.91
Investments required on establishment of certified almond nurseries	1.679	0.34	0.34	0.34	0.34	0.34
Investments required on almond oil processing units	0.031	0.03	-	-	-	-
Investment on almond shelling	1.226	0.18	0.35	0.35	0.35	-
Value chain level training	0.288	0.12	0.09	0.09	0.06	-
Government Loans (One year interest free)	0.858	0.17	0.18	0.18	0.18	0.14
Total investments (M. US$)	9.984	2.29	2.28	2.24	1.86	1.40

9.8. Economic Viability of Cluster Development Plan

In Table 31, undiscounted net cash flow achieved by the farming and non-farm business community are estimated on yearly basis. It revealed that the net present value of the project is US$ 56.31 Million, whereas, the Internal Rate of Returns (IRR) for the almond cluster development in Balochistan is 136% clearly indicating an economically viable project. It clearly implies that it is worth investing into the cluster for the uplift of the almonds production in the area through various proposed farm, value chain, and processing level investments.

Table 31: Net-Present Value (Million US$) and Internal Rate of Returns (%) in the Focal Point of Balochistan Cluster

Items	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8
Net-cash flow after deducting all costs from the benefits stream (Undiscounted)	*-2.75*	*0.62*	*4.08*	*10.09*	*16.64*	*20.12*	*21.78*	*23.33*
Net Present Value (NPV)	**56.31**							
Internal Rate of Returns (%)	**136%**							

9.9. Concluding Remarks

This report is presented in view of existing potentials of main almond growing areas and identified the almond clusters as part of the Vision 2025 of Government of Pakistan. It is concluded that the development impact of the interventions in Balochistan clusters shall be encouraging, sustainable and long-lasting. The estimated Internal Rate of Return (IRR) and Net Present Value (NPV) for Loralai Cluster shows economic viability of investing into the cluster. The given recommendations are based on practical experience in the horticulture subject, visits to the core areas of clusters and interviews with almond growers and stakeholders.

Annexure-1: References and data sources

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Annexure-2: LIST OF SAKEHOLDERS

List of Farmers

S. No.	Farmer Name	Dated	Commodity	Contact No.	City/Area
1	Mr. Mr. Mujeebullah	12-8-2018	Almonds	0302 3842242	Loralai
2	Mr.Aabdul Jabbar	12-8-2018	Almonds	0333 8322190	Loralai
3	Mr..Mehmood Khan	11-8-2018	Almonds	0334 7095071	Dukki
4	Mr. Mohammad Hassan	8-11-2018	Almonds	0344 5630787	Skardu

List of Traders & Dealers

S. No.	Name	Dated	Trader/Dealer	Commodity	Contact No.	City/Area
1	Haji Jamal	12-8-2018	Packaging business	Almonds and Plums	0331 3796142	Loralai
2	Mr. Mohammad Yar Khan	12-8-2018	Agribusiness	Almonds etc.	0336 8099639	Loralai
3	Mr. Abdul Qahir	12-8-2018	Pesticides business	Almonds etc.	0311 2128940	Loralai
4	Mr. Habibullah	12-8-2018	Fertilizer Dealer	Almonds etc.	0345 8370313	Loralai

List of Researchers & Administrators

S. No.	Name of Researcher	Dated	Research Institute/Center	Contact No.	Commodity	City/Area
1	Mr. Mohammad Saleem	12-8-2018	Directorate of Agriculture Researc at Loralai	0333 3728515	Almonds	Loralai
2	Mr. Habibullah	12-8-2018	Directorate of Agriculture Researc at Loralai	0334 2407822	Almonds	Loralai
3	Mr. Mauladad	12-8-2018	Directorate of Agriculture Researc at Loralai	0333 7913775	Almonds	Loralai
4	Mr. Nizam ud Din	12-8-2018	Directorate of Agriculture Researc at Loralai	0306 6611181	Almonds	Loralai
5	Mr. Abdullah	12-8-2018	Directorate of Agriculture Researc at Loralai	0333 8333869	Almonds	Loralai

Annexure 3: Feasibility Study for Almond Oil Processing Plant

The almond oil market was valued at $1,118 million in 2016, and is expected to reach $2,680 million by 2023, registering a Cumulative Average Growth Rate (CAGR) of 13.2% from 2017 to 2023. Almonds are the rich source of oil, and it is extracted from almond kernels of tree *Prunus Dulcis*. It is extracted using cold-pressed method and is available in two different forms i.e. sweet almond oil and bitter almond oil. It is a rich source of vitamin E, vitamin B, vitamin A, minerals, omega fatty acids and proteins which makes almond oil an all-purpose carrier and essential oil used in cosmetics, food, and pharmaceutical industry. Key driver influencing the demand for almond oil globally is from increasing demand among cosmetic manufacturers due to high requirement of natural ingredient used in body lotions, face creams, hair oil and in many other products for cleansing and moisturizing purpose. Due to extensive health benefits of almond oil, it has varied uses as facial oil, body oil, baby oil, massage and also in aromatherapy. The global almond oil in cosmetic application is expected to grow at a CAGR of 13.5% from 2017 to 2023. Asia-Pacific is the fastest growing region in terms of both revenue and volume in the global almond oil market United States is the largest sweet almond oil producer in the world. The US alone exports around 75% sweet almond oil in Asia Pacific and Europe region. More than 80% of world's almonds are produced in California. On the other hand, in Europe, Germany and France are world's largest sweet oil consuming countries that hold more than 50% share in the global market. The market is also booming in India and China where almonds are considered as healthy snacks option. Increase in health concerns of consumers in the developing countries, such as India and China, is expected to fuel the growth of the Asia-Pacific almond oil market. Wider scope of almond oil as an essential oil in various applications such as pharmaceutical and aromatherapy have further supplemented the market growth in the region. (Allied market research: https://www.alliedmarketresearch.com/almond-oil-market

https://www.1marketresearch.com/market-reports/sweet-almond-oil-consumption-market-industry-report-122496

Objective:

The objective of this feasibility study is to estimate feasibility of the Almond oil small scale processing plant for the future investors so that following functions in the value chain can be incorporated:

- Shelling → cleaning → Cooking → Pressing → to extraction and loading etc.

The process

Almond oil processing screw cold press oil machine process is given below:

Different extraction methods can be used for almond oil extraction, regarding the screw press, although it is generally defined as a cold pressing system, it requires a temperature increase (preheating) to obtain better results. This increase produces a better oil separation, which can affect extraction yield. In some screw presses, temperature is hard to control and, therefore, the yield presents higher variations. Martínez et al. (2013) evaluated the combined effects of almond

humidity (4, 6, 8, 10 y 12%) and preheating press temperature (20, 40 y 60 °C) on the yield and the quality of obtained oils, and observed that the largest quantity of oil (79.3%) was obtained with a seed humidity of 8% and a preheating temperature of 40 °C. The increase in humidity from 4 to 8% resulted in a higher yield but a posterior increase from 8 to 12%, caused a light decrease. All extraction conditions used were compatible with an acceptable physicochemical quality.

Almond oil extraction using supercritical fluids (CO2) and pressing (both hydraulic and screw press) provides a product that is fit for human consumption with the pleasant sensorial characteristics that belong the initial product (the almond), consequently no refining is needed, making the product a virgin oil.

Figure 3: Process Flow chart of Almond Oil extraction

Source: Martínez et al. 2013.

Product Introduction of Almond oil processing machine

This machine is semi-automatic oil presser is advanced black seed oil machine, characterized by simple design, easy to operate, high production capacity and high oil output rate. Moreover, this kind of machine can be used for various raw materials, and depending on the oil content of particular crop you are pressing, the machine will extract about 90%-95% oil of it. A Screw consists basically of a worm assembly, a shift fitted with spirally-arranged worm sections, rather like a screw. The shaft turns horizontally in a cage consisting of barrel bars that are clamped together forming a kind of slotted tube around the shaft. In turning the worm assembly moves the oil-seed from the feed-end to the discharge-end, expelling the oil through the slots between the bars of the cage. The oil-seed, as it moves along the shaft, loses oil, and its volume decreases accordingly.

Specification of Almond oil cold press machine				
Automatic Grade:	Semi-Automatic	Place of Origin:	Henan, China (Mainland)	
Condition:	New	Type:	Cold & Hot Pressing Machine	
Brand Name:	Beiside	Voltage:	220V/380V	
Power(W):	5.5 Kw	Dimension(L*W*H):	1910*610*765mm	
Weight:	330 Kg	Certification:	CE, ISO9001	
Name:	oil press machine	Application:	Oil Production Line	
Capacity:	80-150 Kg/h	Function:	Press Oil Seeds	
Advantage:		Simple Operation	Character:	Professional Manufacturer
Colour:		Green, Customized	Quality:	Top Level
Material:		Carbon Steel /Stainless Steel	Warranty:	One Year
After-sales Service Provided:			Engineers available to service machinery overseas	

Applications of oil cold press machine

Screw-presses are used for two different tasks. One is to obtain the **maximum oil yield** from a suitably prepared almond seed. This is achieved by a single pressing through the screw-press at high pressure. There is no further oil extraction operation.

The other task of the screw-press is to "**pre-press**" the seed, generally of high oil content, to obtain a cake of more moderate oil content. This cake is then further processed, usually is a continuous solvent extraction plant, to recover most of the remaining oil.

Figure 4: Pictures of the Almond Oil processing machine

Machine's main equipment

Plant and Machinery

The cost of plant & machinery is estimated at US$ **10000** including installation and commissioning. The installed production capacity will be 0.5 tonnes per day. The cost estimates for plant & machinery has been worked out based on the cost figures available from recent orders paced for similar items in the recent past, duly updated to cover the price escalation in the intervening period. These costs are given

Table 32: Plant and Machinery

S. No.	Particulars	Qty.	Rate (US$)
1.	Almond processing Screw cold press Oil machine	1	4000
2.	Almond de-Sheller machine	1	3000
3.	Solar generator	1	3000
	Total		**10000**

Misc. Fixed Asset Costs

US$ 10000 has been estimated under the heading of miscellaneous fixed assets. The details of electrical installations for power distribution have been considered commensurate with the power load and process control requirements. Other miscellaneous fixed assets including furniture, office stationery, telephone and refreshment, workshop, fire-fighting equipment, etc. will be provided on a lump sum basis as per information available with the consultants for similar assets.

Miscellaneous fixed asset cost

S. No.	Particulars	Qty.	Rate (US$)
1.	Office Equipment	1	3000
2.	Furniture and Fixture	1	3000
3.	Fire Fighting	1	1000
4.	Loading Tempo	1	1000
5.	Electrical and water lines Installation	1	2000
	Total		**10000**

Pre-Operative Expenses

Expenses incurred prior to commencement of commercial production are covered under this head that total US$ 22222**.** Pre-operative expenses include establishment cost, rent, taxes, traveling expenses and other miscellaneous expenses. It has been assumed that the funds from various sources shall be available, as required. Based on the project implementation schedule, the expected completion dates of various activities and the estimated phasing of cash requirements, interest during construction has been computed. Other expenses, under this head have been estimated on a block basis, based on information available for similar projects.

Pre-Operative Expenses

Sr. No.	Particular (for 1 year)	Amount (US$)
1.	Interest up to production @ 16% on term loan amount of US$ 173,363 **(30% of total project cost)**	27738
2.	Electricity charges during construction period	500
3.	Technology Know-how	500
4.	Training expenses	500
5.	Travelling Expenses	500
	Total	**22222**

Cost of raw material

Based on a processing capacity of 1 tonne per day taking into account and 200 days of working per year, the annual raw material consumption of the pack house is 200 tonnes. The cost of almond based on its average selling price as determined through interview with randomly selected farmers and converting it into US$ (with conversion rate of one US$=135) is $2624/ton. Adding US$6 per tonne transportation cost from the field to processing unit, the raw material cost for almond oil extraction would be US$**2630**.

Cost of raw material

Particulars	Rate per tonne (US$) for the Almond at the wholesale	Qty. (Tonnes) per annum	Raw material cost (US$)
Almond for Oil extraction	**2624**	**200**	**524800**
Transportation charges/tonnes	**6**	**200**	**1200**

Note: converting 1 tonne shelled almond will produce half tonne almond seed, while from 1 tonne of Almond seed **30** % oil will be extracted, so in the model we will be using conversion factor for oil extraction from per tonne Almond in the same manner.

Land Lease Charge

Required land is 6,000 sq. ft. which has been considered on lease @ US$200 per annum for first year and @ US$255 for the sixth year and subsequently @5% increase every year.

Land lease charges

S. No.	Year	Lease charges Per Annum (US$)
1.	1st year	200
2.	2nd year	210
3.	3rd year	221
4.	4th year	232
5.	5th year	243
6.	6th year	255
	Total	**1361**

Electricity and Water Consumption Charges

The unit cost of electricity has been considered @ PKR.20.70/ unit assuming that the entire power requirement is met from the grid. A power supply of 5.5 Kw is deemed appropriate. The expense

on water supply, treatment and distribution has been suitably considered, based on the tariff by water and sanitation agency (WASA) for per month consumption of water tariff of @ 92.82 PKR/thousand gallons.

Electricity and water consumption charges

S. No.	Description	Amount Per Annum (US$)
1.	Power Consumption	2000
2.	Water Consumption	200
	Total	**2200**

Human Resource Cost

One manager, one supervisor for complete year technical staff Salaries & wages (including benefits) for different categories of employees have been considered based on present day expenses being incurred by other industries in the vicinity. The breakdown of manpower and incidence of salaries & wages are detailed in the table Salary & Wages. Salary & wages are increased @ 5% every year

Salary and wages

Sr. No.	Description	Requirement	Salary/month (US$)	Salary/annum (US$)
1.	Plant Manager	1	500	6000
2.	Supervisor	1	300	3600
3.	Skilled Workers	2	250	3000
4.	Driver	1	200	2400
	Total		**1250**	**15000**

Cost of Project

Sr. No.	Particular	Value (US$)
	Fixed costs	
	Plant and Machinery	8000
	Misc. Fixed Assets	2300
	Pre-operative expenses	29738
	Operating costs	
	Cost of raw material	526000
	Land lease charges	1361
	Electricity and water consumption	2200
	Salary and wages	15000
	Packaging Cost	3911
	Marketing Cost	264
	Margin Money for Working Capital	1000
	Contingencies 5% of Fixed Assets	366
	Total variable costs	**590140**

Project Income Statement

		Year1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Revenue (US$)									
Almond shelling capacity (tonnes/day)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Processing season (days)		100	100	100	100	100	100	100	100
Processing capacity of the whole season (t of shelled almond)		50	50	50	50	50	50	50	50
Reducing water content (5%)		95%	95%	95%	95%	95%	95%	95%	95%
Hulled almond produced with required moisture level (T)		48	48	48	48	48	48	48	48
Conversion factor from hulled almond to oil (T)		33%	33%	33%	33%	33%	33%	33%	33%
Quantity of almond oil produced (t) per season		15.68	15.7	15.7	15.7	15.7	15.7	15.7	15.7
Price of the almond oil @Rs. 1200 per kg (US$/ton)		8889	8889	8889	8889	8889	8889	8889	8889
Price of raw shelled almond @ Rs.350/kg		2222	2222	2222	2222	2222	2222	2222	2222
Price of the almond cakes/powder@Rs. 40 per kg (US$/ton)		296	296	296	296	296	296	296	296
Revenues (US$) from oil		139333	139333	139333	139333	139333	139333	139333	139333
Revenue from almond straw		9430	9430	9430	9430	9430	9430	9430	9430
Total Revenue (US$)		148763	148763	148763	148763	148763	148763	148763	148763
Direct variable costs									
Raw material transportation cost @US$6 per ton (US$/TON)		150	150	150	150	150	150	150	150
Raw material cost (US$)		111111	111111	111111	111111	111111	111111	111111	111111
Packing costs (@PKR20 / liter glass bottle packing)		2322	2322	2322	2322	2322	2322	2322	2322
Labor cost		15000	15000	15750	16538	17364	18233	19144	20101
Electricity and water		2200	2200	2200	2200	2200	2200	2200	2200
Maintenance (1% of the machinery, equipment and furniture cost)		311	311	311	311	311	311	311	311
Land lease charges (5% increment on annual)		200	210	221	232	243	255	268	281
Marketing @ US$ 10 / ton		157	157	157	157	157	157	157	157
Office administration		370	370	370	370	370	370	370	370
Total variable cost including raw material		131822	131832	132592	133391	134229	135109	136034	137004

Gross profit		**148763**	**148763**	**148763**	**148763**	**148763**	**148763**	**148763**	**148763**
Indirect fixed cost									
Machinery	**-31111.11**								
Licensing and regulatory fee	**-150**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**-31261.11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Grand total cost	**-31261.11**	**131822**	**131832**	**132592**	**133391**	**134229**	**135109**	**136034**	**137004**
Net profit (Net cash flow)	**-31261.11**	**16941**	**16931**	**16171**	**15372**	**14534**	**13654**	**12729**	**11759**
NPV	**0.085**	**Rs49,618.55**							
IRR		**49%**							

NPV = 49,618
IRR = 49%

Project Viability:

The Internal Rate of Return of the project is estimated at **49**%, which is significantly higher than the bank return rate of 16%. Hence, the project is deemed financially viable. The NPV of the project is positive (US$ **49,618**) at a discount factor of 16% during the first 6 years of operation considered. This implies that the project generates sufficient funds to cover all its cost, including loan repayments and interest payments during the period. This also indicates that the project is financially viable over the long term.

Annexure 4: Almond Shelling Machine

Background

In Pakistan only 5% of the almond is shelled, while most of the imported almond are in shelled form. The machines and processes are easily available from various sources. The cost of almond hulling and shelling is estimated around US$0.3 per kg in Australia and it could be cheaper in Pakistan because of the low wage rate and land prices in Pakistan. However, it can increase the price of almond kernel by two times of the farm gate prices.

Salient Features of Almond Shelling Machine

1. The almond cracking rate can reach 98% with less than 1% broken rate (for a better cracking effect, you should grade the almonds first).
2. All these procedures are automatic and two people can control the whole almond shelling and separating line.
3. Rotary and adjustable rollers make almond shelling machine suitable for almond with all hardness.
4. Main components all adopt stainless steel and has a long service life.
5. High shelling efficiency with low energy consumption.
6. Low land occupancy and investment.

Technical parameters

No.	Name	Size	Power
1	Hoister	0.6*0.6*6.5m	0.75kw
2	Horizontal sieve grading machine	3.2*1.1*2.5m	1.5kw
3	Three-level Shelling Machine	3.2*2.1*2.6m	6.75KW
4	Kernel shell Separator	3.2*0.9*1.6m	1.5kw/3kw

Price

Price: US$3000 to 10,000 per set

Other Details

Warranty:	1 Year	Production Capacity:	98%
Dimension (L*W*H):	1.9*0.8*1.4M	Condition:	New
Type:	Automatic	Use:	Shelling
Place of Origin:	Henan, China (Mainland)		
Brand Name:	GELGOOG Almond Shelling Machine		
Voltage:	380V 50HZ	Weight:	140kg
Certification:	CE		
After-sales Service Provided:	Field installation, commissioning and training		
Product name:	Almond Cracking and Shelling Line		

Application:	Almond, hazelnut, badam
Capacity:	1ton/h
Function:	Shelling and separating almonds
Feature:	High automation and shelling rate
Model Number	GG
Power (W)	15750 W
Lead Time:	1 to 5 sets at a time
Estimated time:	25 days, otherwise negotiable

Process Involved

For processing the harvested almond is transported to a hulling and shelling facility where it is first cleaned to remove the foreign material from almond. Then hull is removed through dehulling machine to get in-shell almond which are further shelled by almond cracking and shelling machine to produce the kernels. The almonds are transported to another processing facility where they undergo a range of activities such as peeling, sorting, grading, blanching, milling, chipping, roasting, and packaging. Almonds can also be silvered by almond kernel silvering machine into strip shape sliced by almond slicing machine, diced by almond kernel chopping machines into small granules, which are widely used in bakery food processing such as biscuit, candy, chocolate, etc. split, left whole, or ground (meal/flour). Almond milk is now the most popular plant based milk with sales higher than soybean milk. In Australia, during 2014-2015, 192 new product using shelled almond were stocked by supermarkets.

Figure 5: Almond Shelling Processes

Project Income Statement

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Capacity of almond oil extraction per day (t of almond)			6	6	6	6	6	6	6	6	6
Processing season (t)			90	90	90	90	90	90	90	90	90
Quantity of raw almond that can be processed (t)			540	540	540	540	540	540	540	540	540
Converttion factor from un-hulled to hulled			45%	45%	45%	45%	45%	45%	45%	45%	45%
Reducing water content (5%)			95%	95%	95%	95%	95%	95%	95%	95%	95%
Quantity of shelled almond produced with required moisture level (T)			231	231	231	231	231	231	231	231	231
Price of raw unshelled almond @ Rs.300/kg			2222	2222	2222	2222	2222	2222	2222	2222	2222
Price of shelled almond @Rs. 850 per kg (US$/ton)			6296	6296	6296	6296	6296	6296	6296	6296	6296
Price of the almond shells Rs. 100 per 40 kg (US$/ton)			19	19	19	19	19	19	19	19	19
Revenues (US$) shelled almond			1453500	1453500	1453500	1453500	1453500	1453500	1453500	1453500	1453500
Revenue from almond shells			5500	5500	5500	5500	5500	5500	5500	5500	5500
Total Revenue (US$)			1459000	1459000	1459000	1459000	1459000	1459000	1459000	1459000	1459000
Direct varaible costs											
Raw material cost (US$)			1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000
Cost of operational capital (10% of the raw material cost)			10000	10000	10000	10000	10000	10000	10000	10000	10000
Raw material transportation cost @US$15 per tonne (US$/TON)			8100	8100	8100	8100	8100	8100	8100	8100	8100
Packing costs (@PKR5 per kg plastic packing)			8550	8550	8550	8550	8550	8550	8550	8550	8550
Labor cost			47333	47333	47333	47333	47333	47333	47333	47333	47333
Electricity and water @US$1500/month			18000	18000	18000	18000	18000	18000	18000	18000	18000
Maintinance (1% of the machinery, equipment and furniture cost)			10750	10750	10750	10750	10750	10750	10750	10750	10750

Land lease charges (5% increment on annual)			200	210	221	232	243	255	268	281	295
Marketing @ US$ 10 per ton			2,309	2,309	2,309	2,309	2,309	2,309	2,309	2,309	2,309
Office administration			370	370	370	370	370	370	370	370	370
Total variable cost including raw material			1305612	1305622	1305633	1305644	1305655	1305667	1305680	1305694	1305708
Gross profit			1459000	1459000	1459000	1459000	1459000	1459000	1459000	1459000	1459000
Indirect fixed cost											
Machinery		-175000									
Licensing and regulatiry fee		-150	0	0	0	0	0	0	0	0	0
Total		-175150	0	0	0	0	0	0	0	0	0
Grand total cost		-175150	1305612	1305622	1305633	1305644	1305655	1305667	1305680	1305694	1305708
Net profit (Net cash flow)		-175150	153388	153378	153367	153356	153345	153333	153320	153306	153292
NPV	0.085		703,413								
IRR			87%								

NPV = 70341
IRR = 87%

Project Viability:

The Internal Rate of Return of the project is estimated at **87**%, which is significantly higher than the bank return rate of 16%. Hence, the project is deemed financially viable. The NPV of the project is positive (US$ **70341**) at a discount factor of 16% during the first 6 years of operation considered. This implies that the project generates sufficient funds to cover all its cost, including loan repayments and interest payments during the period. This also indicates that the project is financially viable over the long term.

Establishing new Shelling/Hulling unit

Sr. #	Cost items	Amount (US$.)
1.	Existing transport cost (US$/T)	150
2.	Improved transport cost (US$/T)	250
3.	Grading and Packaging Unit	70,000,000
4.	Removal of hull	15,000,000
5.	Chemical treatment for shell softening	15,000,000
6.	Building	30,000,000
7.	Annual Salaries of the Staff	10,000,000
8.	Annual Fixed Cost (US$)	51,851.851
10.	Variable Cost/Annum (US$)	740,740.740
11.	Total Annual Cost	792,592.6
12.	Annual Processing Capacity (Tonnes)	1,200
13.	Processing Cost/Ton	660
14.	Existing costs	100

15.	Mechanical processing cost escalation	6.60
16.	Existing transport cost (US$/T)	150
17.	Improved transport cost (US$/T)	250
18.	Grading and Packaging Unit	70,000,000
19.	Removal of hull	15,000,000
20.	Chemical treatment for shell softening	15,000,000
21.	Building	30,000,000
22.	Annual Salaries of the Staff	10,000,000
23	Annual Fixed Cost (US$)	51,851.851
24	Variable Cost/Annum (US$)	740,740.740
25	Total Annual Cost	792,592.6
26	Annual Processing Capacity (Tonnes)	1,200
27	Processing Cost/Ton	660
28	Existing costs	100

Annexure-5: Itemized distribution of cost

Inputs, Practices and Costs

Sr. #	Cost items	Improved Management practice	Current management practice
1.	Row x Row Distance (Foot)	15	20.00
2.	Plant x Plant Distance (Foot)	15	20.00
3.	Area of Acre	43,560	43560.00
4.	Total Number of Plants/Acre	194	100 – 110
5.	Total Number of Plants/Ha	478	245 – 275
6.	Rounded Figures	475	-
7.	Mortality Allowance	5%	-
8.	Price per 100 Plants (US$)	500	-
9.	Plants cost per ha	2500	-
10.	Labour Cost/ha	200	-
11.	Drip Irrigation System	2,500	-
12.	Total Orchard Establishment Cost/Ha (US$)	5200	-

Costs of Improved orchard management

Sr. #	Cost items	Improved Management practice (US$/ha)	Current management practice (US$/ha)
1.	Labour cost	222	111.11
2.	Fertilizer Cost (Macro-Nutrients)	185	200.00
3.	Fertilizer Cost (Micro-Nutrients)	185	-
4.	Farm Yard Manure	370	73.00
5.	Sprays	398	27.00
6.	Total Management Cost/ha	1361	400.00
7.	Increase in Cost	6.81	