CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

Carrots and Turnips Cluster Feasibility and Transformation Study

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

February 2020

FOREWORD

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

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

FOREWORD

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

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

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

FOREWORD

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

Dr. Babar Ehsan Bajwa
Regional Director
CAB International

FOREWORD

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

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

ACKNOWLWDGEMENT

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 carrots and turnip production, marketing, trade and value chain. Without their support, this report would not have reached to the level of present quality.

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

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

Muhammad Najeeb Ullah

Senior Author

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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 Special Initiatives or the Centre for Agriculture and Bioscience International (CABI).

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AARI	Ayub Agricultural Research Institute
ADP	Annual Development Plan
AMRI	Agricultural Mechanization Research Institute
AOs	Agriculture Officers
ARI	Agriculture Research Institute
CKD	Chaudhary Khair Din & Sons
CPEC	China Pakistan Economic Corridor
DAP	Di-ammonium Phosphate
DFM	Directorate of Farm Mechanization
DPH&FT	Directorate of Post-Harvest & Food Technology
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization of the United Nation Statistics
FEG	Farmer Enterprise Group
FSC&RD	Federal Seed Certification and Registration Department
FS&TRP	Food Science & Technology Research Program
GAP	Good Agriculture Practices
GI	Geographical Identification
GoP	Government of Pakistan
Ha	ha(s)
IPPC	International Plant Protection Convention
IQF	Individually Quick Frozen
IRR	Internal Rate of Return
ISO	International Standard Organization
ISPMs	International Standards for Phytosanitary Measures
Kg	Kilogram
KP	Khyber Pakhtunkhwa
MMD	Mehr Muhammad Din & Sons
MNFS&R	Ministry of National Food Security and Research
NARC	National Agriculture Research Council
NGOs	Non-Governmental Organizations
N: P: K	Nitrogen, Phosphorus and Potassium

NYUT	National Yield Uniformity Trial
PARC	Pakistan Agriculture Research Council
PFVA	All Pakistan Association of Fruits & Vegetables Exporters, Importers & Merchants
PHRC	Post Harvest Research Centre
R&D	Research & Development
SOP	Sulphate of Potash
SWOT	Strengths, Weaknesses, Opportunities, Threats
UAE	United Arab Emirates
UAF	University of Agriculture, Faisalabad
UK	United Kingdom
USA	United States of America
USD	United States Dollar
VRI	Vegetable Research Institute
VRP	Vegetable Research Program

EXECUTIVE SUMMARY

According to last latest available statistics, carrot and turnips were cultivated on an area of 1.17 million ha producing 42.71 million tonnes fresh carrot and turnips in the world. China, with 20.6 million tonnes, was the leader in global production and export valued at US$ 353 million, remotely followed by Netherlands. The top importer of carrot and turnips is Germany, followed by Canada and the USA. Pakistan is ranked at 17th position among the world's top carrot and turnip producing countries.

In Pakistan, carrot and turnips are grown in all provinces but major production is concentrated in Punjab followed by Balochistan and KP. In these provinces four carrot and turnip clusters are identified where its cultivation is concentrated based upon area under the crop and supply period of the fresh produce: Upper KP cluster with Swat its centre point, Central KP cluster with Bunir as its centre point, Central Punjab with Sheikhupura as its centre point, and Eastern Central Balochistan with Killa Saifullah as its centre point.

Pakistan's performance in carrots and turnip production and export has been very discouraging. The production and yield of the crop have negative trend since 2001, which has turned Pakistan's per ha yield less than half of the world average. These trends imply that Pakistan is not only losing its position in the world carrot and turnip production but also its competitiveness. Moreover, these trends have turned Pakistan from a net exporter to a net importer of carrots and turnip. Despite these trends, Pakistan has great potential to catch up on all these fronts, because of a number of advantages including year round availability of the fresh produce and cheap labour force.

To make Pakistan competitive in carrots and turnip production and trade in national and international markets, this study identifies several performance gaps in the production, processing and trading components of the value chain, specifically in the technology, market structure and availability of quality inputs. These included the lack of improved commercial carrot and turnips cultivars to produce high quality marketable fresh produce, conventional cultural practices and improper post-harvest practices for trading in the high-value fresh carrot and turnips market. Pakistan exports a minimal quantity of fresh & chilled carrot and turnips, however, creating additional export market linkages and satisfying quality standards can help Pakistan to realize the true potential of this commodity.

In order to address multilevel challenges from production to product and market development, performance targets were set, based on global average for yield, quality & export and the interventions were designed and proposed for focal points of defined clusters to meet these targets. These interventions include introduction of new high yielding varieties from other clusters and/or other countries with similar environment like Pakistan, improvement of farmer's production practices, post-harvest handling practices including washing, grading, packaging and transportation through improving farmers' and institutional capacities, promoting best value chain practices, incentivizing carrot and turnips processors, establishing value chain improvement infrastructure like pack houses and improving market linkages, etc. Indirect system level interventions would be strengthening of research on carrot and turnip value chain, organizing

producers into Farmers Entrepreneur Groups and other stakeholders' organizations and improving agriculture advisory services. These interventions are to be initiated by government and executed in collaboration with private sector including farmers, traders, exporters, processors and concerned groups/associations. A time-horizon of five years has been set for realizing the intended outcomes of the cluster development interventions.

Total estimated investment required for these interventions to be introduced at the centre points of all clusters in the project mode to be implemented in five years is US$4.37 Million. 45% (US$1.95 million) of this sum will be borne by the government for strengthening carrots and turnip research, capacity building of farmers and other stakeholders along the value chain, subsidies on the establishment of pack houses and providing interest free loans. These incentives will induce the remaining 55% investment in the private sector worth of US$2.42 million. These interventions will improve the value chain operations, thus operational costs of various operations in the value chain which will cost US$0.387 million (undiscounted) during the last year of the project. The Up-gradation Plan will generate the gross return to various stakeholders in the value chain which will be worth of US$4.42 million (undiscounted) during the last year. After discounting all the investments and operational costs, the pooled Net Present Value (NPV) came to US$3.36 million during the five year of the project. The overall Internal Rate of Returns (IRR) from all the clusters is 53%. The cluster level investment and return information can be seen in the Summary Sheet given below.

These carrot and turnip Up-gradation Plan will generate positive impacts on the income and employment of various stakeholders along the value chain. However, these benefits can be achieved only if cluster approach is adopted in totality in resolving the issues along the whole value chain at the local level. Strengthening of research and development and capacity building of the stakeholders to produce and manage quality carrot and turnip production will be the key to the success of the Up-gradation Plan.

Summary Sheet of Carrots and Turnip Cluster

Information	Upper KP	Central KP	Central Punjab	Balochistan	Overall
Area of cluster focal point (ha)	430	325	1307	1060	2062
Production (Tonnes)	8250	6012	27548	18726	41810
Yield of the cluster (tonnes/ha)	19.19	18.50	21.08	17.67	20.3
Area of the cluster (ha)	764	1,558	6,999	2,216	11537
Production of the cluster (tonnes)	12,075	25,674	126,217	38,630	202596
Yield growth without intervention	0.65%	0.65%	-0.45%	0.12%	
Increase production due to improved varieties (tonnes)	2130	1552	6733	4710	10416
Additional value of production (USD)	355444	259022	962861	1150379	1577326
Area under mechanized harvesting	0	0	235	191	426.06
production increased due mechanized (tonnes)			337	235	572
Added value of production due mechanized planting and better crop standing (USD)	0	0	48,143	57,519	105662
Increase in quantity of export on fifth year (tonnes)	533	388	1712	0	2633
Increase in value of export on the fifth year (USD)	198844	144903	639162	0	982909
Production through improved value chain (tonnes)	266	194	856	0	1316
Expected additional value from exports (USD)	76516	87130	261917	0	425562
Total additional value of production (USD)	119564	87130	400291	0	606985
Total number of pack house required	4	4	9	0	17
Number of harvester required	-	-	4	4	8
Total number of planter required	-	-	4	4	8
Investments (US$)					
Strengthening of R&D	148148	111111	444444	444444	1,148,148
Value chain infrastructure (pack houses)	557120	557120	1253520	0	2,367,760
Marketing/export level interventions	148148	111111	370370	0	629,630
Introduction of harvester			2185	9926	12,111
Introduction of planter			9926	9926	19,852
Total investment over five year	**914699**	**779342**	**2219665**	**456556**	**4370263**
Public sector investment	350485	244757	910864	446867	1952973
Private sector investment	564215	534585	1308801	9689	2417289
Economic Analysis					
Total production increased 5th year (tonnes)	**2130**	**1552**	**7070**	**4945**	**15698**
Gross revenue (undiscounted) in 5th year	**673852**	**491054**	**2050457**	**1207898**	**4423261**
Additional operation costs in 5th year	**84673**	**58843**	**206966**	**36570**	**387052**
Net cash flow (undiscounted) in 5th year	**589,179**	**432,211**	**1,843,492**	**1171328**	**4036210**
NPV (US$)	**260,150**	**51,192**	**1,318,330**	**1,729,407**	**3,359,080**
Internal Rate of Return	**28.78%**	**13.17%**	**41.68%**	**176%**	**53%**

INTRODUCTION

1.1. General introduction of the commodity

Carrots and Turnips are two important Rabi vegetables of Pakistan which have low production cost, high profitability, good nutritional value and are suitable for farmers with large to small land holdings. Moreover, carrots and turnips are available almost round the year due to diverse agro-climatic conditions in Pakistan.

1.2. Nutritional value of carrots and turnips

These are good source of many vitamins, minerals. These vegetables are low in calorie density but high in nutritional value. Turnips are loaded with fiber and vitamins K, A, C, E, B1, B3, B5, B6, B2 and foliate (one of the B vitamins), as well as minerals like manganese, potassium, magnesium, iron, calcium and copper. They are also a good source of phosphorus, omega-3 fatty acids and protein. High in fiber, the turnip may help to reduce inflammation of the colon as well as the risk of diverticulosis[1]. Carrots are the perfect snack, crunchy, full of nutrients, low in calories, and taste sweet. They have been linked with benefits for heart and eye health, improved digestion, as well as reduced risk of cancer. Carrots are an excellent source of vitamin A in the form of beta-carotene. They are also a good source of several B-vitamins, vitamin K and potassium. Lutein, predominantly found in yellow and orange carrots and is important for eye health. Lycopene found in red and purple carrots decrease the risk of cancer and cardiovascular disease. Polyacetylenes, a bioactive compound found in carrots protect against leukemia and cancer cells[2].

1.3. Carrot & Turnip Production in Pakistan

In Pakistan, Carrots and turnips are grown on almost 28.60 thousand ha of area which is 10.47 % of the total area under vegetables. Following table summarizes current status of area, production, yield and value of carrots and turnips in Pakistan.

Table 1: Current status of Carrots & Turnips in Pakistan 2015-16

Name of territory	Area		Production		Yield	Value
	000 Ha	Share	000 Tonnes	Share	Tonnes/Ha	Million US$
Punjab	17.46	61.05%	326.63	66.48%	18.71	74.88
KP	3.91	13.67%	58.21	11.85%	14.88	13.34
Sindh	3.15	11.01%	37.16	7.56%	11.79	8.52
Balochistan	4.04	14.13%	69.3	14.10%	17.14	15.89
Pakistan	28.6		491.35		17.18	112.64

Source: MNFS&R (2017)

[1] Health benefits of turnips (https://www.medicalnewstoday.com/articles/284815.php)
[2] Carrot: Nutrition facts & health benefits (https://www.healthline.com/nutrition/foods/carrots)

However, there is difference between the statistics reported by FAOSTAT and that MNFS&R (2017). As per FAO statistics 2016, total area of carrots and turnips in Pakistan is 29.04 thousand ha and production is 509.07 thousand tonnes with average yield of 17.5 tonnes/ha. These statistics are somewhat higher then reported by MNFS&R (2017). In this report, MNFS&R (2017) are used to estimate the national trends and comparison statistics across provinces while FAO statistics are used for international comparison.

Carrots and turnips cover almost 0.12% of total cropped area of Pakistan. Balochistan shares major portion with 0.38% of total cropped area under carrots and turnips followed by KP, Punjab and Sindh. Following table illustrates the percentage area of carrots and turnips in total cropped area of each province and Pakistan.

Table 2: Percentage area of carrots and turnips in total cropped area of Pakistan, 2017

Name of territory	Total cropped area[1]	Area of Carrots and Turnips[2]	Percentage cropped area of Carrots and Turnips
	000 Ha	000 Ha	%
Punjab	17040	17.46	0.10
KP	1850	3.91	0.21
Sindh	3220	3.15	0.10
Balochistan	1060	4.04	0.38
Pakistan	23170	28.6	0.12

Source: [1] MNFS&R (2018); [2]MNFS&R (2017)

In addition to their domestic use, carrots and turnips have huge potential as export in raw, fresh and processed form. Especially carrot has high demand in international market in processed form like canned / frozen carrot and pickles. However, full potential of these crops has not yet been utilized due to various reasons including outdated conventional cultural practices, poor quality seed and other inputs (fertilizers and pesticides), manual harvesting, improper post-harvest handling and transportation system, unstable and highly fluctuated market conditions and the last but not the least, limited value addition of these commodities.

As per Fruit, Vegetable and Condiments Statistics of Pakistan, during 2004 and 2016, Pakistan's average annual growth rates in area, production, and per ha yield of carrots and turnips have been at 0.04%, -0.30% and -0.34% (Table 3) respectively. The highest decrease in production of carrots and turnip was in Balochistan followed by Punjab while in Sindh and KP, especially area in Sindh, the trends are positive (Table 3).

There are no exact statistics available about number of farmers engaged in production of carrots and turnips. However, as per statistics of agriculture census 2010[3], total number of farms in Pakistan which reported vegetable cultivation is 507.8 thousand which are 6% of total agricultural farms. If only 10% of these farms cultivate carrots and turnips, the number of farms engaged in carrot production reaches to 50.78 thousand.

[3] Agricultural Census 2010 (http://www.pbs.gov.pk/content/agricultural-census-2010-pakistan-report)

Table 3: Trends in area, production, and yield of carrots & turnips in Pakistan

Year	Pakistan			Punjab			KP			Balochistan			Sindh		
	Area (000 ha)	Production (000 tonnes)	Yield (tonnes/ ha)	Area (Ha)	Production (000 tonnes)	Yield (Tonnes/ ha)	Area (Ha)	Production (000 Tonnes)	Yield (Tonnes /ha)	Area (Ha)	Production (000 Tonnes)	Yield (Tonnes /ha)	Area (Ha)	Production (000 Tonnes)	Yield (Tonnes /ha)
2004	28.47	509.97	17.91	17.77	354.09	19.93	3.46	46.99	13.59	4.66	78.90	16.92	2.58	29.99	11.63
2005	28.78	514.53	17.88	17.98	354.81	19.73	3.36	47.80	14.21	4.82	81.53	16.90	2.61	30.39	11.66
2006	27.76	503.72	18.14	18.12	357.76	19.75	3.41	50.32	14.76	4.18	70.79	16.93	2.06	24.87	12.10
2007	29.05	507.37	17.47	18.26	352.50	19.30	4.04	52.65	13.03	4.48	75.72	16.92	2.27	26.50	11.68
2008	28.69	511.13	17.82	18.33	356.75	19.46	3.62	51.83	14.33	4.40	75.19	17.10	2.34	27.36	11.69
2009	27.86	479.18	17.20	18.71	354.47	18.95	3.57	50.40	14.11	3.33	47.19	14.19	2.33	27.11	11.65
2010	29.59	520.30	17.59	18.85	361.93	19.20	3.53	49.65	14.05	4.53	77.75	17.15	2.67	30.96	11.62
2011	29.19	511.58	17.53	18.71	358.40	19.16	3.55	50.16	14.14	4.12	70.62	17.16	2.81	32.41	11.52
2012	30.04	367.47	12.23	19.48	215.25	11.05	3.63	50.82	14.00	3.83	65.01	16.96	3.10	36.38	11.74
2013	30.23	524.46	17.35	19.37	365.85	18.89	3.80	54.13	14.26	4.05	69.16	17.07	3.01	35.32	11.75
2014	28.55	489.58	17.15	17.59	328.88	18.70	3.83	55.49	14.48	4.02	68.92	17.13	3.11	36.29	11.68
2015	28.60	491.35	17.18	17.46	326.63	18.71	3.91	58.21	14.88	4.04	69.30	17.14	3.15	37.16	11.79
Growth (%)	0.04	-0.30	-0.34	-0.14	-0.65	-0.51	1.10	1.99	0.79	-1.11	-1.01	0.11	1.85	1.99	0.12

Source: MNFS&R (2017)

On the same ground, total number of farms engaged in carrots and turnips production in Punjab is 24.18 thousand, in KP 13.13 thousand, in Sindh 8.64 thousand and in Balochistan 4.83. Stakeholders important in value chain of carrots and turnips are seed companies, seed dealers, farm input suppliers (fertilizers & pesticides, etc.), vegetable markets wholesalers and processors.

As per FAOSTAT Trade Statistics (downloaded on November 2018), exports of carrots and turnips (fresh or chilled) from Pakistan has declined from 5.97 thousand tonnes (worth 0.95 million US$) in 2006 to 0.11 thousand tonnes (worth 0.04 million US$) in 2016. During 2016, Pakistan exported 0.023% of its total local production. Most of the carrot and turnip from Pakistan is exported raw fresh. No proper washing and grading facility is available in the country for fresh produce. Manual washing and visual grading is performed. Minor quantity of processed items like carrot pickles & frozen carrots is also exported. On the other hand, import bill of Pakistan for carrots and turnips (fresh or chilled) has increased from 0.072 million US$ (1.37 thousand tonnes) in 2006 to 1.79 Million US$ (4.16 thousand tonnes) in 2016. During 2016, Pakistan import of carrots and turnips was equal 0.82% of its local production for this commodity.

1.4. Value addition and processing in Pakistan

In Pakistan, value addition and processing of vegetables have always been a poor performing sector. Same is the case with value addition and processing of Carrots and turnips. Most of our farm produce is sold as fresh. In case of Turnips, no considerable value added or processed item is available at international or domestic level. There is limited demand of dried or frozen turnips. However, a variety of value added or processed products of carrots are available in the market. Important examples are carrot pickles, Carrot Marabba and Carrot Halwa (locally called Gajrella) etc. Traditionally these products are prepared at household level or on small scale by local bakeries. However, now many famous food-processing companies has jumped into the market. One example is Icepac Limited, Lahore which is producing and marketing many products of frozen carrots. Fauji Fresh and Freeze, Sahiwal Limited is also involved in business of frozen carrots. Many food processing companies like Shan Foods, Mitchell's Foods and National Foods are making carrot pickles which are marketed both in national and international market. Likewise, Perfect Foods, Lahore is involved in manufacturing of dry carrot products like dried carrot and carrot powder. However, no exact statistics are available for extent of value addition and processing of carrots and turnips in Pakistan. Moreover, most of the value added products of carrots and turnips being sold in local market are imported. Also, value added products of Pakistan are unable to compete in international market due to high cost of production and quality issues.

Table 4: Value added products of carrots & turnips in Pakistan

Manufacturers	Products
Shan Foods, Mitchell's Foods and National Foods etc.	• Carrot Pickles
Fauji Fresh n Freeze, Sahiwal	• Frozen diced carrot • Mix 3 (Carrots, Peas and Cauliflower)
Icepac Limited, Lahore	• Carrot Cubes • Mix 2- (Peas + Carrot) • Mix 3-(Peas + Carrot + S. Corn) • Mix 3-(Peas + Carrot + G. Beans) • Mix 4-(Peas + Carrot + S. Corn + G. Beans)
Perfect Foods Limited, Lahore	• Dried carrots • Carrot powder
Households, Local small traders and bakeries	• Carrot Pickles • Carrot Gajrella (Sweet) • Carrot Marabba (Gajjar ka Marabba)

Source: Market survey and stakeholders' consultation

1.5. Pakistani carrot and turnip production in the Global context

As per FAO statistics, carrots and turnips are sown on an area of 1168.7 thousand ha with production of 42711.8 thousand tonnes globally. Pakistan is ranked 8th in terms of area and 17th in terms of production of carrots and turnips, with1.19 % of total world production for carrots and turnips during 2016. Average yield of Pakistan for carrots and turnips is 17.5 tonnes/ha (78th rank in world) which is only 47.89% of world average yield i.e. 36.55 tonnes/ha. Pakistan's average yield is 88.75% less than of Iceland which has world highest average yield i.e. 155.6 tonnes/ha. Pakistan exports only 0.023% of its local production as compared to world average of 6.74%. Pakistan is ranked 75th and has only 0.003% share in world export value for carrots and turnips. Average export price of Pakistan is 373.36 US$/tonne as compared to world average of 454.19 US$/tonne (Table 5). However, wholesale price of carrots in Pakistan is only 39% of the world average price partly because of the low quality of the produce.

In contrast to Pakistan, the trends in production of carrots and turnips at international level is positive at 2.6% per annum during 2008-16, which is higher than the world population growth suggesting an increase in per capita consumption of the produce. Although, area remained almost stagnant during the period, per ha yield has a strong positive growth during the period. Moreover, the growth in the export of carrots and turnips is higher than the increase in production, suggesting that the produce is becoming increasingly a commercial commodity (Table 6). This creates an opportunity for Pakistan to enter into this market if it can standardize its product and address the quality issues.

Table 5: Carrots & turnips global market and Pakistan

Parameter	World	Pakistan	Rank	Share (%)
Area (000 Ha)	1168.73	29.04	8th	2.48
Production (million tonnes)	42.7	0.509	17th	1.19
Value (Million US$)	24879.64	116.70		0.47
Wholesale price (US$/tonne)	582.7	229.3		39
Yield (tonnes/ha)	36.55	17.53	78th	-
Carrots and turnips (Fresh or Chilled) export weight (000 tonnes)	2878.63	0.11	73th	0.004
Carrots and turnips (Fresh or Chilled) export value (Million US$)	1307.44	0.043	75th	0.003
Export-production ratio in quantity (%)	6.74	0.023	-	-
Export-production ratio in value (%)	5.26	0.038	-	-
Carrots and turnips (fresh or chilled) import weight (000 tonnes)	2522.96	4.16	58th	0.16
Carrots and turnips (fresh or chilled) import value (Million US$)	1261.76	1.79	54th	0.14
Import-production ratio in quantity (%)	5.91	0.82	-	-
Import-production ratio in value (%)	5.07	1.50	-	-
Average export prices (US$/tonne)	454.19	373.36	-	-

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

Table 6: Trends in international carrots & turnips production and trade during 2008-16

Year	Production			Export	
	Area	Production	Yield	Quantities	Values
	(000 ha)	(000 tonnes)	(tonnes/ha)	(000 tonnes)	Million US$
2008	1155	33892	29.3	2019	968
2009	1148	34559	30.1	2066	993
2010	1169	34970	29.9	2172	960
2011	1205	36578	30.3	2302	1110
2012	1193	37301	31.3	2274	1103
2013	1141	38077	33.4	2371	1220
2014	1125	38703	34.4	2312	1111
2015	1154	40561	35.2	2529	1211
2016	1169	42711	36.5	2879	1307
Growth rate (%)	0.1%	2.6%	2.5%	4.3%	3.5%

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

Among the top carrots and turnips producing countries, China produces over 48% of the world production and contributes 37% of the world area under carrots and turnip. Pakistan is ranked 17th in this list with 2.48% share in world carrot and turnips area and 1.19% share in production (Table 7).

Table 7: World major carrots and turnips producing countries of the world

Rank		Production		Area		Yield
	Country	000 Tonnes	World Share	000 Ha	World Share	Tonnes/Ha
1	China	20574.77	48.17%	431.895	37%	47.64
2	Uzbekistan	2250.56	5.27%	32.762	2.80%	68.69
3	Russia	1847.09	4.32%	69.545	5.95%	26.56
4	USA	1374.85	3.22%	33.99	2.91%	40.45
5	Ukraine	876.92	2.05%	43.1	3.69%	20.35
6	Poland	822.00	1.92%	22.308	1.91%	36.85
7	UK	811.12	1.90%	12.678	1.08%	63.98
8	Germany	641.63	1.50%	11.209	0.96%	57.24
17	Pakistan	509.07	1.19%	29.038	2.48%	17.53

Source: FAOSTAT, Prices, Producers Prices-Annual http://www.fao.org/faostat/en/#data/PP

Pakistan's major export of carrots and turnips goes to Kuwait, Qatar, Saudi Arabia and UAE. Major import is from Afghanistan, Australia, China, UAE, Belgium and UK. Pakistan should focus on exporting carrots and turnips to high potential markets like Russia, Canada, South Korea, UAE and Thailand which are among the largest importers of carrots and turnips in the world. South Korea, UAE and Thailand are rapidly growing markets whose imports of carrots and turnips have increased rapidly during the last years. From 2005 to 2016, UAE has shown remarkable 16% growth per year in imports of carrots and turnips.

The macro analysis of the carrots and turnip suggests that Pakistan's performance in this sector is very discouraging. The production and per ha yield of the crop has negative trend since 2001. The yield of carrots in the country is less than one half of the world average. These trends imply that Pakistan is not only losing its position in the world carrot and turnip production, but also its competitiveness. Moreover, these trends have turned Pakistan from a net exporter to a net importer of carrots and turnip. However, Pakistan has a great potential to enter into the ever booming international trade markets of carrots and turnip.

To make Pakistan competitive in carrots in production and trade in national and international markets, Pakistan has to carefully identify gaps and potential and based on these gaps suggest viable interventions for investment along the value chain of the produce. This study intends to conduct this analysis in the regional context for the major carrots and turnip growing clusters in the country.

GOALS AND TARGETS

The overall goal of this study is to transform the carrot and turnip a competitive product and contribute to the Cluster Development Based Agriculture Transformation Plan –V2025. Specific objectives of the study are

1. To identify the major clusters of carrots and turnips production in Pakistan
2. To conduct a detailed diagnosis and SWOT of the carrots and turnips value chain in each cluster
3. To identify technological, institutional, infrastructure and policy gaps in each cluster
4. Assess the potential of carrots and turnips production in each cluster
5. Suggest technological, institutional, infrastructure and policy interventions to achieve the cluster potentials
6. Conduct economic and social feasibility of the suggested interventions

METHODOLOGY

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

I. **Macro-Data**. Relevant macro data were collected from various published and unpublished reports of government and non-governmental organizations and internet search on carrots and turnips value chain **(See annexure I for the macro data sources)**

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

III. **Literature Review.** The literature related to the functioning, gaps, and interventions in carrots and turnips value chain is reviewed and synthesized (**See Annexure III for the literature reviewed**).

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

- Global context of carrots and turnips sector;
- Production potential and review of carrots and turnips sector;
- Cost of production, harvesting, post-harvest processing of carrots and turnips from the growers and grower associations;
- Marketing, trading, and processing from traders, wholesalers, retailers, and processors;
- Issues and constraints relating to production, harvesting, selling, marketing, trading, and processing from all stakeholders;
- Recommendations and benchmarks based on global parameters;

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

LITERATURE REVIEW

According to All Pakistan Fruits and vegetables exporters, importers and merchants association, R&D is a vital element to strengthen the vegetables exports of Pakistan. The R & D should focus on exploration of new varieties, enhancement of shelf-life and disease control in the existing products. PFVA states plan to establish R&D labs in all major vegetable growing areas in liaison with agricultural universities to tap the immense potential of this segment (All Pakistan Fruits and Vegetables Exporters, Importers and Merchants Association, 2018).

Vegetables production system requires improvement in order to get benefits of its high returns. Some immediate steps needed are to develop varieties with high demand, import substitutions, better quality seed, improved irrigation system, integrated pest management and establishment of vegetables processing plants (Agriculture Department, Government of the Punjab, 2018).

Most carrot farmers of the Punjab don't use standard cultivation practices due to lack of capital and information about production technology. Moreover, Farmers are ignorant of quality standards of carrot production for international trade. Processing industry should be established in major carrot production sites that will enhance profitability of the crop and create employment opportunity for local community. Carrot color and weight plays important role in selection of variety and market values. Water shortage in the province is emerging problem for carrot cultivation which needs to be addressed. Mechanized harvesting and proper washing procedure should be introduced to enhance quality of the fresh produce (Ahmad et al., 2012).

Inverse relationship exists between costs of production of carrot and profit whereas price and yield are directly associated with profit. The profitability analysis indicates that growing carrot is a remunerative and successful agro enterprise during winter season in Punjab, Pakistan (Hassan et al., 2005). Use of poor quality ground water significantly lowers the production and quality of the carrot (Bakhsh et al., 2005). Major cost components of carrot production i.e. labor used for different practices, land preparation; seed and fertilizer are significantly related with productivity level of the crop (Mahmood et al., 2017).

Farm services centers established in KP on district level has played important role in dissemination of improved vegetable production technologies to the farmers (Bacha et al., 2018).

River Swat is major source of irrigation in Swat. But resource base of Swat is shrinking day by day creating major threat of water shortage for agriculture sector in future. Vegetables cultivation is vulnerable to both climatic and non-climatic factors in Swat resulting in low productivity (Ahmad et al., 2015).

Balochistan is a water carce province and water shortage is main problem for farmers of Balochistan (Fazl-E-Haider, 2017).

In case of carrots, the price difference ranges around PKR 17/Kg in seasonal months from January to May while it rises to an average price of PKR 33/Kg in June to November. The purchasing time of carrot for processing is the months with lower prices to get an advantage of higher prices in off-season (Agriculture Department, Government of Punjab, 2018).

In Pakistan, very limited quantity of fruits and vegetables is preserved leading to heavy post-harvest losses. Freezing is one of the many preservation methods which involve lowering the product temperature to -18°C. Local market for frozen fruits and vegetables is not very large but Individual Quick Frozen vegetables' is a major category in the world export market of horticultural products. The world market of frozen vegetables is increasing. Pakistan doesn't have any considerable share in IQF exports. This report states that Pakistan can export frozen products of 0.85 Million USD to China. The establishment of frozen food industry has direct effect on farmers and eventually government through value addition, reduction in post-harvest losses and price stability. The farmer gets direct benefit of food processing industry as he gets higher price for his produce (Agriculture Department, Government of Punjab, 2017).

CLUSTER IDENTIFICATION AND CHARACTERIZATION

In Pakistan, carrots and turnips cultivation is distributed across the country. This commodity is cultivated almost in every district of Pakistan. However, over the years certain areas have developed relatively high acreage of carrots and turnips due to various factors including but not limited to climate, crop suitability, market value and inputs availability etc. Four clusters are defined for carrots and turnips based upon the suitability of the area for the crop, percent of the total acreage, quality of the fresh produce and trend or scope of the value addition.

1.6. Geographical Identification of Clusters

In KP, Carrots and turnips are grown on an area of 3.9 thousand ha of which 85% area is under turnip crop. Hence KP is predominantly a turnip growing province. Based upon climatic conditions and cropping pattern, two clusters are identified in KP.

1.6.1. Upper KP cluster:

This cluster consists of districts Swat and Chitral. Total area of carrots and turnips in these two districts is 0.764 thousand ha, which is 19.46% of KP area for carrots and turnips whereas 2.67% of total carrots and turnips area in Pakistan. Almost 86.39 % of this area is under turnip crop, whereas 13.61% is under carrots. Swat is taken as the focal point of the cluster.

Table 8: Carrots and Turnips status in upper KP cluster

Districts	Production (Tonnes)				Area (Has)				Yield (Tonnes/Ha)
	Carrots	Turnips	Total	%age Share	Carrots	Turnips	Total	%age Share	
Swat	0	8250	8250	14.25	0	430	430	10.95	19.19
Chitral	621	3204	3825	6.61	104	230	334	8.51	11.45
Cluster Total	621	11454	12075	20.86	104	660	764	19.46	15.80
KP Total	8134	49757	57891		577	3349	3926		14.75

1.6.2. Central KP cluster:

This cluster consists of districts Bunir, Swabi, Malakand, Lower Dir, Peshawar and Bajour. Total area of carrots and turnips in this cluster is 1.558 thousand ha of which 86.97% area is under turnips whereas 13.03% acreage is under carrot crop (Table 9). Bunir is the cluster focal point of this cluster.

Table 9: Carrots and Turnips status in central KP cluster

Districts	Production (Tonnes)				Area (Has)				Yield (Tonnes/Ha)
	Carrots	Turnip	Total	%age Share	Carrots	Turnip	Total	%age Share	
Bunir	0	6012	6012	10.39	0	325	325	8.28	18.50
Swabi	981	3347	4328	7.48	74	223	297	7.56	14.57
Peshawar	1895	4025	5920	10.23	78	115	193	4.92	30.67
Malakand	362	1223	1585	2.74	28	123	151	3.85	10.50
Dir Lower	190	1451	1641	2.83	23	124	147	3.74	11.16
Bajour Agency	0	6188	6188	10.69	0	445	445	11.33	13.91
Cluster Total	3428	22246	25674	44.35	203	1355	1558	39.68	16.48
KP Total	8134	49757	57891		577	3349	3926		14.75

1.6.3. Central Punjab cluster:

Table 10 shows that in Punjab, carrots and turnips are grown in almost every district. However, Sheikhupura, Kasur, Mandi Bahau Din, Gujrat, Faisalabad and Gujranwala are the major growing districts of the crop. These six districts constitute the central Punjab cluster. Total area of carrots and turnips in these six districts is 6.999 thousand ha which is 24.47% of total Pakistan's area. This cluster contributes 25.69% of Pakistan's production for carrots and turnips. Sheikhupura is the focal point of this cluster.

Table 10: Carrots and Turnips status in central Punjab cluster[4]

Districts	Production (Tonnes)				Area (Has)				Yield (Tonnes /Ha)
	Carrot	Turnip	Total	%age Share	Carrot	Turnip	Total	%age Share	
Faisalabad	5739	14161	19900	5.98	304	684	988	5.57	20.14
Gujrat	1313	20603	21916	6.58	81	1117	1198	6.76	18.29
M.B. Din	1327	20131	21458	6.45	82	1226	1308	7.38	16.41
Gujranwala	4039	13968	18007	5.41	247	623	870	4.91	20.70
Sheikhupura	23320	4228	27548	8.28	1113	194	1307	7.37	21.08
Kasur	14062	3326	17388	5.22	1109	219	1328	7.49	13.09
Cluster Total	49800	76417	126217	37.92	2936	4063	6999	39.47	18.03
Punjab Total	154382	178463	332845		8396	9336	17732		18.77

1.6.4. Balochistan cluster:

In Balochistan, Carrots and Turnips are grown on almost 4.05 thousand ha of which 75.75% area is under carrot crop hence Balochistan is predominantly a carrot growing province. About 54.72% of this area is concentrated in three districts i.e. Killa Saifullah, Loralai and

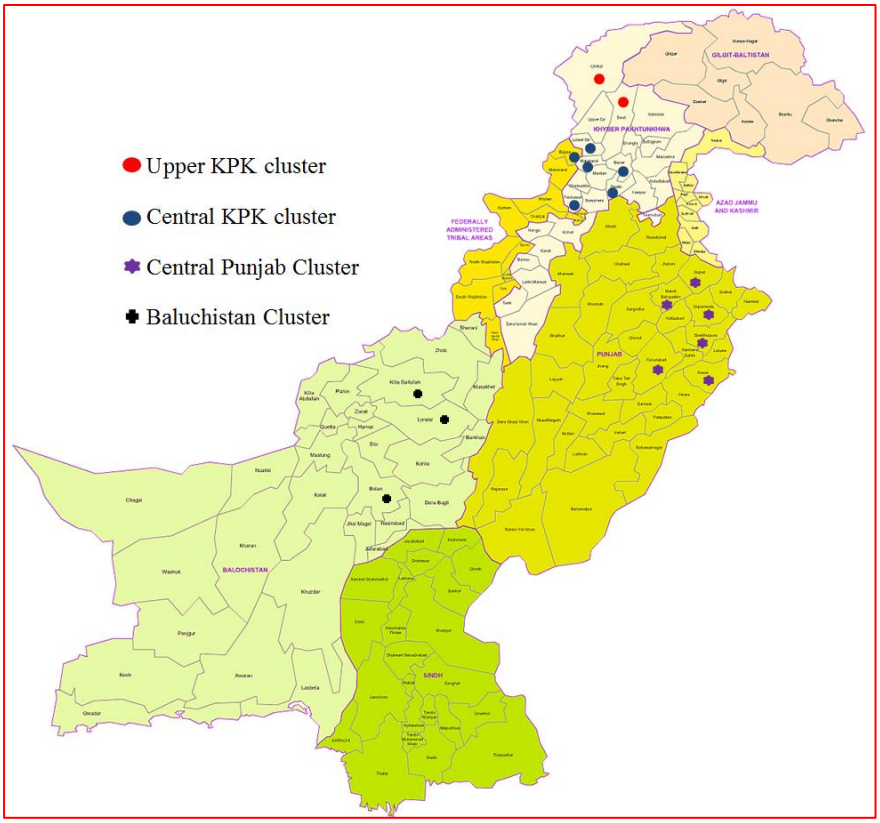
[4] Kharif crops final estimates data book 2016-17 (http://crs.agripunjab.gov.pk/reports)

Kachhi defined as Balochistan cluster. Out of total commodity area, 92.92% of cluster's area is under carrot crop (Table 11). Killa Saifullah is the focal point of the cluster.

Table 11: Carrots and Turnips status in Balochistan cluster[5]

Districts	Production (Tonnes)				Area (Has)				Yield (Tonnes/Ha)
	Carrot	Turnip	Total	%age Share	Carrot	Turnip	Total	%age Share	
Killa Saifullah	18726	0	18726	26.96	1060	0	1060	26.17	17.67
Kachhi	8653	2018	10671	15.37	554	115	669	16.52	15.95
Loralai	8455	778	9233	13.30	445	42	487	12.02	18.96
Total	35834	2796	38630	55.63	2059	157	2216	54.72	17.43
Total Balochistan	53184	16262	69446		3068	982	4050		17.15

Figure 1: Map showing geographical location of four carrot and turnips cluster's districts.



1.7. Comparison of Clusters

In this section, four clusters defined previously for carrots and turnips have been compared for various factors like geographic environment, product type & quality, socioeconomic

[5] Agriculture Book; Balochistan (http://balochistan.gov.pk/index.php?option=com_docman&task=doc_download&gid=7537&Itemid=677)

factors, cultivation practices, supply time, marketing & transportation infrastructure, nature and quantum of value addition and processing.

In Upper KP cluster, Turnip sowing starts from April and continues up to end June and then in August to September. This region supplies good quality purple top turnip to all major markets of Pakistan from June to October. In Central KP cluster, sowing of carrots and turnips is done from mid-august to mid-October whereas production starts from November to February. Most of production of this cluster is consumed in KP markets. Central Punjab cluster has prolonged sowing and supply period for carrots and turnips. In this region, sowing of carrots and turnips starts from August and continues up to end December whereas supply time ranges from November to March for carrots and September to March for turnips. In Balochistan cluster, sowing time ranges from July to mid-august whereas supply time is from August to October. Fresh produce of purple top turnips from upper KP cluster and Carrots from Balochistan cluster are normally transported to big markets of the country especially Punjab and fetch comparatively higher prices in the market due to scarcity period. Upper KP and Central KP clusters offer high potential for export of fresh carrots and turnips to high value markets like UAE due to organic nature of the produce. Whereas, Central Punjab cluster is ideal for establishment of carrots and turnips processing industry like frozen carrots due to prolonged supply period and lower prices during peak supply period. Also, this cluster offers high potential of local seed production of carrots and turnips. Likewise, Balochistan cluster is ideal for supply of quality fresh carrots at national and international market.

Cultural practices for carrots and turnips are almost same across all clusters with minor differences. Sowing is done manually on ridges or through broadcast. In case of turnips, either seed is sown in lines on ridges or it is broadcasted in field. In KP, normally no fertilizer is applied in carrot & turnips. In Punjab, farmers are more concerned about soil fertility levels and fertilization. Normal practice is adding one bag of DAP while land preparation, whereas almost 1-2 bags of Urea are applied in splits with water. In case of carrots, some farmers also apply SOP almost one month before harvesting. In Balochistan, normal practice of fertilization in carrot is one Nitrophos during land preparation, whereas one Urea or Nitrophos is applied after two month of sowing. However, in all the cases, no soil analysis is done and use of fertilizers varies from farmers to farmers as per personal experiences and financial circumstances. Harvesting is also manual. After harvesting, produce is sometimes washed, filled in bags and transported to vegetable markets on trucks and mazdas etc.

In all of these regions, marketing practices and protocols are more or less same. Fresh produce reached vegetable market on trucks. Price of the produce is finalized on the spot depending upon visual grading, market demand and supply. Moreover, wholesalers of one market are connected with markets of other cities telephonically and these contacts play important role in wholesale prices of the fresh produce. Following table presents an overall comparison of key characteristics in these four clusters.

Table 12: Characteristics and comparison of Carrots and Turnips clusters

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
Product	Fresh Turnips	Fresh Carrots and Turnips	Fresh Carrots, Turnips & their seed	Fresh Carrots
Districts	District Sawat & Chitral (KP)	District Bunir, Sawabi, Malakand, Pashawar, Lower Dir & Bajour Agency (KP)	Districts Sheikhupura, Kasur, Mandi Bahau Din, Gujrat, Faisalabad and Gujranwala	Districts Kila Saifullah, Kachhi & Loralai (Balochistan)
Focal point	District Swat	District Buner	District Sheikhupura	District Killa Saifullah
Focal point area (000 ha)	0.43	0.325	1.307	1.06
Focal point production (000 t)	8.25	6.012	27.548	18.726
Area of the cluster: (000 Ha)	0.764	1.558	6.999	2.216
Production: (000 Tonnes)	12.075	25.674	126.217	38.63
Average yield: (Tonnes/Ha)	15.8	16.48	18.03	18.06
Percentage of the crop area that lies in the cluster	2.67%	5.45%	24.47%	7.75%
Percentage of the total cropped area in the cluster	0.37%	0.34%	0.25%	1.55%
Geographical and Environmental Factor	• Fertile soils with good organic matter contents	• Suitable fertile soils	• Sandy to clay loam soils	• alluvial plains and considerable part of the soil in these valleys consists of virgin land
	• Mountainous region and is home to lush green valleys,	• Hilly area with large patches of plain soil	• Flat plains	• Mountainous and comprises of valleys with

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
	snow-covered glaciers, forests, meadows and plains			varying elevation above sea level
	• Temperate zone. The summer in lower valley is short and moderate while it is cool and refreshing in the upper northern part	• Dry subtropical climate	• Extreme temperature variations with hot summers and cool winters	• Semi-arid cold climate. It can be termed a “warm summer and cool winter” temperature region.
	• Main sources of irrigation are Canals/Streams of melting glaciers, Lift pumps, Wells & Tube wells etc.	• Rains, underground water (tube wells) and canals are main source of irrigation.	• Main source of irrigation is Tube wells & canal (lower Chenab) Water.	• Main source of irrigation are tube wells and karezes
	• Good quality ground water	• Good quality of ground water.	• Good quality ground water, but this ground water quality is also deteriorating	• Water scarcity, limited underground water
	• The winter season is long and extends from November to March; rain and snowfall occurs during this season. • The average annual rainfall 1000mm to 1200mm. As there is currently no meteorological station, data collected by the station in nearby Dir is used	• To rain seasons, i.e. winter/Rabi rains (November to May) and Summer rain/Moon soon season • Average rainfall is 762 mm per year. The least amount of rainfall occurs in November is 12 mm. With an average of 137 mm, the most precipitation falls in August.	• Hot summers and cool winters, local stepper climate • The average rainfall about 476-635 mm. June-August receive the highest amount of rainfall i.e. 130 mm, While the November receives the least amount of rainfall i.e. 2mm.	• Highly unreliable. • The mean annual rainfall ranges between 125 and 500 mm, most of it in the form of snowfall in the winter

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
	• The hottest month is June with mean maximum and minimum temperature of 33°C and 16°C, respectively. The coldest month is January with mean maximum and minimum temperature of 11°C and -2°C, respectively.	• The temperatures gradually rises up to 44 °C in summers and falls to -2°C in winter gradually.	• June is the warmest month of the year. The temperature in June averages 33.9 °C. January has the lowest average temperature of the year. It is 12.2 °C.	• The summer is warm with mean temperatures ranging from 21 °C to 32 °C. June is the hottest month when mean maximum temperatures exceed 32 °C but do not rise above 38 °C, however, the mean temperature, even in the hottest month, remains below 32 °C. The winter is cool and longer than summer. It lasts for about 7 months (October-April). In winter the mean temperature is below 10 °C and in the coolest month (January) the mean monthly temperature drops below 10 °C

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
Carrots & Turnips growers	• Small to medium land holdings 39% farmers : < 1 acre 41% farmers : 1-2.5 acres 13% farmers : 2.5-5.0 acres 5% farmers : 5-7.5 acres 2% farmers : 7.5-12.5 acres 1% farmers : 7.5-25 acres	• Small to medium land holdings 16% farmers : < 1 acre 38% farmers :1-2.5 acres 28% farmers : 2.5-5.0 acres 11% farmers : 5-7.5 acres 5% farmers : 7.5-12.5 acres 2% farmers : 7.5-25 acres	• Small, medium & large land holdings 8% farmers : < 1 acre 33% farmers : 1-2.5 acres 22% farmers : 2.5-5.0 acres 14% farmers : 5-7.5 acres 12% farmers : 7.5-12.5 acres 7% farmers : 7.5-25 acres 3% farmers : 25-50 acres 1% farmers : 50-100 acres	• Small, medium & large land holdings 3% farmers : < 1 acre 15% farmers : 1-2.5 acres 14% farmers : 2.5-5.0 acres 10% farmers : 5-7.5 acres 12% farmers : 7.5-12.5 acres 11% farmers : 7.5-25 acres 14% farmers : 25-50 acres 12% farmers : 50-100 acres 6% farmers : 100-150 acres 2% farmers : 150 acres & above
	• A large number of farmers in this region are uneducated, so mostly unable to understand and follow new methods of cultivation	• A large number of farmers in this region are uneducated, so mostly unable to understand and follow new methods of cultivation	• Most of farmers in this region are uneducated; however there is considerable number of educated farmers.	• Most of farmers in this region are uneducated
	• No seed production	• No seed production	• Some farmers produce their own seed	• Farmers started to produce their own carrot seed

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
Product Feature	• Good quality purple top turnips	• Good quality purple top turnips. Red core carrots on limited area	• Prolonged supply period (Carrot: November to March & Turnips: September to March)	• Good quality fresh carrots
	• High demand produce as it comes during scarcity period	• Good quality turnips and carrots	• Good quality turnips and carrots	• High demand fresh produce as production comes during scarcity period
	• Less to no residues of pesticides	• Less to no residues of pesticides	• Less to no residues of pesticides	• Less to no residues of pesticides
Variety Feature	**Carrot** • No carrot in district Swat • Limited area in Chitral under carrot (Proline)	**Carrot** • Imported (Proline) varieties • Red flesh and core color • non pithy & sweet in taste • Bulking in 100 to 120 days • Good root length (8"-10")	**Carrot** • local (T-29) and imported (Proline) varieties • Red flesh and core color • Not pithy & sweet in taste • Bulking in 100 to 120 days • Good root length (8"-10")	**Carrot** • local and imported varieties (Major area under "Proline" variety • Beautiful attractive red flesh and core color • Good root length (8"-10") • Color of root remains stable even if harvesting is little early or delayed • sweet in taste

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
	Turnip • Purple top variety covered whole turnip area • Purple skin, white flesh • Good root size and good in taste	**Turnips** • Purple top variety covered whole turnip area • Purple skin, white flesh • Good root size and good in taste	**Turnips** • Early (Local varieties) & late imported varieties • Early variety: Purple top & late variety: Golden ball • **Purple Top:** suitable for early and normal sowing, heat tolerant, purple skin and white flesh color • **Golden ball:** Suitable for normal and late sowing, yellow skin color, off white flesh, late bolting behavior	**Turnips** • Limited area under turnip crop • Most area covered by Purple Top variety
Sowing/Planting	• Sowing is done from April up to end June and August to September	• Sowing is from mid-August to Mid-October	• Sowing from mid-August to January	• Sowing is done from end June to whole month of July.
	• Growers obtain seeds mostly from local seed traders. • Both local (Punjab) and imported seed available	• Growers obtain seeds mostly from local seed traders & seed companies. • Both local (Punjab) and imported seed available	• Growers obtain seeds from franchises of seed companies like CKD & Sons, MMD & Sons, ICI etc. • Few farmers also used their own produced seed. Local seed production to meet the local seed requirement of turnip is also a feature of this area. Carrot seed is produced in very limited quantity.	• Farmers obtain seeds from local seed traders. • Many farmers also produce their own seed.
	• Sowing is done manually through broadcast method	• Sowing is done manually through broadcast method	• Crop is sown either on ridges are through broadcasting.	• Sowing is done manually on ridges in wattar

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
			• After seed broadcasting, ridges are made.	conditions or through broadcast method
	• No proper line to line & plant to plant distance maintained	• No proper line to line & plant to plant distance maintained	• In ridge sowing, Line spacing is maintained. But plant distance is not maintained	• In ridge sowing, Line spacing is maintained. But plant distance is not maintained
Inputs/Management Practices	• No to very limited fertilizer application. • Use of FYM is practiced.	• Highly variable fertilizer application without any soil analysis.	• Highly variable fertilizer application without any soil analysis • On average ratio of N:P:K is 30-40 : 25 : 25	• Variable fertilizer application. • On average application is 45:20:25 NPK in two splits
	• Farmers are using imbalance inputs without soil analysis	• Farmers are using imbalance inputs without soil analysis	• Farmers are using imbalance inputs without soil analysis	• Farmers are using imbalance inputs without soil analysis
	• No effective inputs monitoring system to check quality of seeds, pesticides & fertilizers available in the market.	• No effective inputs monitoring system to check quality of seeds, pesticides & fertilizers available in the market.	• Input supply system is monitored by the Government, but unable to monitor such a huge market.	• No effective inputs monitoring system to check quality of seeds, pesticides & fertilizers available in the market.
	• No thinning or weeding	• No thinning or weeding	• No thinning or weeding	• No thinning or weeding
	• No insecticide or pesticide application	• No insecticide or pesticide application	• No insecticide or pesticide application for root crop. • Insecticide use for seed crop against worms. (1-2 sprays)	• In case of heavy rains, 1-2 sprays for Aphids & worms
Harvesting	• harvesting from June up to October	• harvesting from November to Mid-January	• Harvesting from November to March	• Harvesting from August to October
	• Manual harvesting through labor	• Manual harvesting through labor	• Root crop and seed crop is harvested manually	• Root crop and seed crop is harvested manually
Packaging/ Transportation?	• The fresh turnips are packed	• The fresh turnips are	• The fresh produce is packed	• The fresh produce is

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
	in plastic bags of 50kg generally and transported to vegetables markets through goods transport	packed in plastic bags of 50kg generally and transported to vegetables markets through goods transport	in plastic bags generally and transported to vegetables markets through goods transport. • Sometimes, turnip crop is harvested with leaves and transported to market in bundles of 10 Kg. • The seed crop is dried in sunlight and after manual cleaning is stored in gunny bags in ventilated stores.	packed in plastic bags (40-50Kg) generally and transported to vegetables markets through goods transport. • The seed crop is dried in sunlight and after manual/mechanical cleaning is stored in gunny bags in ventilated stores.
Wholesaler/ Retailer	• Fresh produce is transported to whole sale markets and auctioning in the wholesale market with visual and spot grading	• Fresh produce is transported to whole sale markets and auctioning in the wholesale market with visual and spot grading	• Fresh produce is transported to whole sale markets and auctioning in the wholesale market with visual and spot grading	• Fresh produce is transported to whole sale markets mainly in big cities of Punjab and auctioning in the wholesale market with visual and spot grading
	• The auction in the wholesale market is generally based on the variety and weight, but exact grading is not currently followed.	• The auction in the wholesale market is generally based on the variety and weight, but proper grading is not currently followed.	• The auction in the wholesale market is generally based on the variety and weight, but proper grading is not currently followed.	• The auction in the wholesale market is generally based on the variety and weight, but proper grading is not currently followed.
	• Market prices depends upon demand and supply	• Market prices depends upon demand and supply	• Market prices depends upon demand and supply	• Market prices depends upon demand and supply
New Technologies/	• No new technology /	• No new technology /	• No new technology /	• No new technology /

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
Infrastructure	infrastructure in production and marketing	infrastructure in production and marketing	infrastructure in production and marketing	infrastructure in production and marketing
	• No food processing	• No food processing. • Carrot pickles on household level	• Big food processing companies are involved in carrot pickles. • Some companies involved in frozen/dried carrots	• No food processing • Carrot pickles on household level
Export	• No export in fresh or processed form	• No export in fresh or processed form	• Some fresh produce is exported • Food companies involved in export of carrot pickles & frozen carrot	• No export in fresh or processed form
Supply Chain/Supply cycle	• Fresh produce available from June to October which is high demand period in the country	• Fresh produce available from December to January	• Fresh produce is available from (Carrot: November to March & Turnips: September to March)	• Fresh produce available from August to October
	• From farmer field, fresh produce transported to big markets in Pakistan	• From farmer field, fresh produce transported to whole sale markets	• From farmer field, fresh produce transported to whole sale markets	• From farmer field, fresh produce transported to whole sale markets
	• From these whole sale markets, produce is distributed throughout the country through retailers and local traders	• From these whole sale markets, produce is distributed throughout the region through retailers and local traders	• From these whole sale markets, produce is distributed throughout the region through retailers and local traders	• From these whole sale markets, produce is distributed throughout the region through retailers and local traders
Certification	• No certification or quality control mechanism	• No certification or quality control mechanism	• No certification or quality control mechanism for fresh produce. FSC&RD looks over the seed	• No certification or quality control mechanism for fresh produce.

Salient Features	Upper KP	Central KP	Central Punjab	Balochistan
			quality assurance & certification matters.	
Socioeconomic networking/Gender involvement	• Manual cultural practices (sowing, harvesting and packaging etc.) involves local labor/family members	• Manual cultural practices (sowing, harvesting and packaging etc.) involves local labor	• Manual cultural practices (sowing, harvesting and packaging etc.) involves local labor including female labor as female labor is less costly	• Manual cultural practices (sowing, harvesting and packaging etc.) involves local labor
	• Only 0.29 percent women are working as wage employees in the district	• Involvement of female labor is almost none due to social and religious reason	• Both male & female labor is equally involved	• Mostly male labor is involved
Subsidies/Incentives/ Facilities	• No specific subsidy/incentive or facility related to this commodity	• No specific subsidy/incentive or facility related to this commodity	• No specific subsidy/incentive or facility related to this commodity	• No specific subsidy/incentive or facility related to this commodity
	• Other subsidies for farmers (e.g. subsidized fertilizers or agricultural implements etc.) are available at limited scale.	• Other subsidies for farmers (e.g. subsidized fertilizers or agricultural implements etc.) are available at limited scale.	• Other subsidies for farmers (e.g. subsidized fertilizers or agricultural implements etc.) are available at limited scale.	• Other subsidies for farmers (e.g. subsidized fertilizers or agricultural implements etc.) are available at limited scale.
Socioeconomic Networks	• No growers or farmers association	• No growers or farmers association	• No growers or farmers association	• No growers or farmers association

Agriculture extension and R&D department in KP and Balochistan is not very effective. General reviews of farmers about government agricultural extension services were not so supporting. However, farmers of Lahore division passed positive comments about Agriculture extension services in the area.

1.8. Description of Value Chain

1.8.1. Upper KP cluster

Purple top turnip is sown in this region. Both imported and local seed is available in the market. Local seed available in the market is produced and supplied from Punjab. Many private seed companies are involved in seed business of turnips in this region. Farmers sow the turnip crop starting from April up to June. Farm input supplies like fertilizer and pesticides are available in local market from local traders and outlets of agricultural companies. However, fertilizers and pesticides use in turnip crop is very limited. Harvesting, washing, packaging and loading on trucks are done manually by local labor. The fresh produce is transported to major vegetable markets of the country like Rawalpindi, Lahore, and Faisalabad etc. No value addition or processing industry is involved in value chain of turnips from this region.

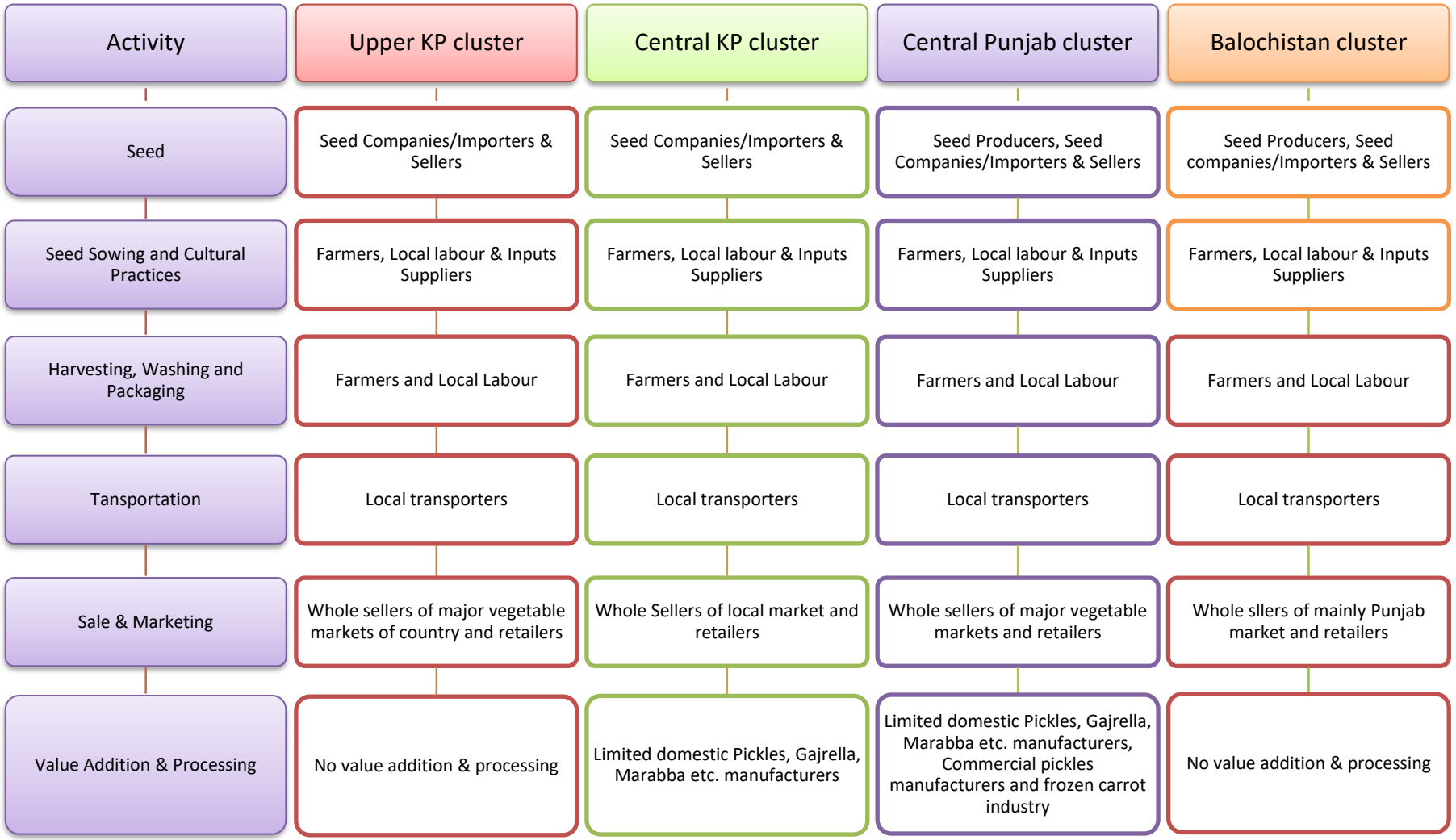
1.8.2. Central KP cluster

Purple top turnip and red carrot (normally Proline variety) is sown in this region. In case of carrot, complete market is occupied by imported seed. For turnips, both local and imported seed is available in the market. Local seed is produced and supplied from Punjab. Sowing is done manually by the local labor. Farm input supplies like fertilizer and pesticides are available in local market from local traders and outlets of agricultural companies. However, fertilizers and pesticides use in crop is very limited. Harvesting, washing, packaging and loading on trucks is done manually by local male labor. The fresh produce is transported to local vegetable markets of KP. Very limited number of locals (domestic and small traders) is involved in manufacturing of carrot pickles and gajrella (local sweet dish), etc.

1.8.3. Central Punjab cluster

Many national and international seed companies are involved in business of carrots and turnips seed in this region. Most of the carrots and Turnips area is under imported varieties. Seed of local varieties of carrots and turnips is available on limited scale. Some farmers also produce their own seed. Sowing is done manually. Farm input supplies like fertilizer and pesticides are available in local market from local traders and outlets of agricultural companies. Harvesting, washing, packaging and loading on trucks is done manually by local labor. The fresh produce is transported to vegetable markets throughout the county depending upon demand, supply and market prices. Many small scale food processors are involved in production of carrots pickles, gajrella, and carrot marabba etc. Some big food processors like Shan foods, National foods and Mitchell's foods etc. are involved in manufacturing of carrot pickles. Fauji Fresh and Freeze and Icepac Limited are involved in production of frozen diced carrots and frozen carrots mix vegetables recipe at national level.

Figure 2: Value chain of carrot and turnips in four clusters



1.8.4. Balochistan cluster

This region supplies fresh carrot from August to October mainly in Punjab vegetable markets. Many farmers produce their own carrot seed. However, imported seed is also available in the market. Sowing is done manually by the local labor. Farm input supplies like fertilizer and pesticides are available in local market from local traders and outlets of agricultural companies. Harvesting, washing, packaging and loading on trucks is done manually by local labor. The fresh produce is transported to vegetable markets of Punjab like Faisalabad, Multan etc.

Government agriculture R&D structure is efficient in Punjab as compared to other provinces. Private seeds and pesticides companies are equally active in all major clusters, however due to more area under crop; Lahore division is their primary focus area.

1.9. SWOT ANALYSIS

1.9.1. Overview

The SWOT analysis was carried out in focus group discussions conducted in major carrots and turnips producing areas with the consultation and participation of different stakeholders. The results are organized around the value chain functions, including inputs, production, storage, and marketing, processing and trade.

1.9.2. Upper KP cluster

The upper KP cluster is home to good quality Purple top turnips. This region has many strengths and opportunities including but not limited to favorable agro ecological conditions, less insect pressure and off season supply. Major weaknesses include, non-availability of area specific high yielding varieties, small land holding, outdated cultural practices, weak agricultural R&D and extension setup, inadequate investment in research, technology development, breeding and marketing, no trend towards post-harvest grading and packaging and unstable marketing infrastructure. Branding of fresh turnips of this region as organic mountain turnips in international market is a good opportunity for this region by introducing standardized production and post-harvest practices. Threats include climate change and natural disasters. Table. 13 presents the SWOT analysis for this cluster.

1.9.3. Central KP cluster

Similar to Upper KP cluster, climate change and shift in cropping patterns are major threats to carrot and turnips in this cluster. Major strengths of this cluster include favorable environment for good quality fresh production and easy access to major markets of the country. Main weaknesses involve non-availability of high yielding varieties, conventional cultural and post-harvest practices, poor agricultural R&D and extension setup, farmers bias against loans from banks and conventional marketing setup. This region offers a good opportunity for export of fresh carrot and turnips as well as establishment of frozen vegetable plants (Table 14).

Table 13: SWOT Analysis of Upper KP Cluster

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Districts Sawat & Chitral (KP)	**Fresh Turnips**	**Environment/ Climate Change**	• Suitable environment for turnip cultivation. • Good fertile soils with good organic matter contents	• High soil humidity favors disease incidence and adventurous roots of the turnip	• Organic export quality farming • Big opportunity to meet turnip demand of country during scarcity period by increasing acreage	• Humid climate favors diseases • Deforestation Declining organic matter in soils • Changing rainfall patterns
		Input Supplies	• Reliable major fertilizer and pesticide supply system with many National / Multinational Companies providing these chemicals	• Limited availability of certified, quality, and pure variety seed unbalanced use of fertilizers & pesticides	• soil testing labs can play a major role in matching input use with the soil nutrient conditions	• Use of adulterated or expired pesticides. • Injudicious use of chemicals • Poor quality seed in the market
		Cluster interaction	• High demand of product throughout the country	• Little interaction among farmers and researchers • Poor agricultural extension services to the farmers • Producers have little information about the quality requirements in national and international market	• Possibility of learning from progressive farmers in the cluster • Strong relation between Commission Agents/Wholesaler and Contractors (each have knowledge about quality demand at least in national market) can be transformed into quality-based supply contract • Strengthen the researchers, extension workers and farmers interaction	• Export opportunities may be declined due to declining quality of the farm gate produce

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		Production Management practices	• Fertile soils rich in organic matter • Low insect pressure	• Farmers don't accept loan on interest • Lack of quality seed • Traditional method of sowing • Extensive labor is involved in cultural practices of the crop • Flood irrigation wastes water • Manual harvesting procedure	• Export quality produce may be increased significantly by adopting mechanized farming, water conservation technologies, systematic training modules for farmers and standardize post-harvest handling techniques	• Illiterate farmers and small land holdings • No mechanized farming and dependence on human labor for cultivation practices increase cost of production making vulnerable to compete in international market. • Difficulty of training illiterate farmers about high tech methods and techniques
		Transportation	• Good road infrastructure connecting cluster with all big cities • Easy to transport in distant cities due to long shelf life of the fresh produce	• No environment (temperature, humidity, etc.) control during transportation • Improper staking during transportation		
		Marketing	• High price of the produce as harvesting time synchronize with scarcity period (High demand/Low supply) of the country	• Farmers disconnect with the market • No grading and proper packaging before transportation • Auctioning in the wholesale market with visual and spot grading	• Financial support to farmers in form of quality based delivery contracts • Big opportunity to reform the old market practices in the province • Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		Trade/Export	• Export quality produce due to less residual effects	• Limited capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality product	• Increase area under crop • Mechanized farming to reduce cost of production	• Slow development of quality infrastructure, lack of stakeholders interest in capacity building to produce and maintain quality product
		Processing		• No trend of post-harvest grading and processing • Nonexistence of any high demand processed product in the market	• Chopped dried or pickled turnip used in some parts of the worlds	

Table 14: SWOT Analysis of Central KP Cluster

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Buner, Swabi, Peshawar, Lower Dir, Malakand & Bajur (KP)	**Fresh Carrot and Turnips**	**Environment/ Climate Change**	• Medium to clay loam soil • Cool climate and well drained land which are very much suitable for organic cultivation.	• High humidity favors disease incidence	• Organic export quality farming	• Climate change • Humid climate favors diseases • Water scarcity • Organic matter depletion
		Input Supplies	• Reliable major fertilizer and pesticide supply system with many National / Multinational Companies	• Limited availability of certified, quality, and pure variety seed	• soil testing labs can play a major role in matching input use with the soil nutrient conditions	• Use of adulterated or expired pesticides. Injudicious use of chemicals • Poor quality seed in the market
		Cluster interaction	• Near big markets like Rawalpindi, Peshawar	• Inadequate research and extension services at	• Possibility of learning from progressive farmers in the cluster	

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
			and Islamabad	government level • Producers have little information about the quality requirements in national and international market • No contract farming with defined quantities and quality parameter • Farmers don't accept loan on interest	• Strong relation between Commission Agents/ Wholesaler and Contractors (they have knowledge about quality demand at least in national market) can be transformed into quality-based supply contract • Strengthen the research and farmers interaction	
		Production Management practices	• Fertile soils rich in organic matter • Low insect pressure	• Lack of quality seed • Traditional method of sowing • Manual cultural practices • Flooding irrigation wastes water and deteriorate quality • Imbalance and sub-optimal use of fertilizer • Injudicious use of pesticide • Improper harvesting procedure • No contract farming with defined quantities and quality parameter	• Export quality produce may be increased significantly by adopting mechanized farming, water conservation technologies, systematic training modules for farmers and standardize post-harvest handling techniques	• Illiterate farmers and small land holdings • Crop production may be adversely effected in this area due to changing rain patterns and water scarcity. • Non mechanized farming and dependence on human labor in cultivation • Practices increase cost of production making vulnerable to compete in international market. • Difficult to train illiterate farmers about high tech production techniques
		Transportation	• Good road infrastructure connecting cluster with all big cities	• No environment (temperature, humidity, etc.) control during transportation • Improper staking during	• Availability of proper boxes in the market already being used in certain other vegetables	

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
				transportation • High fuel cost especially diesel used in transportation		
		Marketing	• Good quality, high demand produce • Proximity to big markets like Islamabad, Rawalpindi and Peshawar	• Unstable market prices • No stable marketing policy / infrastructure • No farmers association • No grading ,proper packaging and transportation	• Financial support to farmers in form of quality based delivery contracts • Big opportunity to reform the old market practices in the province • Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	
		Trade/Export		• Auctioning in the wholesale market with visual and spot grading • Little capacity of farmers and traders and no quality infrastructure to produce, handle, and market the quality product for export • High cost of production	• Mechanized farming to reduce cost of production • Quality based contract farming between farmers and exporters	• Slow development of quality infrastructure, • lack of stakeholders interest in capacity building to produce and maintain quality product
		Processing		• Unavailability of modern processing plants, technologies, and equipment for processing • Lack of capacity and resources for small scale stakeholders to get involved in processing • No trend of post-harvest grading and processing	• Huge demand of processed carrot in domestic and international market • Processing Opportunity for dry carrot and pickles or mix vegetables recipes for local as well as international market • Government incentives for the establishment of processing plants	

1.9.4. Central Punjab cluster:

This cluster is the hub of carrot and turnip production in Pakistan. Main strengths of this cluster are favorable climate for good quality carrot and turnips production, multiple sowing times for early mid and late planting, prolonged supply period of fresh production, already established carrot processing (frozen carrots) plants, highly favorable climate for local seed production, comparatively strong and effective agricultural extension system medium to large land holding of farmers, comparatively better cultural practices like use of fertilizers, literate farmers, excellent roads and transport infrastructure etc. Non availability of high yielding varieties, outdated manual cultural practices, poor post-harvesting handling practices, poor agricultural R&D structure and highly unstable and conventional marketing system are major weaknesses of this cluster. Worsening situation of water availability is major threat to carrot and turnips production in this region. This cluster offers a huge potential for establishment of carrot processing plants (Frozen carrots/canned carrots etc.) thanks to bulk produce and low prices during peak supply periods, easy access to international markets by air and already present setups of carrot processing industry. Table 15 presents the SWOT analysis of Central Punjab cluster for carrot and turnips.

1.9.5. Balochistan cluster:

This cluster is home to high quality fresh carrots during scarcity period in Punjab. However similar to other clusters, cultivation of low yielding varieties, poor and manual cultural practices, inadequate use of fertilizers, illiterate farmers, no access to advanced production technology, poor agricultural R&D system and inefficient extension services to the farmers are major hurdles in exploring true potential of this cluster. Water shortage is serious threat to carrot and turnips production in this region. Potential of export quality carrot and turnips production is big plus of this cluster. Detailed SWOT analysis of this cluster is given in Table 16.

Table 15: SWOT Analysis of Central Punjab Cluster

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Lahore, Faisalabad & Gujranwala Division (Punjab)	**Fresh Carrot & Turnips Seed (carrots and Turnips)**	**Environment/ Climate Change**	• Suitable environment for multiple sowing times (August to January for fresh produce) • Suitable environment for quality seed production • Prolonged availability of fresh produce	• Poor soils with low organic matter • Declining canal water • Unfit underground water	• Suitable environment for quality seed production • Huge potential for local quality seed production to reduce import bill	• Climate change and changing rain patterns • Climate change disturbing cropping pattern • Declining canal water and underground water • Declining soils fertility
		Input Supplies	• Reliable major fertilizer and pesticide supply system with many National / Multinational Companies providing these chemicals	• Limited availability of certified, quality, and pure variety seed • Poor seed production, procurement and certification system	• soil testing labs can play a major role in matching input use with the soil nutrient conditions	• Use of adulterated or expired pesticides. • Injudicious use of chemicals
		Cluster interaction	• Strong interaction among farmers and researchers • Effective agricultural extension setup • Progressive farmers with large land holdings • Contract farming for quality fresh carrot and turnips and seed production	• Producers have little information about the quality requirements in national and international market • Non availability of interest free loans • No legislation at government end for contract farming	• Possibility of learning from progressive farmers in the cluster • Strong opportunity of contract farming among farmers and seed companies for quality seed production • Strong relation between Commission Agents/Wholesaler and Contractors (each have knowledge about quality demand at least in national market) can be transformed	

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
					into quality-based supply contract • Strengthen the research and farmers interaction	
		Production Management practices	• Progressive farmers with big land holdings • Easily labor availability for field operations • Subsidized agricultural implements for field operations	• Lack of quality seed • traditional method of sowing • Manual cultural practices • Flooding irrigation wastes water and deteriorate fruit quality • Imbalance and sub-optimal use of fertilizer • High seed rate • Injudicious use of pesticide • Improper harvesting procedure • Despite of ideal conditions for seed production, limited trend of carrot and turnips seed production in farmers	• Export quality produce may be increased significantly by adopting mechanized farming, water conservation technologies, systematic training modules for farmers and standardize post-harvest handling techniques • Training of farmers for quality seed production • Establishment of carrots and turnips seed processing units	• Crop production may be adversely effected in this area due to changing rain patterns and water scarcity. • Non mechanized farming and dependence on human labor in cultivation practices increase cost of production making vulnerable to compete in international market. • Difficulty of training illiterate farmers about high tech methods and techniques
		Transportation	• Good road infrastructure connecting cluster with all big cities	• No environment (temperature, humidity, etc.) control during transportation • Improper staking during transportation • High fuel cost especially diesel used in		

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
				transportation		
		Marketing	• Bulk produce in peak season • Good quality produce • Prolonged availability of fresh produce	• Unstable market prices • No stable marketing policy / infrastructure • No grading, proper packaging and transportation • Auctioning in the wholesale market with visual and spot grading	• Financial support to farmers in form of quality based delivery contracts • Big opportunity to reform the old market practices in the province • Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	
		Trade/Export	• Bulk surplus fresh produce during peak season • Some food companies involved in processing of carrot for pickles to sale in local and international market	• Little capacity of farmers and traders and no quality infrastructure to produce, handle, and market the quality product for export • High cost of production and can't compete in international market • No government policy to support the exporters and processors	• Mechanized farming to reduce cost of production • Big opportunities for food processing companies and exporters in form of carrot pickles and dry/frozen carrots and turnips • Quality based contract farming between farmers and exporters • Quality seed production for local demand to reduce seed import	• Unstable electricity and gas prices and supply for industry • Slow development of quality infrastructure, • Lack of stakeholders interest in capacity building to produce and maintain quality product

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		Processing	• Bulk fresh produce (Carrots & Turnips) available for processing • Some food companies involved in processing of carrot for pickles, frozen carrots to sale in local and international market	• High cost of production • No trend of post-harvest grading and processing • Lack of capacity and resources for small scale stakeholders to get involved in processing	• Huge demand for pickles (Carrots) and frozen carrot in local and international market • Government incentives for establishment of small processing plants	

Table 16: SWOT Analysis of Balochistan Cluster

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Killa Saifullah and Loralai (Balochistan)	**Fresh Carrot**	**Environment/ Climate Change**	• Suitable environment for carrot crop when carrot production in other regions of country not possible (i.e. June to September) • Suitable environment for quality seed production	• Area is effected by drought • Water shortage • Heavy rainfalls during July & August (Carrot maturity time) may adversely affect carrot root quality	• Very suitable area for quality carrot production during scarcity period	• Drought / Water scarcity • Uneven pattern of rainfalls • Declining underground water • Declining soils fertility
		Input Supplies	• Reliable major fertilizer and pesticide supply system with many National / Multinational Companies providing these chemicals	• Limited availability of certified, quality, and pure variety seed • Poor seed production, procurement and certification system	• soil testing labs can play a major role in matching input use with the soil nutrient conditions	• Use of adulterated or expired pesticides. • Injudicious use of chemicals
		Cluster interaction	• High demand of produce (fresh carrot)	• Little interaction among farmers and researchers • Poor agricultural extension services to the farmers	• Possibility of learning from progressive farmers in the cluster • Strong opportunity of	

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
				• Producers have little information about the quality requirements in national and international market • Non availability of interest free loans • No legislation at government end for contract farming	contract farming among farmers and seed companies for quality seed production • Strong relation between Commission Agents/Wholesaler and Contractors (each have knowledge about quality demand at least in national market) can be transformed into quality-based supply contract • Strengthen the research and farmers interaction	
		Production Management practices	• Easily labor availability for field operations	• Lack of quality seed • Traditional method of sowing • Manual cultural practices • Flooding irrigation wastes water and deteriorate fruit quality • Imbalance and sub-optimal use of fertilizer • High seed rate • Injudicious use of pesticide • Improper harvesting procedure	• Export quality produce may be increased significantly by adopting mechanized farming, water conservation technologies, systematic training modules for farmers and standardize post-harvest handling techniques • High quality seed production by contract farming among private seed companies and farmers • Training of farmers for quality seed production • Establishment of carrots seed processing units	• Crop production may be adversely effected in this area due to changing rain patterns and water scarcity. • Non mechanized farming and dependence on human labor in cultivation practices increase cost of production making vulnerable to compete in international market. • Difficulty of training illiterate farmers about high tech methods and techniques

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
		Transportation	• Good road infrastructure connecting cluster with all big cities • Produce (Fresh carrot) is sent to big cities of Punjab	• No environment (temperature, humidity, etc.) control during transportation • Improper staking during transportation • High fuel cost especially diesel used in transportation		
		Marketing	• High demand of produce (fresh carrot) • Good quality produce • Prolonged availability of fresh produce	• High demand produce (Fresh carrot) but unstable market prices • No stable marketing policy / infrastructure • No grading, proper packaging and transportation • Auctioning in the wholesale market with visual and spot grading	• Financial support to farmers in form of quality based delivery contracts • Big opportunity to reform the old market practices Emerging supermarkets can introduce contract with farmers which may improve retailing quality, and reduce post-harvest losses and trading margin	
		Trade/Export	• Good quality fresh carrot	• As produce of this region comes during scarcity period, production hardly meets the fresh carrot demand of country so no trend for export • Little capacity of farmers and traders and no quality infrastructure to produce, handle, and market the quality product for export • High cost of production and can't compete in international market • No government policy to support the exporters and	• Mechanized farming to reduce cost of production • Big opportunities for food processing companies and exporters in form of carrot pickles and dry/frozen carrots • Quality based contract farming between farmers and exporters • Quality seed production for local demand to reduce seed import	• Unstable electricity and gas prices and supply for industry • Slow development of quality infrastructure, • lack of stakeholders interest in capacity building to produce and maintain quality product

Cluster	Products	Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
				processors		
		Processing	• Good demand of carrot pickles & frozen carrots in national and international market • Some locals involved in carrot pickles production at very small and local scale	• High cost of production • No trend of post-harvest grading and processing • Lack of capacity and resources for small scale stakeholders to get involved in processing	• Demand for pickles (Carrots) and frozen carrot in local and intern1ational market • Government incentives for establishment of small processing plants	

CHALLENGES FACED BY THE CLUSTERS

1.10. Climate change:

Climate change is a common threat to whole agriculture sector of Pakistan; hence, same is the case with carrots and turnips. Rainfalls at maturity stage of carrots and turnips in KP deteriorate the quality of the produce and favor disease incidence. Likewise, in Punjab, rainfall right after sowing adversely affects the germination. Early onset of summer season reduces quantity and quality of the late carrots and turnips crops in the Punjab. High temperature during summer lowers the yield and quality of seed crop. In Punjab, limited supply of canal water and falling underground water level imposes serious threat to carrot and turnips cultivation. Water shortage is the most serious threat to carrot and turnips cultivation in Balochistan. Tube wells are the main source of irrigation in this region and water shortage is becoming serious issue for the farmers.

1.11. Weak Research & Development

Carrots and turnips yield of Pakistan is significantly lower than world average. The main reason for this is non-availability of high yielding varieties/hybrids specifically breed for specific agro ecological conditions and conventional cultural practices. The seed market is mainly occupied by imported seed. NARC is responsible to conduct adaptability trials/NYUT trials of imported varieties/hybrids at national level to check suitability of these varieties in local climatic conditions. But, in case of carrots and turnips no adaptability/NYUT trials are being conducted. Various types of carrot and turnips varieties/seed are being marketed by different seed company without any adaptability trials. FSC&RD department is responsible for registration of the varieties and issuance of import permit. But there are serious lop holes in variety registration system of FSC&RD which benefit seed companies marketing inferior varieties. In Punjab, Vegetable Research Institute, AARI, Faisalabad is responsible to conduct adaptability trials of imported varieties and hybrids of carrot and turnips. But due to limited resources, this institute only evaluates the varieties in Faisalabad and on basis of one location performance; FSC&RD allows marketing of variety in whole province. At government level, breeding program for carrot and turnips is very poor. No new variety of carrots and turnips has been evolved in KP and Balochistan since decades. In Punjab, VRI, Faisalabad has evolved a variety of red core Carrot “T-29” and two turnip varieties i.e. Purple Top and Golden. Likewise, Pakistan is also far behind in research on improved production practices and mechanization of cultural practices like sowing and harvesting which are major limiting factor for low yield and poor quality of the fresh produce. Central Punjab is also an ideal location for quality seed production of carrot and turnips. Many farmers produce their own seed. Even then, main seed market is dominated by imported seed of carrot and turnips. Vegetable Research Institute, Faisalabad is doing local seed production of carrot and turnips, but due to limited resources, this is not sufficient to meet local need.

1.12. Constraints at Production level

Carrot and turnips cultural practices of farmers across the Pakistan are outdate and conventional. Sowing and harvesting is manual. Normally sowing is done through broadcast method. No proper line to line & plant to plant distance is maintained. This results in higher seed rate than recommended. Uneven plant spacing results in uneven root size. Fertilizer and other inputs use is highly variable and varies farmer to farmer. Moreover, as in Punjab, Carrot & turnips are sown in different seasons as early, normal and late crop. But no season specific varieties are available to the farmers. Farmers are using same variety for multiple seasons. Agricultural extension service is not very effective in KP and Balochistan. These practices result in low yield and poor quality of the produce. Moreover, manual labor is involved in harvesting of carrot and turnips (Table 17). This practice is major component of production cost.

Table 17: Gaps and constraints at production level

Sr.#	Parameter	Upper KP	Central KP	Central Punjab	Balochistan
1	Locally evolved high yielding Varieties/Hybrids	Not available	Not available	Available	Not available
2	Certified Seed	Limited availability	Limited availability	Limited availability	Limited availability
3	Commercial inputs	Limited use	Limited use	Limited use	Limited use
4	Extension services	Very poor	Very poor	Adequate	Very poor
5	Labor input	Family/Local labor	Local labor	Local labor	Local labor
6	Harvesting	Manual	Manual	Manual	Manual

1.13. Constraints at Post-Harvest & Processing Level

In case of carrot and turnips, no post-harvest value addition or processing is being practiced in KP and Balochistan. Almost all of the produce is consumed fresh. Likewise in Punjab, most of the produce is consumed fresh. Normal practice of farmers is to manually harvest the crop, wash it with canal or tube well water and send it to vegetable markets either filled in plastic bags or open in trucks. A huge international market for fresh carrot and turnips exists but there is need to develop proper fresh produce handling plants for washing, grading and then packaging of the produce as per international standards for transportation in national and international markets. Only few (5-6) exporters are involved in export of fresh carrot and turnips. These exporters preferably buy fresh produce directly from farmer field at rate of 15-35 PKR/Kg depending upon season; do simple wash and manual grading. In Punjab, some food processors are involved in manufacturing of carrot pickles and frozen carrots, but it is very limited. There is huge demand of frozen/chilled carrots in international market, but Pakistan fails to capture these markets due to its high cost of production and low quality of the produce. A strong relationship between producers and processors is needed

for quality based contract farming to overcome these issues, which is currently lacking (Table 18). Moreover, strong legislation at government end is required to protect the rights of all stockholders involved in value chain of processed carrots and turnips.

Table 18: Gaps and Constraints at post-harvest and processing level

Sr.#	Parameter	Upper KP	Central KP	Central Punjab	Balochistan
1	Fresh produce handling unit	Not available	Not available	Not available	Not available
2	Processing/value addition technologies in use	Not available	Not available	Limited	Not available
3	Shovel ready investment projects	Not available	Not available	Available	Not available
4	Access to energy for processing	Available	Available	Available	Limited availability
5	Contract Farming	Lacking	Lacking	Lacking	Lacking

1.14. Constraints at Trading Level:

Most of the carrot and turnips produce is traded fresh. Carrot and turnips are consumed across the country and being traded in almost all the major vegetable markets. Farmers tend to send their produce in high value vegetable markets to fetch higher prices. For example, Upper KP purple top turnips and Balochistan's carrot are sent to Punjab markets due to high market rates. There are no proper storage facilities in vegetable markets. Fresh produce is kept in open and rates are decided on visual basis and overall market situation. Market prices are highly variable depending upon season, demand and supply. There is no proper price control policy which results highly variable returns to producers. Sometimes, producers fetch very good price and earn good revenue but there are times, when market prices are so down the farmers can't even recover their original cost. There are times; farmers prefer to plough their crop in the field instead of sending in the market due to very low market prices. However, whole sellers in vegetable markets are always in win win state. Communication services are easily available and farmers are connected with different vegetable markets telephonically to get information about current market rates. At international level, Pakistan fails to fetch higher prices for its produce due to poor quality and higher cost of production. This high cost of production is at farmer level and transportation level. Almost 0.1 to 0.2 Million PKR required for transport of fresh produce of carrot and turnips in refer containers to seaport in Karachi. Another major constraint is poor information and capacity of local exporters about certifications and regulations required to export produce in high end international markets. Exporters have to face many difficulties for getting registration and quarantine/Phytosanitary certifications for export purpose. There are very few laboratories for testing and issuance of quality certifications (Table 19).

Table 19: Gaps and constraints at trading level

Sr.#	Parameter	Upper KP	Central KP	Central Punjab	Balochistan
1	Marketing channels	Traditional	Traditional	Traditional	Traditional
2	E-Commerce platforms	Not available	Not available	Not available	Not available
3	Contract farming	No	No	No	No
4	Export readiness	No	No	Limited	No
5	Certification (Phytosanitary)	No	No	No	No
6	Branding	No	No	Limited	No

A national level policy is needed to focus on quality production of fresh carrots & turnips and establishment of frozen carrot processing units as per international standards. This will not only help to stabilize market prices at national level but will also earn a huge foreign exchange to the country from exports.

CLUSTER DEVELOPMENT POTENTIAL

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

1.15. Production Potential:

Upper and Central KP clusters are home to fresh organic purple top turnips. Likewise, Balochistan cluster is hub for high quality carrot production. Central Punjab is blessed with prolonged supply period for fresh carrot and turnips. However, per unit production of these clusters is far less then world average. Pakistan's average national yield is more than half to that of world average yield. A considerable yield gap of 21, 20, 18 and 19 tonnes/ha exists in upper KP, central KP, Central Punjab and Balochistan clusters, respectively. This huge yield gap is due to many factors which may be summarized as non-availability of high yielding varieties and poor crop management practices. However, this is average yield data and not true representative of individual advanced farmer's production. Many farmers in central Punjab easily get 30-35 tonnes/ha production.

By introducing high yielding, season specific varieties and adopting improved cultural and inputs management practices, this huge international yield gap can be covered. If average yield of these clusters is increased by only 50%, this will produce additional 6 thousand tonnes (worth 1 million US$) in upper KP, 13 thousand tonnes (worth 2 million US$) in central KP, 97 thousand tonnes (worth 13 million US$) in central Punjab and 19 thousand tonnes (worth 4.7 million US$) in Balochistan cluster fresh carrot and turnips. Moreover, this significant increase in average yield of these clusters will ultimately result increase in average yield of other carrots and turnips growing areas and ultimately national average yield and hence national production. By increase in local production quantity and quality, Pakistan will save about 1.79 Million US$ which we spend on import of carrots and turnips. Moreover, this additional production will create many farm level labor opportunities.

1.16. Potential Demand in National and International Market

Carrots and Turnips are very important winter vegetables and a huge demand exists both in national and international market. Carrots and Turnips are consumed mostly fresh throughout the world either as salad or in cooked form. A very limited market exists for dried/ready to cook turnips in international market. However there is a considerable demand

for value added or processed products of carrots like frozen carrots, canned carrots, carrot pickles and carrot mix recipes at domestic and international level.

World production of carrots and turnips has increased from 22.24 million tonnes in 2001 to 42.71 million tonnes in 2016 with average increase rate of 5.76% per year. Production and hence demand of carrots and turnips is increasing rapidly at global level. If we look at production of world top 5 carrot and turnips producing countries, China, Uzbekistan, Russia, USA and Ukraine, only USA has negative annual growth rate of -1.24%. Otherwise, China has annual average growth rate of 14.79%, Uzbekistan 29.16%, Russia 2.55% and Ukraine 5.60%. This implies that additional production in Pakistan can easily be absorbed in international market if Pakistan can meet international quality standards.

1.17. Pakistan's Current and Potential Share of the Market

As noted earlier, Pakistan ranks at 73rd position in export by exporting only 0.115 thousand tonnes carrots and turnips which is only 0.004% of world's total export. Export production ratio of Pakistan is only 0.023% which is far less then world average export production ratio of 6.74%. By increasing export to production ratio of identified carrot & turnip clusters to 6.74%, Pakistan's export for carrot and turnips will increase to 27.6 thousand tonnes (still 0.01% of total world carrot and turnip export). This will generate additional US$10 million of foreign revenue at current export price of 373.36 US$/ton.

1.18. Emerging Trends and Potential Markets

At present, Pakistan is exporting carrots and turnips mainly to gulf countries like Kuwait, Qatar, Saudi Arabia and UAE. The main reason for exporting to these countries is comparatively less strict quality parameters for export. Moreover, Pakistan produce has good demand in these regions due to large number of Pakistanis working in these countries. However, gulf countries are also implementing strict quality control laws for import of fruits and vegetables. Recently, UAE has banned import of fruits and vegetables from 5 countries due to inferior quality and high residues of pesticides in the product. World's top carrots and turnips importing countries are given in Table 22. Thailand has the highest annual growth rate of 57.42% for imports of carrots and turnips either fresh or chilled followed by South Korea (40.36%), Russia (18.90%) and UAE (16.84%). Collectively these countries account for 61.20% of world's total import for carrots and turnips. Belgium, Germany, USA, France and Canada are the high value markets for carrots and turnips. But these countries have very strict quality and quarantine standards for export of fruits and vegetables including carrots and turnips. We are presenting in this report the measures by which we can capture these high-end markets through improved production technology, standardized farm practices and production of high demand value added products of carrots and turnips.

1.19. Improvement in Quality and National Quality Gaps

Pakistan's current export price for carrot & turnips (fresh or chilled) is 373.36 US$/t which is considerably low then world average export price of 454.19 US$/t. Most of major carrot exporting countries produces and export orange carrots which are less sweet and less juicy then Pakistan's red varieties. Even then, Pakistan failed to capture any considerable share of world export. This failure may be attributed to various factors start from farmer's field to National policy levels. Carrots and turnips production, logistics, marketing and trade practices vary considerably from country to country at global level. However, there are some set rules for each practice which are being followed by top carrots and turnips producing and exporting countries. In this section, we are describing these rules/practices being followed in world leading countries by various stakeholders of carrots and turnips (Table 20).

Table 20. Rules/practices being followed in world leading countries by various stakeholders of carrots and turnips

Variety and Seed	1- Agriculture R & D department ensures availability of high yielding good quality varieties suitable for specific agro ecological conditions. Objective oriented breeding is done to develop varieties suitable fresh consumption or value addition. E.g. for fresh consumption those carrots are favored which are juicy, tender and sweet. Whereas for drying purpose, specific carrot varieties with high fiber contents are suitable. 2- Farmers select best variety as per their climatic conditions and end produce requirement e.g. for fresh consumption or processing. 3- Good quality pure seed is used
Production Practices	1- Contract based farming between farmers and exporters or fresh produce marketers 2- Mechanical sowing which not only ensures proper plant to plant and line to line distance but also reduces cost of production 3- Use of recommended seed rate 4- Balanced use of fertilizers as per soil analysis and expert's recommendations 5- Balanced and controlled irrigation (Drip irrigation as being practiced in Israel in carrot production) 6- Proper and/or limited use of pesticides 7- Mechanical harvesting reducing harvesting damages and cost of production 8- Proper cooling and packaging of the fresh produce
Transportation	1- Purpose built containers and vehicles for transportation 2- Transportation in controlled environment vehicles (Controlled temperature

	and humidity)
Marketing	1- Government policies ensure the stable market prices 2- Interlinked and online marketing system which ensure up-to-date information to all stake holders about current market prices and trends
Value addition and/or Processing	1- All standardized SOPs for quality assurance are strictly followed 2- Mechanized procedures to reduce cost of production 3- Sanitary practices are strictly followed 4- Proper and attractive packaging of desired volume/weight as per consumer preference
Extension Services	1- Strong and efficient agricultural extension system 2- Provide guidance to farmers about latest and recommended varieties and cultural practice.
Stakeholder's interaction	1- As practiced in Israel, a carrots and turnips growers association financed by the farmers and other stake holders. This association holds weekly and monthly meetings in which government agricultural R&D and extension department representatives also participate. During these meetings, current crop situation, farmer's problems and requirements are discussed. This association gives targets to R&D departments to focus their research activities as per farmer's requirements.
Government level Policies	1- Exporters friendly policies 2- Promote and incentivize the processing & value addition industry

To compete in international market and to improve the quality and price of carrots and turnips to international level, we have to adopt international quality standards at each segment of the value chain. If we increase export price of only 5% of the produce to that of national export price in previously defined clusters, it will generate additional revenue of 8 million US$.

1.20. Improved Processing:

There is no any considerable processed or value added product of turnips at national or international level. Moreover, local market for frozen or canned carrots is very limited but showing positive growth. However, IQF fruits and vegetables is a major category of world export for horticultural products. The world market of frozen vegetables was 5.8 billion US$ in 2015 increasing from 4.7 billion US$ in 2007; translating into an overall growth of 24%. Frozen carrot is traded under the category (HS 071080) and it includes all other types of frozen vegetables also. This category accounts for 55% share (of worth 3198 Million US$) of total export of frozen vegetables. There are no exact statistics for export of frozen carrots

from Pakistan, but export base is small. Increase or decrease in total exports strongly depends on getting or losing individual export orders from different importing countries. In 2015, Pakistan exported 6.4 thousand tonnes of frozen vegetables (mixture) under the code HS071080 of worth 259 Million PKR[6].

Central Punjab has bulk supply of fresh carrots from December to March, which results in extremely low market prices. Sometimes farmers prefer not to harvest crop as cost of harvesting exceeds the market price. Processing of extra production of carrot to frozen carrot, during these months will not only stabilize the market prices but will also earn huge foreign revenue through export. If only 5% of the produce from central Punjab is processed/frozen and exported, it will generate additional revenue of 6.4 Million US$.

This increase in production, processing and export will also create many job opportunities at different levels of value chain.

[6] Prefeasibility study; IQF Vegetables/Fruits (http://www.agripunjab.gov.pk/system/files/3%20-%20Frozen%20Fruits%20and%20Vegetables%20Processing%20Unit%20-%20IQF.pdf)

STRATEGIES, POLICIES, AND NETWORKING TO REALIZE THE POTENTIALS

The issues and shortcoming of carrots and turnips value chain discussed in previous section, may be summarized into following points

1- Low quality and yield

2- Improper post-harvest handling of fresh produce

3- Poor marketing and trading practices

4- Limited value addition and processing

These four components of carrots and turnips value chain in each cluster need to be improved to realize full potential of the clusters. Based on these gaps and discussions with stakeholders, following targets are fixed for the five-year development projects:

The purpose of the whole exercise is to develop a research-based cluster development plan for carrot and turnips to achieve the following targets (Table 21).

Table 21: Targets of Carrots and Turnips cluster plan

Sr.#	Targets
1	To increase Pakistan's average yield by 25% in next 5 years
2	To convert 2.5% of total production to frozen/chilled products for domestic and export purpose
3	To increase Pakistan export production ratio from 0.02% to 2.5% within next five years
4	To substitute 4.16 thousand tonnes of import with higher domestic production in Pakistan
5	To increase the quality of the 2.5% of the produce equal to the world average quality so that its export price may be increased by 17.80% to make it equal to world average export price.

In this section, we define policies and strategies for each cluster to improve to achieve these targets.

1.21. Policy Reforms

At national policy level, government should bring major reforms in seed sector, Agricultural R&D sector, agriculture extension sector, and processing industry. At start, import of high yielding carrot and turnip varieties should be introduced as per specific agro ecological conditions of each cluster but in long term Government should devise policy to promote local seed production, mechanized farming, quality based contract farming and value addition industry. Government should promote local value addition industry by imposing ban or high

taxes on imported value added products. Subsidies and incentives should be specific and results driven. For instance, import duties on all farm machineries and post-harvest technologies should be eliminated, but these technologies should be clearly defined. Attractive subsidies and incentives should be given to attract local investors into mechanized farming and food processing industry. Moreover, a nationwide program should be developed, in which all rural districts can compete for Cluster Development Grants to specialize in high-value crops for export. Another policy recommendation is to include fresh carrot and turnips and their frozen products in bilateral/multilateral trade agreements with friendly countries like gulf countries which are huge market of fresh and frozen vegetables.

At the local level, government should support and train farmers to make small marketing groups like Framers Enterprise Group (FEGs) especially in KP and Balochistan where land holdings are small and farmers have limited resources. These groups may be established at tehsil & union council levels. Government should incentivize these groups with farm machinery for mechanization and washing grading and packaging machinery for proper post-harvest handling of their produce. These groups will be trained for proper branding of their produce in collaboration with proposed Pakistan carrots and turnips growers & exporters association under the umbrella of All Pakistan Fruits and Vegetables Exporters, Importers and Merchants Association. This association should have a website of its own and work to promote best practices, share knowledge, technology and lobby with Government for enabling policies on behalf of FEGs.

1.22. Strategies for Upper KP cluster:

In this section, strategies are described to increase production, improve value chain and promote export of fresh turnips from this cluster.

1.22.1. Production level strategies:

Major limiting factor for low yield of turnips in this cluster is non-availability of quality seed of high yielding varieties specifically evolved for typical climatic conditions, small land holdings, cultivation on terraces and poor cultural practices.

Organization of turnip growers. Farmers should be organized at multilevel in turnips growers' association at union council level and FEGs on district level. As individual farmers in this region has limited resources, making growers association at union council level will pole the resources of farmers resulting in better crop management practices. Likewise, FEGs at district level will provide a platform to farmers for proper marketing practices and opportunity for product branding. These associations should be linked with the proposed National level carrots and turnips growers and exporters association.

Importing high yielding germplasm. For immediate increase in per unit yield, high yielding varieties should be introduced from other countries as per specific climatic conditions. Provincial agricultural R&D department will decide specific varietal characteristics required for specific region by discussion with previously proposed FEGs. R&D department will also be responsible for varietal field trials and testing adaptability of imported germplasm. Private seed companies may also be involved for export of high

yielding germplasm. But a strong variety/germplasm evaluation and seed quality control mechanism should be developed by provincial R&D department to test adaptability of germplasm imported by private seed companies. At least 2 years' adaptability data at 4 locations (two in swat & Chitral each) should be mandatory for getting import permit for a specific variety.

1.22.2. Improvement of farmer's cultural practices

For farmers training, agriculture extension sector in the cluster should be restructured and strengthened. R&D department should develop a complete technology package for turnip cultivation. Regional agricultural extension department should develop model plots of turnips at union council level. Farmer's meetings should be arranged at these model plots for demonstration of improved production technology. Union council level turnips grower's associations may provide a platform for establishment of model plots and trainings. \in this region, turnip sowing is done through broadcasting. This not only increase per unit seed rate and hence cost of production but also lines and plant spacing is not maintained. This results in uneven size of fresh turnips which fetch lower price in national and international market. Due to small land holding and terracing of land, large machines are not successful in this region. Small hand driven turnip sowing drills are being proposed for this region. Through these drills, lines and plant spacing in the field is properly maintained. These hand drills may be imported by China and/or locally prepared by provincial farm mechanization department through reverse engineering. Government should provide 20% subsidy on import of these drills. Private agricultural companies may also be involved here.

Specifications[7]

Number of Rows	1-6
Line spacing	8-20 cm
Planting distance	2-51cm
Planting depth	0-3cm
Dimension	86×15×42cm
Weight	12kg
Planting speed	2.5-3.5 Km/Hour

Figure 3: Hand driven turnip and carrot seeder

[7] Hand driven carrot and turnip seeder (https://www.alibaba.com/product-detail/1-6-rows-Carrots-turnips-beets_60719516208.html?spm=a2700.7724857.normalList.2.4c5c15da9BESwv)

1.22.3. Strategies for Value Chain improvement

Fresh turnips are high price commodity and offer high export potential. But fresh turnips from this region fail to fetch higher prices in the international market. One reason for this is poor/substandard post-harvest level practices. Strategies are proposed to improve fresh turnips value chain and hence increase quantity, quality and price of fresh produce.

Establishment of Post-harvest handling units/Pack Houses. Exporters/FEGs should be incentivized to establish one post-harvest handling unit/Pack house for fresh turnips and carrots. Fresh produce of farmers will be properly washed, graded, packaged and stored as per national and international standards in these units. Subsidy may be given on the import of machinery required for establishment of these pack houses. From these units, fresh produce will be transported /exported in ordinary/refer trucks to the national/international market. Detailed feasibility report for establishment of Pack house is given in Annexure IV.

Branding of the fresh produce. This cluster is home to high quality fresh turnips. Fresh turnip exporters should be motivated and trained to establish brands of their fresh produce like *fresh organic turnips or mountain fresh turnips*. PFVA in collaboration with government should train and facilitate exporters about various certification requirements, marketing and international standards for successful establishment of brands.

1.22.4. Marketing and Trade level strategies

Increase the export to production ratio. A small unit will be established in the department of agriculture at provincial level consisting of three scientists (marketing specialist, economists and information analyst) with supporting staff. It will provide information regularly to the stake holders about international market requirements (i.e. potential buyers, standards and prices etc.). This unit will work in collaboration with proposed national level carrot and turnips growers and exporters association.

One window operation for certifications. A major limiting factor of low export to production ratio is the difficulty faced by the exporters is in meeting mandatory registration and certification requirements of the importing country. No quality and quarantine testing laboratory is present in this area. Likewise, Government should ease the registration procedure for the exporters. Government should establish a collection/ facilitation center at district level to facilitate the exporters in required certifications.

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

Holding competition and rewards for exporters. Special competition will be held and rewards will be provided for outstanding exporters of fresh turnips. These competitions will be held at cluster level and jointly organized by national carrot & turnips growers & exporters association and Government.

Training of stakeholders to adopt ISPMs. International consultants will be engaged by the National carrot & turnips growers and exporters association to spell out requirements at production, processing, transportation, storage, and marketing levels and provide training to trainers who in turn will train farmers, traders & exporters, etc. to adopt the ISPMs standards. Fifty farmers and 10 other stakeholders will be trained to adopt the ISPMs in each district every year.

1.23. Strategies for Central KP cluster:

In this section, strategies are described to increase production, improve value chain and promote export of fresh turnips from this cluster.

1.23.1. Production level strategies

Low yielding varieties & poor cultural practices are main reason of low production in this reason. To increase per unit production in this area, following strategies are proposed.

Organization of turnip growers. Union council level turnip grower's associations and district level FEGs will be established under umbrella of National Carrot & Turnips Growers and Exporters association with same objectives and functions as described previously.

Importing high yielding germplasm. Private seed companies and provincial agricultural R&D department will import high yielding turnip varieties for this region. Provincial agricultural R&D department will decide specific varietal characteristics required for specific region by discussion with previously proposed FEGs. Variety/germplasm evaluation and seed quality control mechanism should be developed by provincial R&D department to test adaptability of germplasm imported by private seed companies. At least 2 years' adaptability data (one location in each district) should be mandatory for getting import permit for a specific variety.

Improvement of farmer's cultural practices. Provincial R&D department will develop a complete turnips cultivation package. Agricultural extension department will establish demonstration plots of new varieties and technology package at union council levels in association with grower's associations as described previously. Small hand driven turnip sowing drills are also being proposed for this region. These hand drills may be imported by China and/or locally prepared by provincial farm mechanization department through reverse engineering. Government should provide 20% subsidy on import of these drills. Private agricultural companies may also be involved here.

1.23.2. Strategies for value chain improvement:

In this section, strategies are proposed to improve value chain of fresh turnips for increased quality and price.

Establishment of Post-harvest handling units/Pack House. Government will provide subsidy to FEGs/Exporters on fresh turnip washing & grading machines to establish one post-harvest handling unit/Pack house for fresh carrots and turnips. Fresh produce of

farmers will be properly washed, graded, packaged and stored as per international standards in this unit. Detailed feasibility report for establishment of Pack house is given in Annexure IV.

Branding of the fresh produce. Fresh turnip exporters/FEGs will be trained to establish brands of their fresh produce like *fresh organic turnips or mountain fresh turnips*. PFVA in collaboration with government will train and facilitate exporters/FEGs about various certification requirements, marketing and international standards for successful establishment of brands.

1.23.3. Marketing and Trade level strategies:

Increase the export to production ratio. Three scientist's unit at provincial level described in previous cluster will also function here.

One window operation for certifications. No quality and quarantine testing laboratory is present in this area. A collection/facilitation center will be established in each district to ease the registration procedure for the exporters & facilitate the exporters in required certifications.

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

Holding competition and rewards for exporters. Special competition will be held and rewards will be provided for outstanding exporters of fresh turnips. These competitions will be held at cluster level and jointly organized by national carrot & turnips growers & exporters association and Government.

Training of stakeholders to adopt ISPMs. International consultants will be engaged by the National carrot & turnips growers and exporters association to spell out requirements at production, processing, transportation, storage, and marketing levels and provide training to trainers who in turn will train farmers, traders & exporters, etc. to adopt the ISPMs standards. Fifty farmers and 10 other stakeholders will be trained to adopt the ISPMs in each district every year.

1.24. Strategies for Central Punjab cluster:

In this section, strategies are described to increase production, improve value chain, enhance processing and promote export of fresh carrot and turnips from this cluster.

1.24.1. Production level strategies

Punjab has main share in area & production of carrot and turnips in Pakistan. Over the years, per unit yield of Punjab has declined with average annual growth rate of -0.51%. Main reason for this decline is early sowing of crop by farmers. Three main crops of carrot and turnips are sown in this region i.e. early, normal and late crop. Normally prices are higher for early crop due to limited supply. Farmers try to fetch higher market prices by sowing their

crops earlier when temperature is high. But no specific varieties are available for early crop. This results in lower yield. Other reason for low production is poor cultural practices.

Strengthening of Research & Breeding. Vegetable Research Sub-Station, Sheikhupura of Vegetable Research Institute, Faisalabad will be upgraded to Root Vegetables Research Institute, Sheikhupura. This institute will be responsible for evolution of high yielding carrot and turnips varieties for specific sowing seasons, development of improved technology package and training of master trainers (AOs & Fas) of agricultural extension department.

Importing high yielding germplasm. For immediate increase in per unit yield, high yielding varieties will be introduced from other countries as per specific climatic conditions and sowing season. For early crop (August & September sowing), heat tolerant varieties are required. Likewise, for late season crop (December & January sowing) low temperature tolerant and late bolting varieties are required. Previously proposed Root Vegetables Research Institute will test the adaptability of these imported varieties for at least two years in each district. FSC&RD department will issue import permit to private companies based upon two years multi-locational yield data.

Improvement of farmer's cultural practices. Master trainers of agricultural extension department (AOs and FAs) will train the farmers about improved cultural practices by seminars, farmer meetings and demonstration plots. At least one demonstration plot will be established in each union council. Central Punjab consists of fertile plan lands very suitable for mechanized farming. Tractor mounted carrot & turnips sowing and harvesting machines will be introduced in this area. For small farmers, hand driven sowing drills will also be introduced. These machines will be imported from China and/or then locally prepared by AMRI through reverse engineering. Government will provide 20% subsidy on import of this machinery. Private agricultural companies may also be involved here.

Strengthening of seed production. This region offers great opportunity for quality local seed production. This seed will not only meet local requirement but also the requirement of other provinces. Many farmers in this region are producing their own seed. Previously proposed Root Vegetables Research Institute will develop seed production technology and this will be disseminated to farmers through Agri. Extension department. Private seed companies will be motivated for quality based contract seed production with farmers as already being practiced in Peas and cereal crops.

1.24.2. Strategies for value chain improvement

Central Punjab ha glut period of carrot & turnips during peak season, which results in low farm gate & wholesale price at domestic level. This offers a good potential to fresh vegetable exporters & processors to export and process the excess produce and earns foreign exchange. But export of fresh carrot & turnips and carrot processing is very limited. In this section, we are proposing strategies to increase export of fresh carrot & turnips and export price by improving overall value chain; proper post-harvest handling, washing, grading, packaging of fresh produce as per international standards, branding and marketing of the fresh produce.

Establishment of Post-harvest handling units/Pack House. Fresh vegetable exporters will be incentivized to adopt international standards through establishing one post-harvest handling unit/Pack House for fresh carrot & turnips. Contract based quality farming will be promoted between farmers & exporters. Exporters will purchase the fresh produce of farmers at farmgate and deliver to Pack House where it will be properly washed, graded, packaged and transported to the port. Subsidy may be given on the import of machinery required for establishment of these units. Direct linkage between farmers and exporters will eliminate the middle man hence reducing overall cost of value chain. Detailed feasibility report for establishment of Pack house is given in Annexure IV.

Branding of the fresh produce. Exporters will be motivated and trained to establish brands of their fresh produce. PFVA in collaboration with government will train and facilitate exporters about various certification requirements, marketing and international standards for successful establishment of brands.

1.24.3. Value addition and processing level strategies

Although, major world trade of carrot and turnips is in fresh form, trend of frozen carrots consumption is rising globally. In central Punjab cluster, bulk supply of carrot is available from December to March at lower price which is ideal for production of frozen carrot. The objective of these strategies is to convert 5% of the fresh produce to frozen carrot products. Most of this frozen carrot will be for export purpose. Some will be for domestic market as per demand.

Establishment of IQF plants. There are already two IQF units established in Punjab i.e. Icepac Ltd. and Fauji Fresh n freeze which are producing frozen diced carrots on limited scale. We are proposing to encourage the private sector to establish three IQF plants in central Punjab (One in each division of cluster) to convert certain percentage of cluster production into frozen carrots. As carrot supply is seasonal and no fresh produce is available throughout the year, these IQF plants will also produce other frozen vegetables to function on year round basis. Various vegetables are available round the year in Punjab for year round economical functioning of these IQF units. These plants will be established through public private partnership in which government will provide land and subsidy on import of IQF machinery.

1.24.4. Marketing and Trade level strategies:

Purpose of these strategies is to increase carrot & turnips export production ratio of Pakistan up to world average of 5.0%. Key strategies being proposed for this purpose are (a) establishment of a provincial level body consisting of three scientists (marketing specialist, economists and information analyst) which will provide information regularly to the stakeholders about international market requirements, (b) Ease the registration procedure for fresh vegetable exporters and establishment of one window operation for various certifications/Quarantine & quality tests required for export of carrot and turnips, (c) Providing international exposure to top exporters, (d) holding competition and rewards for the exporters and (e) training stakeholders to adopt ISPMs.

1.25. Strategies for Balochistan cluster:

In this section, strategies are described to increase production, improve value chain and promote export of fresh carrots from this cluster.

1.25.1. Production level strategies

Low yielding varieties and poor inputs and management practices are the main factors for low yield of carrots in this cluster. Following strategies are being proposed to increase per unit production of carrots in this region.

Importing high yielding germplasm. High yielding good quality varieties will be imported from other countries. Provincial agricultural R&D department will test adaptability of these varieties. At least two adaptability trials will be performed in each district of the cluster. Private seed companies may also be involved for export of high yielding germplasm. At least 2 years adaptability data should be mandatory for getting import permit for a specific variety.

Improvement of farmer's cultural practices. For farmers training, agriculture extension sector in the cluster needs to be strengthened. Provincial agricultural R&D department will be responsible for development of a complete technology package for carrot cultivation and training of extension department. Agricultural extension department will establish model plots of carrots at union council level for demonstration of production technology and various cultural practices to farmers. Small hand driven carrot sowing drills and tractor driven planters and harvesters are being proposed for this region. Through these drills, lines and plant spacing in the field is properly maintained. These hand drills may be imported by China and/or locally prepared by provincial farm mechanization department through reverse engineering. Government will provide 20% subsidy on import of these machinery. Private agricultural companies may also be involved here.

1.25.2. Strategies for value chain improvement, marketing and trading:

Strategies for value chain improvement, marketing and trading are same as proposed for central Punjab.

A common intervention proposed is to establish a National Carrot and Turnips growers and exporters association under umbrella of PFVA. This should be a joint activity for all the clusters, with an interactive website and marketing apps.

BENEFITS AND COST OF CLUSTERING

This section discusses the costs associated with cluster development strategies presented in previous section in focal points of the clusters. This also identifies resources and requisite inputs for achieving all the targets given in the previous section. An economic and social

impact analysis has also been conducted that evaluates the benefits of the carrot and turnips cluster development interventions in target regions.

1.26. Focal point of Upper KP cluster (District Swat)

1.26.1. Interventions and Implementing Agencies

The program will have three main components:

1. Improvement in productivity by introducing improved varieties and management practices.
2. Improvement in export-production ratio by introducing market/export level strategies
3. Improvement in value chain by establishing value chain infrastructure like pack-houses.

These interventions will be introduced in collaboration with various agencies like PARC, provincial agriculture departments, and private sector (Table 22).

Table 22: Interventions and implementing agencies for district Swat of Upper KP cluster (District Swat)

S#	Cluster Strategy	Interventions	Implementing Agency
1	Production level strategies *(Increase yield by 25% in 5 years and reduce import of carrot and turnips to zero)*	Organization of turnip farmers	PARC, VRP (ARI,KP), Private Seed Companies
		Importing high yielding good quality cultivars	
		Adaptability testing and supply of certified seed to the farmers	
		Development of economical and sustainable production technology package involving mechanization of cultural practices (Sowing)	
		Establishment of demonstration plots and training of farmers for improved production practices Incentivizing small sowing and harvesting machines.	
2	Improvement in Value Chain *(Improved post-harvest practices, transportation and fetch higher price for export)*	Incentivize the private sector to establish fresh turnips handling units/Pack Houses (Washing, grading & Packaging)	PARC, FS&TRP KP,
		Branding of the fresh produce	
		One window operation for quality and quarantine certification	
3	Marketing & Trading level strategies *(Increase the export to production ratio up to 2.5% in five years; Improve the*	Provision of market information on standards, price and potential customer segments	PFVA & PARC
		Sponsor international tours for high potential exporters	
		Holding of competition and rewards for exporters	
		Provide incentives for adopting best practice and certification regimes	

	quality and export price up to international standard)	Establish a carrot and turnips exporters association under umbrella of PFVA with a website and marketing apps	
		Train the stakeholders to adopt ISPMs as per IPPC	

1.26.2. Interventions and Benefits

It is assumed that the introduced intervention at production level will increase productivity by 25% which will be achieved gradually over a period of 4 years starting from the 2nd year and will add gross revenue of US$0.355 million during the last year of the project (Table 32).

The market level interventions like improving interaction with international market and getting awareness of these markets is expected to increase export from0.02% to 5% which will gradually increase and bring a gross revenue of US$0.199 million during the last year of the project (Table 32).

The improvement in value chain by introducing four pack-houses in the focal point of the cluster will improve the quality thus price of the produce which will be treated in the pack house. This is expected to increase prices of the export from US$373 to US$454 tonne. In addition, 2.5% of the produce destined to domestic market will also get international price. This will generate a total gross revenue of UD$0.12 million during the last year of the project. All these interventions will generate a total gross revenue of US$0.67 million during the last year of the project (Table 23).

Table 23: Gross Revenue from interventions in focal point of Upper KP cluster

Parameters [All amounts: 000USD]	Year 2	Year 3	Year 4	Year 5
Intervention-1: Yield increase (25% total)	6.25%	12.50%	18.75%	25.00%
Additional production (t)	522	1051	1587	2130
Expected additional value (US$)	87,150	175,434	264,861	355,444
Intervention 2: increase in export-production ratio to 5%	1.25%	2.50%	3.75%	5.00%
Increase in export (ton)	111	237	377	533
Expected additional value from export (US$)	41,441	88,328	140,761	198,844
Intervention 3: Improvement in value chain Production that will pass through improved value chain (both for domestic and international market	55.5	118.3	188.5	266.3
Gross revenue from the improved value chain (US$)	14,825	38,769	73,212	119,564
Total Expected Additional Gross Benefits (US$)	143,417	302,531	478,834	673,852

1.26.3. Costs and Investments

The above proposed interventions will add cost of producing, processing, and value addition of carrots and turnip. The costs of the proposed interventions involve two types of costs i) value chain improvement costs and ii) sector support investment costs.

i. Operational Cost at Value Chain Level.

The major cost drivers in carrot and turnips value chain are the; a) Cost of production inputs and harvest; b) Cost of washing, grading and packaging c) Cost of transportation; d) Cost of processing and marketing; and e) Cost of wholesale, retailing and shelfing. The cost structure for carrot and turnips value chain in focal points of previously defined clusters is presented in Table 24. All the production and processing level operational costs add up to US$0.847 million during the last year of the project at just the focal point of the cluster.

Table 24: Added cost structure at value chain level in focal point of Upper KP cluster

Cost Items			Year 2	Year 3	Year 4	Year 5
Total cost/Ha for Carrot & Turnips in Upper KP cluster	**765**		Incremented costs/year based on total area of focal point			
Percent increase in the cost of production (Inputs & Harvest)		80%	20%	40%	60%	80%
Total increase in cost of production (Inputs & Harvest) (000 USD)	220		1,195	4,813	10,899	19,503
Percent increase in the cost of washing, grading & packaging for local market		25%	6%	13%	19%	25%
Total increase in the cost of washing, grading & packaging for local market (USD)	117		136	533	1,173	2,038
Percent increase in Cost of transportation & value addition (washing grading and packaging) in Pack House		0%	0%	0%	0%	0%
Total increase in cost of transportation & value addition (washing grading and packaging) in Pack House (USD)	264		12,311	26,239	41,816	59,070
Percent increase in the cost of transportation from field to market		25%	6%	13%	19%	25%
Total increase in the cost of transportation from field to market (USD)	117		199	802	1,816	3,249
Percent increase in the cost of wholesale, shelfing & retailing		25%	6%	13%	19%	25%
Increase in the cost of wholesale, shelfing & retailing (USD)	47		54	212	468	812
Total increase in the cost (US$)			**13,896**	**32,600**	**56,172**	**84,673**

Note: Based on extensive consultation with stakeholders, it is evaluated that the total cost/ha of turnips value chain is $765/ha in District Swat of Upper KP cluster. Production/harvest cost is estimated to be 29% of the total cost/ha. Similarly, the costs of washing, grading & packaging for local market is 15%, Cost of transportation is 15% and cost of Wholesale, Shelfing & Retailing is 6% of total cost/ha. Cost of transportation is cost of transporting one ha produce from field to Islamabad market. The cost of transportation and value addition of carrot and turnip in pack house is 35% of total cost/ha. These costs are expected to escalate over the period of 5 years along the expansion of volumes, services and new transactions in value chain due to positive effects of cluster development interventions. The yearly value chain costs have been calculated by multiplying increase in cost/ha in particular cost head with total number of has in focal point. In District Swat, the

production/harvest costs are expected to increase by 80% in five years. Similarly, increase in costs of washing, grading & packaging, transportation, and shelfing/retailing are set to 25%.

ii. System Level Investment.

An investment of US$0.91 Million is needed to support the cluster development efforts in focal point (district Swat) of upper KP cluster (Table 25). The major investment would be on establishing the pack houses followed by market/export level investment. About 38% of this investment will be made by the public sector in terms of strengthening research and development activities, incentivizing the establishment of pack houses and market level investment. With these investments, the private sector will bring the remaining 62% investment. The Federal government will share 20% of the total public funding while remaining 80% may come from the provincial government by establishing a Cluster Development Fund under PCP.

The highest investment would be on setting up pack houses where basic facility of washing, grading, packing, etc. would be available. Four collection centers would be established in Central KP. These centers will be owned by FEGs. Any farmers can use the service of the center and even can use the brand name of the center on charge basis.

Table 25. Investment requirements in Upper KP Cluster focal point (District Swat)

Description	Total	Year-1	Year-2	Year-3	Year-4
Investments required on R&D (USD)	148,148	59,259	59,259	59,259	59,259
Investments for value chain improvement-pack house (USD)	557,120	139,280	139,280	139,280	139,280
Investments on marketing/export (USD)	148,148	59,259	44,444	22,222	22,222
Government loan on private investment	61,283	15,320	15,321	15,321	15,321
Total investments (USD)	914,699	273,119	243,490	199,045	199,045

1.26.4. Economic Viability

The estimated Net Present Value (NPV) of all the interventions over the period of five year is positive t 0.261 million, and the Internal Rate of Return (IRR) is 29% (Table 26).

Table 26. Economic Analysis of the upgradation plan in Upper KP Focal Point

Value Chain Based Costing (000)	Year1	Year 2	Year 3	Year 4	Year 5
Net cash flow (undiscounted) after deducting all costs and investments (US$)	-365,880	-144,889	132,726	285,457	589,179
Net Present value (US$)= 260,15 0					
Estimated Internal Rate of Return (IRR)= 29%					

1.27. Focal point of Central KP cluster (Bunir District)

1.27.1. Interventions and Implementing Agencies

The program will have three main components:

1. Improvement in productivity by introducing improved varieties and management practices.
2. Improvement in export-production ratio by introducing market/export level strategies
3. Improvement in value chain by establishing value chain infrastructure like pack-houses.

These interventions will be introduced in collaboration with various agencies like PARC, provincial agriculture departments, and private sector (Table 27).

Table 27: Interventions and implementing agencies for focal point of central KP cluster

S#	Cluster Strategy	Interventions	Implementing Agency
1	Production level strategies *(Increase yield by 25% in 5 years and reduce import of carrot and turnips to zero)*	Organization of turnip farmers	PARC, VRP (ARI,KP), Private Seed Companies, Private Agricultural Companies
		Importing high yielding good quality cultivars	
		Adaptability testing and supply of certified seed to the farmers	
		Development of economical and sustainable production technology package involving mechanization of cultural practices (Sowing)	
		Establishment of demonstration plots and training of farmers for improved production practices	
2	Improvement in Value Chain *(Improve post-harvest practices, transportation and fetch higher price for export)*	Incentivize the private sector to establish fresh carrot & turnips handling units/Pack Houses (Washing, grading & Packaging)	PARC, FS&TRP KP,
		Branding of the fresh produce	
3	Marketing & Trading level strategies *(Increase the export to production ratio up to 2.5% in five years; Improve the*	One window operation for quality and quarantine certification	PFVA & PARC
		Provision of market information on standards, price and potential customer segments	
		Sponsor international tours for high potential exporters	
		Holding of competition and rewards for exporters	
		Provide incentives for adopting best practice and certification regimes	

	quality and export price up to international standard)	Establish a carrot and turnips exporters association under umbrella of PFVA with a website and marketing apps.	
		Train the stakeholders to adopt ISPMs as per IPPC	

1.27.2. Interventions and Benefits

It is assumed that the introduced intervention at production level will increase productivity by 25% which will be achieved gradually over a period of 4 years starting from the 2nd year and will add gross revenue of US$0.26 million during the last year of the project (Table 28).

The market level interventions like improving interaction with international market and getting awareness of these markets is expected to increase export from 0.02% to 5% which will gradually increase and bring a gross revenue of US$0.145 million during the last year of the project (Table 28).

The improvement in value chain by introducing four pack-house in the focal point of the cluster will improve the quality thus price of the produce which will be treated in the pack house. This is expected to increase prices of the export from US$373 to US$454 tonne. In addition, 2.5% of the produce destined in domestic market will also get international price. This will generate a total gross revenue of UD$0.087 million during the last year of the project. All these interventions will generate a total gross revenue of US$0.49 million during the last year of the project (Table 28).

Table 28: Gross Revenue from various interventions in focal point of central KP cluster

Parameters [All amounts: 000USD]	Year 2	Year 3	Year 4	Year 5
Intervention-1: Yield increase (25% total)	6.25%	12.50%	18.75%	25.00%
Additional production (t)	381	766	1157	1552
Expected additional value (US$)	63,509	127,843	193,012	259,022
Intervention 2: increase in export production ratio to 5%	1.25%	2.50%	3.75%	5.00%
Increase in export (ton)	80.9	172.4	274.7	388.1
Expected additional value from export (US$)	30,199	64,367	102,577	144,903
Intervention 3: Improvement in value chain Production that will pass through improved value chain (both for domestic and international market	40	86	137	194
Gross revenue from the improved value chin (US$)	10,803	28,252	53,351	87,130
Total Expected Additional Gross Benefits	**104.5**	**220,5**	**348.9**	**491.1**

1.27.3. Costs and Investments

The above proposed interventions will add cost of producing, processing, and value addition of carrots and turnip. The costs of the proposed interventions involve two types of costs i) value chain improvement costs and ii) sector support investment costs.

i. Operational Cost at Value Chain Level

The major cost drivers in carrot and turnips value chain are the; a) Cost of production inputs and harvest; b) Cost of washing, grading and packaging c) Cost of transportation; d) Cost of processing and marketing; and e) Cost of wholesale, retailing and shelfing. The additional operating cost structure for carrot and turnips value chain in focal points of previously defined clusters is presented in Table 29. All the production and processing level operational costs add up to US$0.588 million during the last year of the project at just the focal point of the cluster.

Table 29: Cost structure at value chain level in focal point Central KP cluster

		Year 1	Year 2	Year 3	Year 4	Year 5
Total cost/Ha for Carrot & Turnips in Central KP cluster	**728**	Incremented costs/year based on total area of focal point				
Percent increase in the cost of production (Inputs & Harvest)		0%	18%	35%	53%	70%
Total increase in cost of production (Inputs & Harvest) (USD)	235	0	846	3,404	7,709	13,794
Percent increase in the cost of washing, grading & packaging for local market		0%	6%	13%	19%	25%
Total increase in the cost of washing, grading & packaging for local market (USD)	122	0	107	419	923	1,603
Percent increase in Cost of transportation & value addition (washing grading and packaging) in Pack House		0%	0%	0%	0%	0%
Total increase in cost of transportation & value addition (washing grading and packaging) in Pack House (USD)	261	0	8,654	18,445	29,394	41,523
Percent increase in the cost of transportation from field to market		0%	6%	13%	19%	25%
Total increase in the cost of transportation from field to market (USD)	61	0	79	316	717	1,282
Percent increase in the cost of wholesale, shelfing & retailing		0%	6%	13%	19%	25%
Total increase in the cost of wholesale, shelfing & retailing (USD)	49	0	43	168	369	641
Total increase in the cost			*9,728*	*22,752*	*39,112*	*58,843*

Note: Based on extensive consultation with stakeholders, it is evaluated that the total cost/ha of turnips value chain is $728/ha in District Buner of Central KP cluster. Production/harvest cost is estimated to be 32% of the total cost/ha. Similarly, the costs of washing, grading & packaging is 17%, Cost of transportation is 8% and cost of Wholesale, Shelfing & Retailing is 7% of total cost/ha. Cost of transportation is cost of transporting one

ha produce from field to local market. The cost of transportation and value addition of carrot and turnip in pack house is 36% of total cost/ha. These costs are expected to escalate over the period of 5 years along the expansion of volumes, services and new transactions in value chain due to positive effects of cluster development interventions. The yearly value chain costs have been calculated by multiplying increase in cost/ha in particular cost head with total number of has in focal point. In District Buner, the production/harvest costs are expected to increase by 70% in five years. Similarly, increase in costs of washing, grading & packaging, transportation, and shelfing/retailing are set to 25% over five years.

ii. System Level Investment

An investment of US$0.78 million is needed to support the cluster development efforts in focal point (district Bunir) of central KP cluster (Table 30). The major investment would be on establishing the pack houses followed by market/export level investment. About 36% of this investment will be made by the public sector in terms of strengthening research and development activities, incentivizing the establishment of pack houses and market level investment. With these investments, the private sector will bring the remaining 64% investment. The Federal government will share 20% of the total public funding while remaining 80% may come from the provincial government by establishing a Cluster Development Fund under PCP.

The highest investment would be on setting up pack houses where basic facility of washing, grading, packing, etc. would be available. Four collection centers would be established in Central KP. These centers will be owned by FEGs. Any farmers can use the service of the center and even can use the brand name of the center on charge basis. The profit of the center could be shared among farmers based on their investment share in establishing the center.

Table 30. Investment requirements (US$) in Central KP Cluster focal point

Description	Total	Year-1	Year-2	Year-3	Year-4
Investments required on R&D	111,111	44,444	33,333	16,667	16,667
Investments required for value chain improvement-pack house	557,120	139,280	139,280	139,280	139,280
Investments on market/export interventions	111,111	44,444	33,333	16,667	16,667
Government loan on private investment	61,283	15,320.80	15,320.80	15,320.80	15,320.80
Total investments (USD)	**779,342**	**243,490**	**221,267**	**187,934**	**187,934**

1.27.4. Economic Viability

The estimated Net Present Value (NPV) of all the interventions over the period of five year is positive t 0.241 million, and the Internal Rate of Return (IRR) is 24% (Table 31).

Table 31. Economic Analysis of the Upgradation Plan in Central KP Focal Point

Value Chain Based Costing (000)	Year1	Year 2	Year 3	Year 4	Year 5
Net cash flow (undiscounted) after deducting costs and investments (US$)	-365,880	-144,889	132,726	285,457	589,179
Net Present value (US$)= 241,429					
Estimated Internal Rate of Return (IRR)= 24%					

1.28. Focal Point of Punjab cluster (Sheikhupura)

1.28.1. Interventions and Implementing Agencies

The program will have five main components:

1. Improvement in productivity by introducing improved varieties and management practices.
2. Introduction of carrot and turnip planter
3. Introduction of carrot a turnip harvester
4. Improvement in export-production ratio by introducing market/export level strategies
5. Improvement in value chain by establishing value chain infrastructure like pack-houses.

These interventions will be introduced in collaboration with various agencies like PARC, provincial agriculture departments, and private sector (Table 32).

Table 32. Interventions and implementing agencies Sheikhupura of Central Punjab cluster

S#	Cluster Strategy	Interventions	Implementing Agency
1	Production level strategies *(Increase yield by 25% in 5 years and reduce import of carrot and turnips to zero)*	Importing high yielding good quality cultivars	PARC, AARI, UAF, AMRI, Private Seed Companies
		Adaptability testing and supply of certified seed to the farmers	
		Strengthening the breeding program and seed production of carrot & turnips in the region	
		Development of economical and sustainable production technology package involving mechanization of cultural practices (Sowing & Harvesting)	
		Import of carrot sowing and harvesting machinery, reverse engineering of the machines for local adaptation, demonstration of their operations in the field and training of farmers for their operations.	PARC, AMRI, private sector

		Establishment of demonstration plots and training of farmers for improved production practices	Agri. Extension Dept. Punjab
2	Improvement in Value chain *(Improve post-harvest practices and fetch higher price for export)*	Incentivize the private sector to establish fresh carrot & turnips handling units/Pack Houses (Washing, grading & Packaging)	PARC, PHRC (AARI)
		Branding of the product	
3	Processing & Value addition strategies *(To process 2.5% of the fresh produce for frozen carrot production*	Encouraging the private sector to establish one IQF plants for frozen carrot production	
		Branding of IQF frozen carrot and carrot mix recipes	PARC, PHRC (AARI), PFVA, private sector
3	Marketing & Trading level strategies *(Increase the export to production ratio up to 2.5% in five years; Improve the quality and export price up to international standard)*	One window operation for quality and quarantine certification	PFVA & PARC
		Provision of market information on standards, price and potential customer segments	
		Sponsor international tours for high potential exporters	
		Holding of competition and rewards for exporters	
		Provide incentives for adopting best practice and certification regimes	
		Establish a carrot and turnips exporters association under umbrella of PFVA with a website and marketing apps	
		Train the stakeholders to adopt ISPMs as per IPPC	

1.28.2. Interventions and Benefits

It is assumed that the introduced intervention at production level will increase productivity by 25% which will be achieved gradually over a period of 4 years starting from the 2nd year and will add gross revenue of US$0.96 million during the last year of the project (Table 33).

Incentivizing the introduction of mechanical harvesters through 20% subsidy, interest-free loans, and demonstration of the impact of mechanical harvesting on the saving of post-harvest losses will add the gross revenue of farmers by US$0.048 million in the Shiekhupura focal point of Punjab cluster. About four harvesters will be planted during the project period. Four mechanical harvesters will be introduced in the focal point during the project period.

The market level interventions like improving interaction with international market and getting awareness of these markets is expected to increase export from 0.02% to 5% which

will gradually increase and bring a gross revenue of US$0.64 million during the last year of the project (Table 33).

The improvement in value chain by introducing pack-house in the focal point of the cluster will improve the quality thus price of the produce which will be treated in the pack house. This is expected to increase prices of the export from US$373 to US$454 tonne. In addition, 2.5% of the produce destined in domestic market will also get international price. This will generate a total gross revenue of UD$0.4 million during the last year of the project. All these interventions will generate a total gross revenue of US$2.1 million during the last year of the project (Table 33).

Table 33: Gross Revenue from interventions in focal point of Central Punjab cluster

Parameters [All amounts: 000USD]	Year 2	Year 3	Year 4	Year 5
Intervention-1: Yield increase (25% total)	6.25%	12.50%	18.75%	25.00%
Additional production (t)	1706	3397	5073	6733
Expected additional value (US$)	243,994	485,793	725,410	962,861
Intervention 2: Introducing mechanical sowing Saving in production due to mechanical sowing (ton)	85.31	169.86	253.64	336.66
Expected additional value (US$)	12200	24290	36271	48143
Intervention 3: increase in export-production ratio to 5%	1.25%	2.50%	3.75%	5.00%
Increase in export (ton)	364	772	1,221	1,712
Expected additional value from export (US$)	136,045	288,065	455,842	639,162
Intervention 4: Improvement in value chain Production that will pass through improved value chain (both for domestic and international market	45,425	103,485	175,286	261,917
Gross revenue from the improved value chain (US$)	52,788	134,667	249,301	400,291
Total Expected Additional Gross Benefits (000 US$)	*445.03*	*932.8*	*1,466.8*	*2,050.5*

1.28.3. Costs and Investments

The above proposed interventions will add cost of producing, processing, and value addition of carrots and turnip. The costs of the proposed interventions involve two types of costs i) value chain improvement costs and ii) sector support investment costs.

i. Operational Cost at Value Chain Level

The major cost drivers in carrot and turnips value chain are the; a) Cost of production inputs and harvest; b) Cost of washing, grading and packaging c) Cost of transportation; d) Cost of processing and marketing; and e) Cost of wholesale, retailing and shelfing. The additional operating cost structure for carrot and turnips value chain in focal points of previously defined clusters is presented in Table 34.

In this cluster, mechanical transplanters will be introduced which will improve the cost efficiency as it will have lower transplanting cost than manual transplanting. This is reflected in negative cost of transplanting. On the other hand, mechanical harvesting has positive costs, but it will reduce harvest losses as reflected in gross revenue in the previous section.

Table 34: Cost structure at value chain level in focal point Central Punjab cluster

			Year 1	Year 2	Year 3	Year 4	Year 5
Total cost/Ha for Carrot & Turnips in Central Punjab cluster	**3147/ha**		Incremented costs/year based on total area of focal point				
Percent increase in the cost of production (Inputs & Harvest)		27%	0%	7%	14%	20%	27%
Total increase in cost of production (Inputs & Harvest) (USD)	513/ha		0	2,888	11,329	25,248	44,571
Percent increase in the cost of washing, grading & packaging for local market		25%	0%	6%	13%	19%	25%
Total increase in the cost of washing, grading & packaging for local market (USD)			0	492	1,905	4,146	7,120
Percent increase in cost of transportation & value addition (washing grading and packaging) in Pack House	0	0	0	0	0	0	0
Total increase in cost of transportation & value addition (washing grading and packaging) in Pack House (USD)	64/ton	0	0	35,075	74,269	117,526	164,789
Percent increase in the cost of transportation from field to market		25%	0%	6%	13%	19%	25%
Total increase in the cost of transportation from field to market (USD)			0	708	2,821	6,318	11,181
Percent increase in the cost of marketing		0%	0%	0%	0%	0%	0%
Total increase in the cost of processing & marketing (000USD)	2074		0	20.099	42.345	66.704	93.143
Percent increase in the cost of wholesale, shelfing & retailing		25%	0%	6%	13%	19%	25%

Total increase in the cost of wholesale, shelfing & retailing (000USD)	53/ton		0	197	762	1,658	2,848
Cost of mechanical harvesting (USD)	221/ha	268	537	805	1,073	268	537
Cost of mechanical planter (USD)	-75/ha	-6154	-12309	-18463	-24617	-6154	-12309
Total increase in the cost (000USD)				*33,474*	*79,314*	*137,237*	*206,966*

Note: Based on extensive consultation with stakeholders, it is evaluated that the total cost/ha of carrot & turnips value chain is $3147/ha in District Sheikhupura of Central Punjab cluster. Production/harvest cost is estimated to be 16% of the total cost/ha. Similarly, the costs of washing, grading & packaging is 4%, Cost of transportation is 4% and cost of Wholesale, Shelfing & Retailing is 2% of total cost/ha. The cost of transportation and value addition of carrot and turnip in pack house is 8% of total cost/ha. These costs are expected to escalate over the period of 5 years along the expansion of volumes, services and new transactions in value chain due to positive effects of cluster development interventions except the cost of processing. The yearly value chain costs have been calculated by multiplying increase in cost/ha in particular cost head with total number of has in focal point. In District Sheikhupura, the costs of production/harvest, washing, grading & packaging, transportation, and shelfing/retailing are set to increase by 27%, 25%, 25% & 25% over five years. Thus the added total costs in 5th year stand at $0.207 million with total cost/ha of 3590 US$ (Table 34).

i. System Level Investment.

An investment of US$2.2 million is needed to support the cluster development efforts in focal point (district Sheikhupura) of central Punjab cluster (Table 35). The major investment would be on establishing the pack houses followed by market/export level investment. About 41% of this investment will be made by the public sector in terms of strengthening research and development activities, incentivizing the establishment of pack houses and promoting the mechanical transplanters and harvesters, and market level investment. With these investments, the private sector will bring the remaining 59% investment. The Federal government will share 20% of the total public funding while remaining 80% may come from the provincial government by establishing a Cluster Development Fund under PCP.

The highest investment would be on setting up pack houses where basic facility of washing, grading, packing, etc. would be available. Nine collection centers would be established in Central KP. These centers will be owned by FEGs. Any farmers can use the service of the center and even can use the brand name of the center on charge basis. The profit of the center could be shared among farmers based on the share of their investment in establishing the center.

A significant higher amount of R&D strengthening is allocated for this cluster because to strengthen the role of AARI in carrot research especially in its station in Sheikhupura. Four

mechanical harvesters and four mechanical transplanters will be incentivized through 20% subsidy which will cost respectively US$2.18 thousand and US$9.9 thousands.

Table 35. Investment requirements (US$) in Central Punjab Cluster focal point

Description	Total	Year-1	Year-2	Year-3	Year-4
Investments required on R&D	444,444	177,778	133,333	66,667	66,667
Investments on value chain improvement-pack house	1,253,520	278,560	278,560	278,560	417,840
Investment required on harvester	2,185	546	546	546	546
Investment on planter	9,926	2,481	2,481	2,481	2,481
Investments on marketing/export	370,370	148,148	111,111	55,556	55,556
Government loans	139,219	30,975	30,975	30,975	46,295
Total investments	2,219,665	887,866	665,900	332,950	332,950

1.28.4. Economic Viability

The estimated Net Present Value (NPV) of all the interventions over the period of five year is positive at 1.32 million, and the Internal Rate of Return (IRR) is 42% (Table 36).

Table 36. Net Cash flow, NPV, and IRRI of the upgradation Plan in Central Punjab Focal Point

Value Chain Based Costing (000)	Year1	Year 2	Year 3	Year 4	Year 5
Net cash flow (undiscounted) after deducting all costs and investments (US$)	-887,866	-254,346	520,550	996,637	1,843,492
Net Present value (US$)= 1,318,330					
Estimated Internal Rate of Return (IRR)= 42%					

1.29. Focal point of Balochistan cluster (Killa Saifullah)

1.29.1. Interventions and Implementing Agencies

The program will have five main components:

1. Improvement in productivity by introducing improved varieties and management practices.
2. Introduction of carrot and turnip planter
3. Introduction of carrot a turnip harvester
4. Improvement in export-production ratio by introducing market/export level strategies
5. Improvement in value chain by establishing value chain infrastructure like pack-houses.

These interventions will be introduced in collaboration with various agencies like PARC, provincial agriculture departments, and private sector (Table 37).

Table 37. Interventions and implanting agencies for district Killa Saifullah of Balochistan cluster

S#	Cluster Strategy	Interventions	Implementing Agency
1	Production level strategies *(Increase yield by 25% in 5 years and reduce import of carrot and turnips to zero)*	Organization of carrot farmers	PARC, Agriculture Research Department, Balochistan, PFVA, Private Seed Companies
		Importing high yielding good quality cultivars	
		Adaptability testing and supply of certified seed to the farmers	
		Strengthening the breeding program and seed production of carrot & turnips in the region	
		Development of economical and sustainable production technology package involving mechanization of cultural practices (Sowing & Harvesting)	PARC, DFM, Private Agricultural Companies
		Import of carrot sowing and harvesting machinery, reverse engineering of the machines for local adaptation, demonstration of their operations in the field and training of farmers for their operations	
		Establishment of demonstration plots and training of farmers for improved production practices	Agri. Extension Dept. Balochistan
2	Improvement in Value chain *(Improve post-harvest practices and fetch higher price for export)*	Incentivize the private sector to establish fresh carrot handling units/Pack Houses(Washing, grading & Packaging)	PARC, DPH&FT
		Branding of the fresh produce	

3	Marketing & Trading level strategies *(Increase the export to production ratio up to 2.5% in five years; Improve the quality and export price up to international standard)*	One window operation for quality and quarantine certification	PFVA, PARC & DPH&FT
		Provision of market information on standards, price and potential customer segments	
		Sponsor international tours for high potential exporters	
		Holding of competition and rewards for exporters	
		Provide incentives for adopting best practice and certification regimes	
		Establish a carrot and turnips exporters association under umbrella of PFVA with a website and marketing apps	
		Train the stakeholders to adopt ISPMs as per IPPC	

1.29.2. Interventions and Benefits

It is assumed that the introduced intervention at production level will increase productivity by 25% which will be achieved gradually over a period of 4 years starting from the 2nd year and will add gross revenue of US$1.15 million during the last year of the project (Table 38).

Incentivizing the introduction of mechanical sowing through 20% subsidy, free interest loans, and demonstration of the impact of mechanical harvesting on the saving of post-harvest losses will add the gross revenue of farmers by US$0.0.058 million in the Killa Saifullah focal point of Balochistan cluster. About four planters will be introduced during the project period. All these interventions will generate a total gross revenue of US$1.2 million during the last year of the project (Table 38).

Table 38. Gross Revenue from interventions in focal point of Central Punjab cluster

Parameters [All amounts: 000USD]	Year 2	Year 3	Year 4	Year 5
Intervention-1: Yield increase (25% total)	6.25%	12.50%	18.75%	25.00%
Additional production (t)	1173	2349	3528	4710
Expected additional value (US$)	286,562	573,812	861,750	1,150,379
Intervention 2: Introducing mechanical sowing Saving in production due to mechanical sowing (ton)	14.66	58.73	132.30	235.48
Expected additional value (US$)	3582	14345	32316	57519
Total Expected Additional Gross Benefits (000 US$)	*290,144*	*588,157*	*894,066*	*1,207,898*

1.29.3. Costs and Investments

The above proposed interventions will add cost of producing, processing, and value addition of carrots and turnip. The costs of the proposed interventions involve two types of costs i) value chain improvement costs and ii) sector support investment costs.

i. Operational Cost at Value Chain Level

The major cost drivers in carrot and turnips value chain are the; a) Cost of production inputs and harvest; b) Cost of washing, grading and packaging c) Cost of transportation; d) Cost of processing and marketing; and e) Cost of wholesale, retailing and shelfing. The additional operating cost structure for carrot and turnips value chain in focal points of previously defined clusters is presented in Table 39. The major increase in the operational cost would be due to the introduction of new varieties and management system. In this cluster, mechanical transplanters will be introduced which will improve the cost efficiency as it will have lower transplanting cost than manual transplanting. This is reflected in negative cost of transplanting. On the other hand, mechanical harvesting has positive costs, but it will reduce harvest losses as reflected in gross revenue in the previous section.

Table 39: Cost structure at value chain level in focal point Balochistan cluster

			Year 1	Year 2	Year 3	Year 4	Year 5
Total cost/Ha for Carrot & Turnips in Balochistan cluster	**1412**		Incremented costs/year based on total area of focal point				
Percent increase in the cost of production (Inputs & Harvest)		14%	0%	4%	7%	11%	14%
Total increase in cost of production (Inputs & Harvest) (USD)	630		0	1,482	6,008	13,700	24,678
Percent increase in the cost of washing, grading & packaging for local market		25%	0%	6%	13%	19%	25%
Total increase in the cost of washing, grading & packaging for local market (USD)	130		0	545	2,209	5,036	9,072
Percent increase in Cost of transportation & value addition (washing grading and packaging) in Pack House		0	0	0	0	0	0
Total increase in cost of transportation & value addition (washing grading and packaging) in Pack House (USD)	341		0				
Percent increase in the cost of transportation from field to market		25%	0%	6%	13%	19%	25%
Total increase in the cost of transportation from field to market (000USD)	259		0	1,090	4,417	10,072	18,143

Percent increase in the cost of wholesale, shelfing & retailing		25%	0%	6%	13%	19%	25%
Total increase in the cost of wholesale, shelfing & retailing (USD)	52		0	218	883	2,014	3,629
Cost of mechanical harvesting (USD)	221/ha	218	435	653	870	218	435
Cost of mechanical planter (USD)	-75/ha	-4,955	-9,911	-14,866	-19,822	-4,955	-9,911
Total increase in the cost (USD)				*-1,404*	*4,042*	*16,609*	*36,570*

Note: Based on extensive consultation with stakeholders, it is evaluated that the total cost/ha of carrot value chain is $1412/ha in District Killa Saifullah of Balochistan cluster. Production/harvest cost is estimated to be 45% of the total cost/ha. Similarly, the costs of washing, grading & packaging is 9%, Cost of transportation is 18% and cost of Shelfing & retailing is 4% of total cost/ha. Cost of transportation is cost of transporting one ha produce from field to Faisalabad market. The cost of transportation and value addition of carrot and turnip in pack house is 24% of total cost/ha. These costs are expected to escalate over the period of 5 years along the expansion of volumes, services and new transactions in value chain due to positive effects of cluster development interventions. The yearly value chain costs have been calculated by multiplying increase in cost/ha in particular cost head with total number of has in focal point. In District Killa Saifullah, the costs of production/harvest, washing, grading & packaging, transportation, and shelfing/retailing are set to increase by 14%, 25%, 25% & 25% over five years. Thus the added total costs in 5th year stand at $0.366 million (Table 39).

i. System Level Investment.

An investment of US$0.457 million is needed to support the cluster development efforts in focal point (district Killa Saifulah) of central Punjab cluster (Table 40). The major investment would be on establishing the pack houses followed by market/export level investment. About 98% of this investment will be made by the public sector in terms of strengthening research and development activities, promoting the mechanical transplanters and harvesters, and market level investment. In this cluster, the major role is played by the public sector, except that farmers will invest on harvesters and planters with government support. The Federal government will share 20% of the total public funding while remaining 80% may come from the provincial government by establishing a Cluster Development Fund under PCP.

A significant higher amount of R&D strengthening is allocated for this cluster to strengthen the role of AZRI in carrot research especially in Kill Safullah. Four mechanical harvesters and four mechanical transplers will be incentivized through 20% subsidy which will cost respectively US$2.18 thousand and US$9.9 thousands.

Table 40. Investment requirements (US$) in Balochistan Cluster focal point

Description	Total	Year-1	Year-2	Year-3	Year-4
Investments required on R&D	444,444	177,778	133,333	66,667	66,667
Investment on harvester	2,185	546	546	546	546
Investment on planter	9,926	2,481	2,481	2,481	2,481
Government loans	1332	333	333	333	333
Total investments	456,556	182,622	136,967	68,483	68,483

1.29.4. Economic Viability

The estimated Net Present Value (NPV) of all the interventions over the period of five year is positive at 1.7 million, and the Internal Rate of Return (IRR) is 176% (Table 41).

Table 41. Net Cash flow, NPV, and IRRI of the upgradation Plan in Central Punjab Focal Point

Value Chain Based Costing (000)	Year1	Year 2	Year 3	Year 4	Year 5
Net cash flow (undiscounted) after deducting all costs and investments (US$)	-182,622	154,581	515,632	808,974	1,171,328
Net Present value (US$)= 1,729,407					
Estimated Internal Rate of Return (IRR)= 176%					

1.30. Conclusions

Increase in per unit production of carrot and turnips will directly result in economic uplift of farmers. Likewise, increase in export and processing of fresh turnip and carrots will help to stabilize the domestic market prices of the commodity, which otherwise cause heavy economic loss to the farmers during glut period of the crop. Export will create new business and employment opportunities.

Any environmental degradation is unlikely to happen from carrot and turnips promotion. Carrot and turnips are among the vegetables which receive minimum to zero pesticides applications. No big positive or negative environment change is expected to occur by promotion of carrot and turnips clusters and proposed interventions. In conclusion, the overall economic, social and environmental impact of the cluster development program shall be positive, sustainable and long lasting.

PROGRAMS AND PLANS

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

In support of the strategies and interventions proposed in section 9 of this report, the following programs/plans are recommended to further strengthen the interventions and to creating greater opportunities for participation and learning in focal point of each cluster.

1.31. Program for Organization and Networking of Stakeholders

The following program is proposed for organization of stakeholders at different levels of value chain. Farmer level organization is being proposed specifically for upper & central KP clusters.

Table 42: Program for organization and networking of stakeholders

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1. District Swat (Upper KP cluster)				
1.1	• Form Turnips Farmers Entrepreneur Groups (FEGs) at union council level • Form one Farmer Enterprise Group (FEG) at district level. having a membership of at least 25 farmers.	Organization of turnip farming community for collective action	KP Agri. Extension Department	Short to medium term (1 to 2 years)
1.2	• Form fresh turnips exporters Association at market/business level. At least 4 exporters should be initially involved.	Improve coordination between the stakeholders of turnips value chain	NGOs, Private Sector	Short to medium term (1 to 2 years)
2. District Buner (Central KP cluster)				
2.1	• Form Turnips Farmers Entrepreneur Groups (FEGs) at union council level • Form one Farmer Enterprise Group (FEG) at district level. having a membership of at least 25 farmers.	Organization of turnip farming community for collective action	KP Agri. Extension Department	Short to medium term (1 to 2 years)
2.2	• Form fresh turnips exporters Association at market/business level. At least 4 exporters should	Improve coordination between the	NGOs, Private Sector	Short to medium term (1 to 2 years)

	be initially involved.	stakeholders of turnips value chain		
3. District Sheikhupurar (Central Punjab cluster)				
3.1	• Form fresh carrot & turnips turnips exporters & processors Association at market/business level. At least 5 exporters and 2 processors should be initially involved.	Improve coordination between the stakeholders of carrot & turnips value chain	PFVA, Provincial Agri R&D department, Private Sector	Short to medium term (1 to 2 years)
4. District Killa Saifullah (Balochistan cluster)				
4.1	• Form fresh carrot exporters Association at market/business level. At least 5 exporters should be initially involved.	Improve coordination between the stakeholders of carrot & turnips value chain	PFVA, Provincial Agri R&D department, Private Sector	Short to medium term (1 to 2 years)

These district level exporter association should be linked with proposed national level Carrot and Turnips exporters and processors association under the umbrella of Pakistan Fruits and Vegetables Exporters, Importers and Merchants Association.

1.32. Program for Research Reform

The following program indicative areas for further research to strengthen the carrot & turnip clusters in the focal points of identified clusters are proposed along with the estimated costs.

Table 43: Program for research reforms

S#.	Identification of Areas for Further Research	Research Purpose/ Priority	Indicative Research Institutions
1. District Swat (Upper KP Cluster)			
1.1	• Identify suitable high yielding cultivars • Develop improved production technology package for turnip growers • Introducion of hand driven turnip seed drills	Turnips production improvement Short to medium term (1 to 2 years)	PARC, VRP (ARI,KP), KP agri. Extension Department
1.2	• Develop strategy for quickly distributing improved cultivars and production technology among farmers • Establishment of turnips model plots at Union Council level	Improve cultural practices & hence turnips production Short to medium term (1 to 2 years)	PARC, VRP (ARI,KP), KP agri. Extension Department
1.3	• Consultation with fresh vegetable exporters to assess interest in value chain improvement & establishing a Turnips Exporters Association • Scoping survey to identify new products and potential buyers	Create market Linkages for quality turnips (Domestic and Export) Medium to long Term (2 to 5 years)	Private businesses, Export promotion board, Embassies, PFVA
1.4	• Research into Climate change related negative impacts such as new diseases and shifts in crop cycle	Investigate into climate related negative impacts on horticulture	PARC, VRP (ARI,KP), KP agri. R&D Department

		Medium to Long term (2 to 5 years)	
2.1	• Identify suitable high yielding cultivars • Develop improved production technology package for turnip growers • Introducion of hand driven turnip seed drills	Turnips production improvement Short to medium term (1 to 2 years)	PARC, VRP (ARI,KP), KP agri. Extension Department
2.2	• Develop strategy for quickly distributing improved cultivars and production technology among farmers • Establishment of turnips model plots at Union Council level	Improve cultural practices & hence turnips production Short to medium term (1 to 2 years)	PARC, VRP (ARI,KP), KP agri. Extension Department
2.3	• Consultation with fresh vegetable exporters to assess interest in value chain improvement & establishing a Turnips Exporters Association • Scoping survey to identify new products and potential buyers	Create market Linkages for quality turnips (Domestic and Export) Medium to long Term (2 to 5 years)	Private businesses, Export promotion board, Embassies, PFVA
2.4	• Research into Climate change related negative impacts such as new diseases and shifts in crop cycle	Investigate into climate related negative impacts on horticulture Medium to Long term (2 to 5 years)	PARC, VRP (ARI,KP), KP agri. R&D Department
3. District Sheikhupura (Central Punjab cluster)			
3.1	• Identify suitable high yielding cultivars for early normal and late sowing • Develop improved production technology package for carrot & turnip growers • Introducion of hand driven & tractor mounted seed drills and harvesters	Carrot & Turnips production improvement Short to medium term (1 to 2 years)	PARC, AARI, UAF, AMRI, Private Seed Companies
3.2	• Develop strategy for quickly distributing improved cultivars and production technology among farmers • Establishment of carrot & turnips model plots at Union Council level	Improve cultural practices & hence production Short to medium term (1 to 2 years)	PARC & Povincial Agri. Extension Department
3.3	• Development of Seed production technology and local seed production • Consultation with private seed companies to access interest & potential for local seed production	Increase local seed production Short to medium term (1 to 2 years)	PARC, AARI & Private Seed Companies
3.3	• Consultation with fresh vegetable exporters and processors to assess interest in value chain improvement and processing & establishing a Carrot & Turnips Exporters Association • Scoping survey to identify new products/frozen carrots and potential buyers	Create market Linkages for quality freshed carrot & turnips and processed/frozen carrots (Domestic and Export) Medium to long Term (2 to 5 years)	PARC, PHRC PFVA

3.4	• Research into Climate change related negative impacts such as new diseases and shifts in crop cycle	Investigate into climate related negative impacts on horticulture Medium to Long term (2 to 5 years)	PARC, UAF, AARI
	•		
4. District Killa Saifullah (Balochistan cluster)			
3.1	• Identify suitable high yielding cultivars for early normal and late sowing • Develop improved production technology package for carrot growers • Introducion of hand driven & tractor mounted seed drills and harvesters	Carrot production improvement Short to medium term (1 to 2 years)	PARC, Agriculture Research Department, Balochistan, DFM
3.2	• Develop strategy for quickly distributing improved cultivars and production technology among farmers • Establishment of carrot & turnips model plots at Union Council level	Improve cultural practices & hence production Short to medium term (1 to 2 years)	PARC & Povincial Agri. Extension Department
3.3	• Consultation with fresh vegetable exporters to assess interest in value chain improvement & establishing a Carrot Exporters Association • Scoping survey to identify new products/frozen carrots and potential buyers	Create market Linkages for quality freshed carrot (Domestic and Export) Medium to long Term (2 to 5 years)	PARC, DPH&FT , PFVA
3.4	• Research into Climate change related negative impacts such as new diseases and shifts in crop cycle	Investigate into climate related negative impacts on horticulture Medium to Long term (2 to 5 years)	Provincial R&D Department, PARC

The estimated costs for research plan mentioned in the above table have already been counted as part of the cluster investments given in Section 9.

ANNEXURES:

Annexure 1: Macro Data Resources

- Agriculture Book; Balochistan (http://balochistan.gov.pk/index.php?option=com_docman&task=doc_download&gid=7537&Itemid=677)
- Applicable discount rate set by SBP accessed on 25-Oct-2018 (http://www.sbp.org.pk/ecodata/index2.asp)

- Carrot & Turnips area; All countries (http://www.factfish.com/statistic/carrots%20and%20turnips%2C%20area%20harvested)
- Carrot & Turnips export weight; All countries (http://www.factfish.com/statistic/carrots%20and%20turnips%2C%20fresh%20or%20chilled%2C%20export%20weight)
- Carrot & Turnips import weight; All countries (http://www.factfish.com/statistic/carrots%20and%20turnips%2C%20fresh%20or%20chilled%2C%20import%20weight)
- Carrot & Turnips production; All countries (http://www.factfish.com/statistic/carrots%20and%20turnips%2C%20production%20quantity)
- Carrot & Turnips yield; All countries (http://www.factfish.com/statistic/carrots%20and%20turnips%2C%20yield)
- Carrot: Nutrition facts & health benefits (https://www.healthline.com/nutrition/foods/carrots)
- District Wise Area & Production of Carrot & Turnips in KP (http://crs.kp.gov.pk/)
- Health benefits of turnips (https://www.medicalnewstoday.com/articles/284815.php)
- Kharif crops final estimates data book 2016-17 (http://crs.agripunjab.gov.pk/reports)
- MNFS&R (Ministry of National food Security and Research (2017) Agricultural statistics of Pakistan 2015-16, Economic Wing, MNFS&R, Islamabad. (http://www.mnfsr.gov.pk/frmDetails.aspx)
- MNFS&R (Ministry of National Food Security and Research) (2017) Fruit, vegetables & condiments statistics of Pakistan 2004-05 to 2015-16, Economic Wing, MNFS&R, Islamabad (www.amis.pk/files/F&V%20Statistics%202015-16.pdf)
- Pakistan Carrot & Turnips Export (Fresh and Chilled) (http://www.factfish.com/statistic-country/pakistan/carrots%20and%20turnips%2C%20fresh%20or%20chilled%2C%20export%20weight)
- Pakistan Carrot & Turnips Import (Fresh and Chilled) (http://www.factfish.com/statistic-country/pakistan/carrots%20and%20turnips%2C%20fresh%20or%20chilled%2C%20import%20weight)
- PBS (Pakistan Bureau of Statistics) (2010) Agricultural Census of Pakistan 2010, PBS, Islamabad (http://www.pbs.gov.pk/content/agricultural-census-2010-pakistan-report)
- Prefeasibility study; IQF Vegetables/Fruits (http://www.agripunjab.gov.pk/system/files/3%20-

%20Frozen%20Fruits%20and%20Vegetables%20Processing%20Unit%20-%20IQF.pdf)

Annexure 2: List of Stakeholders Consulted

Sr.#	Name	Address
1	Hayat Ullah (Seed, Pesticide and Fertlizer dealer)	Kassan Zarai Spray Centre, Kunda Mor, Sawabi 0346-9833362
2	Syed Hadayt Hussain (Seed, Pesticide and Fertlizer dealer & Carrots/Turnip Farmer)	Zarai Falahi Markaz, Meros Mandi, Mardan 0334-9492806
3	Latif Ur Rehman (Seed, Pesticide and Fertlizer dealer)	Haseeb Seed Store, Peshawar 0300-5902756
4	Altaf Ahmad (Seed Importer/Dealer)	Gull International, Rawalpindi 0300-5163812
5	Hadayt Ullah (Carrots/Turnip Farmer)	Kunda More, Sawabi
6	Wasif Ali (Carrots/Turnip Farmer)	Village Tolandi, Shera Adda sawabi 0333-9417928
7	Mian Tahir Saeed (Carrots/Turnip Farmer)	Jhumra, Faisalabad 0300-8665110
8	Buland Iqbal (Seed, Pesticide and Fertlizer dealer)	Sheva Adda, Sawabi 0302-5683942
9	Raees Zaman (Agronomist, ICI Seeds, KP)	ICI Seeds, Sawabi 0303-7772702
10	Dr. Ahmad Din (Food Technologist)	Post-Harvest Research Institute, AARI, Faisalabad 0321-7535783
11	Dr. Ubaid Ur Rehman Director Seed, CKD Seeds,	Chaudhary Khair Din & Sons, Gujranwala 0300-8698182
12	Mr. Gulzar (Turnip Grower)	Fasal Chak, Qila Deedar Singh, Gujranwala (0302-666202)1
13	Abdul Jalal (Carrot Grower)	Mara Tangi, Nekheter, Loralai (0333-7190390)
14	Syed Usman Ali (Fresh Carrot & Turnip Exporter)	Suaz & Co. (pvt.) Ltd., Rawalpindi (0345-5161685)

Annexure 3: References (Literature Reviewed)

Agriculture Department, Government of Punjab. (2017). *Pre-Feasibility Study Individual Quick Frozen (IQF) Vegetables/Fruits*. Lahore: Retrieved from http://www.agripunjab.gov.pk/system/files/3%20-%20Frozen%20Fruits%20and%20Vegetables%20Processing%20Unit%20-%20IQF.pdf

Agriculture Department, Government of Punjab. (2018). *Feasibility Study Report Fruit & Vegetable Canning Unit*. Lahore: Retrieved from http://www.agripunjab.gov.pk/system/files/01-Fruit%20and%20Vegetable%20Canning%201.pdf.

Ahmad, H., Öztürk, M., Ahmad, W., & Khan, S. M. (2015). Status of Natural Resources in the Uplands of the Swat Valley Pakistan. In M. Öztürk, K. R. Hakeem, I. Faridah-Hanum & R. Efe (Eds.), *Climate Change Impacts on High-Altitude Ecosystems* (pp. 49-98). Cham: Springer International Publishing.

Ahmad, S. S., & Khan, M. Z. (2017). Role of farm services center regarding empowerment of vegetables growers in District Charsadda. *Sarhad Journal of Agriculture, 33*(3), 377-384.

Ahmad, T., Amjad, M., Nawaz, A., Iqbal, Q., & Iqbal, J. (2012). Socio-economic study of carrot cultivation at farm level in the Punjab province of Pakistan. *African Journal of Agricultural Research, 7*(6), 867-875.

All Pakistan Fruit & Vegetable Exporters Importers & Merchants Association. (2018). Brief about the PFVA retrieved from http://www.pfva.net.

Bacha, M. S., Nafees, M., & Adnan, S. (2018). Farmers' Perceptions about Climate Change Vulnerabilities and their Adaptation Measures in District Swat. *Sarhad Journal of Agriculture, 34*(2), 311-326.

Bakhsh, K., Ashfaq, M., & Alam, M. W. (2005). Effects of poor quality of ground water on carrot production: A comparative study. *Journal of Agriculture and Social Sciences, 1*(1), 38-40.

FAOSTAT (Food and Agriculture Organization Statistics) Production, Crops http://www.fao.org/faostat/en/#data/QC

FAOSTAT, (Food and Agriculture Organization Statistics). 2020. Trade, Crops and Livestock Products http://www.fao.org/faostat/en/#data/TP

Fazl-E-Haider, S. (2017). Worrying times ahead for Balochistan's agriculture, *Pakistan & Gulf Economist Dated: 29th May, 2013*. Retrieved from

http://www.pakistaneconomist.com/2017/05/29/worrying-times-ahead-for-balochistans -agriculture/

Hassan, I., Bakhsh, K., Salik, M. H., Khalil, M., & Ahmad, N. (2005). Determination of factors contributing towards the yield of carrot in Faisalabad (Pakistan). International Journal of Agriculture and Biology, 7(2), 323-324.

Mahmood, I., Hassan, S., Bashir, A., Qasim, M., & Ahmad, N. (2017). Profitability analysis of carrot production in selected Districts of Punjab, Pakistan: An empirical investigation. Journal of Applied Environmental and Biological Sciences, 7(2), 188-193.

MNFS&R (Ministry of Food Security and Research). 2018. Agriculture Statistics of Pakistan 2017-18., Economic Wing, MNFS&R, Government of Pakistan, Islamabad.

MNFS&R (Ministry of National Food Security and Research (2017). Fruit, Vegetable & Condiments Statistics of Pakistan: Economic Wing, MNFS&R. Government of Pakistan, Islamabad.

Annexure 4: Feasibility study of Carrot and Turnip pack house

Carrot is one of the major vegetable produced and consumed in Pakistan and it occupies a prime position n among the winter vegetables. The production and consumption of Carrot and turnip is increasing in Pakistan. The issue of post-harvest handling facilities for horticultural products especially Carrot and turnip has not been attended, especially for the emerging farmers. In addition, the low prices that farmers have received from local markets have convinced most carrot and turnip growers to bypass local markets in established national markets, where demand is almost always high and prices are therefore good. In these markets, products can be sold to domestic and foreign consumers. They cannot afford to pay exorbitant membership fees and compliance with regulations and quality standards such as ISO, Hazard and Critical Control Point (HACCP) as required by both national and international retailers. For most of the interventions initiated, the development of post-harvest handling technologies in the form of fresh product depots and fresh product packaging would reduce post-harvest losses.

The aim of this study is to produce a feasibility report on the carrot and turnip pack house in the proposed cluster(s). The pack house will include packaging, grading and supply of cold stores, which could benefit emerging market producers to increase their income and gross output by supplying markets with high quality fresh carrot and turnip, processors and retailers.

Objective:

The objective of this feasibility study is to estimate feasibility of the pack-house in carrot and turnip for the future investors so that following functions in the value chain can be incorporated:

Cleaning, Insect pest and diseases control after harvest, grading, packing, cooling, loading etc.

The diagrammatic process flow is described below;

Harvesting

↓

Dumping into field lugs or bulk bins & placing into bags

Transportation to pack house

↓

Elimination of damaged fruits

↓

Washing, brushing with soap and fungicide & rinsing in fresh water

Drying & waxing

Sorting for quality & sizing & Packing in Cartons

Palletization, pre-cooling & Temporary storage

Loading and transportation to markets

Process flow of post-harvest handling of carrot and turnip in pack house

Packing Process

For designing a pack house following stages are required to be considered in general:

Step One

The first step is to know what the volume of carrot and turnip is needed to be processed during the season. This will determine what equipment will be needed, its capacity, the size of the building and cold storage. An important consideration for the packing shed location is the nearness to the production field and access roads. Since the packing shed is usually in operation during the hot summer months, a site with shade would be beneficial, although this may not be feasible for a small operation. To keep the building cool, good ventilation and fans will be needed. Insulation will also help keep the building cool.

Step Two

Next, develop a flow diagram of all the post-harvest handling processes, which will be used with carrot and turnip. This diagram will help the layout development of the packing shed.

The produce should always move in one direction, with no crossovers of the product from each step in the packing operation. This has become more important, as fresh produce handling methods must now include procedures and practices to prevent the spread of pathogens. Since there are no steps like heating to eradicate pathogens in carrot and turnip, action must be taken to prevent contamination and recontamination. There should be one door for receiving produce from the field, and one door for shipping packed produce out. The workers should wear gloves and avoid direct body touch with the produce.

Step Three

Arrangements must be made for a good water source and adequate utilities. Water used to wash the produce must be potable (safe to drink). An approximately 2-inch main water line with 1-inch laterals is recommended. The floors should be sloped to 6 inches wide drains that are 6- to 8-inches deep. Hot water is needed for cleanup and workers personal hygiene. The produce washing water should be chlorinated from 100 to 200 ppm. This recommended level kill pathogens that cause produce decay. However, it is not high enough to kill some food borne pathogens. The chlorine level should be checked throughout the day. As time passes, chlorine ions bind to organic matter and lose their effectiveness. Chlorination can be achieved by using household bleach, swimming pool chlorine or injection of compressed chlorine gas into the washing water. If a dump tank is used, the water should be changed

frequently, especially if root crops or ones that had contact with the ground are being packed.

Special attention needs to be given to the electrical requirements of the packing shed. It may be housing automated washing and sizing equipment, pre-cooling facilities and cold storage units. The refrigeration equipment for the cold storage and chilling water for hydro-cooling often requires 3-Phase electrical power.

Step Four

The disposal of both liquid and solid waste is an important consideration in designing and setting up a packing shed. Maintaining and conserving water quality becomes an issue for produce operations— how to properly handle wastewater from the packing line can also become a problem. Wastewater should never be dumped into the household septic system or the septic system for the toilets, showers and sinks in the packing facility.

The volume of wastewater will overwhelm these systems and reduce their effectiveness. Floor drains will be needed in the facility to carry wastewater to a separate septic field. The solid waste (culled produce) may be composted, spread on fallow fields or sold as animal feed.

Step Five

Design a receiving area and packing line, which is fit for individual needs. The receiving area should be elevated so that produce can be easily unloaded off the trucks or wagons carrying it from the field.

The height will depend on the vehicles used. Dollies, pallet jacks, and forklifts can then be used to load several harvest containers. The shipping area should also be elevated for easy loading to markets (Figure 2).

Loading Dock for carrots

- **Packing Lines**

The packing line is always multifunctional, regardless of whether it is a sink and table or a high-speed automated conveyor line. Photographs of different types of packing facilities are given below

Field Packing

Large scale packing line

Small scale packing line

Below are the parts of an all-purpose packing line:

A receiving area, which can include a dump tank to initially clean and cool produce.

A washing area, which can include the dump tank and a spray washer/brusher. This can be part of a conveyor belt system that automatically moves the produce, or simply a stock tank. The water used should be chlorinated at 100 to 200 ppm (Figure 6).

Figure 6: Automatic washer for carrot and turnips

A drying area for the wet produce.

Before being packed into containers, produce may be dried on sponges in a conveyor system or on screening tables.

An area for grading and sizing. Some culling can be done initially in the receiving area, especially if the produce is diseased, low grade or deformed. This can be a large table where produce can be spread out for inspection, a rotating table or conveyor belt with a seizer.

An area for packing produce into shipping, holding or marketing containers. This is often done in conjunction with grading and sizing.

There are specialized pieces of equipment for specific crops

Carrot and turnip are waxed to limit water loss for the wholesale market—therefore, it needs a waxer.

Carrot and turnip are sold in bags of various specifications; therefore pack house must have weighing machine to fill the bags according to the required specification.

Scales must be certified by Department of Agriculture Division of Weights and Measurements.

For high-end market, carrot and turnip are packed in corrugated boxes or in container. After produce has been packed into shipping containers, the container should be labeled with what it is; the size, count or net weight; grade; the shipper's name and address; the date packed and a tracking code that incorporates the harvest date, bin number, packing time, packer number, inspector number and gassing room number for tomatoes and Honeydew melons.

Components of a Pack House

Apart from main packing lines, the following facilities are also required to be made part of pack house for its proper management and handling practices.

Product arrival and pre-cleaning/sorting

Main grading washing and packing hall

Cold storage

Product arrival and Pre cleaning/sorting

The amount of heat in produce is governed by the temperature around it. The temperature difference between newly harvested produce and its optimum storage temperature is an indicator of field-heat. Rapidly lowering the temperature of harvested produce to near storage temperature is known as pre-cooling, or removal of field-heat. Produce is usually pre-cooled to 78 or 88 percent of the temperature difference. Additional cooling is limited by the time and energy required to reduce the produce temperature to the optimum storage temperature.

Pre-cooling equipment and procedures need to be incorporated into the packing shed design. Packed produce should pass quickly and efficiently from the packing line to the pre-cooling area. Removal of field heat from the produce is important to prolong and maintain its post-harvest life.

Many methods are available to pre-cool fruits and vegetables. It is essential to rapidly cool produce to optimum storage temperature. Studies shown that pre-cooling greatly increases produce storage life. Without pre-cooling, many common fruits and vegetables would not be available in quantity and quality. Cold storage slows produce respiration and breakdown by enzymes, slows water loss and wilting, slows or stops growth of decay-producing microorganisms, slows the production of ethylene, the natural ripening agent, and “buys time” for proper marketing. Metabolic activity of fruits and vegetables produces heat. Produce also stores and absorbs heat. The objective of optimum storage conditions is to limit the production, storage and absorption of heat by produce.

Following are the most common pre-cooling methods used internationally:

Room Cooling

Hydro-cooling

Evaporative Cooling

If hydro cooling is used, special attention must be made to how the cooling water is managed. If the water source can supply both the packing line and the hydro-cooling, then where and how the waste water will be disposed needs to be addressed and dealt with.

If air-cooling is used, extra cold storage units and high-capacity refrigeration units will be needed. Cold storage is the last stop before the produce is shipped to market. For a small grower who markets what they pack daily, this may be just a cool corner by the door before it is loaded for market.

Refrigerated cold storage is recommended if the produce is not marketed every day. It should be close to the shipping area.

Main grading washing and packing hall:

The main grading washing and packaging hall is the place where most of the operation will be conducted. A proposed layout of the facility is attached as under;

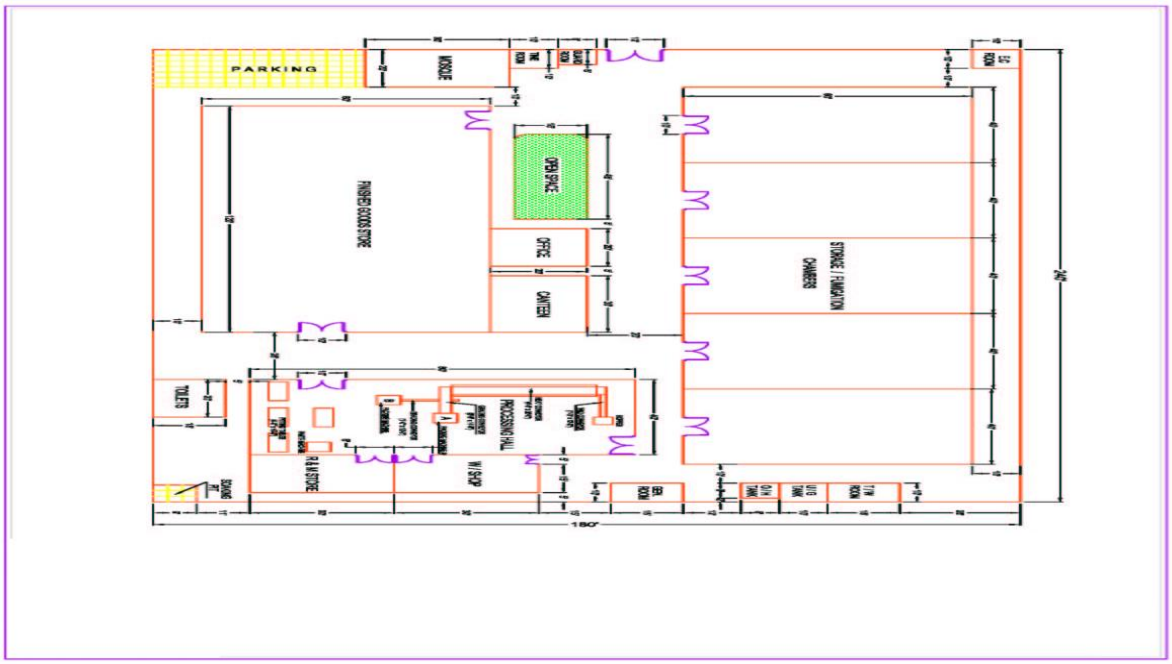


Figure 7: Map of the Carrot and turnip pack house

Machinery and Equipment:

Selection of plant and machinery is the most important decision for setting up a food processing unit. All machinery and equipment used in the processing line should have proper efficiency. All the plant and machinery should be erected in such a way that the material flow is unidirectional to avoid cross contaminations. The machinery should not occupy more than 1/3rd of the total floor area for smooth operation of labour.

Chain Pulley Block
Capacity: 5 Ton
Supplier: Max Industries, India
Supplier Product Code: HH2050
Price: US $1200
Power Source: Hand Pulled
Motorized Conveyor for Bulk Material Handling
Supplier: AMC System Technology (Suzhou) Co., Ltd
Model No. – AMCRL006
Dimension (L*W*H) – Customized
Voltage – 110V/220V/380V
Power – 1500 W or Customized
Capacity – 1500kg or customized
Price – US $1300
Hydraulic Pallet lift (manual)
Supplier: Baoding Dali Hoisting Machinery Co. Ltd

Model No. – PDL -3T hand Pallet
Price – US $250
Box Strapping Machine
Supplier: Henan Bedo Machinery Equipment Co. Ltd
Model No. – BD-001
Voltage – 220V
Power – 50 KW
Price – US $250
Electronic Weighing Machine
Supplier: Yuvo
Model No. – 730
Voltage – 220V
Capacity – 1500kg
Price – US $900
Shrink Wrapping Machine
Supplier: Ruian Yongxin Machinery Factory
Model No. – BTH 450 + BM500L
Dimension (L*W*H) – 3850*1500*1300mm
Voltage – 220V/380V
Power – 50Hz
Price – US $3000
Grading and Sorting Table
Supplier: Tianjin Sure International Trading Co. Ltd
Model No. – Sure -CBM
Dimension – 1000 - 10000mm
Voltage – Customized
Power – 0.18 – 2.5KW
Price – US $ 3000
Platform Type Scales
Supplier: Sanghai Uni-weigh System (Tech)Co. Ltd
Price – US $ 1700
Tray Wrapping Machine
Supplier: Shandong China Coal Group Ltd
Model No. – HW450
Dimension – 540*680*200mm
Voltage – 220V
Power – 270W
Price – US $ 1800
Hot Air Dryer
Supplier: Henan Xingyang Mining Machinery Manufactory
Model No. – ZT
Dimension – Depends on the model
Voltage – 380V
Price – US $ 8,000
Washer
Supplier: Zhengzhou Azeous Machinery Co. Ltd

Model No. – AUSNW
Dimension (L*W*H) – 3800*760*1200mm
Voltage – 380v/50hz/3phase
Power – 3.5KW
Capacity – 500kg – 4000kg/hr
Price – US $ 7000
Small cold store
Supplier: Taizhou Nimbus Machinery Co. Ltd
Price – US $3400
13 Grading and sorting table
Automatic vegetable grading and sorting line (1 tonneper hour)
Price-US$1000-27000
Supplier: RUIAN
Supper silent DEUTZ
Solar generator (60KVA)
Price-US$8900
Supplier –Fujian XINHENGXIN Motor Company Limited

Pack house project summary

Plant capacity	10 Tonnes per day; 900 tonnes annually
No. of shifts	One (8 hours per shift) per day
Working days in a year	90

Capital Costs:

Land and building:

For building and civil work about 6,000 sq. feet of land will be required for this project and built up area required will be 1500 sq. ft. consisting of production hall, washing, packaging, storage etc. The cost of building and civil work would be US$**16000** at a rate of US$10/square feet assuming land will be leased in the project.

Plant and Machinery:

The cost of plant & machinery is estimated at US$ **86000** including installation and commissioning. The installed production capacity will be 10 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 Plant and Machinery

S. No.	Particulars	Qty.	Rate (US$)
1.	Solar generator	1	8900
2.	Chain Pulley Block	1	1200
3.	Motorized conveyor for bulk material handling	1	1300

4.	Hydraulic pallet lift manual	1	250
5.	Box strapping machine	1	250
6.	Electronic weighing machines (1500Kg.)	1	900
7.	Shrink Wrapping Machine	1	6000
8.	Grading & Sorting Table	1	3000
9.	Inspection Tables	3	300
10.	Platform Type Scales (30kg)	2	1700
11.	Platform Type Scales with Printer (15 kg)	10	150
12.	Platform type scales (120 kg)	5	100
13.	UPS for above Machines	5	200
14.	Tray Wrapping Machine	1	1800
15.	Hot Air Dryer – for Removing water applied Externally	1	8000
16.	Waxing Unit	1	2500
17.	Washer	1	7000
18.	Automatic vegetable grading and sorting line (1 tonneper hour)	1	15000
19.	Packaging machine, Pouch sealing machine	1	170
20.	Cold Storage	1	7000
21.	PU Building for Pack house (1500 sq. ft.)	1	16000
22.	Ethylene Generator 3 nos. (Sure Ripe)	1	200
23.	Ethy-gen II Concentrate (45 cases)	1	200
24.	Gastech. Air Sampling Kit Unit 1 no. 1	1	180
25.	Ethylene Monitoring Tube - 1 Box	1	180
26.	Carbon di-oxide Monitoring Unit	1	400
27.	1 0.04 0.04 30 Additional Dryers for Removing Moisture-1MT Per Day	1	120
28.	Pallets and Bins		3000
	Total		**86000**

Misc. Fixed Asset Costs:

US$ **21580** 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 machinery & equipment, equipment for water supply, 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. The details of miscellaneous fixed assets and their associated costs are been shown in table below:

Miscellaneous fixed asset cost

S. No.	Particulars	Qty.	Rate (US$)
1.	Office Equipment	1	2000

2.	Furniture and Fixture	1	3000
3.	Miscellaneous Accessories	1	2000
4.	Vegetable Display Crate	50	200
5.	Display Board	5	60
6.	Fire Fighting	1	70
7.	Computer with Accessories	2	1000
8.	ERP System	1	10000
9.	Water Treatment Plant – 500 litres per hour	1	1000
10.	Loading Tempo	1	250
11.	Electrical and water pipes Installation	1	2000
	Total		**21580**

Pre-Operative Expenses:

Expenses incurred prior to commencement of commercial production are covered under this head that total US$ **31700.** 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$)
1.	Interest up to production @ 16% on term loan amount of US$ 138000 **(30% of total project cost)**	22000
2.	Electricity charges during construction period	1200
3.	Marketing Launch Expenses	1000
4.	Technology Know-how and consultancy fees	5000
5.	Training expenses	1500
6.	Travelling Expenses	1000
	Total	**31700**

Cost of raw material:

Based on a processing capacity of 10 tonnes per day taking into account and 90 days of working per year, the annual raw material consumption of the pack house is 900 tonnes. The cost of fresh carrot and turnip 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 $167/ton. Adding US$20 tonne transportation cost from the field to pack house, the raw material cost for pack house would be US$187.

Cost of raw material

Particulars	Rate tonne (US$) for the raw carrot and turnip at the wholesale/pack house	Qty. (Tonnes) per season	Raw material cost (US$)
Carrot and turnip	187	900	168,300

Land Lease Charge:

Required land is 6,000 sq. ft. which has been considered on lease @ US$200 per annum for first three years and @ US$200 for the fourth 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	200
3.	3rd year	210
4.	4th year	220
5.	5th year	231
	Total	**1061**

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 60 KVA 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 gallon. Water requirements are approximately 500 gallons per day.

Electricity and water consumption charges

S. No.	Description	Amount Per Annum (US$)
1.	Power Consumption	4000
2.	Water Consumption	200
	Total	**4200**

Human Resource Cost

One pack house manager, one accountant for six months, one supervisor for six months 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.	Pack house manager	1	750	9000
2.	Accountant	1	520	6240
3.	Supervisor	2	740	8880
4.	Skilled Workers	4	1200	1440
5.	Driver	1	370	4440
6.	Security Guard	1	225	5400
	Total		**3805**	**48360**

Cost of Project

Sr. No.	Particular	Value (US$)
1.	**Fixed costs**	
1.1.	Plant and Machinery	86000
1.2.	Misc. Fixed Assets	21580
1.3.	Pre-operative expenses	31700
2.	**Operating costs**	
2.1.	Cost of raw material	168300
2.2.	Land lease charges	1061
2.3.	Electricity and water consumption	4200
2.4.	Salary and wages (For 180 days)	48360
2.5.	Margin Money for Working Capital	1500
2.6.	Contingencies 5% of Fixed Assets	2158
	Total variable costs	**364859**

Project Income Statement

Revenues	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue (US$)						
Quantity of carrot & Turnip that goes in value addition or capacity of pack house (t)		900	900	900	900	900
Price of the value added carrot & Turnip(US$/ton)		373	373	373	373	373
Total revenues after processing (US$)		336024	336024	336024	336024	336024
Direct variable costs						
Raw material price (US$/TON) plus transportation		187	187	187	187	187
Raw material cost (us$)		168165	168165	168165	168165	0
Packing costs (@PKR20 per 25 kg box)		5333	5333	5333	5333	
Labor cost		48360	48360	48360	48360	
Electricity and water		4200	4200	4200	4200	
Maintenance (1% of the machinery, equipment and furniture cost)		1393	1393	1393	1393	
Land lease charges (5%) increment on annual	200	200	210	221	232	
Marketing (US$2/ton)		1800	1800	1800	1800	

Transportation cost from pack-house to market and port		7163	7163	7163	7163	
Office administration		370	370	370	370	
Total variable cost		237171	237181	237192	237203	187
Gross profit		98853	98843	98832	98821	335837
Indirect fixed cost						
Machinery	-139280					
Licensing and regulatory fee	-150	0	0	0	0	
Total	-139430	0	0	0	0	
Grand total cost	-139430	237171	237181	237192	237203	0
Net profit (Net cash flow)	-139430	98853	98843	98832	98821	336024
NPV	**8.5%**	**375,849**				
IRR	**74%**					

Net profit (Net cash flow) = 336,024

NPV = 374,152

IRR = 74%

Annexure 5: Feasibility for Carrots & Turnip Harvester

Operating efficiency @ 0.5 acre per hr (ha per hr)	**0.2**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Per day efficiency @8 hrs work every day (h)	**1.62**					
working days in a year	**30**					
Area harvested in a season (ha)	**49**					
Revenues						
Revenue (US$)						
Increase in per ha yield (%)	**0%**		0%	0%	0%	0%
Base year yield (t/ha)			20.89	20.79	20.70	20.61
Total increase in production for the whole season (t)			0.0	0.0	0.0	0.0
Price of carrots (US$/ton)			143	143	143	143
Increase in revenue due to improved yield (US$)			**0**	**0**	**0**	**0**
Direct variable costs						
Cost of manual harvesting (US$/ha)			100	100	100	100
Cost of mechanical harvesting (US$/ha)			64	64	64	64

Saving in cost (US$/ha)			**35**	**35**	**35**	**35**
Total saving in cost during the season (US$)			**1718**	**1718**	**1718**	**1718**
Variable Cost						
Maintenance (2% of the machinery cost)			11	11	11	11
Depreciation			42	42	42	42
Land lease charges (5%) increment on annual		15	16	17	17	18
Fuel consumption charges 32L @124 Rs including price of Mobil oil	**32**	124	1427	1427	1427	1427
Total variable cost			1496	1497	1498	1499
Total additional variable cost			**-221**	**-221**	**-220**	**-219**
Gross profit			221	221	220	219
Machinery		-546.30				
Total		**-546**	**0**	**0**	**0**	**0**
Grand total cost		**-546**	**-221**	**-221**	**-220**	**-219**
Net profit (Net cash flow)		**-546**	**221**	**221**	**220**	**219**
NPV	**8.5%**		161.8			
IRR			22%			

Annexure 6: Feasibility for Carrots & Turnip Planter

Operating efficiency @0.5acre per hr (ha per hr)	**0.20**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Per day efficiency @8 hrs work every day (ha)	**1.6**					
Working days in a year	**60**					
Area transplanted in a season (ha)	**97**					
Revenues						
Revenue (US$)						
Increase in per ha yield (%)	**5%**		0.06	0.13	0.19	0.25
Total increase in production for the whole season (t)			6.07	12.14	18.21	24.28
Price of wholesale (US$/ton)			244	244	244	244
Increase in revenue due to improved yield (US$)			**1483**	**2966**	**4448**	**5931**
Direct variable costs						
Cost of manual planting (US$/ha)			109.8	109.8	109.8	109.8
Cost of mechanical planting (US$/ha)			31.4	31.4	31.4	31.4
Saving in cost (US$/ha)			**78.4**	**78.4**	**78.4**	**78.4**
Total saving in cost during the season (US$)			**7618**	**7618**	**7618**	**7618**
Variable Cost						
Maintenance (2% of the machinery cost)			50	50	50	50
Depreciation			198	198	198	198
Land lease charges (5%) increment on annual		100	105	110	116	122
Fuel consumption charges 22.23L/ha @124 Rs including price of Mobil oil	**0**	0	0	0	0	0
Total variable cost			**-7265**	**-7260**	**-7254**	**-7248**
Gross profit			**8748**	**10225**	**11702**	**13179**
Indirect fixed cost						
Machinery		-2481.48				
Total		**-2481**	**0**	**0**	**0**	**0**
Grand total cost		**-2481**	**-7265**	**-7260**	**-7254**	**-7248**
Net profit (Net cash flow)		**-2481**	**8748**	**10225**	**11702**	**13179**
NPV	**8.5%**		**30,358**			
IRR			**367%**			