CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

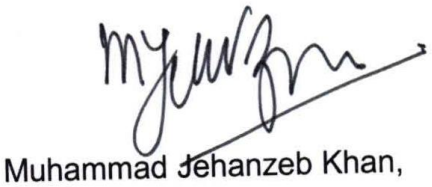
Cucumber Cluster Feasibility and Transformation Study

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. Internationally reputed foreign/ local consultants like Dr. Derek Byerlee, Dr. Kijiro. Otsuka and national consultant Mr. Sohail Moghal were also engaged to understand the cluster-based development approach and conduct cluster-based feasibility analysis. An EXCEL-based Model was developed which was validated by our national consultants. Separate viabilities for individual technologies and products suggested in each commodity are also estimated.This humongous task would not have been possible to complete without the excellent cooperation and facilities provide by CABI, the hard work of commodity specialists and our research team especially Mr. Yasar Saleem Khan and Ms. Aqsa Yasin. The true reward of our hard work is the implementation of the proposed policies, strategies and interventions to develop agriculture commodity clusters in the country.

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

ACKNOWLEDGEMENT

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

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

I am also grateful to **Centre for Agriculture and Bioscience International** (CABI) and it's 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.

Dr. Muhammad Tariq
Senior Author

Citation:

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

DISCLAIMER

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

TABLE OF CONTENTS

FOREWORD **6**

ACKNOWLEDGEMENT **7**

TABLE OF CONTENTS..... 9

LIST OF TABLES **11**

LIST OF FIGURES **11**

LIST OF ACRONYMS **12**

EXECUTIVE SUMMARY **14**

1. INTRODUCTION **17**

1.1 Cucumber as a fruit vegetable 17

1.2 National Cucumber Production 17

1.3 Global Context 19

2. OBJECTIVES **23**

3. METHODOLOGY **24**

4. LITERATURE REVIEW **25**

5. CLUSTER IDENTIFICATION AND CHARACTERIZATION **27**

5.1. Identification of Clusters 27

..... 28

5.2. Comparison of Cluster Characteristics 28

5.3. Description of value chain 32

5.4. SWOT Analysis 35

5.4.1. Overview 35

5.4.2. SWOT Analysis of Southern Punjab 35

5.4.3. SWOT Analysis of Balochistan 39

6. CHALLENGES FACED BY THE CLUSTER **44**

6.1 Climate Change and Increasing Shortages of Water 44

6.2 Constraints at Production Level 44

6.3 Constraints at Post-Harvest Level 45

6.3.1. Value addition 45

6.3.2. Constraints at Processing Level 45

6.3.3. Constraints at Trading Level 45

7. CLUSTER DEVELOPMENT POTENTIAL **47**

7.1. Overview 47

7.2. Production Potential 47

7.3. Processing/canning of cucumber 47

7.4. Improvement in Quality 47
7.5. Saving in Post-Harvest Losses 48
7.6. International Standards 48
8. PLAN, POLICIES AND STRATEGIES 49
8.1. Plan 49
8.2. Policies 49
8.3. Strategies for Southern Punjab Cluster 50
8.3.1. Production Level Strategies 50
8.3.2. Value Addition Level Strategies 50
8.3.3. Marketing and Trading/Export Strategies 51
8.4. Strategy for Balochistan Cluster 51
8.4.1. Production Level Strategies 52
8.4.2. Value Addition Level Strategies 53
8.4.3. Marketing and Trading Level Strategies 53
9. BENEFITS AND COSTS OF CLUSTERING 54
9.1. Investments, Costs and Returns in Punjab and Balochistan 54
9.2. Summary of Investment Costs 55
9.3. Economic, Social and Environmental Returns 56
9.4. Conclusion 58
10. PROGRAMS AND PLANS 59
10.1. Organization and Networking of Stakeholders 59
10.2. Program for Research Reform 60
11. ANNEXURES 62
Annexure 1: Macro Data Sources and Literature Reviewed 62
Annexure-2: List of Stakeholders Consulted 63
Annexure-3: Feasibility Study for Cucumber pack house 64

LIST OF TABLES

Table 1: Area production and yield of cucumber by province during 2015-16 18
Table 2: Province wise area (000 ha) production (000 tonne) of Cucumber 2008-2016 19
Table 3: Comparison of world vs. Pakistani Cucumber sector, 2016 19
Table 4: Trend in the world cucumber production and export during 2008-17 20
Table 5: Top Cucumber Producing Countries of the World (2016) 21
Table 6: Top Ten Cucumber Exporting Countries of the World (2016) 21
Table 7: Top Cucumber Importing Countries of the World (2016) 21
Table 8: Cucumber production areas by cluster, 2016-17 27
Table 9: Characteristic and Comparison of Cucumber Clusters 28
Table 10: SWOT Analysis of Cucumber Southern Punjab Cluster (C-1) 35
Table 11: SWOT Analysis of Balochistan Cucumber Cluster (C-2) 39
Table 12: Gaps and constraints at production level 44
Table 13: Gaps and Constraints at post-harvest and processing level 45
Table 14: Gaps and Constraints at Trading Level 46
Table 15: Inputs and infrastructure needs for development of South Punjab cluster 54
Table 16: Inputs and infrastructure needs for development of Balochistan cluster 55
Table 17: Summary of Investment costs 56
Table 18: Economic Returns and Investments in Southern Punjab 57
Table 19: Economic Returns and Investments in Balochistan 57
Table 20: Program for Organization and Networking of Stakeholders 59
Table 21: Program for Research Reform 60

LIST OF FIGURES

Figure 1: Different stages of the cucumber 17
Figure 2: Map of Pakistan Showing Cucumber Production 28
Figure 3: Value chain of Cucumber 34

LIST OF ACRONYMS

AARI	Ayub Agricultural Research Institute
ADP	Annual Development Plan
AMRI	Agricultural Mechanization Research Institute
AOs	Agriculture Officers
ARI	Agriculture Research Institute
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
FAs	Field Assistants
FEG	Farmer Enterprise Group
FS&TRP	Food Science & Technology Research Program
FSC&RD	Federal Seed Certification and Registration Department
GAP	Good Agriculture Practices
GI	Geographical Identification
GoP	Government of Pakistan
Ha	Hectare
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

MNFS&R	Ministry of National Food Security and Research
NARC	National Agricultural Research Centre
NGOs	Non-Governmental Organizations
NPK	Nitrogen, Phosphorus, Potassium
NYUT	National Yield Uniformity Trial
PARC	Pakistan Agricultural Research Council
PFVA	All Pakistan Association of Fruits & Vegetables Exporters, Importers & Merchants
PHRC	Post Harvest Research Centre
PKR	Pakistani Rupee
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
US$	United States Dollar
VRI	Vegetable Research Institute
VRP	Vegetable Research Program

EXECUTIVE SUMMARY

Global cucumber is cultivated on 2.27 million ha and producing around 83.7 million tonnes of cucumber with an average per ha yield of 37 tonnes. Pakistan ranks 50th among the world's cucumber producing countries, cultivating the crop on 4.6 thousand ha and producing 61 thousand tonnes of cucumber with an average yield of 13.2 tonnes. China is the global leader in cucumber production. Worldwide, 15% of cucumber production is exported, valued at US$ 2.5 billion. Overall, the value of cucumber exports rose at the rate of 2.0% per annum during 2008-16. Spain is the top exporter followed by Mexico. According to the last available statistics, cucumber was cultivated on an area of 4.6 thousand ha with a total production of 60.6 thousand tonnes by an average yield of 13.2 ton per ha in Pakistan. Presently, Pakistan lags far behind the global average in per ha yields, quality, price and exports. However, the country has great potential to hold on all these fronts because of many advantages including proximity with China and Gulf countries, the seasonal difference with the main producers and favorable production cost especially low labor cost.

Pakistan is an importer of cucumber equivalent to 20% of its production and the yield of cucumber in the country is only 36% of the world average yield. Although growth rate in cucumber production is higher than the population growth in the country as well as growth in the global production but to make the Pakistani cucumber competitive in national and international markets lot more needs to be done. Because of the wide variation in socio-economic and geographical situation in which cucumber is grown, a cluster approach has been adopted to evaluate the gaps along various segments of the value chain and to identify the viable interventions in various regionally contiguous regions or clusters.

Cucumber in Pakistan is grown in all provinces of the country but major production is concentrated in Punjab followed by Balochistan and Khyber Pakhtunkhwa. Two clusters, one in Southern Punjab with Pakpattan as its centre point and the other in Eastern Balochistan with Khuzdar as its centre point are identified based on the concentration of area under the crop and supply of fresh produce. Wide variation in yield exists in per ha yield across the clusters.

In this study several performance gaps were identified at the production, processing and trading components of the value chain, specifically with the technology, transportation and value chain development. These included the lack of improved commercial cucumber cultivars, management practices to produce high quality marketable fruit, absence of packaging and proper transport for trading in the high-value fresh cucumber market and lack of processing. Currently, Pakistan is not a regular cucumber exporter in large quantities.

In order to address multilevel challenges from production to product and market development, performance targets were set based on global average for yield, quality and export and the interventions were designed to meet these targets over the period of five years. Keeping in view the gaps and constraints, specific interventions have been proposed for all clusters. These interventions include introducing high-yielding cucumber varieties/hybrids for open field and for protected cucumber production, introducing improved management practices especially protected cultivation, promote the establishment of certified nurseries and improvement in value chain for export through encouraging the establishment of pack houses in Punjab clusters and capacity building of stakeholders in both the clusters. The indirect interventions include strengthening of

cucumber research and capacity building of producers through demonstrations. These interventions are to be initiated by government and executed in participation with the private sector including the farmers, traders and their groups/associations. A time-horizon of five years is set for determining the outcomes of the cluster development interventions.

As part of this study, several performance gaps are identified in cucumber production. These included the lack of improved cultivars, primitive production technology, high pest pressure and low quality of the produce. The specific performance targets were set for both the clusters and strategies were designed to achieve these targets. Specific interventions were suggested to achieve these targets which include area to be brought under insect net, improvement in management practices and improvement in the value chain by setting pack houses in each cluster. These interventions are to be initiated by government and executed in collaboration with participation of private sector including the farmers, traders and their groups/associations. A time-horizon of five years has been set for realizing the intended outcomes of the cluster development interventions.

The total estimated investment of this cluster development/up gradation plan is US$0.93 million for both the clusters. Out of this (53%) borne by the government in terms of strengthening the value chain research on cucumber, capacity building of stakeholders, subsidy on pack houses and interest free loans for the value chain infrastructure. Accounting for all the yearly value chain costs including the production, value addition and marketing costs applied over five years, the estimated Internal Rate of Return (IRR) for both the clusters is 29%; for Southern Punjab 25% and for Balochistan it is 72%. The pooled Net Present Value (NPV) for both the clusters is positive at US$0.3164 million. These IRRs are based on respective investment costs in each cluster centre point and the present value of resulting revenues over a period of five years. This indicates that cluster development interventions are likely to generate positively return on the investment made and would add additional value can be seen in the Summary Sheet given below.

These interventions would result in far reaching economic and social impacts, including increased productivity and production, higher quality of cucumber, increased income to farmers and other stakeholders and employment in rural areas thus benefiting all the stakeholders of cucumber clusters in Punjab and Balochistan. The interventions are expected to create new jobs.

However, these benefits will be achieved only if the cucumber related research is strengthened and capacity of stakeholders' is strengthened to produce and manage the quality cucumber.

Summary Sheet of Cucumber Cluster

Information	Southern Punjab (Pakpattan)	Baluchistan (Khuzdar)	Overall
Area of the cluster (ha)	1265	621	1886
Production of the cluster (tonnes)	34757	4555	39312
Current yield of the cluster (tonne/ha)	27.5	7.3	20.8
Area of cluster focal point (ha)	174	284	458
Production of the focal point (tonnes)	8,346	2,074	10,420
Added production- improved practices (tonnes)	5754	1824	7578
Added value - improved practices (US$)	980306	310050	1290355
Saved production – reduce PH losses (tonnes)	2206	319	2525
Added value - reduced PH losses (US$)	375784	54259	430043
Added value– improved VC operation (US$)	281,605	6,703	288,308
Added value – all interventions in the 5th(US$)	1,356,089	364,309	1,720,398
Added production cost- Input & harvest (US$)	747,507	184,431	**931,937**
Added VC cost (washing, grading, etc.): (US$)	328,300	140,362	**468,662**
Added transportation, marketing, storage cost:(US$)	11,348	1,676	**13,024**
No of pack house required	3	0	**3**
Investments required on R&D interventions (US$)	300,000	50,000	350,000
Promotion of protected cultivation (US$)	15,000	15,000	30,000
Investments on value addition-pack house (US$)	411,600	-	411,600
Government loan on private investment (US$)	45,276	-	45,276
Investment on certified nurseries (US$)	20,000	5,000	25,000
Stakeholders training (US$)	50,000	20,000	70,000
Total investment required over five year (US$)	841,876	90,000	931,876
Public sector investment (US$)	444,596	58,000	502,596
Private sector investment (US$)	397,280	32,000	429,280
Production level investments	385000	**90,000**	**475,000**
Value chain level investments and processing	456876	**0**	**456,876**
Overall benefits (US$) and rate of return			
Total production increase in 5th year (tonnes)	7,960	2,143	10,103
Gross revenue (undiscounted) in 5th year	1,637,694	371,011	2,008,706
Additional operation costs in 5th year	1,087,155	-326,468	760,687
Net cash flow (undiscounted) in 5th year	550,540	44,543	595,083
NPV (US$)	240234.2	44542.96	316403
Internal Rate of Return	25%	72%	29%

1. INTRODUCTION

1.1 Cucumber as a fruit vegetable

Cucumber (*Cucumis sativus*) is one of the most popular salad vegetables in Pakistan. Cucumber is susceptible to moisture loss and decay but bruising and compression injury are very common when careful harvest and handling practices are not followed. Cucumber has a light to dark green color, thin skin, moisture-rich flesh with tiny seeds inside, and is enjoyed best in salads, sandwiches, or as a juice. It has high water content that helps remain the human body hydrated and the low-calorie content makes it a great choice for a weight loss diet.

The cucumber fruit grows rapidly to harvest and picking the fruit as soon as they reach marketable size maintains the vitality and productive capacity of the plant. The fruit is harvested at a range of developmental stages, depending on the intended use. The time from planting until the beginning of the harvest generally ranges between 55 to 60 days, depending on the cultivars and growing conditions. Cucumber fruit is normally harvested at maturity; near full size but before the seeds are fully enlarged and become hard. The two main external indices of harvest maturity are fruit size and skin color. The main internal indices of harvest maturity are seed development, ocular jelly formation, and flesh texture. Fresh market slicing cucumbers should be at least 15 cm (6 inches) long and firm to the touch (Figure 1). Skin color is another widely used index for assessing fruit maturity. Fruit are generally at their highest eating quality when the skin is uniformly green. Fruit that are too mature have a tough leathery skin and are bitter in flavor. At proper harvest maturity, a jelly-like material will be formed in the seed cavity. Seed development is also used to determine harvest maturity. The seeds should be uniform white in color and immature (Figure 2).

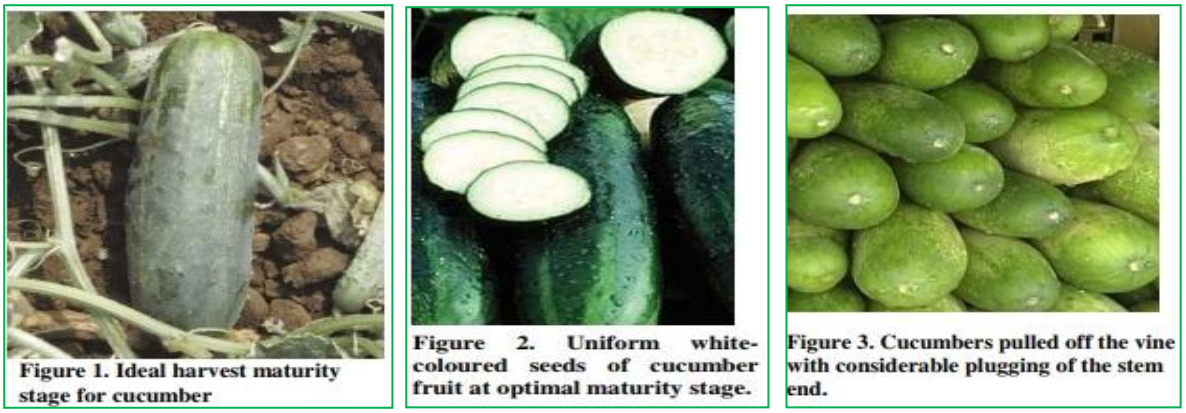


Figure 1. Ideal harvest maturity stage for cucumber

Figure 2. Uniform white-coloured seeds of cucumber fruit at optimal maturity stage.

Figure 3. Cucumbers pulled off the vine with considerable plugging of the stem end.

Figure 1: Different stages of the cucumber

1.2 National Cucumber Production

In Pakistan, almost the entire production volume is marketed domestically. Currently, no production goes into processing. The total production of cucumber in Pakistan was 54.29 thousand tonnes; harvested from an area of 3.38 thousand ha with the average yield of 16

tonne/ ha in 2016. If we compare the average yield with that obtained at experiment stations, the gap in yield is about 60%.Cucumber has high commercial value. Keeping in view its importance, farmers and traders are extremely careful in handling the product at every stage of the value chain. However, Pakistan is the developing country and like many other fruits and vegetables, losses in cucumber are in the range of 35-40%.

Punjab is the leading cucumber producing province of Pakistan as it occupies 52.5% of cucumber area and has share of 82.8% of production in the country during 2016 (Table 1). Per ha yield is also highest in Punjab at 25.3 tons per ha while 7.3 tonnes in Balochistan.

Table 1: Area production and yield of cucumber by province during 2015-16

S#.	Province	Production (tonnes)	Production Share (%)	Area (ha)	Area share (%)	Yield (tonne/ha)
1	Punjab	44919	82.8	1772	52.5	25.3
2	Balochistan	6777	12.5	925	27.3	7.32
3	Sindh	2592	4.7	684	20.2	3.79
4	Pakistan	54288	100	3381	100	16.0

Source: MNFS&R (2016)

Area under cucumber in Pakistan has increased from 2.65 thousand ha in 2008 to 3.38 ha in 2016 with an annual growth rate of 3.3%. Similarly, production has also increased from 37.4 thousand tonnes to 54.3 thousand tonnes during the corresponding years producing an average annual growth of 5.2%. This implies that yield in cucumber also increased at a rate of 1.9% per annum. The increase yield and production are highest in Punjab while acreage increase was highest in Balochistan (Table 2).The yield growth is positive in Punjab and Balochistan.

Table 2: Province wise area (000 ha) production (000 ton) of Cucumber 2008-2016

Year	Punjab			Sindh			Balochistan			Pakistan		
	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield
2008-09	1.392	29.901	21.48	0.516	2.086	4.04	0.741	5.415	7.31	2.649	37.402	14.1
2009-10	1.477	32.044	21.7	0.711	2.699	3.8	0.795	5.808	7.31	2.983	40.551	13.6
2010-11	1.581	35.183	22.25	0.696	2.683	3.85	0.882	5.847	6.63	3.159	43.713	13.8
2011-12	1.742	38.952	22.36	0.715	2.749	3.84	0.94	6.834	7.27	3.397	48.535	14.3
2012-13	1.795	40.439	22.53	0.61	2.325	3.81	1.094	7.183	6.57	3.499	49.947	14.3
2013-14	1.767	39.436	22.32	0.616	2.383	3.87	1.145	8.345	7.29	3.528	50.164	14.2
2014-15	1.805	43.298	23.99	0.682	2.596	3.81	0.939	6.872	7.32	3.426	52.776	15.4
2015-16	1.772	44.919	25.35	0.684	2.592	3.79	0.925	6.777	7.33	3.381	54.288	16.1
Annual growth (%)	**3.6**	**5.6**	**2.0**	**1.5**	**1**	**-0.5**	**4**	**4.2**	**0.2**	**3.3**	**5.2**	**1.9**

Source: MNFS&R (2016)

The import of cucumber in Pakistan has increased exponentially from just 2 tonne valued at US$ 01 thousand in 2010 to 11.1 thousand tonnes valued at US$ 2.3 million in 2016. During the period, the import has escalated to 20% of the domestic production.

1.3 Global Context

On the global scale, the production of fresh cucumbers is estimated at 83.7 million tonnes during 2017. However, more than a quarter of production is grown for the processing industry which makes cucumbers the world's leading vegetable for processing.

Pakistan perform very low in terms of per ha yield, export-production ratio and export price in the international cucumber sector. Its yield is only 36% of the world average yield. It contributes 0.07% of the world production however, its farm gate price is lower than the world average suggesting a great potential for world export on one hand, but great challenges to improve its value chain. The world exports are 2.65 million tonnes which is about 15% of its production and earns US$ 2.3 billion from cucumber while Pakistan export in cucumber is nil (Table 3).

Table 3: Comparison of world vs. Pakistani Cucumber sector, 2016

Parameter	World	Pakistan	Share (%)
Area (000 ha)	2271	4.6	0.20
Production (000) tonne	83754	60.6	0.07
Yield (tonnes/ ha)	36.88	13.2	35.84
Value of production (million US$)	40228	22.1	0.05
Farm gate price (US$/tonne)	480	365	75.91

Quantity of international trade (000 tonnes)	2652	0.0	0.00
Value of international trade (million US$)	2305	0.008	0.00
Export quantity as % of production	15%	0%	-
Export value as % of production value	6%	0%	-
Average export prices (US$ /tonne)	869	800	92.04

Source: FAOSTAT, Production, Crops, Trade

Internationally the cucumber production has increased at an annual rate of 4.2% per annum during 2008-16, which is much higher than the population growth implying that per capita consumption of cucumber is increasing globally. The increase in production is contributed both by the expansion in cucumber area as well as its yield although contribution of yield improvement is much higher. Cucumber export and its value are increasing at the rate of 2.0% and 2.1% per annum, which is lower than the increase in production (Table 4).

Table 4: Trend in the world cucumber production and export during 2008-17

Year	World Cucumber Production			World Cucumber Export	
	Area	Production	Yield	Quantities	Values
	(000 ha)	(000 tonne)	(tonne/ha)	(000 tonne)	million US$
2008	1921	58423	30.4	2425	2125
2009	1967	60639	30.8	2096	1801
2010	2021	62514	30.9	2321	2050
2011	2091	67891	32.5	2429	2029
2012	2116	70783	33.5	2328	2141
2013	2111	73220	34.7	2432	2384
2014	2141	76120	35.6	2588	2306
2015	2175	78701	36.2	2602	2135
2016	2219	80527	36.3	2652	2305
2017	2271	83754	36.9	NA	NA
Annual growth (%)	**1.7**	**4.2**	**2.6**	**2.0**	**2.1**

Source: FAOSTAT, Production, Crops

Worldwide cucumber is planted on an estimated area of 2271 thousand ha with production of 83.7 million tonnes during 2017. This translates into an average yield of 36.88 tonnes/ha. More than 40 countries are involved in its production. Volume of global gross exports reached at 2.6 million tonnes valued at US$2.3 billion (Table 4) and Pakistan has a negligible share of 0.001% and 0.003%, respectively. Cucumber trade of Pakistan is only 10 tonnes.

China is the top cucumber producing country in the world in terms of cucumber area and production followed by Russia, Turkey and Iran. Pakistan ranks at 50thwith respect to cucumber production in the world (Table 5).

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

Rank	Country	Production 000(tonnes)	Area 000(ha)	Yield (tonne/ha)
1	China	61,949	1155.8	53.6
2	Russia	1,992	68.7	29.0
3	Turkey	1,811	37.5	48.2
4	Iran	1,707	59.4	28.7
5	Ukraine	948	49.8	19.0
6	Uzbekistan	933	19.6	47.4
7	Mexico	886	18.6	47.6
8	United States	802	48.0	16.7
9	Spain	770	8.5	90.6
50	Pakistan	54	3.4	15.0

Source: FAOSTAT, Production, Crops

Mexico is the largest exporting country from Europe followed by Spain in terms of quantity of cucumber export while opposite in terms of the value of cucumber export earnings (Table 6). Currently Pakistan is not a regular exporter of cucumber. However, Pakistan may increase cucumber export by catering the potential market and other markets efficiently after applying phytosanitary standards of the world, improving value chain, and adopting Good Agricultural Practices (GAP).

Table 6: Major Cucumber Exporting Countries of the World (2016)

Rank	Country	Quantity (000 tonnes)	Country	Value (Million US$)
1	Mexico	694	Spain	61
2	Spain	633	Mexico	48
3	Netherlands	351	Netherlands	42
4	Canada	145	Canada	20
5	China	73	Belgium	7
6	Belgium	69	Iran	6
7	Belarus	61	USA	6

Source: FAOSTAT, Trade, Crops and Livestock Products

USA is the top importer of cucumber followed by Germany and United Kingdom (Table 7). Pakistan is net importer of cucumber and ranks at 14th position in term of value of cucumber import in the world market with an import of 11.1 thousand tonnes which is about 20% of its domestic production valued at US$ 2.8 million during 2016.

Table 7: Top Cucumber Importing Countries of the World (2016)

Rank	Country	Quantity (000tonnes)	Country	Value (Million US$)
1	USA	873	USA	745
2	Germany	466	Germany	531

3	United Kingdom	156	United Kingdom	178
4	Russian Federation	116	Russian Federation	125
5	Netherlands	99	Netherlands	106
6	Belgium	98	France	83
7	France	78	Belgium	79
8	Czechia	75	Canada	64

Source: FAOSTAT, Trade, Crops and Livestock Products

In summary, although cucumber production in Pakistan is growing at a reasonable rate, suggesting increasing per capita cucumber availability in the country. But it has to go a long way to become a competitive partner in the national and international cucumber market. The yield of cucumber is only 36% of the world average yield and it is a net importer of cucumber importing worth of US$ 2.28 million, which is about 20% of its production. To transform Pakistan's cucumber and make it an international competitive partner in cucumber market, it has to reform its production, value chain and trade strategies. Because of the wide variation in the cultivation of cucumber in various regions of Pakistan, this study has adopted the cluster approach to analyze the whole value chain of the commodity in its main regional contiguous growing regions and identify viable intervention for this transformation.

2. OBJECTIVES

The overall goal of this study is to analyze the whole value chain of cucumber at cluster level and contribute to the Cluster Development Based Agriculture Transformation Plan -V2025. Specific objectives of the study are:

1. To identify the major clusters of cucumber production in Pakistan
2. To characterize and conduct SWOT analysis of each cucumber cluster
3. To identify technological, institutional, infrastructure and policy gaps in each cluster
4. Assess the potential of cucumber production in each cluster
5. Suggest technological, institutional, infrastructure and policy interventions to achieve the cluster potential
6. Conduct economic and social feasibility of the suggested interventions.

3. METHODOLOGY

The data and information related to the characteristics, gaps, potential and needed interventions to meet the gaps in cucumber 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 cucumber value chain **(Annexure 1).**
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 **(Annexure 2)**.
III. **Literature Review.** The literature related to the functioning, gaps, and interventions in cucumber value chain is reviewed and synthesized (**Annexure 1)**.

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

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

The author then used these data to first identify the cucumber cluster in the country and then in consultation with stakeholders prescribes the characteristics of each cluster, identified the cluster strengths, weaknesses, opportunities & threats (SWOT), investigated the functioning of existing value chain, and quantified the cluster potentials. Based on the above analysis, the author derived 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. Cucumber Transformation Plan is also formulated which identifies sustainable cluster upgrading strategies for the development of the cucumber sector that can help create significant economic opportunities for producers, processors and all the stakeholders participating at different points of the value chain.

4. LITERATURE REVIEW

According to All Pakistan Fruits and Vegetables 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.

Ibrahim & Omotesho (2013) explained that vegetables are considered as an essential part of agriculture because these are a source of livelihood and foreign exchange. These are useful for health, maintenance of nutrition level and resistance against diseases.

The production of off-season plants was helpful for the reduction at high prices at the beginning and end of the vegetable season. Temperature and humidity were under the control of farmers in off season or in tunnels (SMEDA, 2016). Extension in the season and yield of a particular vegetable is observed in case of off-season cultivation (Iqbal et al., 2009).

Alboghdady & Shata (2014) explored the technical efficiency in the production of cucumber under greenhouses, plastic tunnels and open field system. Results confirmed the difference in efficiency among various cultivation systems. They pointed out toward the improvement of efficiency and productivity. Education, extension services and agricultural knowledge were found beneficial for the improvement of efficiency.

As per statistics, 52766 tonnes cucumber was produced from an area of 3426 has during 2014-15 with an average yield of 15.4 t ha-1 in Pakistan. In Punjab 43298 tonnes cucumber was produced from an area of 1805 has during the same year. Punjab shares about 52.68% in area and 82% in production of cucumber (Fruit, Vegetable and Condiments Statistics of Pakistan 2015-16).

The current regional economic intensification and changes in food habits have made both the production and consumption of fruits and vegetables increasingly important. The fruit and vegetable sector plays a key role in improving agricultural incomes, poverty reduction, food security and sustainable agriculture. However, this sector suffers greatly from post-harvest losses. Some estimates indicate that about 30-40% of the fruit and vegetables are lost or released after leaving the farm gate. Massive losses after the harvest lead to yield losses for the producers. International markets reject fruit and vegetables that contain illegal pesticides, pesticide residues that are beyond acceptable limits, and are poorly labeled and packaged (FAO, 2006).

Use of poor quality ground water significantly lowers the production and quality of the cucumber in some areas. Major cost components of cucumber production, i.e., labor used for different management practices, land preparation; seed and fertilizer are significantly related with productivity level of the crop. Balochistan is a water scarce province and water shortage is main problem for farmers in the province (UN&PO).

In cucumber, the price difference ranges around PKR 40/kg in seasonal months from April to July while it rises to an average price of PKR 60/kg in August to March (stakeholder's discussion, 2018).

In Pakistan, very limited quantity of fruits and vegetables is preserved leading to heavy post-harvest losses. Farmer gets direct benefit of food processing industry as they get higher price for his produce (stakeholder's discussion, 2018).

Traditionally, before refrigerated shipping and various moisture-sealing methods became common, cucumbers were pickled shortly after picking as the preservation method of choice. For this, the thin skin is ideal; because it lets the pickling juices pass into the cucumber without all that fussy slicing. With a big enough jar, one can have a relatively simple time pickling a bunch of whole cucumbers. The advantage of plastic-wrapping cucumbers over waxing is that you don't have to deal with the wax. Generally, people would peel waxed cucumbers, and that would certainly affect the presentation and nutritional properties of the cucumber. Cucumbers have a relatively thin skin, so when kept out for any period of time, are likely to lose moisture and dry out quickly if nothing is done to prevent it. Often cucumbers are waxed as one method to seal the moisture (Geiger, B. 2011).

5. CLUSTER IDENTIFICATION AND CHARACTERIZATION

5.1. Identification of Clusters

In this study following two clusters have been identified:

The Southern Punjab Cluster (C1). This cluster consists of ten districts of Southern Punjab (Table 8 and figure 1) with Pakpattan as its focal point. The cluster covers 67% of the total cucumber area in Punjab and supply 70% of production in the province. The cluster focal point, Pakpattan has highest share in cucumber production in the province.

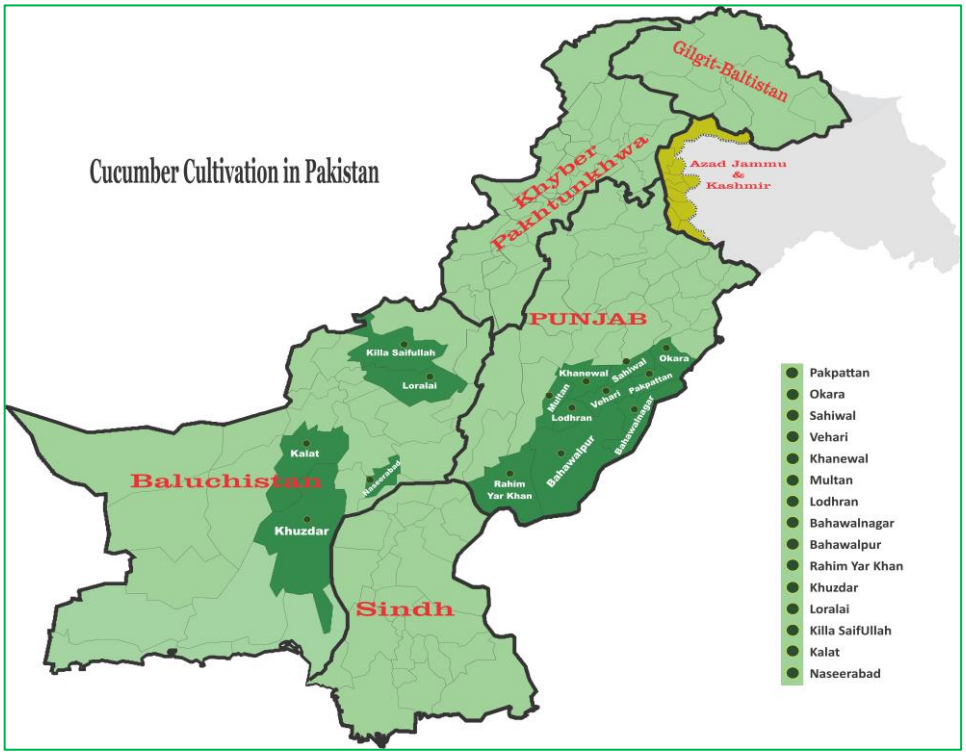
The Eastern Balochistan Cluster (C2). The cluster includes 5 districts all contributing about 67% of cucumber produced in the Province. Khuzdar has been taken as cluster focal point for Balochistan cluster (Table 8).

Table 8: Cucumber production areas by cluster, 2016-17

District	Area (ha)	% Share in cluster area	Production (tonnes)	Share(% of production	Yield (tonne/ha)
Southern Punjab Cluster (C1)					
Multan	279	22.06	4481	12.89	16.06
R.Y. Khan	243	19.21	4930	14.18	20.29
Vehari	186	14.70	2507	7.21	13.48
Pakpattan	174	13.75	8346	24.01	47.97
Bahawalpur	93	7.35	2039	5.87	21.92
Okara	85	6.72	3606	10.37	42.42
Lodhran	61	4.82	3120	8.98	51.15
Sahiwal	52	4.11	2480	7.14	47.69
Khanewal	51	4.03	988	2.84	19.37
Bahawalnagar	41	3.24	2260	6.50	55.12
Total cluster	1265	100.0	34757	100.0	27.48
Total Punjab	1895	66.74	49588	70.09	26.16
Balochistan Cluster (C2)					
Khuzdar	284	31	2074	31	7.3
Killa Saifullah	105	11	750	11	7.1
Kalat	86	9	662	10	7.7
Nasirabad	80	9	598	9	7.5
Loralai	66	7	471	7	7.1
Cluster Total	621	67	4555	67	7.3
Balochistan	925	-	6784	-	7.3

Source: MNFS&R (2016)

Figure 2: Map of Pakistan Showing Cucumber Production



5.2. Comparison of Cluster Characteristics

The Southern Punjab clusters have fertile lands with abundant resources and plenty of water, while Eastern Balochistan cluster is a desert oasis. The main focus of the Punjab and Baluchistan Clusters is to produce disease free, quality table cucumber. The cluster of Southern Punjab and Eastern Balochistan supply cucumber to the urban centers of Sindh and Punjab for trade. Table 9 presents an overall comparison of key characteristics in all three these clusters:

Table 9: Characteristic and Comparison of Cucumber Clusters

Salient Features	Southern Punjab Cluster (C1)	Balochistan Cluster (C2)
Products	**Fresh cucumber**	**Fresh cucumber**
Districts	Pakpattan, Multan, Lodhran, Okara, Khanewal, Vehari Bahawalpur, Rahim Yar Khan, Bahawalnagar	Khuzdar, Killa Saifullah Kalat, Nasirabad, Loralai
Focal point district/Tehsil/Mouza	Pakpattan	Khuzdar
Area of the cluster: (ha)	1265	621
Production: (tonnes)	34757	4555
Average yield: (tonne/ha)	27.48	7.33

Salient Features	Southern Punjab Cluster (C1)	Balochistan Cluster (C2)
Products	**Fresh cucumber**	**Fresh cucumber**
Percentage of the crop area that lies in the cluster (Cucumber area of the cluster/Cucumber area in the country) % age	37%	18%
Geographical and Environmental Factors	Sandy loam to clay	Loam/silt texture
	Medium altitude with mostly flat and plain areas	Combination of mountainous and plain areas
	Hot in summer and cold in winter	Mild cool climate during summer and cool in winter
	Average rain fall in the cluster is 100-300 mm	Average rain fall in the cluster is 150-400 mm
	Heavy rain in monsoon is affecting the production	Climate is dry, no effect of rain fall on production
	Flood irrigation is normal practice from tube well and canal source. About 20% crop receive irrigation through drips	Irrigation from traditional Karez and tube well sources No drip irrigation system
Cucumber Growers	Small to large size landholding ranging from 1 to 80 acres	Small and medium size landholding ranging from 5 to 20 acres
	No formal Cucumber Growers Associations	No formal Cucumber Growers Associations
	Availability of abundant labor for cucumber production	Scarcity of labor
	Large number of farmers in this region are trained and follow the guidelines provided by seed & pesticide marketing companies	Majority of farmers in this region are not well aware about modern practices, Private seed or pesticide marketing companies are very few
Gender Involvement	Cultural practices usually involve family or hired labor	No involvement of gender
Product Features	Both smooth and rough cukes 6-8 inches long	Smooth cukes 6-8 inches long
	Demand remains high throughout the year	Demand remain high throughout the year
	Lush green	Lush green
Variety Feature	Nobel F-1, 14-270, Savier, Yallah, Chever, 2833 and Mehran, 9786, Saad, Syngenta, Taha, Jamil, Nabil, Luna and Dala	Nobel F-1, Savier, Yallah, Chever and Mehran, 9786, Saad and Syngenta

Salient Features	Southern Punjab Cluster (C1)	Balochistan Cluster (C2)
Products	**Fresh cucumber**	**Fresh cucumber**
	Exotic (Green, light green color) and desi cucumbers are grown	Exotic and desi cucumbers are grown
Planting	Planted in rows with 12 inches plant to plant distance and row to row 30 to 48 inches	Planted in rows with 12 inches plant to plant distance and row to row 36 to 48 inches
	Direct seeding is usual practice/ seedlings grown and transplanted on beds	Direct seeding is usual practice/ seedlings grown and transplanted on beds
Tunnels	About 75% crop is grown in plastic tunnel. Mostly low to medium height tunnels are in practice. Protective farming is becoming popular	About 10 % crop is grown in plastic tunnel. Mostly low height tunnels are in practice
Input/Management Practices	Fertilizer application: SSP, $CaNH_3$, MOP, Urea	Fertilizer application: Urea, DAP, SOP
	50% of the farmers are using imbalance/inadequate inputs without soil analysis	Majority of the farmers apply under dose of fertilizer and other inputs without soil analysis
	Normal practice is broad cast i.e. higher doses than required	Normal practice is broad cast i.e. higher doses than required
Weeding/Pruning/ Harvesting	Plastic mulch and weedicides are usually practice to control weeds. Pruning of extra stems to get maximum size of cucumber	Normally weedicides are used to control weeds. Pruning is done to get maximum size of cucumber
	Harvesting depends upon the time of sowing either in open field or in tunnels. Normally 2 to 3 crops are harvested in a year	Harvested in July to October
	Pre-harvest losses are 5-10% and post-harvest losses are 10% to 20%	Pre-harvest losses are 5-10% and post-harvest losses are 10% to 20%
Packaging/ Transportation	Packed generally in Polyethylene bags without grading and transportation in polyethylene & netted bags	Packed generally in Polyethylene bags without grading and transportation in polyethylene & netted bags
	Waxing facilities are not available	Waxing facilities are not available
	Watering is normal practice to keep cucumber fresh	Watering is normal practice to keep cucumber fresh

Salient Features	Southern Punjab Cluster (C1)	Balochistan Cluster (C2)
Products	**Fresh cucumber**	**Fresh cucumber**
Diseases	Powdery mildew, downy mildew, cucumber mosaic virus	Powdery mildew, downy mildew, cucumber mosaic virus
Pesticides and insecticides	Many applications of Insecticides and fungicides are required during the crop cycle	Application of Insecticides and fungicides is in practice
	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.
Wholesaler/Retailer	Farmers sell their product in whole sale market through dealers. Some of the farmers have pre-harvest contracts also	Farmers sell their product in whole sale market. There is no pre-harvest contract
	The auction in the wholesale market is generally based on the variety and weight, but exact grading is done by retailers.	The auction in the wholesale market is generally based on the variety and weight, but exact grading is done by retailers.
	The average market retail price of cucumber is Rs.30 to Rs.60/kg	The average market retail price of cucumber is Rs.30 to Rs.50/kg
	Prices remain high at the commencement of the season, decline gradually as supply increases.	Prices remain high at the commencement of the season, decline gradually as supply increases.
	Sold as fresh in local and national markets	Sold as fresh in local and national markets
	Marketing through conventional methods	Marketing through conventional methods
Export	Lack of facilities to export the product	Lack of facilities to export the product
New Technologies/ Infrastructure	Drip and plastic tunnels are becoming popular	Drip and plastic tunnels are not affordable by the farmers
	Packing and cold storage facilities are not available	Packing and cold storage facilities are not available
Value Addition	No value addition/ processing	No value addition/ processing
	No pickle formation/ value addition for local utilization or export purpose	No pickle formation/ value addition for local utilization or export purpose

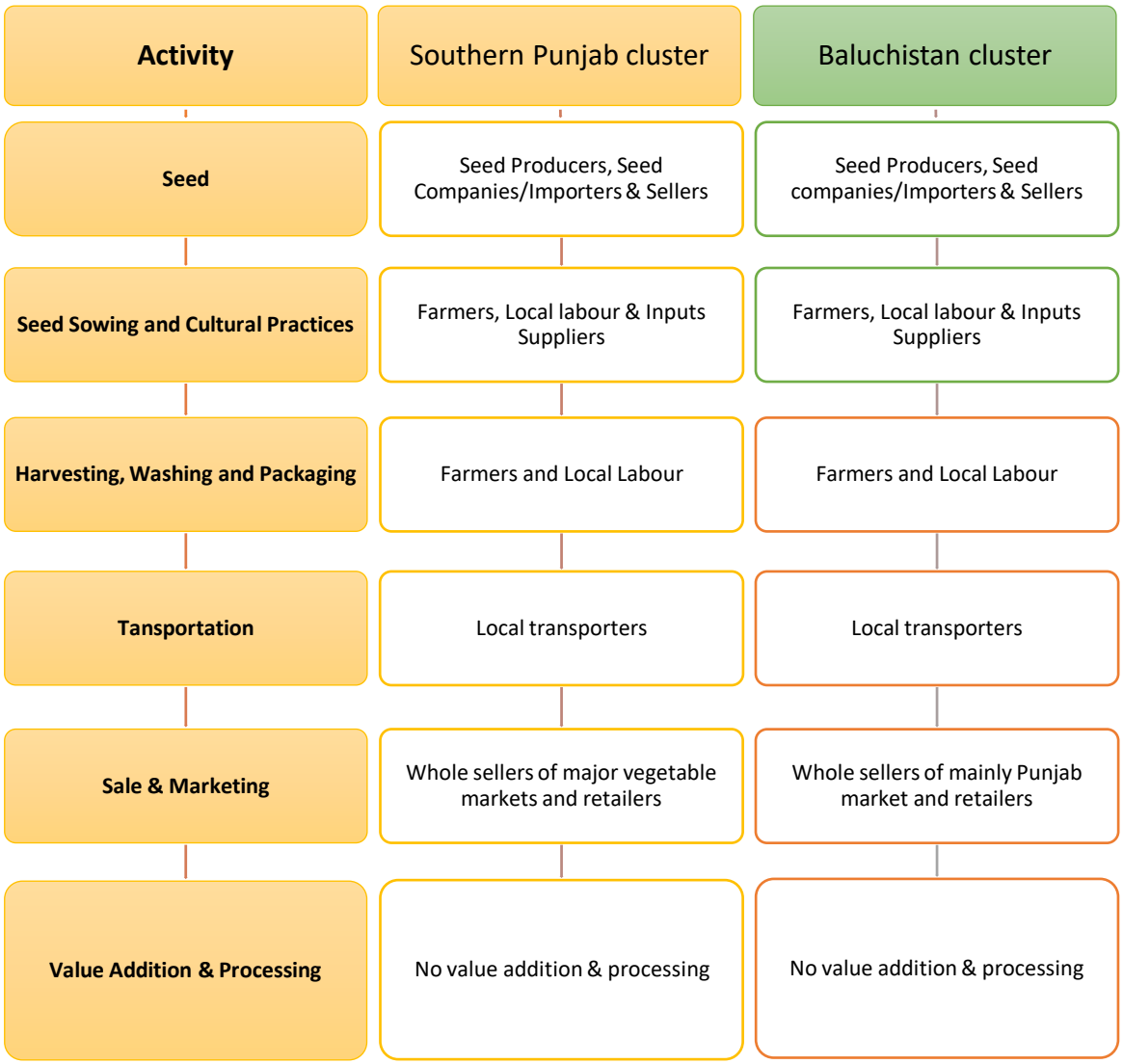
Salient Features	Southern Punjab Cluster (C1)	Balochistan Cluster (C2)
Products	**Fresh cucumber**	**Fresh cucumber**
Supply Chain	The chain is fragmented and less integrated; price spread is uneven	The chain is fragmented and less integrated; price spread is uneven
	Govt. facilitation not available to find new markets and export facilities	Govt. facilitation not available to find new markets and export facilities
Certification	No certification or quality control mechanism	No certification or quality control mechanism for fresh produce.
Cost of production	Open field cultivation cost is around Rs.10/kg of produce whereas it is much higher in case of tunnels The average cost/ ha ranges between Rs.285,000-400,000	Open field cultivation cost is around Rs.10/kg of produce whereas it is much higher in case of tunnels The average cost/ ha ranges between Rs.140,000-200,000
Financial Benefit	A typical open field producer earns about Rs.10-15/kg of cucumber depending upon quality and season, whereas from tunnel production the profitability is much higher. The profitability depends upon the harvesting time	A typical open field producer earns about Rs.17/kg of cucumber depending upon quality and season, whereas from tunnel production the profitability is much higher
Subsidies/Incentives/ Facilities	Financial support from public sector is available for drip irrigation and tunnel farming	Financial incentives are not available at govt. level
Research and Development	Agriculture/horticulture department provides extension services in the province. There is no research institution working in the cluster. However, seed and pesticide marketing companies are providing technical support in growing cucumber	Lack of departmental /extension services
Socioeconomic Networks	The role of NRSP is important in improving cucumber cultivation in the cluster	The role of BRSP is important in improving cucumber cultivation in the province

5.3. Description of value chain

Many national and international seed companies are involved in business of cucumber seed in this region. Most of the cucumber area is under imported varieties/ hybrids. Seed of local varieties of cucumber is also available on limited scale. Some farmers also produce their own seed. 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, packaging and loading on trucks are done manually by local labor. The fresh produce is transported to vegetable markets throughout the county depending upon demand, supply and market prices. Government agriculture research and development structure is more effective in Punjab as compared to other provinces. Agriculture extension setup is not much effective in both the clusters. Private seeds and pesticides companies are active in Punjab.

Figure 3: Value chain of Cucumber



5.4. SWOT Analysis

5.4.1. Overview

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

5.4.2. SWOT Analysis of Southern Punjab

The cluster has many strengths and opportunities, including a natural comparative advantage with respect to agro-ecological conditions, and off-season production as compared with major competitors and proximity to China and Gulf countries. Major weaknesses are poor planning, policy, low priority/neglect, poor cold storage infrastructure and inadequate investment in research, technology development/breeding, extension, marketing, etc. Threats include diseases and natural disasters, such as, climate change, energy shortages for cold storage and processing, and non-transparent trading practices in local market systems. These factors generally hold back investment into the value chain, inhibiting its development. The following (Table 10) presents the SWOT analysis for the Punjab.

Table 10: SWOT Analysis of Cucumber Southern Punjab Cluster (C-1)

Parameters	Strengths	Weakness	Opportunities	Threat
Environment/ Climate Change	Sandy loam to clay texture, temperate climate makes the region ideal for cultivating and growing different varieties of cucumber	In upper parts of the region, frost and precipitation may affect flowering and bearing of the fruit	Starting from south to North, fruit is ready for harvest successively. Fresh fruit is available from February to July	Severe rain fall in moon soon sometimes hamper the fruit bearing capacity of cucumber vines and cause erosion
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/ hybrid 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
	Application of required fertilizers can benefit the farmer	In appropriate methods of fertilizer	Modern methods of precision agriculture/ liquid	Extra/ under dose may hamper the growth and affect the production

Parameters	Strengths	Weakness	Opportunities	Threat
		application increase the cost	application with drip irrigation	
	Organic fertilizer opportunities are available in the region	Low uptake and usage of fertilizers	Local farmyard manure can be used after processing	Un processed farm yard manure may cause soil borne diseases
Cluster interaction	Large number farmers grow cucumber in this cluster	Little interaction among farmers and researchers	Possibility of learning from progressive farmers in the cluster	Lack of optimal coordination and integration of cucumber value chain actors
	Creating high value for the growers, traders and retailers	Producers have little information about the quality requirements in national and international markets	Possibility of collective efforts for achieving the economies of scale	
Production Management practices	Farmers having traditional skills in cucumber production	Traditional management practices are faulty (notably pruning, layout and fertility management and irrigation)	Potential for horizontal and vertical expansion potential exist; Road infrastructure improving	Impact of climate change, swings in weather conditions
	Commercial and exotic new varieties/ hybrids can enhance the production to optimum level.	Certified, quality and pure variety/ hybrid seeds are very costly	Govt./ Research departments can establish mother nurseries to produce different varieties/ hybrids at local level	Costly seeds increase the cost of production
	Irrigation water available at most of areas	Flood irrigation not only waste the water, also is a cause of weed and disease transportation	Facilitation can be made available at subsidized rates of drip irrigation system to save cost of irrigation & water	Extensive water wastage can cause scarcity /shortage of water in future
	Improved management practices can cover the yield gap of 5 tonne per ha	Lack of knowledge about improved management practices	Govt. institutions and other partners are available for capacity building of farmers	Lack of interest and non-serious behavior of scientists and extension workers

Parameters	Strengths	Weakness	Opportunities	Threat
	Possibility of diversification into improved varieties	Unorganized and mixed plantation in orchards	Local hybrids can be established by research organization	Lack of budget, scientists and germplasm for establishment of exotic varieties.
Pre & post-harvest handling	Through improved practices of pre and post-harvest handling optimum yield potential can be achieved i.e. up to 40 tonne/ha and can minimize the post-harvest losses	Pre- and post-harvest losses due to lack of skills and infrastructure (i.e., storage facilities); losses/wastages are nearly 10-20% of total production	Training institutes at public and private level can play role for capacity building to minimize pre & post-harvest losses	Pre & post-harvest losses can cause heavy financial losses.
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 transportation	Advantage of exporting to nearby countries	--
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	--

Parameters	Strengths	Weakness	Opportunities	Threat
			losses and trading margin	
Certification of crop	Certification process may be made easier by new legislation and involvement of private sector	Lack of knowledge and interest in certification process due to large no of formalities	Agencies for certification of crop and fruit are available	Un certified crops and fruits cannot be fit for export and good quality and price at domestic levels.
Phytosanitary certification	Certification process results in disease free production	Lack of knowledge and interest in certification process due to large no of formalities and non - friendly behavior and low cost	Certification process may be made easier by new legislation and involvement of private sector	Un certified and diseased produce is vulnerable to heavy losses and phytosanitary threats at cross border levels.
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 & market the quality product for export • High cost of production & can't compete in international market • No government policy to support the exporters and processors	• Mechanized farming to reduce cost of production • 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
Processing	Grading at farm level, processing (waxing, grading) and quality packing may enhance the crop value	Processing machinery not available. Non-grading (rather topping the good quality cucumber over poor quality) by the harvest contractor	Machinery can be made available to farmer associations for processing	Processing of cucumber potentially by large corporations may impact the margins of small processors

Parameters	Strengths	Weakness	Opportunities	Threat
Value addition	Cucumber can be used in many value-added products such as (Pickle, make up products, pulp and juice)	Little capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality value added products	Emerging supermarkets can introduce contract with farmers which may value added products	
e-Marketing	Direct marketing and time to say good bye to conventional marketing	Lack of knowledge and illiteracy, Conventional auctioning in the wholesale market with visual and spot grading	Registered & certified produce will be sold directly & easily without wastage of time and involvement of extra stakeholders	Conventional system is a hurdle for best prices to farmers and users

5.4.3. SWOT Analysis of Balochistan

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

Table 11: SWOT Analysis of Balochistan Cucumber Cluster (C-2)

Parameters	Strengths	Weakness	Opportunities	Threat
Environment/ Climate Change	Loam/silt texture, slight cold and temperate climate makes the region ideal for cultivating and growing different varieties of cucumber	In upper parts of the region, frost and snow may affect flowering and bearing of the fruit	Starting from south to North, fruit is ready for harvest successively. Fresh fruit is available from July to October	Severe drought hampers the fruit bearing capacity of cucumber vines
Input Supplies	Growing demand for input supplies including fertilizers, fungicides and pesticides	Non-availability/ application of appropriate quality fertilizer, pesticides and micronutrients	The private sector can fill the gap by providing input supplies to the growers or by	Commercial fertilizers and pesticides may increase the cost of production

Parameters	Strengths	Weakness	Opportunities	Threat
		in local input market	use of organic fertilizers and pesticides	
	Application of required fertilizers can benefit the farmer	In appropriate methods of fertilizer application increase the cost	Modern methods of precision agriculture/ liquid application with drip irrigation	Extra/ under dose fertilizer may hamper the growth and affect the production
	Organic fertilizer opportunities are available in the region	Low uptake and usage of fertilizers	Local farmyard manure can be used after processing	Un processed farm yard manure may cause soil borne diseases
Cluster interaction	Large number, more than 5,000 farmers grow cucumber in Balochistan	Little interaction among farmers and researchers	Possibility of learning from progressive farmers in the cluster	Lack of optimal coordination and integration of cucumber value chain actors
	Cucumber value chain is functional in the region, creating high value for the growers, traders and retailers	Producers have little information about the quality requirements in national and international markets	Possibility of collective efforts for achieving the economies of scale	
Production Management practices	Farmers having traditional skills in cucumber production	Traditional management practices are faulty (notably pruning, layout and fertility management and irrigation)	Potential for horizontal and vertical expansion potential exist; Road infrastructure improving.	Impacts of climate change, swings in weather conditions
	Commercial and exotic new varieties/ hybrids can enhance the production to optimum level.	Certified, quality, and pure variety /hybrid seeds are very costly	Govt./ Research departments can establish mother nurseries to produce different varieties/	Costly seeds increase the cost of production

Parameters	Strengths	Weakness	Opportunities	Threat
			hybrids at local level	
		Shortage of water, underground water is very deep 800-1200 feet	Facilitation can be made available at subsidized rates of drip irrigation system to save cost of irrigation and water	Drought is serious problem for vegetable production.
	Improved management practices can cover the yield gap of 5 tonne per ha	Lack of knowledge about improved management practices	Govt. institutions and other partners are available for capacity building of farmers	Lack of interest and non-serious behavior of scientists and extension workers
	Possibility of diversification into improved varieties	Unorganized and mixed plantation in orchards	Local hybrids can be established by research organization	Lack of budget, scientists and germplasm for establishment of exotic varieties.
Pre & post - harvest handling	Through improved practices of pre and post - harvest handling optimum yield potential can achieved i.e., up to40 tonne/ha and can minimize the post - harvest losses	Pre- and post-harvest losses due to lack of skills and infrastructure (i.e., storage facilities); losses/wastages are nearly 10-20% of total production	Training institutes at public and private level can play role for capacity building to minimize pre & post - harvest losses	Pre & post - harvest losses can cause heavy financial losses.
Transportation	Motorways & Highways connects the region with all major cities in the country.	Access roads to remote areas prone to blockages High fuel cost especially diesel used in transportation; high freight costs	Availability of net container in the market as already being used in certain other fruits	Large distances may hamper the transportation to northern region of the country
Marketing	• Bulk produce in peak season	• Unstable market prices	• Financial support to	--

Parameters	Strengths	Weakness	Opportunities	Threat
	• Good quality produce • Prolonged availability of fresh produce	• No stable marketing policy / infrastructure • No grading, proper packaging and transportation • Auctioning in the wholesale market with visual and spot grading	farmers about 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 & trading margin	
Certification of crop	Certification process may be made easier by new legislation and involvement of private sector	Lack of knowledge and interest in certification process due to large no of formalities	Agencies for certification of crop and fruit are available	Un certified crops cannot be fit for export and good quality and price at domestic levels.
Phytosanitary certification	Certification process results in disease free production	Lack of knowledge and interest in certification process due to large no of formalities and non-friendly behavior and low cost	Certification process may be made easier by new legislation and involvement of private sector	Un certified and diseased produce is vulnerable to heavy losses and phytosanitary threats at cross border levels.
Trade/Export	• Bulk surplus fresh produce during peak season • Some food companies can be involved in processing of cucumber for	• Little capacity of farmers and traders and no quality infrastructure to produce, handle, and market the	• Mechanized farming to reduce cost of production • Big opportunities for food processing companies and	• Unstable electricity and gas prices and supply for industry • Slow development

Parameters	Strengths	Weakness	Opportunities	Threat
	pickles to sale in local and international market	quality product for export • High cost of production can't compete in international market • No government policy to support the exporters and processors	exporters in form of pickles, quality based contract farming between farmers and exporters • Quality seed production for local demand to reduce seed import	of quality infrastructure, • Lack of stakeholders interest in capacity building to produce and maintain quality product
Processing	Grading at farm level, processing (waxing, grading) and quality packing may enhance the crop value	Processing machinery not available.	Machinery can be made available to farmer associations for processing	Processing of cucumber potentially by large corporations may impact the margins of small processors
Value addition	Cucumber can be used in many value-added products such as (Pickle, make up products, pulp and juice)	Little capacity of farmers and traders and little quality infrastructure to produce, handle, and market the quality value added products	Emerging supermarkets can introduce contract farming which may introduce value addition products	--
e-Marketing	Direct marketing and time to say good bye to conventional marketing	Lack of knowledge and illiteracy, Conventional auctioning in the wholesale market with visual and spot grading	Registered & certified produce will be sold directly & easily without wastage of time and involvement of extra stakeholders.	Conventional system is a hurdle for best prices to farmers and users.

6. CHALLENGES FACED BY THE CLUSTER

6.1 Climate Change and Increasing Shortages of Water

Frost and strong dusty/sandy winds and storms in Balochistan during flowering/blossoming season greatly impact the yield and quality of production. Climate change related impacts, such as new diseases and shifts in crop cycle are also emerging issues in all the clusters.

Agriculture in Balochistan dependent on underground water which is physically scarce due to over-extraction and variation in the climate, such as prolonged drought. There is no issue of irrigation water for cucumber in Punjab.

6.2 Constraints at Production Level

Extensive extension system of the Department of Agriculture is present in the cluster of Punjab although few extension workers are aware of the technical issues and their solutions in cucumber, while agricultural extension services are not effective at all in Balochistan. Lack of extension services results in low yield and poor quality of the produce. Manual labor is involved in harvesting of cucumber in all the clusters which is major component of production cost.

The expensive imported hybrid seed is a major constraint in cucumber cost of production. The average per ha price of imported hybrid seed ranges from Rs.400,000 to 600,000. The international hybrid seed companies like Syngenta, ICI, Advanta and Sky seeds are providing the seed along with technical assistance to cucumber farmers. The availability of local seed is very limited in Balochistan province.

Table 12: Gaps and constraints at production level

Parameter	Southern Punjab Cluster	Balochistan Cluster
Locally evolved high yielding Varieties	Limited availability	Not available
Certified Seed	Limited availability	Not available
Commercial inputs	Available	Limited
Extension services	Adequate	Very poor
Labor input	Family/Local labor	Local labor
Credit	Available	Limited
Research system	Moderate	poor

6.3 Constraints at Post-Harvest Level

6.3.1. Value addition

Value addition is not practiced in any cluster. At present, fresh cucumber is simply graded and packed in netted & plastic bags and sent to the auction markets in major cities, in unrefrigerated vehicle, such as on the rooftop of passenger vans. Obviously, this product fetches a lower price compared to the 'processed product', delivered directly to super markets, under the cold chain conditions. In fresh cucumber, processing involves grading and then cooling the fruit to less than 4 degrees centigrade, before packing and loading onto cold containers for transportation. Storage of cucumber is generally done less than 14 days as visual and sensory quality deteriorate rapidly. Shriveling, yellowing, and decay are likely to increase storage beyond two weeks.

Respiration varies up to 10°C above different stages of maturity. Less mature cucumbers have high respiration rates. Harvesting of fruit at advanced stage of development and store at high temperature can cause yellowing. Cucumbers should be packed in strong, well-ventilated containers, which is currently not a practice.

However, despite availability of these technologies, their uptake and adoption are not automatic and requires support, strategy and incentives. The public sector does not have to take up the entire responsibility on its own, but seek win-win solutions by working with the private sector and NGO partners. In both provincial clusters, market links are heavily reliant on the tenacity of the individual processor, creating a constricted market structure.

Table 13: Gaps and Constraints at post-harvest and processing level

Parameter	Southern Punjab Cluster	Balochistan Cluster
Fresh produce handling unit	Not available	Not available
Processing/value addition technologies	Not available	Not available
Ready investment projects	Not available	Not available
Access to energy for processing	Available	Limited

6.3.2. Constraints at Processing Level

There is no cucumber processing in Pakistan whereas in rest of the world 25% of cucumber production goes to processing. The technologies needed for processing, packaging, and storage varies in quality and efficiency. Many of the processing technologies for fresh cucumber are lacking, which is both a problem and an opportunity for improvement.

6.3.3. Constraints at Trading Level

Most of the produce is traded fresh. Cucumbers are consumed throughout 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. Proper storage facilities are not available

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 on season, demand and supply. There is no proper price control policy which results in highly variable returns to producers. Sometimes, the producers get very good price and earn good revenue but there are times, when market prices are so down that farmers can't even recover their original cost. Whole sellers in vegetable markets are always in win-win position. Communication services in Punjab are easily available and farmers are connected with different vegetable markets in telephonically to get information about current market rates, but such services are relatively weak in Baluchistan. Another major constraint is poor information and ability 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.

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

Although commission agents provide loans to farmers to buy inputs for cucumber, but such contracts are not based on quantity, quality or price. The development workers have to think how to convert the existing contracts into quality, time, and price specific.

Table 14: Gaps and Constraints at Trading Level

Parameter	Southern Punjab Cluster	Balochistan Cluster
Marketing channels	Traditional	Traditional
E-commerce platforms	Not available	Not available
Contract farming	Limited	No
Export readiness	Lacking	Lacking
Certifications (phytosanitary)	No	No
Branding	Lacking	Lacking

In summary, an agricultural policy guiding public and private investment and sector support programs to develop the vegetable industry is highly desirable both in Punjab and Balochistan. Improvements are also needed with the provision of up-to-date and useful market information to inform producers, processors and traders.

7. CLUSTER DEVELOPMENT POTENTIAL

7.1. Overview

In this section an attempt is made to evaluate the potential in the clusters in terms of production, quality and market side of cucumber value chain based on the targets set in Section 2 for incremental improvements in the cluster performance.

7.2. Production Potential

The global average yield is 37 tonnes/ ha, whereas in Pakistan it is 16 tonne/ ha thus a yield gap of 21 tonnes/ ha exists. The estimated average yield for Balochistan is 7.0 tonne/ ha and 26 tonnes/ ha for Punjab, respectively.

In this scenario, increase in average cucumber yield can be achieved relatively easily in all the clusters because of the availability of suitable technologies to achieve the target. In this regard, high yielding hybrids along with appropriate production practices can produce 25-40 tonnes/ha cucumbers. Moreover, good agricultural practices are also very much documented. Bringing farmers closer to the recommended inputs and management practices can bridge the huge yield gaps and Pakistan can significantly boost its cucumber production.

The new imported hybrids, varieties, and management practices indicate that actual potential is much higher, but cucumber stakeholders believe that 15% improvement in cucumber yield in Punjab and 40% increase in Balochistan by these technologies is quite probable. This will increase the gross income in Punjab Cluster by US$ 2.40 million and in Balochistan Cluster by US$ 0.77 million. This will increase the production of 14 thousand tonnes in the Punjab cluster and 4.6 thousand tonnes in Balochistan cluster. This additional production of 22.6 thousand tonnes will be just sufficient to replace almost all the imports in the country, which will save the country about US$ 2.2 million. Increasing production potential will result in creation of nearly 600 new jobs at production level in both Punjab and Balochistan clusters. These jobs will be mainly for hired poor wage earner.

7.3. Processing/canning of cucumber

Although possibilities of processing of cucumber exists, such as cucumber pickles and technologies are also available for this, but our discussion with stakeholders suggest that cucumber pickles are not very much liked in Pakistan. Lots of efforts will be required to initially compete in international markets. Therefore, cucumber processing has been dropped.

7.4. Improvement in Quality

One of the areas of concern in cucumber sector of Pakistan is that of gap between domestic and the global prices of the commodity are very high. For example, price of imported cucumber

is US$ 220 while domestically produced cucumber is US$ 170 indicating poor value chain of domestically produced cucumber. One of the reasons of this difference is the low quality of the produce because of its poor post-harvest handling. If cucumber is passed through the pack-house where it is properly graded, washed and packed before it is marketed, it can substantially improve its quality and price. It is assumed that 20% of the domestic produce in Punjab cluster can be passed through the pack-houses in the concentrated area of cucumber production in the province. This will also require additional certification companies, packaging materials, improved transportation facilities, etc. which can generate some 100 jobs in Punjab. In Balochistan, installation of pack-houses will not be possible because of the small size of production scattered in various districts, however, proper training of the producers about post-harvest management practices like proper washing, packaging, and transportation, etc. is expected to improve the quality of the produce, although improvement in price after these operations will be modest from US$ 170 to US$ 190.

7.5. Saving in Post-Harvest Losses

The improvement in cucumber value chain handling through packed houses in Punjab and training of farmers and other value chain players in Balochistan will not only improve the quality of the produce but also reduce the post-harvest losses. It is estimated that such management will reduce post-harvest losses from 10% to 5% in Punjab and from 10% to 5%. This will generate an additional income of US$ 0.89 million in Punjab and US$ 0.12 million in Balochistan to various stakeholders along the chain

7.6. International Standards

To improve the quality and price of cucumber to international level, adoption of international quality standards at each segment of the value chain is required. IPPC (International Plant Protection Convention) is the international treaty under which common standards are developed for pest control in plants and plant products across international borders. The Commission on Phytosanitary Measures (CPM) is the governing body of the IPPC and it has adopted a number of International Standards for Phytosanitary Measures (ISPMs) that provide guidance to contracting parties in meeting the aims and obligations of the Convention.[1]In addition, each country has its own specific standards for each crop. Lot of work is needed to become competitive in international market. But if the country can invest R&D and quality infrastructure, it can generate extra revenue and employment in cucumber sector in the country. Most of this employment will be generated to the poor in crop production and value chain management processes thus helping to bring down poverty in rural areas.

[1]Adopted International Standards for Phytosanitary measures (ISPMs). https://www.ippc.int/en/core-activities/standards-setting/ispms/#publications

8. PLAN, POLICIES AND STRATEGIES

8.1. Plan

The purpose of the whole exercise is to develop a research-based cluster transformation plan for cucumber to achieve the following targets.

Targets of Cucumber Cluster Plan

- Increase yields by 20% from the current base
- Reduce postharvest losses by half from the current benchmarks
- Transforming the country into self-sufficient in cucumber and possibly net exporter
- Improve the value chain of cucumber to enable the cucumber to compete with imported cucumber.

8.2. Policies

At the policy level, the current practice of providing general subsidies and “export rebates” to selected commodities should be eliminated, as these are grossly abused. Instead, subsidies and incentives should be specific and result driven. Moreover, investment incentives for quality infrastructure should be carefully reviewed and enhanced. A nationwide program should be developed, in which all districts can compete for Cluster Development Grants to specialize in specific high-value crops for export. Another policy recommendation is to include cucumber in bilateral/multilateral trade agreements with friendly countries especially with China and try to seek help from China for improved value chain management. There is lot of potential in this area due to seasonal difference with China and European markets.

At the local level, supporting farmers to organize themselves as marketing groups, such as Farmers Enterprise Group (FEGs), would be a key element of the strategy, for achieving economies of scale, access to inputs, finance, technology, and market information, especially in the Punjab where farm size is small. It is, therefore, suggested that these special incentives should be organized for these groups, especially in the focal points of cucumber clusters. The FEGs should be established by combining various cucumbers producing union council. Special loans can be provided on concessional terms to each FEG to allow them to market their cucumber under a brand name, help various stakeholders in adopting best practices, hold trade fairs, competitions and arrange various training events, etc. The FEGs should ensure the quality of cucumber at the group level and negotiate terms for contract farming.

The farmers of the two clusters should join some other association to voice their issues at the national level. The associations should have a website of its own on cucumber and work to promote best practices, share knowledge, technology and lobby with government for enabling policies, on behalf of its members.

8.3. Strategies for Southern Punjab Cluster

8.3.1. Production Level Strategies

The primary production strategy is to narrow the yield gap with the global average. The plan is to increase the yields from the current base of 15 tonnes per ha to 20tonnes per ha, or closer to the global average of 37 tonne/ha. This will be done by:

a) **Importing high quality germplasm:** The Punjab needs germplasm having traits of high yields with tolerance to frost and resistant against mildew and other diseases. Such germplasm can be obtained from China, Chile, France, Italy, Turkey, or USA. So diplomatic and commercial links should be used to get the much-needed germplasm from these countries.

b) **Supply of latest and certified varieties/hybrids to farmers:** Available or imported improved cucumber varieties/hybrids in protected cultivation will be promoted to farmers within the 1st year of the project by establishing demonstration fields of these varieties/hybrids in the focal districts of both the clusters of Punjab.

c) **Establishment of Strong Cucumber Research Program:** For long-run sustainability, a strong research program on cucumber will be established in BARI, Chakwal, Punjab and Ayub Agriculture Research Institute (AARI) Faisalabad covering important issues along the value chain. The program will initially rely on the selection of high yielding material from the wide array of germplasm collected, but later it will do some breeding work in developing new varieties/hybrids for protected cultivation. Special varieties/hybrids will be screened for protected cultivation for fresh market. The advance lines (not varieties) will be tested in different districts of Punjab and to finalize the varieties suitable for the cluster.

d) **Promotion of protected cultivation:** Protected cultivation will be supported through FEGs by providing subsidies to the plastic tunnels and drip irrigation system.

e) **Training:** Five established cucumber fields in the cluster will be used as demonstration plot where good agricultural practices will be adopted and farmers will be frequently invited for training purpose. It will be highly desirable to invite experts from China to help in putting in place specific phytosanitary standards needed for export to China in these demonstration plots. Moreover, 100 farmers will be provided on-hand training in each cucumber growing district of the cluster. One of the key objectives of this intervention shall be to bring the postharvest losses from 10% of total production down to 5% in Punjab over five years.

8.3.2. Value Addition Level Strategies

Value addition means harvesting at the right time, washing the product immediately after harvest, cooling, sorting, grading, retail packaging and branding. In this way, not only higher prices are ensured but the product's shelf life can be extended and retail level losses are

reduced. The main value addition strategies would be providing pack-houses in the Punjab cluster while providing training to farmers and value chain actors on proper management of the crop at the time of harvesting and post-harvesting. This will be achieved by:

a) **Branding of Cucumber products**: Each FEG will get its product branded and cost of branding will be initially borne by the FEG and charged from the farmers who will sell their fresh and canned produce through the FEGs. For branding, the 'Fresh' and 'Organic Food' business models are additional options to improve the value for the farmer groups and other value chain actors. Certifications for IPPC, Phytosanitary, Organic and Fair Trade can be pursued as other value-added strategies.

b) **Forming Cucumber Association of Pakistan:** This should be a joint activity for all the clusters, which should have a website and develop its own marketing apps.

8.3.3. Marketing and Trading/Export Strategies

Multi folds strategies are suggested to improve marketing and trading at domestic and international levels. Currently, Pakistan is not a regular cucumber exporter. For its export to the world market proper commercial strategies are required. To bring our production to export ratio at par to the world average level in five years, following strategies are suggested:

- Improve production through increase in area, introducing new cultivars and promoting best management practices.
- Providing market information. A small cell will be established in the department of agriculture in Punjab each consisting of three scientists (marketing specialist, economist and information analyst) with supporting staff which will provide information to the stakeholders about international market requirements (i.e., standards, price, potential buyers, etc.).
- Sponsoring international tours. Top three best exporters will be sent abroad every year to identify potential markets and new buyers at 20% government expenses.
- Holding competition and rewards for exporters. Special competition will be held and rewards will be provided for outstanding exporters of value added fresh cucumber. These competitions will be held at the cluster level.

8.4. Strategy for Balochistan Cluster

The Balochistan is not good on the production side because of scarce resources and distant locations of farms, compared to the Punjab. For example, there is scarcity of water and electricity in Balochistan and problem of road infrastructure; here farmers are going through a transition from subsistence to the commercial farming. Still, there is room for improvement. The following strategies are recommended for interventions related to production technology, management, product diversification, market segmentation and other value-added measures that are needed to be taken to get maximum value from the cucumber cluster.

8.4.1. Production Level Strategies

Appropriate production practices, careful harvesting, cooling, proper packaging and transport, all contribute to good produce quality. In order to reduce post-harvest losses of cucumber, there is a need for better handling, packing and grading. Policy makers need to know more about the costs and benefits of investment for loss reduction. The extra cost afforded by the consumer in the form of multiple and poor grading can be reduced by proper packing and grading. In this connection, there is an urgent need to develop the confidence of both producers and retailers on grading. Beside this, quality cannot be improved after harvest; therefore, it is important to harvest cucumber at the proper stage, size and at peak quality. Immature or over mature produce may not last long in storage.

The production strategy for the Balochistan is to increase the yield by 300% from the current base of 7 tonne/ha. This will include importing germplasm from Chile, France, Italy or Turkey and multiplying it in government facilities.

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

a) **Importing high quality germplasm**. Balochistan also needs infusion of new germplasm, having specific traits to suit the prevailing conditions in the province, such as tolerance to drought and pests. Such germplasm can be imported from China, Turkey or USA (California). Bilateral and multilateral agencies can be approached, such as Consultative Groups on International Agriculture Research (CGIAR), FAO or the Chinese Academy of Agricultural Sciences(CAAS) as well as Pakistan's missions overseas, for assistance in accessing the require germplasm.

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

c) **Promotion of protected cultivation:** Protected cultivation will be supported through FEGs by providing subsidies to the plastic tunnels and drip irrigation system.

d) **Training:** Five established cucumber fields in the cluster will be used as demonstration plot where good agricultural practices will be adopted and farmers will be frequently invited for training purpose. It will be highly desirable to invite experts from China to help in putting in place specific phytosanitary standards needed for export to China in these demonstration plots. Moreover, 100 farmers will be provided on-hand training in each cucumber growing district of the cluster. One of the key objectives of this intervention shall be to bring the post-harvest losses from 10% of total production down to 5% in over five years in Balochistan.

8.4.2. Value Addition Level Strategies

As in the Punjab, value addition is missing steps in the Balochistan. Therefore, the strategy would be the same for the establishment of cold chains. This will be achieved by incentivizing the private sector to establish pack-houses in cucumber growing areas which include grading, washing, packing, and small cold stores for fresh cucumber for export and domestic market. The feasibility of cucumber pack house is given in Annexure 3.

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

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

b) **Certifications for IPPC, Phytosanitary, Organic** and fair trade can also be pursued as other value-added strategies.

8.4.3. Marketing and Trading Level Strategies

To increase the export to production ratios various measures including; a) the provision of market information (standards, process and potential buyers) have been suggested. In this regard, a small cell in agriculture department will be established to regularly provide market information to various stakeholders; b) Sponsoring international tours – for example top three exporters shall be sent abroad on exposure visits at 20% government expenses; and c) Holding of competition and rewards for exporters.

Measures are to be taken to improve the quality and export price and in order to meet the international standards. The suggested interventions include; a) provide incentives for adopting best practice and certification regimes - for this, special tax incentives will be provided to establish certification companies in the Province. The government will also incentivize various stakeholders along the value chain to adopt these practices by paying 20% of the machinery cost recommended by the certification agencies at various levels. However, farmers have to agree to pay for any additional infrastructure, labor, and monitoring costs. b) Training stakeholders to adopt ISPMs. International consultants will be engaged by the FEG to spell out requirements at production, processing, transportation, storage, marketing levels and provide training of trainers who in turn will train farmers, processors, traders, exporters, etc. to adopt the ISPMs standards. Three hundred farmers and 25 other stakeholders will be trained to adopt the ISPMs in each cluster every year. A common intervention proposed is to establish a Cucumber Association of Pakistan with an interactive website and marketing apps.

9. BENEFITS AND COSTS OF CLUSTERING

This chapter discusses the costs associated with cluster development strategies presented in previous chapter. This also identifies resources and requisite inputs for achieving all the targets given in Chapter 2. An economic and social impact analysis has also been conducted that evaluates the benefits of the cucumber cluster development interventions in two target regions of Punjab and Balochistan.

9.1. Investments, Costs and Returns in Punjab and Balochistan

An investment of US$ 0.84 million is needed to support the cluster development efforts in Southern Punjab Cluster. Little more than one half (53%) of this investment will be required by the public sector and remaining will come from the private sector. Twenty percent of the public sector investment may be provided by the federal government by establishing a Cluster Development Fund (CDF) under Planning Commission of Pakistan (PCP). The remaining 70% should come from the provincial budgets.

Details are given as in the following table for South Punjab Cluster;

Table 15: Inputs and infrastructure needs for development of South Punjab cluster

Cluster-1			
S#	**Cluster Strategy**	**Interventions**	**Implementing Agency**
1	**Production level strategies** *(To increase yield by 50%)*	Importing high yielding good quality cultivars	PARC, AARI, UAF
		Adaptability testing and supply of certified seed to the farmers	
		Strengthening the breeding program and seed production of cucumber in the region	
		Development of economical and sustainable production technology package	
		Establishment of demonstration plots and training of farmers for improved production practices	Agri. Extension Dept. Punjab
Cost of this component (000 US$) :			**1813**
2	**Value addition strategies**	Cooling, sorting, grading, retail packaging and branding	PARC, PHRC (AARI), PFVA
		Providing pack-houses along with training on pre and post-harvest aspects	
		Branding of cucumber and formation of associations	
Cost of this component (000 US$):			**360**
3	**Marketing & Trading level strategies** *(Increase the export to production ratio to world average of*	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	

	4% in five years; Improve the quality and export price up-to international standard)	Provide incentives for adopting best practice and certification regimes	
		Establish a cucumbers exporters association under umbrella of PFVA with a website and marketing apps	
		Train the stakeholders to adopt ISPMs as per IPPC	

Similarly, an investment of US$ 0.90 million is proposed for improving the cucumber cluster in Balochistan. This shall help strengthen the production, processing and market segments of cucumber value chain in the province.

Table 16: Inputs and infrastructure needs for development of Balochistan cluster

Cluster-2			
S#	**Cluster Strategy**	**Interventions**	**Implementing Agency**
1	**Production level strategies** *(To increase yield by 300%)*	Importing high yielding good quality cultivars	PARC, Provincial Agricultural R&D Department
		Adaptability testing and supply of certified seed to the farmers	
		Strengthening the breeding program and seed production of cucumber in the region	
		Development of economical and sustainable production technology package	
		Establishment of demonstration plots and training of farmers for improved production practices	Agri. Extension Balochistan
Cost of this component (000 US$)			**243**
2	**Value addition strategies**	Cooling, sorting, grading, retail packaging and branding	PARC, Provincial FS&T Department, PFVA
		Providing pack-houses along with training on pre and post-harvest aspects	
		Branding of cucumber and formation of associations	
Cost of this component (000 US$)			**64**
3	**Marketing & Trading level strategies** *(Increase the export to production ratio to world average of 4% 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 cucumbers exporters association under umbrella of PFVA with a website and marketing apps	
		Train the stakeholders to adopt ISPMs as per IPPC	

Investment costs of the above activities are summarized in the Table 17.

9.2. Summary of Investment Costs

Table 17: Summary of Investment costs

Description	Value
Southern Punjab	
Total Investment (million US$)	0.841
Total ha of land in Southern Punjab under cucumber production	1895
Estimated investment per ha (000 US$)	**0.443**
Balochistan	
Total Investment (million US$)	090
Total ha of land in Balochistan under cucumber production	925
Estimated investment per ha (000 US$)	**1.0**
*Currency conversion rates @Rs.135=1 US$	

The estimated investment cost per ha in Southern Punjab is US$ 443 whereas it is US$ 1000 in Balochistan. Detailed reasons of the cost and benefit will be discussed in the next chapter.

9.3. Economic, Social and Environmental Returns

The proposed investments are likely to generate substantial economic, social and environmental returns. As discussed in the previous chapters, the key objective of cluster development is to improve the overall efficiency of cucumber sector in the country. This efficiency shall be realized as a result of measures taken at production, processing and marketing levels as shown in the form of various interventions in table 18.

Total value chain cost including those of production, washing, grading & packing, transportation, marketing, storage, shelving and retailing are applicable from year 2 to year 5, the total of which ranges from US$ 203,843 in 2nd year and US$ 1,087,155 in 5th year. The total initial cluster investment is US$ 841876 in Southern Punjab.

Table 18: Economic Returns and Investments in Southern Punjab

Parameters	Overall (US$)	Year 1	Year 2	Year 3	Year 4	Year 5
Current Situation Yield, production and value	25,382,615	-	6,158,425	6,281,594	6,407,226	6,535,370
First Intervention Increase yield by 50% over 5 years	2,403,180	-	230,941	471,120	720,813	980,306
Second Intervention Post-Harvest losses to be reduced from 20% to 10%	891,770	-	79867	168818	267301	375784
Third Intervention Improvement in value chain	506,226	-	14,428	61,748	148,444	281,605
Economic Returns Economic returns after interventions	3,801,175	-	*325,236*	*701,686*	*1,136,559*	*1,637,694*
Net Economic Returns Economic returns when costs are offset	**1,325,017**	-	*121,394*	*254,701*	*398,383*	*550,540*
Cluster Investments Total investments made	841,876	306,292	267,792	210,042	57,750	
Net Benefits (US$) Discount Rate (8.5%)		**-306,292**	**-146,398**	**44,659**	**340,633**	**550,540**
PV of Economic Returns (US$)	125,900	*-282,297*	*-124,359*	*34,964*	*245,792*	*366,134*
Estimated Internal Rate of Return (IRR)			**25.5%**			

A discount rate of 8.5% is applied to calculate the discounted values of investments as well as to estimate the present value of future economic returns. Based on these parameters, the present value of the future economic returns range will be negative in 1st and 2nd year, and positive in subsequent years. Total NPV will be US$ 125.9 thousand. The Internal rate of return is estimated 25.5% (Table 18).

Table 19: Economic Returns and Investments in Balochistan

Parameters	Overall (US$)	Year 1	Year 2	Year 3	Year 4	Year 5
Current Situation Yield, production and value	3,099,569	-	*774,660*	*774,815*	*774,970*	*775,125*
First Intervention Increase yield by 300% over 5 years	774,970	-	77,466	154,963	232,491	310,050
Second Intervention Post-Harvest losses to be reduced from 20% to 10%	125,935	-	10,652	23,244	37,780	54,259
Fourth Intervention Improvement in value chain	15,386	-	1,269	2,803	4,611	6,703
Economic Returns Economic returns after interventions	916,290	-	*89,386*	*181,010*	*274,882*	*371,011*
Cost Heads	712,828	-	*52,830*	*121,915*	*211,614*	*326,468*

Different cost heads from value chain						
Net Economic Returns Economic returns when costs are offset	203462	-	*36,557*	*59,095*	*63,268*	*44,543*
Cluster Investments Total investments made on the cluster	90,000	36,000	27,000	13,500	13,500	
Net benefits (US$) Discount Rate (8.5%)	113,462	-36,000	9,557	45,595	49,768	
NPV of Economic Returns	46,546	*-33,180*	*8,118*	*35,697*	*35,911*	*29,623*
Estimated Internal Rate of Return (IRR)			**72%**			

Total value chain cost including those of production, washing, grading, packing, transportation, marketing, storage, shelving and retailing are applicable from year 2 to year 5, the total of which ranges from US$ 52830 in 2nd year and US$ 326468 in 5th year. The total initial cluster investment is US$ 90,000 in Balochistan.

The net economic benefits after offsetting the value chain costs from revenues shall be negative in 1st and 2nd year. This amount is exactly equal to the value chain costs in year 1 and 2, as no revenues or benefits are expected in 1st and 2nd year of cluster development interventions. The 1st and 2nd year of interventions is rather considered as the incubation period.

Based on these parameters, the present value of the total future economic returns (NPV) US$ 45,546. The Internal rate of return is estimated 72%, which is not feasible for investment in this cluster.

Any environmental degradation is unlikely to happen from promotion of cucumber clusters; rather the increase in cucumber plantation shall contribute towards plant diversification and soil stabilization, though most of the production will come from protected plantation. The climate change impact manifesting in fluctuating temperatures, variable precipitation, and more frequent and intense climate events, there is clearly a need to reduce the risks so as to make the communities more self-reliant and climate resilient.

9.4. Conclusion

In conclusion, the overall economic, social and environmental impact of the cluster development program shall be positive, sustainable and long lasting except in Balochistan Cluster. Accounting for all the fixed costs and variable costs including the production, processing and marketing cost, the estimated Internal Rate of Return (IRR) for Southern Punjab 25% and for Balochistan is 72%, the IRR is based on respective investment costs in each region and the present value of resulting revenues over the period of five years. These estimated IRRs signify the fact that cluster development interventions are likely to positively impact not only the existing output of cucumber clusters, but also likely to add additional value increasing the overall potential of the cucumber value chain across the country.

10. PROGRAMS AND PLANS

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

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

10.1. Organization and Networking of Stakeholders

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

Table 20: Program for Organization and Networking of Stakeholders

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1. Punjab				
1.1	Form Cucumber Farmer Enterprise Groups (FEGs) at grassroots level. 2 FEGs in total with each having a membership of at least 50 farmers. Punjab has 18 Cucumber producing districts, and thus 1 FEGs per district	Organization of cucumber farming community for collective action	Village Organizations (VOs), LSOs, NGOs (AKRPS), DoA, Punjab, Department of rural development Punjab	Short to medium term (1 to 2 years)
1.2	Form Cucumber Traders Association at market/business level. At least 10 associations should be initially involved (five in each cluster)	Improve coordination between the stakeholders of cucumber value chain	DoA, Punjab, NGOs, Private Sector	Short to medium term (1 to 2 years)
2. Balochistan				
2.1	Form Cucumber Farmer Enterprise Groups (FEGs) at grassroots level. 4 FEGs in total with 1 FEG in each Cucumber producing district and FEG each having a membership of at least 30 farmers	Organization of cucumber farming community for collective action	NGOs, DoA, Balochistan, Department of rural development Balochistan.	Short to medium term (1 to 2 years)
2.2	Form Cucumber Traders Association at market/business level. At least 5 associations should be initially involved.	Improve coordination between the stakeholders of	DoA, Balochistan, NGOs, Private Sector	Short to medium term (1 to 2 years)

		Cucumber value chain		

10.2. Program for Research Reform

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

Table 21: Program for Research Reform

S#.	Identification of Areas for Further Research	Research Purpose/ Priority	Indicative Research Institutions
1. PUNJAB			
1.1	• Identify suitable cultivars for cucumber growing areas • Develop strategy for quick dissemination	• Cucumber production improvement • (Short to medium term (1 to 2 years)	BARI, Chakwal, AARI, PARC, DoA, Punjab
1.2	• Develop training modules • Develop formats for Farmer Field Schools (FFS) for on-farm training of cucumber producers	• Improve production management and On-farm skills • (Short to medium term (1 to 2 years)	BARI, Chakwal, AARI, PARC, DoA, Punjab
1.3	Survey for identification of target group of 10 associations	• Product Diversification for Cucumber • (Short to medium term (1 to 2 years)	BARI, Chakwal, AARI, PARC, DoA, Punjab
1.4	• Consultation with associations to assess interest in establishing pack houses • Scoping survey to identify new products and potential buyers	• Create market Linkages for value added Cucumber (Domestic and Export) • Medium to long Term (2 to 5 years)	BARI, Chakwal, AARI, PARC, DoA, Punjab
1.5	• Identify suitable fresh produce buyers to link with in premium markets through a market survey • Consultation to decide on implementation strategy – wholesale market or individual traders	Medium to long Term (2 to 5 years)	BARI, Chakwal, AARI, PARC, DoA, Punjab
1.6	Research into climate change related negative impacts such as new diseases and shifts in crop cycle	• Investigate into climate related negative impacts on horticulture • Medium to Long term (2 to 5 years)	BARI, Chakwal, AARI, PARC, DoA, Punjab
2. BALOCHISTAN			
2.1	Survey for identification target group of 4 processors	• Product diversification from Processed Cucumber • Short to medium term (1 to 2 years)	Private businesses, DoA, Balochistan
2.2	• Consultation with processors to assess interest in establishing a Fruit Processor Association • Scoping survey to identify new products and potential buyers	• Create market linkages for quality Processed Cucumber (Domestic and Export) • Medium to long Term (2 to 5 years)	Private business, DoA, Balochistan, Export Promotion Board, Embassies

2.3	• Identify suitable fresh fruit traders to supporting the cluster • Identify suitable fresh fruit buyers to link with in premium markets through a market survey • Consultation to decide on implementation strategy for wholesale market or individual traders	Medium to long term (2 to 5 years)	FEG clusters; Farmer Associations; Business associations and cooperatives
2.4	Research into climate change related negative impacts such as new diseases and shifts in crop cycle	• Investigate into climate related negative impacts on horticulture • Medium to Long term (2 to 5 years)	DoA, Balochistan, P&D department, Research Institutions

Note: *The estimated costs for research plan mentioned in the above table have already been counted as part of the cluster investments given in chapter 10*)

11. ANNEXURES

Annexure 1: Macro Data Sources and Literature Reviewed

1. Agriculture Statistics of Pakistan (2015-16), Ministry of National Food Security and Research, Pakistan: http://www.mnfsr.gov.pk/frmDetails.aspx
2. Alboghdady M.A.A., M.A. Shata (2014) Stochastic frontier analysis of cucumber production under different cultivation systems in Ismailia Governorate, Egypt. Journal of Agricultural Economics and Social Sciences, Mansoura University 5: 1063-1073.
3. Brian Geiger. 2011. Cucumber Preservation, Fine cooking magazine
4. FAO (Food and Agriculture Organization) (2006). Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region, FAO, Rome
5. FAOSTAT (Food and Agriculture Organization Statistics) 2020 (Production, Crops http://www.fao.org/faostat/en/#data/QC
6. FAOSTAT, (Food and Agriculture Organization Statistics). 2020. Trade, Crops and Livestock Products http://www.fao.org/faostat/en/#data/TP
7. PFVA. 2017. 'Balochistan's fruits, veg. exports can fetch $1 billion a year'. The News International. Accessed online from www.thenews.com.pk/print/240162-Balochistans-fruits-veg-exports-can-fetch-1-billion-a-year
8. SMEDA, 2016. Pre-feasibility study (offseason vegetable farming–high tunnel). Small and Medium Enterprises Development Authority, Ministry of Industries & Production, Lahore.
9. Ibrahim HY, O.A. Omotesho (2013) Determinant of technical efficiency in vegetable production under Fadama in northern guinea savannah, Nigeria. Journal of Agricultural Technology 9: 1367-1379.
10. Iqbal Q, M. Amjad, M.R. Asi, M.A. Ali, R. Ahmad (2009) Vegetative and reproductive evaluation of hot peppers under different plastic mulches in poly/plastic tunnel.
11. Fruit, Vegetable and Condiments Statistics of Pakistan (2016)., Ministry of National Food Security and Research, Islamabad.
12. UN&PO (Unrepresented Nations and People's Organizations). 2015. Balochistan: Severe Water Shortage Due to Climate Change and Pakistani Actions: https://unpo.org/article/18690

Annexure-2: List of Stakeholders Consulted

The following stakeholders were consulted during this feasibility study exercise

S#	Name	Title	Location	Contact
1.	Aqeel Feroze	Assistant Horticulturist	BARI,Chakwal	03027302043
2.	Dr. Ghulam Jellani	Principal Scientific Officer	HRI, NARC	+92 51 9255061
3.	Mian Shaukat	Farmer, Seed Trader	Mamon kanjan	03454111141
4.	Iftikhar Ahmad	Famer	Attock	0344-9628112
5.	Khadim Hussain	Farmer	FatehJang	0335-5457591
6.	Shaukat Rasool	Farmer	Chakri	03462020829
7.	Haji M. Israr	Trader	Quetta	03347645459
8.	Waseem Baran	Horticulture	Baluchistan	03337810705

Annexure-3: Feasibility Study for Cucumber pack house

The production and consumption of Cucumber (*Cucumis sativus*) is increasing in Pakistan. Cucumber cultivation in tunnels has become famous among farmers to meet growing demand in the country. There are three different uses for cucumbers on the market: fresh, freshly cut and in brine. The issue of post-harvest handling facilities for horticultural products has not been attended for the emerging cucumber farmers. In addition, the low prices that farmers have received from local markets have convinced most cucumber growers to bypass local markets in established national markets, where demand is mostly high and prices are therefore good. In these markets, products can be sold to domestic and foreign consumers. However, due to poor management after harvesting of cucumber, the quality and presentation of the produce remain poor thus it does not fetch good price. To overcome this problem, we propose here to incentivize pack-houses in cucumber producing areas which will improve post-harvest management, improve its presentation, and fetch high price.

Objective:

The aim of this study is to produce a feasibility report on the cucumber pack house. The pack house will include packaging, grading and supply of cold stores, which could benefit producers for high-end emerging market by increasing their incomes as they supply high quality fresh cucumbers with proper presentation.

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 Cartonnes

Palletization

Loading and transportation to markets

Process flow of post-harvest handling of cucumber

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 cucumber 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 cucumber. 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 cucumber, 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 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.

Loading Dock

- **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

Large scale packing line

Packing Field

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.

Automatic washer

- 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.

- Cucumbers are waxed to limit water loss for the wholesale market-therefore, it needs a waxer.
- Cucumber 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, cucumbers 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 show 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

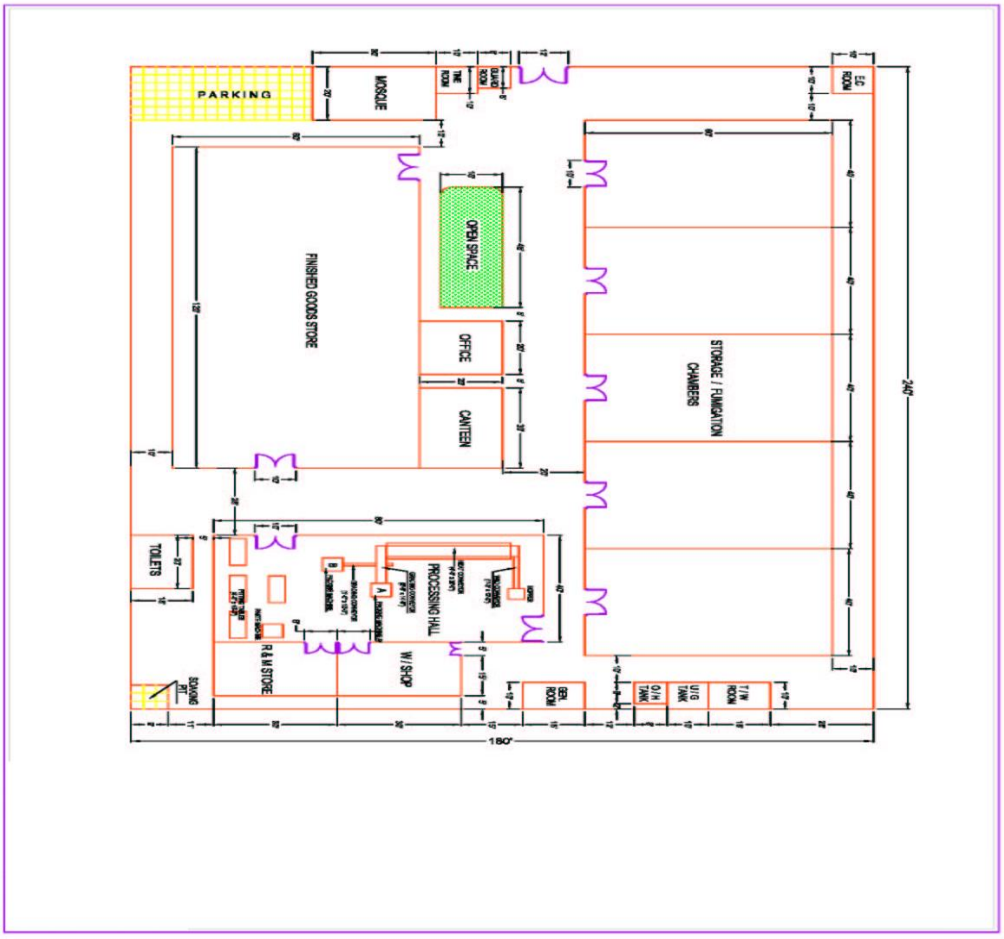
If hydro cooling is used, special attention must be made to how the cooling water is managed. If the water source can supply both the packing line and the hydro-cooling, then where and how the waste water will be disposed needs to be addressed and dealt with.

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;



Map of the cucumber 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 labor.

1. Chain Pulley Block

   - Capacity: 5 Tonne
   - Supplier: Max Industries, India
   - Supplier Product Code: HH2050
   - Price: US $1200
   - Power Source: Hand Pulled

2. 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

3. Hydraulic Pallet lift (manual)

    - Supplier: Baoding Dali Hoisting Machinery Co. Ltd
    - Model No. – PDL -3T hand Pallet
    - Price – US $250

4. Box Strapping Machine

    - Supplier: Henan Bedo Machinery Equipment Co. Ltd
    - Model No. – BD-001
    - Voltage – 220V
    - Power – 50 KW
    - Price – US $250

5. Electronic Weighing Machine

    - Supplier: Yuvo
    - Model No. – 730
    - Voltage – 220V
    - Capacity – 1500kg
    - Price – US $900

6. 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

7. 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

8. Platform Type Scales

    - Supplier: Sanghai Uni-weigh System (Tech)Co. Ltd
    - Price – US $ 1700

9. Tray Wrapping Machine

    - Supplier: Shandong China Coal Group Ltd
    - Model No. – HW450
    - Dimension – 540*680*200mm
    - Voltage – 220V
    - Power – 270W
    - Price – US $ 1800

10. Hot Air Dryer

- Supplier: Henan Xingyang Mining Machinery Manufactory
- Model No. – ZT
- Dimension – Depends on the model
- Voltage – 380V
- Price – US $ 8,000

11. 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

12. Small cold store

- Supplier: Taizhou Nimbus Machinery Co. Ltd
- Price – US $3400

13 Grading and sorting table

- Automatic vegetable grading and sorting line (1 tonne per hour)
- Price-US$1000-27000
- Supplier: RUIAN

13. 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; 1800 tonnes annually
No. of shifts	One (8 hours per shift) per day
Working days in a year	180

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 intervening period. These costs are given in the following tables:

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 tonne per 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$ **21500** 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 lines Installation	1	2000
	Total		**21500**

Pre-Operative Expenses:

Expenses incurred prior to commencement of commercial production are covered under this head that total US$ **29700.** Pre-operative expenses include establishment cost, rent, taxes, travelling 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	**29700**

Cost of raw material:

Based on a processing capacity of 10 tonnes per day taking into account and 180 days of working per year, the annual raw material consumption of the pack house is 1800 tonnes. The cost of fresh cucumber 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 $177.8/tonne. Adding US$20 per tonne transportation cost from the field to pack house, the raw material cost for pack house would be US$197.

Cost of raw material

Particulars	Rate per tonne (US$) for the raw cucumber at the wholesale/pack-house	Qty. (Tonnes) per season	Raw material cost (US$)
Cucumber	170	1800	354600

Land Lease Charge:

Required land is 6,000 sq. ft. which has been considered on lease @ US$300 per annum for first three years and @ US$330 for the fourth year and subsequently @10% increase every year.

Land lease charges

S. No.	Year	Lease charges Per annum (US$)
1.	1st year	300
2.	2nd year	300
3.	3rd year	300
4.	4th year	330
5.	5th year	353
	Total	**1583**

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.	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$)
Fixed costs		
1	Plant and Machinery	86100
2	Misc. Fixed Assets	16380
3	Pre-operative expenses	28700
Operating costs		
1	Cost of raw material	354600
2	Land lease charges	1583
3	Electricity and water consumption	4200
4	Salary and wages (For 180 days)	48360
5	Margin money for working capital	1500
6	Contingencies 5% of fixed assets	819
	Total variable costs	**542242**

Project Income Statement

Revenues		Year0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue (US$)							
Quantity of cucumber that goes in value addition (tonnes)			**1800**	**1800**	**1800**	**1800**	**1800**
Price of the value added cucumber (US$/tonne)			**220.00**	**220.00**	**220.00**	**220.00**	**220.00**
Total revenues (US$)			**396000**	**396000**	**396000**	**396000**	**396000**
Direct variable costs							
Raw material price			170	170	170	170	170
Raw material cost			306667	306667	306667	306667	0
Packing costs (@PKR20 per 20 kg box)			13333	13333	13333	13333	
Labour cost			48360	48360	48360	48360	
Electricity and water			4200	4200	4200	4200	
Maintenance (1% of the machinery, equipment and furniture cost)			1362	1362	1362	1362	
Land lease charges (10%) increment on annual		100	100	105	110	116	
Marketing (US$20/tonne)			3600	3600	3600	3600	
Office administration			613	613	613	613	
Total variable cost			**378406**	**378411**	**378416**	**378421**	**170**
Gross profit			**17594**	**17589**	**17584**	**17579**	**395830**
Indirect fixed cost							
Machinery		-136200					
Licensing and regulatory fee		-150	0	0	0	0	
Total		**-136350**	**0**	**0**	**0**	**0**	
Grand total cost		**-136350**	**378406**	**378411**	**378416**	**378421**	**0**
Net profit (Net cash flow)		**-136350**	**17594**	**17589**	**17584**	**17579**	**396000**
NPV	8.5%		**170,153**				
IRR		**32%**					

Project Viability:

The Internal Rate of Return of the project is estimated at **32**%, which is significantly higher than the bank return rate of 16%. Hence, the project is deemed financially viable. The NPV of the project is positive (US$**170,153**) at a discount factor of 16% during the first 5 years of operation considered. This implies that the project generates sufficient funds to cover all its cost, including loan repayments and interest payments during the five years' period. This also indicates that the project is financially viable over the long term.