CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

Brinjal Cluster Feasibility and Transformation Study

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

February 2020

FOREWORD

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

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

FOREWORD

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

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

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

FOREWORD

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

Dr. Babar Ehsan Bajwa
Regional Director
CAB International

FOREWORD

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

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

ACKNOWLEDGEMENT

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

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

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

Dr. Makhdoom Hussain
The Senior Author

Citation:

Hussain, Makhdoom., Ali Mubarik, Yasin Aqsa and Yasar Saleem Khan. (2020) Brinjal 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. 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).

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AARI	Ayub Agriculture Research Institute
ADP	Annual Development Plan
AZRI	Arid Zone Research Institute
Bt	*Bacillus thuringiensis*
CBR	Central Board of Revenue
CDF	Community Development Fund
DoA	Department of Agriculture
EU	European Union
FAO	Food & Agriculture Organization
FFS	Farmer Field School
GAP	Good Agriculture Practices
GDP	Grand Domestic Product
GoP	Government of Pakistan
Ha	ha(s)
ICM	Integrated Crop Management
IPM	Integrated Pest management
KP	Khyber Pakhtunkhwa
M.	Million(s)
MINFAL	Ministry of Food, Agriculture and Livestock
MNSF&R	Ministry of National Food Security & Research
NARC	National Agricultural Research Centre
NGOs	Non-Governmental Organizations
NPK	Nitrogen, Phosphorus, Potash
PARC	Pakistan Agricultural Research Council
PHDEC	Pakistan Horticulture Development and Export Company
PKR	Pakistani Rupee
R&D	Research & Development
RY Khan	Rahimyar Khan
SARC	Southern-zone Agricultural Research Center
SWOT	Strengths, Weaknesses, Opportunities, Threats
TDAP	Trade Development Authority of Pakistan
TDAP	Trade Development Authority Pakistan

UK	United Kingdom
USA	United States of America
USAID	United States Agency for International Development
US$	United States Dollar
ZTBL	Zarai Traqiyati Bank Limited

EXECUTIVE SUMMARY

Eggplant, aubergine, or brinjal is a plant species grown for its edible fruit. The spongy, absorbent fruit of the plant is widely used in cooking in many different cuisines and often considered a vegetable. Globally it is grown on about 1.8 million ha producing over 50 million tonnes of brinjal annually with an average yield of 28.6 tonnes per ha. The total area under brinjal cultivation in Pakistan is 8.48 thousand ha with production of 84.69 thousand tonnes and average yield of 10 tonnes per ha. China and India is the major producer of brinjal while Pakistan ranks at 14th position in terms of brinjal area and 18th in terms of its production.

Pakistan is losing its position in the world brinjal market as its production and productivity has been stagnated while the world brinjal production is growing at the rate of 2.8% per annum because of the improvement in its productivity as well as area under brinjal cultivation. Pakistan is producing only one third of the world average per ha yield and only 2% of the top world brinjal producing countries. Pakistan is not contributing anything in the brinjal export market despite its farm-gate price is far lower than the world average. However, Pakistan has great potential to catch up on all these fronts because of several advantages, including proximity with China who is the major producer of brinjal in the world, the seasonal difference with the main producers, year-round production and availability and favourable production costs especially cheap labour.

To convert brinjal into a competitive commodity which can self-thrive in the domestic and international markets, the Planning Commission of Pakistan initiated this study to look into the gaps and potentials in the whole value chain of brinjal, prepare a strategy plan to achieve these potentials and suggest economically viable interventions along the value chain to implement the plan. Such analysis was considered more robust if undertaken at cluster level so that regional context can be incorporated in preparing the brinjal upgradation plan. In this study, macro-data were analysed, several stakeholders along the value chain were consulted and literature were reviewed to analyse the value chain of brinjal at its cluster level, prepare a plan to harness the potentials and evaluate the economic and social feasibility of suggested interventions.

Brinjal cultivation in Pakistan is relatively scattered throughout the country, although only Punjab province contributes 53% in brinjal area and 65% in its total production of the country. Two main brinjal growing cluster are identified in Punjab for further detailed analysis in this study: Central Punjab Cluster with Faisalabad as its centre point and Southern Punjab Cluster with Rahim Yar Khan district as its centre point having 25% and 20% concentration of brinjal production respectively.

As part of this study, several performance gaps are identified in brinjal 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 improvement in management practices, area to be brought under insect net and improvement in the value chain by setting pack houses in each cluster. The cultivation under insect net will be safe from borers' infestation and free from insecticide sprays hence can be send to high-end domestic market. 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/upgradation plan is $1.79 million for both the clusters. About 65% of the investment will have to be shoulder by the government in terms of strengthening brinjal research, improving extension services, capacity building of producers, incentivizing the establishment of pack houses, and providing loans to establish these pack-houses. 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 23%; for Southern Punjab 20% and for Central Punjab it is 24%. The Net Present Value (NPV) for both the clusters is positive at US$0.22 million. These IRRs are based on respective investment costs in each cluster focal 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.

These benefits of the investment will be realized only if the research and development system in the country, especially at the province level, is responsive to the stakeholders' needs along the value chain. Moreover, stakeholders have to provide training to produce and deliver quality brinjal in which Farmers Entrepreneur Groups (FGEs) can play a critical role.

Summary Sheet

Information	South Punjab	Central Punjab	Overall
Area of the cluster (ha)	1426	1655	3081
Production of the cluster (tonne)	17003	20881	37884
Current yield of the cluster (kg/ha)	11.9	12.6	12.3
Area of cluster focal point (ha)	473	500	973
Production of the focal point (tonnes)	5,260	6,200	11,460
Yield of the focal point (tonne/ha)	11	12.4	11.8
Added in production - improved practices (tonnes)	534	629	1163
Added value –improved practices (M.US$)	0.1	0.09	0.2
Added in production due to added area in net (tonnes)	427	503	930.6
Added produce value – added area in net (M. US$)	0.06	0.1	0.1
Added value through pack-house (M. US$)	0.87	1.32	2.2
Production level investment (M. US$)	0.3	0.35	0.6
Number of Pack house required	4.0	4.00	8.0
per unit operating cost of value addition (US$/tonne)	123.0	123.03	246.1
Investments (M. US$)			
Strengthening R&D (M. US$)	**0.200**	0.200	0.400
Capacity building and interactions (M. US$)	0.050	0.150	0.200
Pack-houses (M. US$)	0.252	0.252	0.503
Loans (M. US$)	0.006	0.028	0.033
Total investments (US$)	**0.507**	**0.629**	**1.136**
Total public sector investments including loans and subsidies	0.3	0.4	0.7
Total private sector investment	0.2	0.2	0.4
Economic Analysis (M. US$)			
Increase in production due to all interventions (tonnes)	961	1,133	5,219
Gross revenue (undiscounted) in 5th year	0.49	0.70	1.20
Additional operation costs in 5th year	0.25	0.32	0.57
Net cash flow (undiscounted) in 5th year	0.25	0.38	0.63
NPV	0.08	0.15	0.22
IRR	20%	24%	23%

1. INTRODUCTION

1.1. Brinjal as a Vegetable

Eggplant, aubergine, or brinjal is a plant species grown for its edible fruit. The spongy, absorbent fruit of the plant is widely used in cooking in many different cuisines, and is often considered a vegetable, even though it is a berry by botanical definition. As a member of the genus Solanum, it is related to the tomato and the potato[1].

Brinjal is an important source of nutrition. Raw brinjal is composed of 92% water, 6% carbohydrates, 1% protein, and negligible fat. It provides low amounts of essential nutrients, with only manganese having a moderate percentage (11%) of the Daily Value. It is moderate source of Vitamins and minerals. Minor changes in nutrient composition occur with season, environment of cultivation (open field or greenhouse), and genotype. The capability of the fruit to absorb oils and flavors into its flesh through cooking is well known in the culinary arts[2].

Different cultivars of the plant produce fruit of different size, shape, and color, though typically purple. The most widely cultivated varieties/cultivars in Europe and North America today are elongated ovoid, with a dark purple skin. A much wider range of shapes, sizes, and colors is grown in India, Pakistan and elsewhere in Asia. Larger cultivars weighing up to a kilogram grow in the region between the Ganges and Yamuna[3].

Colors vary from white to yellow or green, as well as reddish-purple and dark purple. Some cultivars have a color gradient, white at the stem, to bright pink, deep purple or even black. Green or purple cultivars with white striping also exist. Chinese cultivars are commonly shaped like a narrower, slightly pendulous cucumber. Also, Asian cultivars of Japanese breeding are grown.

Brinjal is a hardy crop than other vegetables. Due to its hardness, it can be successfully grown in dry area with low irrigation facilities. It can grow throughout the year. Currently, Pakistan neither imports nor exports brinjal.[4]

1.2. Brinjal Production in Pakistan

Brinjal is cultivated on small marginal family farms in Pakistan for whom it is a major source of income for many resource-limited farmers. The fruit and shoots borer (FSB) is the most devastating pest on brinjal which not only cause a significant yield loss but also reduce the quality of the product. To manage the pest problems, farmers rely mainly on the application of chemical pesticides. Other methods of pests control, such as integrated pest management, mechanical control, etc. are not very popular among farmers due to the lack of collective actions, high work demands and difficulties in applying them.

[1& 2] https://en.wikipedia.org/wiki/Eggplant

[3] https://www.lovefarmorganics.com/?page_id=1175

[4] FAOSTAT, data retrieved on 29th November 2018

Furthermore, transgenic/genetically modified technology has emerged as an alternative to chemicals to control insect pests, reduce herbicides, manage related problems and provide many other benefits. Bt. brinjal is a transgenic aubergine that contains a gene from the soil bacterium *Bacillus thuringiensis (Bt)*, plant is resistant to lepidopteran insects such as the brinjal fruit and shoot borer. However, this technology i.e. Bt brinjal is not registered nor cultivated in Pakistan.

In recent years, the total area under brinjal cultivation has been around 8.48 thousand ha with production of 84.69 thousand tonnes in year 2016 and average yield of 10.0 t/ha. Brinjal is cultivated in all four provinces; Punjab contributes 53% in brinjal area and 65% in its total production in the country. This is followed by Balochistan having a contribution of 20% in area and 15% in production. The per ha yield is also highest in Punjab followed by KP while the yield is lowest in Sind. Overall, brinjal covers 0.04% of total cropped area in the country. In Punjab, Sindh, KP & Balochistan, the contribution is respectively 0.03, 0.04, 0.05 & 0.15% (Table 1).

Table 1: Provincial distribution of brinjal area and production and its contribution in total cropped area

Province	Area (000 ha)		Production (%)		Yield	Share in total cropped area (%)
	Area (000 ha)	Share (%)	Production (000 tonnes)	Share (%)	(ton/ha)	
Punjab	4.46	53.3	54.2	64.7	12.2	0.03
Sindh	1.41	16.8	8.2	9.8	5.8	0.04
KP	0.87	10.4	9.1	10.9	10.5	0.05
Balochistan	1.63	19.5	12.3	14.7	7.5	0.15
Total	8.37	100.0	83.8	100.0	10.0	**0.04**

Source: MNFS&R (2018)

During 2008-16, the brinjal production in Pakistan has declined at a rate of 0.9% per annum, which is mainly because of the declining acreage under brinjal while per ha yield trend (can be estimated from production less acreage trends) remained almost stagnant during the period (Table 2). Except Baluchistan, production trends were negative in all the provinces which was mainly due to the decline in area although declining trend in per ha yield in KP was quite strong. In Balochistan, area and production trends are strongly positive, while trend in per ha yield is also positive although not very strong during this period.

Table 2: Province wise area production of Brinjal from 2008-2016 (Area in ha, production in 000 tonnes)

Year	Punjab		Sindh		KP		Baluchistan		Pakistan	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
2008-09	4744	57.4	1766	10.4	1033	12.0	1130	8.3	88148	88.1
2009-10	4780	57.3	1778	10.7	1109	11.8	1377	10.2	89972	90.0
2010-11	4697	56.4	1500	9.1	916	10.1	1377	9.2	84707	84.7
2011-12	4896	58.7	1493	6.4	888	9.8	1490	11.1	85965	86.0
2012-13	4897	58.9	1384	8.1	1320	13.7	1443	10.5	9044	91.1
2013-14	4617	55.2	1409	8.2	903	9.2	1536	11.5	8465	84.1
2014-15	4452	54.2	1400	8.2	841	8.4	1632	12.3	8325	83.0
2015-16	4460	54.2	1410	8.2	867	9.1	1631	12.3	8368	83.8
Annual growth (%)	-1.0	-0.9	-3.6	-3.7	-2.7	-4.2	4.4	5.0	0.0	-0.9

Source: MNFS&R (2018)

1.3. Global Scenario

In 2016, global production of brinjal is about 51 million tonnes. That year, almost 1.8 million ha were devoted to the cultivation of brinjal in the world giving an average yield of 28 tonnes per ha. During 2008-16, the brinjal production of the world has increased at a rate of 2.8% per annum, which is higher than the global average population growth suggesting that more per capita brinjal is available internationally. This is in contrast with Pakistan where brinjal production has declined during the period. This along with the strong population growth in the country suggests that per capita availability of brinjal has declined in Pakistan during 2008-16.

A small amount of less than one-half million-tonnes worth of less than one half billion US$ of brinjal is traded internationally. Moreover, the international trade in brinjal has not increasing as fast as its production during the last nine years of 2008-16, suggesting that increasingly more production is available locally (Table 3). Pakistan neither import nor export brinjal (Table 3).

Table 3: Trend in international brinjal production and trade and during 2000-16

Years	*World production*			*World's export*		*Pakistan's Export*	
	Area (000 ha)	Production (000 Tonnes)	Yield (hg/ha)	Export (000 ton)	Export (Million US$)	Export (ton)	Export (1000 US$)
2008	1607	39817	24.8	415	416	0	0
2009	1691	43481	25.7	448	407	0	0
2010	1718	44075	25.7	458	449	0	0
2011	1753	45018	25.7	439	468	0	0
2012	1804	46955	26.0	440	456	0	0
2013	1855	48889	26.4	420	502	0	0
2014	1861	49954	26.8	442	455	15	5
2015	1801	50551	28.1	471	437	2	1
2016	1788	51193	28.6	473	452	0	0
Growth rate (%)	1.3	2.8	1.5	0.9	1.1	0	0

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

While internationally one percent of the locally produced brinjal production and two percent of its values are traded internationally, Pakistan does not contribute anything in this market despite the fact that farmgate price of brinjal in Pakistan is only one third of the international average farmgate prices (Table 4).

Table 4: Pakistan vs world Brinjal scenario during 2016

Parameter	World	Pakistan	Share (%)
Area (000 ha)	1858	8.5	0.46
Production (000)	52309	84.6	0.16
Value of production (Million US$)	21598	11.2	0.05
Yield (ton/ha)	28.15	9.97	35
Farm gate price (US$/tonne)	413	132	32
Quantity of international trade (000 ton)	456	0.0	0.00
Value of international trade (Million US$)	451	0.007	0.00
Export quantity as % of production	1%	0%	-
Export value as % of production value	2%	0%	-
Average export prices (US$/tonne)	989	0	-

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

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

The farmgate prices in Pakistan is also lowest among the major brinjal producing countries in the world (Table 5). This not only reflects an advantage for competing in international

market but also a challenge to improve the value chain of brinjal to meet national and international standards of high-end market within the country and abroad.

Table 5: Producer price (US$/tonnes)

Country	Year 2015
Saudi Arabia	1184
Netherlands	972
Spain	783
Turkey	477
China	462
Mexico	392
Iran	312
Pakistan*	132

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

Moreover, Pakistan has lagged far behind in brinjal per ha yield. It obtained less than one third of the average brinjal yield globally during 2016 (Table 4). Compared to major producing countries, like Netherland and Belgium who produce 486 and 450 tonnes per ha, the brinjal yield in Pakistan is only 2% of the yield in these countries.

Over 62% of brinjal output in the world comes from China alone followed by India who claims in 24.5% of world total brinjal production. Egypt, Turkey, and Iran are also major producers. In terms of acreage, China and India contribute 43% and 30% in the total global brinjal area under cultivation. Netherland and Belgium have the highest yield of 486 and 450 tonnes per ha, respectively. (Figure 2).

The top importing countries of brinjal are USA, France, and Germany, while top exporting countries of Brinjal are Spain, Mexico, Netherland, Turkey. USA is one of the major exporters as well as importer of brinjal (Table 6). As per FAOSTAT, Pakistan imported 525 and 23 tonnes brinjal in year 2014 & 2015 respectively, no brinjal import was reported after that. However, Pakistan's brinjal exports were nil/negligible.

Table 6: Main importers/exporters of brinjal (tonnes)

#	Main Importer		Main Exporters	
1	USA	69529	Spain	151665
2	France	50306	Mexico	61658
3	Germany	49661	Netherlands	53546
4	UK	25401	Turkey	21743
5	Canada	24937	USA	17411
6	Italy	21152	Saudi Arabia	16839
7	Russia	18949	Honduras	12017

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

Concluding the analysis of macro level brinjal situation in Pakistan and at global level, Pakistan overtime is losing its position in world brinjal market because of its continuous stagnation in brinjal production and productivity, while the growth rate in brinjal production

and productivity at the global is quite high. As a result, while per capita availability of brinjal in the world is increasing, it has been declining in Pakistan. Despite Pakistan's significant lower farmgate prices compared to the world average, Pakistan could not contribute in international brinjal trade. Pakistan has opportunity to learn efficient brinjal production from its neighboring countries like China with whom it has good economic and social relationship.

To improve the competitiveness of brinjal, the Planning Commission of Pakistan has initiated this study to identify gaps and potential, prepare a plan with strategies and suggest economically viable technological and institutional interventions along the value chain of brinjal. This study will conduct this analysis at the brinjal-cluster level to incorporate the regional context in the analysis.

2. GOAL AND OBJECTIVES

The prime goal of this study is to suggest interventions for the purpose of improving the value chain of brinjal so that its competitiveness can be improved in the national and international markets. The specific objectives are:

i. To identify the major clusters of brinjal production in Pakistan;

ii. To characterize each cluster and conduct a diagnosis and SWOT of brinjal value chain in each cluster;

iii. To identify technological, institutional, infrastructure and policy gaps in each cluster;

iv. Assess the potential of chili production in each cluster;

v. Suggest technological, institutional, infrastructure and policy interventions to achieve the cluster potentials;

vi. Conduct economic feasibility of the suggested interventions;

vii. Make suggestions to improve the competitiveness of the brinjal sector in Pakistan.

3. METHODOLOGY

To achieve the above objectives, various data collection sources were explored and tools were developed to collect these data as explained below:

3.1 Macro data

Relevant macro data were collected from various published and unpublished reports of government and non-governmental organizations and internet search on brinjal value chain. A list of data to be explored and its sources were identified before starting the exercise. The required statistics were obtained from the FAOSTAT, national and provincial statistics and crop estimates **(See Annexure-1)**

3.2 Stakeholders consulted

Primary information was collected through meetings, consultations, key informant interviews, surveys and focus group discussions using structured tools and open-end questionnaires. List of stakeholders consulted are given in **(See Annexure-2)**

3.3 Literature review

The literature related to the functioning, gaps, and interventions in brinjal value chain is reviewed and synthesized (**See Annexure-4 for the list of literature reviewed**).

The conclusion from the literature and stakeholders' discussions were used in identifying the gaps of potential in various identified brinjal clusters, and propose interventions to harness these potentials.

4. LITERATURE REVIEW

Pugalendhi et al. (2010) explained the characteristics and benefits of brinjal, cultivars are available in a variety of shapes ranging from egg shaped or oval to club long shaped with different colours like yellow, green, white, black and purple. Brinjal is not only used as a fresh vegetable but it has medicinal values with many health benefits

Baloch et al. (2012) investigated that in Pakistan the average farmer is not well aware about the advanced crop production technologies. A little information is available to the brinjal farmers about advanced methods of cultivation and crop raising patterns to reduce production cost as in the case of developed vegetable growing countries of the world. As a result, the average brinjal yield per unit area achieved in the country is very low. It can be significantly improved if proper package of production technology is adopted by the average vegetable grower.

Cavaye et al. (2016) studied the community capacity was studied to develop vegetable value chains in the Southern Philippines. Three value chains were identified as priorities for development: supermarket-led, wholesaler-led and farmer cluster-led. Smallholders face a range of logistic, economic and commercial barriers to the effective marketing of vegetables including poor postharvest handling, poor roads, lack of consumer feedback and inconsistent supply. Many farmers also lacked resources to buy seeds and other inputs and borrowed money at high interest from wholesalers to fund basic farm operations.

Anny et al. (2016) studied interference of middlemen on vegetable price with reference to brinjal marketing channel in Bangladesh and concluded that farmers in the country have less bargaining power and the marketing channel is dominated by market intermediaries. The price of produces is largely fixed by them and they enjoy more benefits than farmers. The number of middlemen in existing vegetable supply chain is large for which the end consumers have to pay higher price because of adding mark up in the grower's selling price. As the vegetable growers have not enough market information, middlemen exploit them in terms of price. Reduction of the number of middlemen is possible by developing a farmers' association which will perform many activities which are now performed by middlemen. Govt. can take initiatives to establish integrated wholesale market or auction market. Contract farming can be an easy and effective way to reduce the interference of middlemen on produce price. Again, for the development of marketing system, both private and public investments are needed to come forward.

Singh & Mishra, 2014, studied supply chain management through vertical coordination in vegetable industry and concluded that perishability reduction, wastage reduction, yield increase, demand security, off seasonal availability, control of price fluctuation, availability of proper variety, quality control, risk reduction, system transparency, grade and standard improvement, technology support and enhancement of vegetable growers benefits are the variables which should be studied for the development of vegetable supply chain in vertically coordinated approach. Moreover, in the vertically coordinate supply chain approach the effects of the mutual interest, long term relationship, shared benefit, open information, stability and interdependence that can support in development of a sound supply chain in vegetable industry can benefit in multi ways to all the stakeholders.

Cortbaoui and Ngadi, 2016, studied inefficient handling and high postharvest losses in the Caribbean supply chain of fresh fruits and vegetables. In this study, two different approaches to characterize the postharvest practices and losses of key agricultural commodities (tomato, string beans, brinjal, okra and cucumber) were developed. Results from modified count and weight method revealed that small producers experienced greater postharvest loss compared to large ones due to lack of timely access of the former group on spoilage control technologies and to market and their low degree of knowledge about the high-value crop production. As the produce travelled throughout the supply chain, it started to lose significantly ($P < 0.05$) its freshness and its marketable value as well. At the marketing level, small and large retailers experienced substantial postharvest quantitative and qualitative losses. These losses were due to inappropriate handling and exposure to undesirable environmental conditions.

Kumar et.al. (2011) discussed that production losses in brinjal due to insect pests are very high in South Asia and explained that the production of brinjal faces a number of problems which cause enormous yield losses. Among the insect-pests, the most devastating is the fruit and shoot borer (FSB), which not only causes a significant yield loss (60-70%), but deteriorates the product quality also, making the produce less remunerative.

5. CLUSTER IDENTIFICATION AND CHARACTERIZATION

5.1 Identification of Brinjal clusters

RY Khan, Bahawalpur and Bahawalnagar, Multan, Muzaffargarh, and Bhakhar in South Punjab, and Faisalabad, Khanewal, Okara, Sahiwal, Vehari, and T.T. Singh in Central Punjab are the main brinjal producing areas in Pakistan (Figure 2).

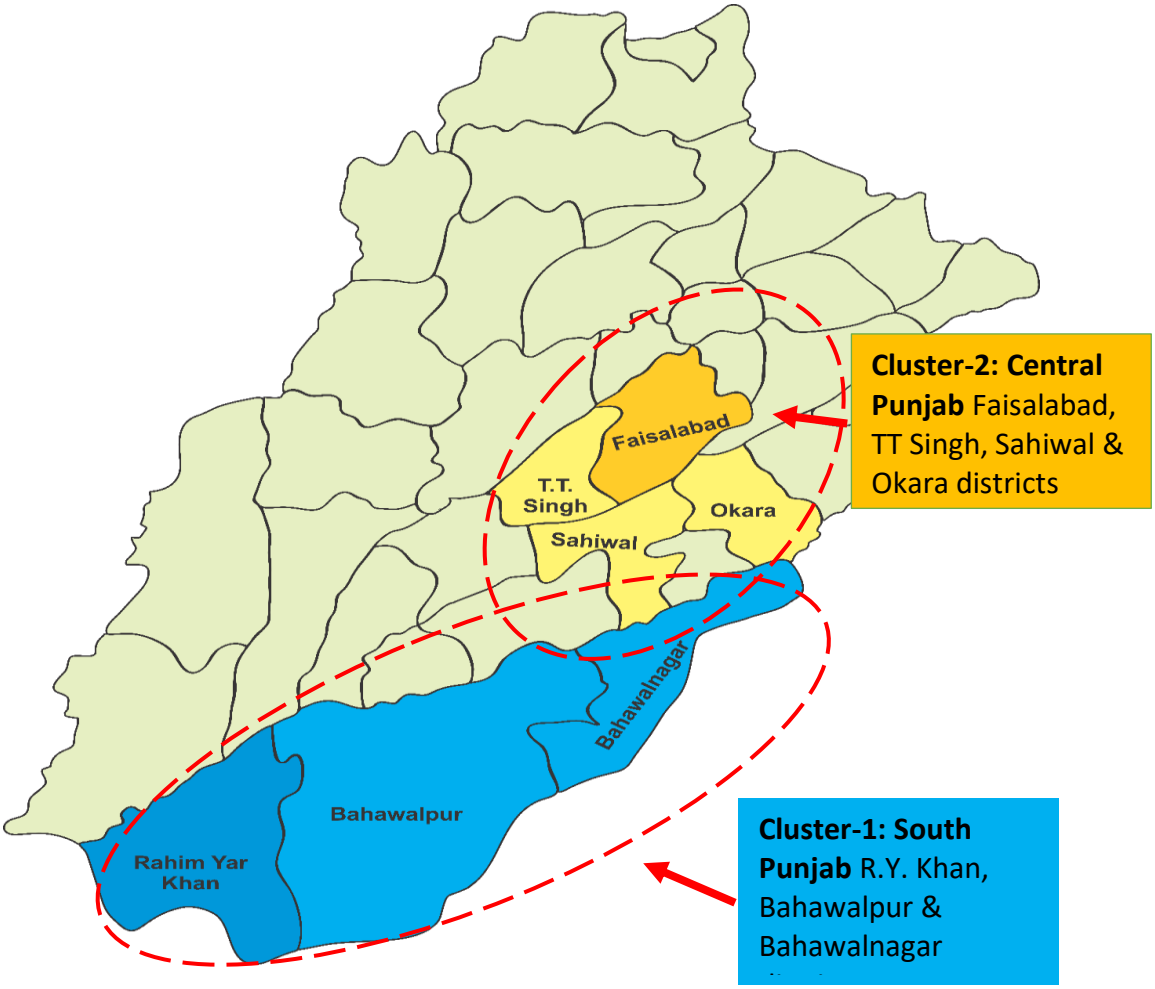


Figure 1: Brinjal Cluster area in Punjab, Pakistan

As noted earlier, Punjab is the main province where brinjal production is concentrated, therefore, we consider only Punjab districts to identify brinjal cluster. Based on the district level data on brinjal in Table 7, following clusters in Punjab are identified in this study:

5.1.1 Cluster-1: South Punjab

South Punjab consists of R.Y. Khan, Bahawalpur, Bahawalnagar, Multan, Muzaffargarh, and Bhakhar with R.Y. Khan as its focal point. The cluster contributes 32% in area and 31% in production of Punjab. The focal point alone respectively contributes 11% and 10% in the total Punjab area and production. The R.Y. Khan district is the last Southern district of Punjab and strategically located with the respect to vegetable markets in Northern Sindh. The highest per yield in the cluster is of Multan and lowest in Bahawalnagar.

5.1.2 Cluster-2: Central Punjab

This cluster includes Faisalabad, Khanewal, Okara, Sahiwal, Vehari, and Toba Tek Singh districts with Faisalabad as its focal point. The cluster contributes 37% in area and 39% in the total production of the Punjab. The focal point contributes 8% in area and production of Punjab. Faisalabad has a big vegetable market and is well connected with other vegetable markets in Punjab.

5.1.3 Potential Cluster in the Future

A. Balochistan (Khuzdar, Lasbella, Turbat districts)
B. Sindh (Tando Allah Yar, Hyderabad, Sanghar districts)
C. Non-Cluster Districts of Punjab.

Significant area and production of brinjal is scattered in many other districts of Punjab (Table 7). But they itself have small brinjal area, and are distant apart from each other, thus does not qualify the definition of a cluster. For example, Kasur is particularly a district having significant brinjal area but do not have large enough area by itself to make a cluster and no close by district is a major brinjal growing districts. However, Kasur may become a potential future cluster to serve brinjal to nearby big markets in the eastern side of Punjab like Lahore, Sheikhupura, and Sialkot if it further expands its area under brinjal.

Table 7: District Wise brinjal area and production in Punjab

Sr. No	District	Area (ha)	Area share in Punjab (%)	Production (Tonnes)	Production share in Punjab (%)	Yield (t/ha)
	Total Punjab	**4460**	**100**	**54200**	**100**	12.15
	Southern Cluster	**1426**	**32.0**	**17003**	**31.4**	11.92
1	R.Y. Khan	473	10.6	5260	9.7	11.12
2	Bahawalpur	221	5.0	2977	5.5	13.47
3	Bahawalnagar	239	5.4	2180	4.0	9.12
4	Multan	184	4.1	2717	5.0	14.77
5	Muzaffargarh	167	3.7	1975	3.6	11.83
6	Bhakhar	142	3.2	1894	3.5	13.34
	Central Cluster	**1655**	**37.1**	**20881**	**38.5**	12.62
7	*Faisalabad*	368	8.3	4500	8.3	12.23
8	Khanewal	315	7.1	4076	7.5	12.94
9	Okara	253	5.7	3219	5.9	12.72
10	Sahiwal	256	5.7	2948	5.4	11.52

Sr. No	District	Area (ha)	Area share in Punjab (%)	Production (Tonnes)	Production share in Punjab (%)	Yield (t/ha)
11	Vehari	232	5.2	3117	5.8	13.44
12	T.T. Singh	231	5.2	3021	5.6	13.08
	Non-cluster districts of Punjab	**1380**	**30.9**	**16012**	**29.7**	11.60
13	Kasur	311	7.0	3736	6.9	12.01
14	Sargodha	113	2.5	1202	2.2	10.64
15	Gujranwala	106	2.4	1179	2.2	11.12
16	Nankana sahib	85	1.9	1176	2.2	13.84
17	Sheikhupura	78	1.7	1046	1.9	13.41
18	Mianwali	53	1.2	718	1.3	13.55
19	Jhang	46	1.0	683	1.3	14.85
20	Sialkot	47	1.3	636	1.2	11.16
21	Rajanpur	69	1.5	590	1.1	8.55
22	Attock	60	1.3	574	1.1	9.57
23	Gujrat	40	0.9	513	1.0	12.83
24	Lodhran	37	0.8	475	0.9	12.84
25	Pakpatan	71	1.6	418	0.8	5.89
26	Chiniot	29	0.6	415	0.8	14.31
27	Khushab	28	0.6	366	0.7	13.07
28	Layyah	21	0.5	345	0.6	16.43
29	Rawalpindi	34	0.8	343	0.6	10.09
30	Chakwal	39	0.9	319	0.6	8.18
31	Hafizabad	29	0.6	309	0.6	10.66
32	MB Din	28	0.6	274	0.5	9.79
33	DG Khan	14	0.3	256	0.5	18.29
34	Narowal	16	0.4	175	0.3	10.94
35	Jhelum	15	0.3	118	0.2	7.87
36	Lahore	5	0.1	85	0.2	17.00
37	Islamabad	6	0.1	61	0.1	10.17

Source: Provincial crop estimates 2016-17

5.2 Characterization of Clusters

5.2.1 Wider adaptability of brinjal to Pakistani conditions

Brinjal is a popular vegetable which is grown the year around. This can be grown successfully under the wide-ranging climatic conditions in Pakistan especially in the Punjab and Sindh & Balochistan

5.2.2 Growing seasons

In both the clusters, there are two growing seasons of brinjal i.e., sowing in July & February & harvested in Sep-Dec and Mar-Jun, respectively. Brinjal seeds are sown on nursery beds

to raise seedlings for transplanting in field. The transplanting age of nursery is about 45 days.

5.2.3 Control of pests

Brinjal shoot and fruit-borer is the major pest and causes a serious damage to the fruits leading to severe reduction in yield. The damage starts soon after transplantation and continues till harvest. Short pinkish larva of the pest initially bores into the terminal shoots resulting in withering and drying of the shoot. In the later stage, it bores into the young fruits by making holes and feeds inside which makes the fruit unfit for consumption.[5] Injudicious use of pesticides is observed in brinjal to control fruit & shoot borers & other sucking insects. There is limited use of Integrated Pest Management Practices to control pest to reduce pesticide use.

5.2.4 Value addition

Thousands of farmers are engaged in brinjal cultivation who sells their produce in fruit & vegetable markets. There is no value addition and processing activity along the value chain of brinjal. The Southern Cluster is relatively hotter and drier compared to the Central Cluster. Three crops are taken consecutively in each cluster which may cause long-term sustainability problem. However, some farmers rotate their land under brinjal cultivation every year. The comparison of the characteristics of selected cluster is given in table below:

5.3 Cluster characterization

Table 8: Comparison of characteristics across selected clusters

Characteristics	Cluster-1: South Punjab	Cluster-2: Central Punjab
Districts	RY Khan, Bahawalpur, & Bahawalnagar	Faisalabad, Toba Tak Singh, Sahiwal & Okara
Area (ha)	1426	1655
Production (tonnes)	17003	20881
Percentage of the brinjal area that lies in the cluster (brinjal area of the cluster/brinjal area in the country)	32%	37%
Percentage of total cropped area in the cluster (brinjal area in the cluster/total cropped area in the cluster)	0.05%	0.05%
Focal point	Rahimyar Khan	Faisalabad
Area of focal point (ha)	473	368

[5] https://www.dawn.com/news/257614

Production of focal point (tonnes)	5260	4500
Yield at focal point (t/ha)	11.0	12.2
No of Farmers in the focal point	1000s	1000s
Geographical and environmental factors	Loam to clay loam soilsandy in Cholistan	Mostly loam soils, in some areas clay loam
	Some areas are highly saline	Some area is saline
	Canal water is available, ground water is marginally fit and unfit in some areas	Canal water is available, ground water is marginally fit and unfit in some areas
	Flat lands	Flat lands
	Altitude is 80 m	Altitude is 184 m
	Irrigated soils	Irrigated lands
	Climate classified as [Hot Desert Climate] by the Köppen-Geiger system	Climate classified as BWh by the Köppen-Geiger system
	June is the warmest month with an average of 36°C, and lowest average is 13.3°C in January	June is the warmest month with an average of 34°C, and lowest average is 11.9°C in January
	Average annual rainfall is 101 mm. Precipitation is mostly in monsoon months	Average annual rainfall is 346 mm. Precipitation is mostly in monsoon season, winter months receive very low/no rainfall.
	Winter nights receive frost	Winter nights receive frost
Crop cycle	**Sowing** 1st Crop = Mid-Feb 2nd Crop = Last week of June 3rd Crop = Nov **Transplanting** 1st Crop = 1st week of Apr 2nd Crop = Last week of Jul 3rd Crop = Mid-Feb **Harvesting** 1st Crop = June - Sep 2nd Crop = Sep- Dec 3rd Crop = Apr- Jun	**Sowing** 1st Crop = Mid-Feb 2nd Crop = Last week of June 3rd Crop = Nov **Transplanting** 1st Crop = 1st week of Apr 2nd Crop = Last week of Jul 3rd Crop = Mid-Feb **Harvesting** 1st Crop = June - Sep 2nd Crop = Sep- Dec 3rd Crop = Apr- Jun
Brinjal growers	Small to medium farmers	Small to medium farmers
Type	Round to long types	Round to long types
Variety features	**AARI varieties:** Nirala (Oblong), Dilnashen (Round type), Bemissal (Long variety) **Exotic varieties/Hybrids:** Jhansi F1 (Round), Kokila F1 (oblong), Jhanak-F1, Sandia. The Adoption level of AARI varieties is low due to unavailability of seed and lack of facilities in public sector. However, private sector companies market imported seed mainly from India. The potential of brinjal varieties is about 30-40 t/ha.	**AARI varieties:** Nirala (Oblong), Dilnashen (Round type), Bemissal (Long variety) **Exotic varieties/Hybrids:** Jhansi F1 (Round), Kokila F1 (oblong) Jhanak-F1, Sandia. The Adoption level of AARI varieties is low due to unavailability of seed and lack of facilities in public sector. However, private sector companies market imported seed mainly from India. The potential of brinjal varieties is about 30-40 t/ha.

Nursery preparation	Farmers buy brinjal seed from local markets, mostly seed of exotic varieties is available in markets. Seed price per ha is about 6000-7000 PKR.	Farmers buy brinjal seed from local markets, mostly seed of exotic varieties is available in markets. Seed price per ha is about 6000-7000 PKR. One Private company in Gujranwala is marketing brinjal nursery @PKR 3/plant, that will cost PKR 75000-80000/ha.
	Farmers grow the brinjal nursery, and then nursery is transplanted to field. About 500-625 g seed is required to sow nursery for a ha. No commercial nursery exists.	Farmers grow the brinjal nursery, and then nursery is transplanted to field. About 500-625 g seed is required to sow nursery for a ha. No commercial nursery exists.
	In summer, the nursery is prepared in 35-40 days, in winter it takes 85-95 days.	In summer, the nursery is prepared in 35-40 days, in winter it takes 85-95 days.
	Optimum plant population is 25000-30000 plants per ha.	Optimum plant population is 25000-30000 plants per ha.
Land preparation	2-3 ploughing followed by planking and bed preparation with bed shaper or ridger. Mainly family labor is used for land preparation.	2-3 ploughing followed by planking and bed preparation with bed shaper or ridger. Mainly family labor is used for land preparation.
Major pests	Fruit/shoot borer is main factor in yield reduction and low quality. To control this menace, farmers usually apply 30-40 sprays which is of great concern. Other insects are Jassid & whitefly	Fruit/shoot borer is main factor in yield reduction and low quality. To control this menace, farmers usually apply 30-40 sprays which is of great concern. Other insects are Jassid & whitefly
Input/management practices	The crop is sown on beds. Farmers apply imbalance fertilizer [NP @ 125:75:60 kg/ha, and use of micronutrients is very little	The crop is sown on beds. Farmers apply imbalance fertilizer [NP @ 125:75:60 kg/ha], and use of micronutrients is very little.
	30-40 sprays to control fruit & shoot borers	30-40 sprays to control fruit & shoot borers
	Usually optimum plant population is not maintained which is a factor of low yield	Usually optimum plant population is not maintained which is a factor of low yield
Irrigation	Furrow irrigation mainly with canal water & supplement with tube well water. Underground water is unfit for irrigation in most of the places.	Furrow irrigation mainly with canal water & supplement with tube well water. Underground water is unfit for irrigation in most of the places, marginally fit in some areas.
Modern technologies	1. Use of raised bed & furrow irrigation 2. Pesticide application to control insects 3. Washing, grading, packing in plastic/gunny bags	1. Use of raised bed & furrow irrigation 2. Pesticide application to control insects 3. Washing, grading, packing in plastic/gunny bags
Crop rotation/cropping pattern		One-year popular rotation Brinjal-Maize-Wheat Brinjal-Maize-Maize Brinjal-Brinjal

Main diseases	Blight, collar rot	Blight, collar rot
Picking	The fruit picking is done once the stalk is weak and the fruit is in soft form. Some farmers get picking twice a weak. Labor is hired for picking @ 8500-12000 PKR per picking.	The fruit picking is done once the stalk is weak and the fruit is in soft form. Some farmers get picking twice a weak. Labor is hired for picking @ 8500-12000 PKR per picking.
Marketing	Low price & rate fluctuation, Round type is preferred and fetch more price	Low price & rate fluctuation, Round type is preferred and fetch more price
	The farmers sell their produce to fruit & vegetable markets in RY Khan, Bahawalpur and in local markets.	Farmers sell their produce in Fruit & Vegetable Market Faisalabad and in other local markets of Faisalabad district. The fruit is auctioned in the markets by commission agents.
Processing/Storage	No processing, grading, cleaning & packing is done. Fruit is packed in plastic bags and sold in markets.	No processing, grading, cleaning & packing is done is done. Fruit is packed in plastic bags and sold in markets.
Certification	The brinjal certification is not done, due to its heavy cost. Pesticide are being sprayed injudiciously, brinjal really need to be certified due to pesticide residues.	The brinjal certification is not done, due to its heavy cost. Pesticide are being sprayed injudiciously, brinjal really need to be certified due to pesticide residues.
Research & development	Vegetable Research Institute, Faisalabad is currently working on variety development of brinjal. Provincial/PARC Research setup on vegetable is not established in the South.	Vegetable Research Institute, Faisalabad is currently working on variety development.
Seed companies supplying the brinjal seed	Bayer Crop Sciences, Kanzo Ag, and other local suppliers	Bayer Crop Sciences, Kanzo Ag, Naveel Seed Coprporation, Gujranwala, and other local suppliers

5.4 SWOT Analysis of Clusters

Table 9: SWOT analysis of both clusters

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Environment, climate, soil	- Suitable soil & climate - Brinjal can be grown on all types of soils	- Temperature extremes -	- Vast area available - Two growing seasons in a year	- High temperature & water shortage - Frost damages
Varieties/ technologies/ Quality	- High yielding varieties AARI varieties: Nirala (Oblong), Dilnashen (Round type), Bemissal	- High cost of nursery seedlings - Poor quality seed/nursery - No nursery management - Improper sowing time of nursery & crop	- Diseases/pest free nursery - Nursery sowing under nets - Susceptible varieties	- Shortage of seed & nursery - High nursery cost

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
	(Long variety) Exotic varieties/Hybrids: Jhansi F1 (Round), Kokila F1 (oblong)	- Infested nursery		
Input supplies/ crop management	- Available production technology	- Frequent spray - Improper land preparation - Unavailability of skilled labor - Non-availability of potash fertilizers & micronutrients - Imbalanced fertilizer use - Less irrigation - Less plant population - Poor agronomic practices - Lack of farm mechanization	- Availability of potash fertilizers & micronutrients - Ridge sowing - Balanced fertilizer application & fertigation - Timely irrigation (weekly in hot summer days) - Optimum plant population (10000-12000 plants/acre) - IPM & use of biopesticides	- Pest pressure (borers, jassid & whitefly) - Pesticide residues due to frequent sprays (approx. 40 sprays on crop)
Marketing & industry	- Consumer acceptability - Markets demands - Established production baskets	- Price fluctuation & difference between different types - Middle man involvement - High labor/ transportation charges in markets - Poor quality product - No post-harvest management - No grading - No export	- Proper packaging in plastic boxes - Temperature control storage - Low price - Proper post-harvest management - Enhancing shelf life - Round type & black color - Judicious use of pesticides - Proper/forward marketing - Can be exported to EU and Russia	- Less shelf life - Pesticide residues due to injudicious sprays

5.5 Brinjal Value Chain

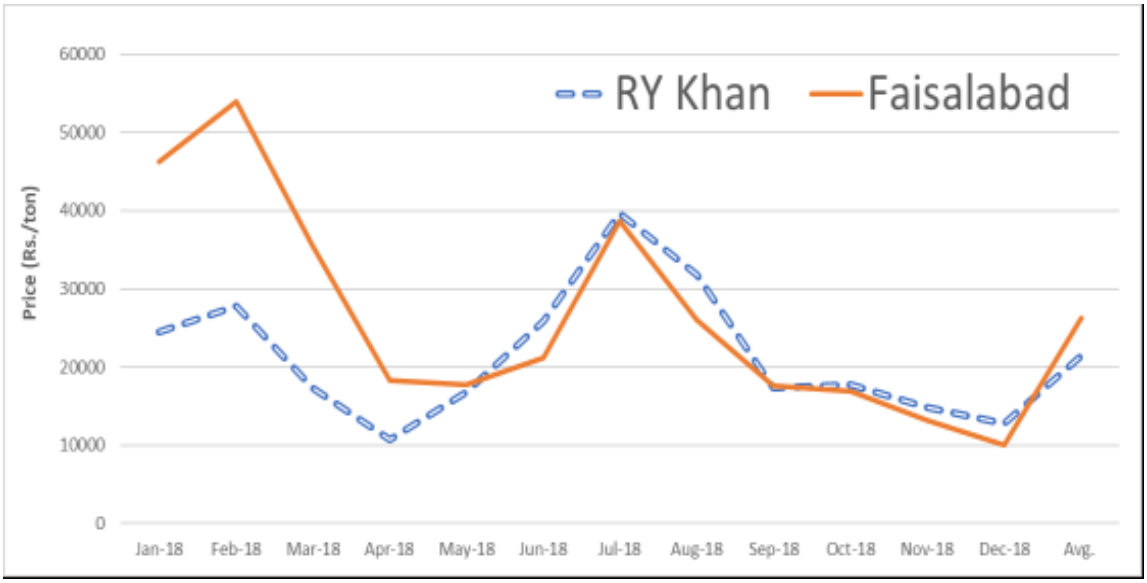
Primitive cultivation methods of nursery raising is used in both the clusters. There is no commercial nursery producing brinjal certified nursery in any of the cluster, neither any seed company supplying certified brinjal seed to farmers. Public sector seed supply service is also non-existence. Fertilizer and pesticide supply are efficient through private sector. Although several micro-nutrients are availability in the market, but little is applied to the crop. Public sector research on brinjal is scantly and uncoordinated. Harvesting is mainly done manually through hired labor.

After harvesting, no grading is done at the farm-level. The produce is packed in gunny bags and transported in open vans. Mostly farmers bring their produce to the market for

auctioning. But sometime, farmers sell their produce to the wholesalers or collectors at their farm. The transportation become the responsibility of the trader. At the time of auctioning in the market, farmers are usually not present. Normally, 'Phariahs' win the bid in auctioning who then sell the produce to retailers in small lots. The retailers usually do wash, and grading based on the size and appearance of the produce. There is no storing or proper packaging at any stage of the value chain.

The brinjal price is highly variable across the markets and season (Figure 2).

Figure 2: Price of the brinjal in the focal point



In both markets, prices are highly fluctuating across the months. However, prices are high in the months of January, February, March, July and August and low in the months of September-December[6].

5.6 Best International Practices

International best practices in production, logistics, marketing, trade, etc.

- Quality seed/nursery
- Fertilizer management
- Resistant varieties and IPM
- Proper harvesting, grading, transportation to pack house, cleaning/washing, grading, waxing, packing
- Proper storage/shipment
- SPS measures
- Export Control Act

[6] AMIS, Punjab

6 CHALLENGES FACED BY THE CLUSTERS

The clusters face numerous challenges which are discussed below:

6.1 Climate change and increasing shortages of water

Pakistan is amongst the most vulnerable countries to climate change impacts. Both the clusters in South & Central Punjab face water shortage. Another issue is the frost in winter months which hampers the crop growth & development and high temperature in summer months. The depleting ground water in Southern Cluster and poor quality saline underground water resources in Central Cluster are adversely affecting the crop production in Pakistan. The soil fertility is depleting at an alarming rate and organic matter in Pakistani soils is very low and continuously depleting.

6.2 Constraints at production level

Mostly growers are small famers and cost of production is high. Yield of brinjal is very low in Pakistan compared to the world average. The major yield limiting factors are susceptible varieties to insect/pest and diseased particularly fruit & shoot borers which cause severe losses during whole crop season. Moreover, it reduces the quality of fruit. Farmers spray 30-40 times during a crop season as no alternative of insect control is available and insect pressure is quite high.

There is no private company supplying the certified brinjal seed to farmer nor any certified commercial nursery. Mostly farmers use their own farm-produced seed thus the quality of seed used by the farmers is low. Moreover, no commercial certified nursery is available. Farmers grow their own nurseries which are disease effected with poor vigor. The high input cost and cost of irrigation are serious constraints. The production technology and extension services are not up to the mark in both the clusters (Table 10).

Table 10: Constraints at production level

S.#	Parameter	South Punjab	Central Punjab
1	Germplasm	Narrow germplasm	Narrow germplasm
2	Locally evolved high yielding varieties	Available from AARI, but not adopted by the farmers	Available from AARI. but not adopted by the farme
3	Private sector seed supply	No seed company supply the certified seed of approved varieties	No seed company supply the certified seed of approved varieties
4	Public sector seed supply	No system available	No system availability
	Commercial certified nurseries	Non	Non
5	Commercial inputs	Imbalance uses of fertilizer	Imbalance uses of fertilizer Injudicious use of pesticides
6	Extension services	Adequate	Adequate
8	Credit	By wholesalers, collectors	By wholesalers, collectors
9	Irrigation	Cost of pumping is increasing because of depleting aquafer	Salty underground water and cost is increasing
10	IPM for pest control	High pressure of fruit and shoot borer, limited use of IPM practices, resulting in injudicious use of pesticides with high costs for farmers and damaging impact on environment.	High pressure of fruit and shoot borer, limited use of IPM practices, resulting in injudicious use of pesticides with high costs for farmers and damaging impact on environment.
11	Advance Management practices	Not developed	Not developed
12	Protected cultivation	Costly and rarely adopted	Costly and not adopted
13	Labor input	Hired labor for harvesting is costly	Hired labor for harvesting is costly

6.3 Constraints at processing level

The brinjal farmers are not aware of value addition technologies such as washing, grading, waxing, and proper packing technologies and their importance in marketing of their produce, thus no such activities are performed (Table 11). The major problem is that no significant brinjal-based product has been identified so far in Pakistan. People like to purchase fresh and disease free brinjal. In addition, there is no legal binding on farmers to keep the pesticide use level within the international prescribed standards.

Table 11: Constraints at post-harvest and processing level

S.#	Parameter	South Punjab	Central Punjab
1	Value addition technologies in use	Not available, not aware, and not in use	Not available, not aware, and not in use
2	Post-harvest operation	Not adequate	Not adequate
3	Legal framework for processing	Not favorable	Not favorable

6.4 Constraints at marketing/trading level

Marketing of produce is a major factor in low value chain efficiency of brinjal; its price highly fluctuates across the months and markets. The lack of farmers' interaction with consumers bar them to understand their quality requirements. There is no certification and branding effort in brinjal. No quality, price, and time bound contracts exists between farmers and traders (Table 12).

Table 12: Constraints at Marketing and Trading Level

S#.	Parameter	South Punjab	Central Punjab
1.	Marketing channels	Traditional	Traditional
2.	Marketing infrastructure	Available	Poor
3.	Price volatility	High	High
4.	Market information about prices and quality	Lacking	Lacking
5.	E-commerce platforms	Not available	Not available
6.	Contract farming	Not reported	Not reported
7.	Export readiness	Lacking, but can be possible with appropriate effort	Lacking, but can be possible with appropriate effort
8.	Branding	Lacking	Lacking

6.5 Major drivers of success or failure

Major drivers for the success and failure of brinjal are listed Table 13

Table 13: Drivers of success and failure

Drivers of failure	Drivers of Success
- Insect susceptible varieties - injudicious use of pesticide - Imbalanced fertilizer application - High labor/production cost - Improper packaging - Poor quality of seed - Low quality produce & no post-harvest management - Price instability & inefficient marketing	-High yielding & pest resistant varieties -Judicious use of pesticides and adoption of IPM -Certified seed/nursery -Price stability & forward marketing - Balanced input application - Improved sowing/ harvesting methods - Quality, post-harvest and proper packaging infrastructure, like pack house. - Organic farming & certification - Processing industry - Explore international markets

7 CLUSTER DEVELOPEMNT POTENTIAL

7.1 Production

Pakistan's average yield is 10 t/ha as compared to world average of 20 t/ha. It is 100% lower than the world average. There is no reason that Pakistan cannot achieve this potential in the long-run. Following are available options to improve per ha yield:

1. The Ayub Agriculture Research Institute has developed technologies and varieties which can give the yield much higher than the world average. These varieties include Nirala (Oblong), Dilnashen (Round type), Bemissal (Long variety) which have the potential of producing 30 tonne per ha.
2. Moreover, adoption of improved management practices such as IPM, bed sowing, weed control, and drip irrigation can substantially improve brinjal yield as well as its quality.
3. Brinjal cultivation under plastic net and insect nets can greatly help to control borers & sucking insects and can increase brinjal yield up to 50%. In this context, successful experiments have been conducted in Vegetable Research Institute, Faisalabad. Moreover, the specific pheromone traps can be used to control borers on brinjal crop.
4. The promotion of certified commercial nurseries where nurseries of certified varieties are produced under controlled condition and are free of infection also has a great potential to improve yield and produce quality.

Adoption of these technologies in package can easily bring the brinjal yield at least at the world average level in the long-run. This can double the production and has the potential of increasing the additional revenue to farmers by US$12.5 million when modern technologies are adopted at the national level.

7.2 Demand of Brinjal

The question is where is the potential to absorb the additional supply of brinjal? As noted earlier the per capita consumption in Pakistan is declining due to its lower domestic supplies. The increased supply of brinjal can be absorbed to curtail the declining trend in its consumption. Pakistan has little potential to export brinjal internationally because of its low per ha yield and under developed value chain, although it may explore the Chinese market to supply brinjal during the harsh winter in China where brinjal demand is expanding.

7.3 Value Chain Potential

Currently, brinjal is not passing through any sophisticated value chain process, like washing, grading, packaging, and branding. No pack-house exist in any brinjal growing areas in Pakistan. However, we believe that there is a significant demand for value added brinjal in high income communities in big cities within the country. This demand is being pushed by supermarkets in these cities. However, such demand is much higher in the Central Punjab Cluster where incomes increases are much higher than in Southern Punjab.

8 PLAN, POLICIES AND STRATEGIES

8.1 The Plan

The main target of the study is to reinvigorate the brinjal clusters in the country. We plan to initially apply modern technologies in production and value chain processes only at the cluster focal point level. Looking at the potential discussed earlier, we believe that the following targets can be achieved relatively easily in a five-year project period:

1. Increase in brinjal yield by 20% on 50% of the focal point area in each cluster.

2. Bring 20% of each focal point brinjal area under insect nets over 5 years and increase yield of the area under insect net by 40%.

3. Increase the value addition of the 15% of the total production plus all the production obtained from insect nets to such level that it can receive at least one half of the international average export price.

These targets will be achieved through various strategies including policy measures and technological interventions as explained in the following sections.

8.2 Strategies

The strategies adopted for cluster development at focal point of each cluster to achieve the above set targets are explained in Table 14:

Table 14: Proposed strategies for clusters

R&D	Production Level Strategies	Marketing/value addition	Policies
- High yielding & insect resistant varieties for both open field and under protected nets. - Acquire international germplasm -Collaboration with international organizations - Standardizing productions technology with special emphasis on cultivation in plastic nets. - IPM module development - Training of scientists on brinjal breeding and technology improvement	-Promotion of balanced input application through demonstration on FEG member farmers. -Promotion of bed sowing through FEG member farmers. -Capacity building of farmers for tunnel cultivation and quality seed production. -Promote IPM to reduce pesticide application through	-20% of the production in Southern cluster and 15% in Central Cluster of Punjab will be passed through the pack-houses for sorting, grading, washing, and proper packaging. - Interest free loans will be provided to establishment pack houses in each cluster for proper grading, waxing, packaging, storage, etc. depending upon the demand for	-Establishment of Farmers Entrepreneur Groups (FEGs) and linking the establishment of pack-houses with FEGs. -Linkages of FEGs with R&D by giving representation in provincial research institute Board -Improve seed/nursery regulation - Organic Act

- Enhancing brinjal R&D infrastructure at the provincial level related to each cluster.	FEGs -20% subsidy on tunnel farming to bring at least 20%of total area under insect nets to escape the threat of fruit and shoot borer and supply during the off-season. - Encouraging the quality seed production through FEGs through buy back arrangements from seed producers at pre-determined price and distributing seed to farmers at 90% of the actual costs (10% subsidy).	value about four pack-houses will be established in each cluster -Promote contract farming through FEGs -Promoting the establishment of Quality Control & Certification Labs in the private sector	

9 BENEFIT AND COST OF CLUSTERING

9.1 South Punjab Cluster

9.1.1. Basic Situation

The study has considered 473 ha of area under Brinjal production in the focal point of South Punjab cluster (Rahimyar Khan) which is currently producing 5,260 tonnes of Brinjal fruit per year. Current yield in the cluster is 11.12 tonnes/ha; showing a negative growth of 0.3%. Following table shows the cluster's current production performance.

Table 15: South Punjab Cluster – Current Production Situation

Area under cultivation in cluster (ha)	1426
Total Production (tonnes)	17003
Production yield (tonnes/ha)	11.9
Area of focal point (ha)	473
Production of focal point (tonnes)	5260
Yield at focal point (t/ha)	11.12
Annual yield growth without intervention	0.3%
Farm gate price of Brinjal (US$/tonne)	147

Brinjal production and its value at the current farm gate price in the next five years in a no-intervention scenario is shown in table.

Table 16: South Punjab Cluster – Brinjal Production in No-Intervention Scenario

	Year 1	Year 2	Year 3	Year 4	Year 5
Default yield (tonnes/ha)	-	11.19	11.22	11.25	11.29
Annual expected production without intervention (Tonnes)	-	5292	5307	5323	5339
Total value of production at farm gate (million US$)	**-**	0.778	0.780	0.783	0.785

9.1.2. Benefits of the Proposed Interventions

9.1.2.1. Intervention 1 - Improved management practices

Farmers would be made to realize to adopt recommended cultivation and integrated insect pest management practices. Quality seed will be provided to farmers along with training on how to prepare nursery. The extension department will start a crash program to introduce new and high yielding varieties to the farmers. It is estimated that these efforts in South Punjab cluster will increase the Brinjal yield by 20% over a period of five years. However, it

is assumed that farmers will gradually adopt new practices and variety; thus, yield increase in the cluster will be gradual at a rate of 5% per year starting from the second year. It is assumed that 50% of the total area in the cluster will be adopting the recommended cultivation practices at a rate of 12.5% per year. Based on these assumptions, the value of increased Brinjal production is shown in the following table 17.

Table 17: South Punjab Cluster - Increased Brinjal Value by Increasing Yield due to improved management practices

	Year 1	Year 2	Year 3	Year 4	Year 5
Current Yield without interventions		11.19	11.22	11.25	11.29
Percent of area where yield will increase due to improved management practices		13%	25%	38%	50%
Area on which improved management practices will be applied (ha)		59.13	118.25	177.38	236.50
Yield increase over five years		20%	20%	20%	20%
Increase in yield (tonnes/ha)		2.24	2.24	2.25	2.26
Additional production from enhanced yield (tonnes)		132	265	399	534
Expected additional value (Million US$)		**0.019**	**0.039**	**0.059**	**0.078**

9.1.2.2. Intervention 2 – Introducing Insect Net and Pack-House for Export

The cultivated under insect net will improve the quality and price of brinjal to be marketed in the local markets. It is assumed that 20% of the total area will be cultivated under insect net from the cluster thus will be sold at higher price than the current price. This will be achieved in four years with the addition of 5% each year. About 1065 tonnes brinjal will be produced in insect nets of value 0.157 million US$, year wise detail starting from second year is shown in table below.

Table 18: Gross revenue from insect net and pack-house in the focal point of Southern Punjab

	Year 1	Year 2	Year 3	Year 4	Year 5
Percentage of area where yield will be increased due to netting		5%	10%	15%	20%
Area under net (ha)		24	47	71	95
Yield increase due to netting (%)		10%	10%	10%	10%
Yield increase due to netting (t)		4.47	4.49	4.50	4.52
Total production from area under net (t)		106	212	319	427
Added value from export of quality produce (million US$)		**0.016**	**0.031**	**0.047**	**0.063**

9.1.2.3. Intervention 3 – Improved Value Addition for Domestic Market

The improved value chain activities such as grading, washing, waxing, proper packaging and storing, branding, etc. will improve the quality and price of brinjal to export and marketed in

the local markets. It is assumed that 10% of the total production will pass through the pack house from the cluster thus will be sold at higher price than the current price. This will be achieved in four years with the addition of 2.5% each year. Benefits from this intervention at an increased price of US$494.5 per tonne-equal to the import price over four years are shown in below table 19.

Table 19: Focal Point of South Punjab Cluster – Value Addition through Pack-houses

	Year 1	Year 2	Year 3	Year 4	Year 5
Percentage of production that pass though pack houses (%)		2.5%	5.0%	7.5%	10.0%
Total volume to be value added through pack-house (t)		241	491	749	1,014
Expected additional value (Million US$) @ 494.5 (US$/t) Price of value added		**0.08**	**0.17**	**0.26**	**0.35**

9.1.3. Total Benefits Summary

Summary of the value of the benefits of the proposed interventions is shown in Table below.

Table 20: Summary of benefits of all interventions in focal point of Southern Punjab Cluster

Benefits Value (Million US$)	Year 1	Year 2	Year 3	Year 4	Year 5
Value of Increased Yield	-	0.019	0.039	0.059	0.078
Added value from export of quality produce	-	0.016	0.031	0.047	0.063
Value of Improved Value Chain	-	0.08	0.17	0.26	0.35
Total Value	**-**	**0.115**	**0.24**	**0.366**	**0.494**

9.1.4. Enhanced Operational Costs of the Interventions

The above proposed interventions will add cost of producing, processing, and value addition of Brinjal. The costs of the proposed interventions involve two types of costs i) value chain improvement operational costs and ii) sector support interventions costs [investments].

Operational Cost. The proposed sector transformation plan includes interventions both for on-farm and off-farm activities. Improvement entails spending more money for carrying out those activities on modern lines. Existing costs and the proposed incremental increases for different cost heads are shown in the following table 21.

Table 21: Focal Point of South Punjab Cluster – Value Chain Costs and Proposed Incremental Increases in Operational Cost

	Cost	Incremental Increase
Cost of Production Inputs and Harvest: Total Cost (US$/ha)	1547	5%

Percentage increase in cost of inputs including netting (%)	-	29%
Cost of value addition in pack houses (US$/t)	123	
Total Cost of value addition (million US$)	0.31	

Investment. South Punjab brinjal cluster has huge growth potential by virtue of its diverse agro ecological conditions. A mega program will be launched that will include strengthening of R&D infrastructure for varietal development program, production technology development, processing and value addition. High yielding brinjal variety resistant to pests & diseases will be evolved and strategy for integrated pest management practices along with cultivation under insect net. Pre-basic brinjal seed will be provided to provincial and private seed companies including interested farmers in FEGs. Provision of certified seeds & nursery to farmers will be ensured in the cluster. Seed regulation will be implemented in the selected districts. Advisory services will be provided on the request of FEGs during the brinjal season. The proposed budget for cluster development interventions in South Punjab will be 0.507 million US$. About 68% of this investment should be provided by the government in strengthening brinjal research, capacity building of stakeholders, incentivizing the insect net and pack houses, and providing cheaper loans. These incentives will bring 32% of the remaining investment by the private sector. Out of the total government investment the Planning Commission can provide 20% by establishing a Cluster Development Fund (CDF) under PSDP. The remaining 80% should come from the provincial budgets through the provincial PSDP. Details are provided in Table below 22.

Table 22: Input & infrastructure requirement of clusters for South Punjab Cluster

S#	Cluster Strategy	Interventions	Implementing Agency	Cost involved Million US$
1.	Strengthening of R&D	Develop a cluster development project	DoA Punjab	-
		Strengthening of R&D infrastructure having HR, infrastructure and other facilities for varietal development program, production technology development, processing and value addition	DoA Punjab/ AARI	0.200
		Acquisition of germplasm		
		Evolve one high yielding variety of brinjal resistant to pests & diseases		
		Production technology development for both the clusters		
		Research on processing & value addition		
		Preparation of nursery production manual		
		Training of master trainers of Agri. Extension		
2.	Provision of certified nursery plants	Ensure the certified nursery plants availability to farmers in selected districts	Punjab Seed Corporations/ private nurseries	-
3.	Extension services	Organize farmers days on Markaz level for better crop management and awareness in RY Khan and Faisalabad districts	DoA Punjab through Agriculture Extension Wing	0.050
		Advisory services throughout the brinjal		

S#	Cluster Strategy	Interventions	Implementing Agency	Cost involved Million US$
		season		
4.	Stakeholders interaction	Organize seminar covering all aspects & whole value chain by involving all stakeholders	DoA Punjab	
5.	Pack house	Establishment of pack house	FEGs	0.252
6.	Loans			0.006
Estimated budget				**0.507**

This proposed cluster development investment will be spent in a period of four years starting from year 1. Yearly distribution of these investments will be driven by the interventions planned for that year. For example, the processing cost [investment] will be driven by the number of pack houses that will be required each year to meet the set production target. For production level R&D strategies, it is assumed that 40% of this cost of production level strategies and marketing/trading level strategies will be spent in year 1, 30% in year 2 and 15% each in year 3 and year 4. With these assumptions, the cost distribution is shown in table below.

Table 23: South Punjab Cluster – Cluster Development Investments Cost Projections (Million US$)

Investment Head	Year 1	Year 2	Year 3	Year 4	Total
Investment on R&D establishment	0.080	0.060	0.030	0.030	**0.200**
Investments on extension services and stakeholder interaction	0.020	0.015	0.008	0.008	**0.050**
Investment on pack houses	0.063	0.063	0.063	0.063	**0.252**
Loans	0.002	0.002	0.001	0.001	**0.028**
Total investments	**0.165**	**0.140**	**0.101**	**0.101**	**0.507**

9.1.5. Economic Viability of Cluster Development Plan

Based on the benefits, costs, and investments of the proposed interventions package in the above paragraphs, the economic viability of the proposition has been calculated in terms of project's NPV and IRR. Discounted cash flow analysis has been carried out using an annual discount rate of 8.5%. Calculations and results are shown in the following table 24.

Table 24: South Punjab Cluster - Economic Viability of Proposed Interventions Package (Million US$)

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Benefits of the Interventions	-	0.119	0.241	0.366	0.494
Total operational costs of the Interventions	-	(0.04)	(0.09)	(0.16)	(0.25)
Total investment costs of the interventions	(0.165)	(0.140)	(0.101)	(0.101)	-
Net Cash Flows	(0.165)	(0.058)	0.049	0.104	0.248

NPV (M. US$)	**0.077**
IRR	**20%**

A positive NPV of US$ 77,000 indicates that the interventions package proposed for uplift and transformation of South Punjab Brinjal cluster is an economically viable proposition.

9.2 Central Punjab Cluster

9.2.1. Current Situation

The study has considered 600 ha of area under Brinjal production in the focal point of Central Punjab cluster (R.Y. Khan) which is currently producing 6,200 tonnes of Brinjal fruit per year. Current yield in the cluster is 12.4 tonnes/ha; showing a negative growth of 0.3%. Following table shows the cluster's current production performance.

Focal Point of Central Punjab Cluster – Current Production Situation

Area under cultivation in cluster (ha)	1108
Total Production (tonnes)	13686
Production yield (tonnes/ha)	12.4
Area of focal point (ha)	600
Production of focal point (tonnes)	6200
Yield at focal point (t/ha)	12.4
Annual yield growth without intervention	0.3%
Farm gate price of Brinjal (US$/tonne)	147

Brinjal production and its value at the current farm gate price in the next five years in a no-intervention scenario is shown in table 25.

Table 25: Central Punjab Cluster – Brinjal Production in No-Intervention Scenario

	Year 1	Year 2	Year 3	Year 4	Year 5
Default yield (tonnes/ha)	-	12.47	12.51	12.55	12.59
Annual expected production without intervention (Tonnes)	-	6,237	6,256	6,275	6,294
Total value of production at farm gate (million US$)	**-**	**0.917**	**0.920**	**0.922**	**0.925**

9.2.2. Benefits of the Proposed Interventions

9.2.2.1. Intervention 1 - Improved management practices

Farmers would be made to realize to adopt recommended cultivation and integrated insect pest management practices. Quality seed will be provided to farmers along with training on how to prepare nursery. The extension department will start a crash program to introduce new and high yielding varieties to the farmers. It is estimated that these efforts in Central Punjab cluster will increase the brinjal yield by 20% over a period of five years. However, it is

assumed that farmers will gradually adopt new practices and variety; thus yield increase in the cluster will be gradual at a rate of 5% per year starting from the second year. It is assumed that 50% of the total area in the cluster will be adopting the recommended cultivation practices at a rate of 12.5% per year. Based on these assumptions, the value of increased Brinjal production is shown in the following table 26.

Table 26: Focal Point of Central Punjab Cluster - Increased Brinjal Value by Increasing Yield due to improved management practices

	Year 1	Year 2	Year 3	Year 4	Year 5
Current Yield without interventions	-	12.47	12.51	12.55	12.59
Percent of area where yield will increase due to improved management practices	-	13%	25%	38%	50%
Area on which improved management practices will be applied (ha)	-	62.50	125.00	187.50	250.00
Yield increase over five years	-	5%	10%	15%	20%
Increase in yield (tonnes/ha)	-	2.49	2.50	2.51	2.52
Additional production from enhanced yield (tonnes)	-	156	313	471	629
Expected additional value (Million US$)	-	**0.023**	**0.046**	**0.069**	**0.093**

9.2.2.2. Intervention 2 – Introducing Insect Net and pack-house for Export

The cultivated under insect net will improve the quality and price of brinjal to be marketed in the local markets. It is assumed that 20% of the total area will be cultivated under insect net from the cluster thus will be sold at higher price than the current price. This will be achieved in four years with the addition of 5% each year. About 1255 tonnes brinjal will be produced in insect nets of value 0.184 million US$, year wise detail starting from second year is shown in table below.

Table 27: Focal Point of Central Punjab Cluster – Gross revenue from area under insect net and Pack house

	Year 1	Year 2	Year 3	Year 4	Year 5
Percentage of area where yield will be increased due to netting	-	5%	10%	15%	20%
Area under net (ha)	-	25	50	75	100
Yield increase due to netting (%)	-	10%	10%	10%	10%
Yield increase due to netting (t)	-	4.99	5.00	5.02	5.03
Total production from area under net (t)	-	125	250	376	503
Added value from export of quality produce (million US$)	-	**0.018**	**0.037**	**0.055**	**0.074**

9.2.2.3. Intervention 3 – Improved Value Addition for Domestic Market

The improved value chain activities such as grading, washing, waxing, proper packaging and storing, branding, etc. will improve the quality and price of brinjal to export and marketed in

the local markets. It is assumed that 15% of the total production will pass through the pack house from the cluster thus will be sold at higher price than the current price. This will be achieved in four years with the addition of 3.75% each year. Benefits from this intervention at an increased price of US$494.5 per tonne-equal to the import price over four years are shown in below table 28.

Table 28: Focal Point Central Punjab Cluster – Gross Revenue through Value Addition

	Year 1	Year 2	Year 3	Year 4	Year 5
Percentage of production that pass though pack houses (%)	-	3.75%	7.50%	11.25%	15.00%
Total volume to be value added through pack-house (t)	-	364	743	1,135	1,542
Expected additional value (Million US$) @ 494.5 (US$/t) Price of value added	**-**	**0.127**	**0.258**	**0.395**	**0.536**

9.2.3. Total Benefits Summary

Summary of the value of the benefits of the proposed interventions is shown in Table below.

Table 29: Focal Point of Central Punjab Cluster - Summary of the Value of Benefits of all Interventions

Benefits Value (Million US$)	Year 1	Year 2	Year 3	Year 4	Year 5
Value of Increased Yield	-	0.023	0.046	0.069	0.093
Added value from quality produce	-	0.018	0.037	0.055	0.074
Value of Improved Value Chain	-	0.127	0.258	0.395	0.536
Total Value	**-**	***0.168***	***0.341***	***0.519***	***0.702***

9.2.4. Enhanced Costs of Proposed Interventions

The above proposed interventions will add cost of producing, processing, and value addition of Brinjal. The costs of the proposed interventions involve two types of costs i) value chain improvement costs and ii) sector support interventions costs [investments].

Operational Cost. The proposed sector transformation plan includes interventions both for on-farm and off-farm activities. Improvement entails spending more money for carrying out those activities on modern lines. Existing costs and the proposed incremental increases for different cost heads are shown in the following table 30.

Table 30: Focal Point of Central Punjab Cluster – Value Chain Operational Costs and Proposed Incremental Increases Cost Head

	Cost	Incremental Increase
Cost of Production Inputs and Harvest: Total Cost (US$/ha)	1514	9%
Percentage increase in cost of inputs including netting (%)	-	36%

Cost of value addition in pack houses (US$/t)	123	
Total Cost of value addition (million US$)	0.47	

Investments. Central Punjab brinjal cluster has huge growth potential by virtue of its diverse agro ecological conditions. A mega program will be launched that will include strengthening of R&D infrastructure for varietal development program, production technology development, processing and value addition. High yielding brinjal variety resistant to pests & diseases will be evolved and strategy for integrated pest management practices along with cultivation under insect net. Pre-basic brinjal seed will be provided to provincial and private seed companies including interested farmers in FEGs. Provision of certified seeds & nursery to farmers will be ensured in the cluster. Seed regulation will be implemented in the selected districts. Advisory services will be provided on the request of FEGs during the brinjal season.

The proposed budget for cluster development interventions in Central Punjab will be 0.630 million US$. About 70% of this investment should be provided by the federal government, by establishing a Cluster Development Fund (CDF) under PSDP. The remaining 30% should come from the provincial budgets. Details are provided in Table below.

Table 31: Input & infrastructure requirement of clusters for Central Punjab Cluster

S#	Cluster Strategy	Interventions	Implementing Agency	Cost involved Million US$
1.	Strengthening of R&D	Develop a cluster development project	DoA Punjab	-
		Strengthening of R&D infrastructure having HR, infrastructure and other facilities for varietal development program, production technology development, processing and value addition	DoA Punjab/ AARI	0.200
		Acquisition of germplasm		
		Evolve one high yielding variety of brinjal resistant to pests & diseases		
		Production technology development for both the clusters		
		Research on processing & value addition		
		Preparation of nursery production manual		
		Training of master trainers of Agri. Extension		
2.	Provision of certified nursery plants	Ensure the certified nursery plants availability to farmers in selected districts	Punjab Seed Corporations/ private nurseries	-
3.	Extension services	Organize farmers days on Markaz level for better crop management and awareness in RY Khan and Faisalabad districts	DoA Punjab through Agriculture Extension Wing	0.150
		Advisory services throughout the brinjal season		
4.	Stakeholders interaction	Organize seminar covering all aspects & whole value chain by involving all stakeholders	DoA Punjab	
5.	Pack house	Establishment of pack house	FEGs	0.252

S#	Cluster Strategy	Interventions	Implementing Agency	Cost involved Million US$
6.	Loans			0.028
Estimated budget				**0.630**

This proposed cluster development investment will be spent in a period of four years starting from year 1. Yearly distribution of these investments will be driven by the interventions planned for that year. For example, the processing cost [investment] will be driven by the number of pack houses that will be required each year to meet the set production target. For production level R&D strategies, it is assumed that 40% of this cost of production level strategies and marketing/trading level strategies will be spent in year 1, 30% in year 2 and 15% each in year 3 and year 4. With these assumptions, the cost distribution is shown in table below.

Table 32: Central Punjab Cluster – Cluster Development Investments Cost Projections (Million US$)

Investment Head	Year 1	Year 2	Year 3	Year 4	Total
Investment on R&D establishment	0.080	0.060	0.030	0.030	**0.200**
Investments required on extension services and stakeholder interaction	0.060	0.045	0.023	0.023	**0.150**
Investment on pack houses	0.063	0.063	0.063	0.063	**0.252**
Loans	0.007	0.007	0.007	0.007	**0.028**
Total investments	**0.210**	**0.175**	**0.122**	**0.122**	**0.630**

9.2.5. Economic Viability of Cluster Development Plan

Based on the benefits, costs, and investments of the proposed interventions package in the above paragraphs, the economic viability of the proposition has been calculated in terms of project's NPV and IRR. Discounted cash flow analysis has been carried out using an annual discount rate of 8.5%. Calculations and results are shown in the following table.

Table 33: Focal Point of Central Punjab Cluster - Economic Viability of Proposed Interventions Package (Million US$)

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Benefits of the Interventions	-	0.168	0.341	0.519	0.702
Total operational costs of the Interventions	-	(0.08)	(0.16)	(0.24)	(0.32)
Total investment costs of the interventions	(0.210)	(0.175)	(0.122)	(0.122)	-
Net Cash Flows	(0.210)	(0.085)	0.060	0.156	0.378
NPV	**0.145**				
IRR	**24%**				

A positive NPV of US$ 145,000 indicates that the interventions package proposed for uplift and transformation of Central Punjab Brinjal cluster is an economically viable proposition.

9.3 Summary of budget

The budget requirement for both the cluster development is described in table 34:

Table 34: Summary of budget

Cluster	Million US$
Cluster-1 South Punjab	0.508
Cluster-2 Central Punjab	0.802
Total	**1.329**

9.4 Conclusion

The overall economic, social and environmental impact of the cluster development program shall be positive, sustainable and long lasting. The IRR of both clusters South Punjab & Central Punjab is 20% & 24%, respectively. The R&D should be emphasized to develop high yielding & insect resistant varieties in addition to production technology and IPM module development. The cultivation of brinjal under plastic nets will be a good step in pesticide-free brinjal production.

10. PROGRAMS AND PLANS

The following programs are proposed for both the clusters

10.1. Program for Research Reforms

Table 35: Program for research reforms

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1.1	Establishment of Brinjal Research Station	To strengthen R&D infrastructure	DoA Punjab/AARI	Short to Medium (1-2 years)
1.2	Acquisition of brinjal germplasm	To enrich germplasm	DoA Punjab/AARI	Short to Medium (1-2 years)
1.3	Development of high yield variety resistant to pests & diseases	To evolve high yield variety resistant to pests & diseases	DoA Punjab/AARI	Medium (2-4 years)
1.4	Production technology development particularly under plastic net	To increase the yield by better management practices	DoA Punjab/AARI	Short to Medium (1-2 years)
1.5	Nursery preparation technology and preparation of nursery manual	To produce healthy nursery plants	DoA Punjab/AARI	Short to Medium (1-2 years)
1.6	Formulation of SOPs for plant protection	Safe food production	DoA Punjab/AARI	Short to Medium (1-2 years)
1.7	IPM module development by cultivation under plastic nets and using pheromone traps	Safe food production	DoA Punjab/AARI	Short to Medium (1-2 years)

10.2. Programs for HR development/capacity building

The following programs are proposed for both the both the clusters.

Table 36: Programs for HR development/capacity building

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1.1	Training of master trainer of agriculture extension staff on brinjal production technology	Capacity building of agriculture extension staff	DoA Punjab/AARI/ Agriculture Extension	Short (1 years)
1.2	Advisory services to farmers	Capacity building of farmers	DoA Punjab/ Agr. Extension	Short to Medium (1-2 years)
1.3	Organizing farmers days on Markaz level for better crop management	Capacity building of farmers	DoA Punjab/ Agriculture Extension	Short to Medium (1-2 years)

10.3. Programs for Networking of Stakeholders

The following programs are proposed for both clusters:

Table 37: Programs for Networking of Stakeholders

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1.1	Organize seminar covering all aspects & whole value chain by involving all stakeholders	Organization of stakeholders	DoA Punjab/AARI/ Agriculture Extension/Relevant Industries/Processors/ Farmers	Short to Medium (1-2 years)

10.4. Programs for Establishment of Quality Control & Certification Lab and pack houses

The following programs are proposed for both the clusters:

Table 38: Programs for Establishment of Quality Control & Certification Lab

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1.1	Establish of Quality Control & Certification Labs in both RY Khan & Faisalabad for quality control of brinjal and certification of produce to support export	For quality control and certification	DoA Punjab/AARI	Short to Medium (1-2 years)
1.2	Establishment of pack house	To enhance shelf life and better marketing	FEGs and Exporters	Short to Medium (1-2 years)

11. ANNEXURES

Annexure-1: Province-wise area, production & yield of brinjal

National and province wise area of brinjal crop (ha)

YEAR	Punjab	Sindh	KP	Balochistan	PAKISTAN
2011-12	4896	1493	888	1490	8767
2012-13	4897	1384	1320	1443	9044
2013-14	4617	1409	903	1536	8465
2014-15	4452	1400	841	1632	8325
2015-16	4460	1410	867	1631	8368

National and province wise production of brinjal crop (000 tonnes)

YEAR	Punjab	Sindh	KP	Balochistan	PAKISTAN
2011-12	58.7	6.4	9.8	11.1	86.0
2012-13	58.9	8.1	13.7	10.5	91.1
2013-14	55.2	8.2	9.2	11.5	84.1
2014-15	54.2	8.2	8.4	12.3	83.0
2015-16	54.2	8.2	9.1	12.3	83.8

National and province wise yield of brinjal crop (t/ha)

YEAR	Punjab	Sindh	KP	Balochistan	PAKISTAN
2011-12	12.0	4.3	11.0	7.5	9.8
2012-13	12.0	5.8	10.3	7.3	10.1
2013-14	12.0	5.8	10.2	7.5	9.9
2014-15	12.2	5.8	10.0	7.5	10.0
2015-16	12.2	5.8	10.5	7.5	10.0
Annual Growth %	0.33	6.98	-0.91	0.00	0.41

Source: Fruit, Vegetables & Condiments Statistics of Pakistan, 2015-16, Ministry of National Food Security & Research, Islamabad

Annexure-2: Meetings made with different stakeholders of Brinjal crop

Discussion with different farmers and commission agents was made regarding the cultivation and marketing of brinjal crop. List of farmers and commission agents are given below:

Scientists/experts

1. Dr. Naveed Akhtar, Director General Agri. Research, KP
2. Dr. Javed Tareen, Director General Agri. Research, Balochistan
3. Mr. Najeebullah, Director, Vegetable Research Institute, Faisalabad
4. Dr. Manzoor Ahmad, Regional Agricultural Research Institute, Bahawalpur
5. Dr. Muhammad Azeem Tariq, Director, Barani Agricultural Research Institute, Chakwal
6. Dr. Khawar Jawad, Director, Entomological Research Institute, Faisalabad
7. Muhammad Iqbal, Director, Plant Pathology Research Institute, Faisalabad
8. Dr. Saeed Ahmad Shah, Vegetable Botanist, Vegetable Research Institute, Faisalabad
9. Mr. Sajid Ahmad, Horticulturist, Extension Wing, Lahore
10. Ch. Abdul Hameed, Director Agri. Extension, Faisalabad
11. Dr. Obaid Ur Rehman, Technical Manager, CKD, Gujranwala
12. Syed Muhammad Amaan Shah, Hyderabad
13. Director Agri. Extension, RY Khan
14. Mr. Tahir Shah, Assistant Botanist, Vegetable Research Institute, Faisalabad
15. Mr. Amir, Assistant Research Officer, Vegetable Research Institute, Faisalabad

Traders:

1. Saeed Khan Enterprises, Exporter, Real Trade Square, Sadar, Karachi
2. Sunny international, Iqbal Colony, Delazak Road, Peshawar
3. Muhammad Hussain Butt, CEO, Niima International, Fresh fruit vegetable & food stuff exporter
4. Adnan Enterprises, Importer & Exporter, New Sabzi Mandi, Super Highway, Karachi
5. Amir Hanif, President Commission Agents, Fruit & Vegetable Market, Faisalabad
6. Kenya Vegetable Seed
7. Abdul Rauf Hanjra, CEO, Hanjra Farms, Okara

Commission agents

Sr.#	Name	Address
1	Haji Muhammad Arshad & Co.	New fruit and vegetable market Sargodha
2	Malik Muhammad Asif & Co.	
3	Malik Muhammad Usman & Co.	
4	Haji Abdul RazzaK & Co.	
5	Lala Yaseen & Co.	
6	Lala Ishaq & Co.	
7	Fauji commission shop	
8	Rana commission shop	
9	Amir Hamza commission shop	
10	Haseeb commission shop	

11	Muhammad Hassan & Co.	
12	Zulfiqar commission shop	
13	M. Iqbal commission shop	
14	Mian Amir Haneef	Fruit and vegetable market Sadhar Faisalabad
15	Muhammad Azam Shah	
16	Haji Muhammad Ilyas & Co.	
17	Sayyad Muhammad Imran Shah	
18	Mr Khurram But	
19	Muhammad Yousaf Secretary Market	
20	Muhammad Saif Inspector Market	
21	Tanveer Khaliq Shami	
22	Muhammad Afzal Kamboh	
23	Zulfiqar Bhutta	

Brinjal growers

Sr. No.	Name	Address
1.	Muhammad Iftikhar	Chak No 309 GB, District T. T. Singh
2.	Sardar Ali	Chak No 308 GB T. T. Singh
3.	Rana Muhammad Ashfaq,	Shorkot road T.T. Singh
4.	Muhammad Hanif,	Peer mahal, T. T. Singh
5.	Mian Muhammad Anwar,	Phaloar Road, Chohla, T T Singh
6.	Binyameen,	Chak No. 317 GB Kheekha bangle, TTS
7.	Mian Muhammad Khalil Zia,	Chak Soondh T. T. Singh
8.	Mian Javed Riaz	Peer mahal, T. T. Singh
9.	Muhammad Zafar Ali	Chak No. 28/SB, Sargodha
10.	Muhammad Saleem	
11.	Mian Sajid Niaz	
12.	Faisalabad Sattar	
13.	Zafar Bashir	
14.	Ch. Muhammad Akram	
15.	Muhammad Afzal	
16.	Muhammad Tariq	
17.	Muhammad Muazzam	
18.	Ch. Abdul sattar	
19.	Master Yaseen	
20.	Ch. Rafaqat Ali	
21.	Ch. Abdul Sattar Gujjar	
22.	Muhammad Bashir	
23.	Nazar Muhammad	
24.	Imran Sattar	
25.	Muhammad Qasim Ali	
26.	Muhammad Tanveer	Satellite Town Sargodha
27.	Mian Saleem, Vegetable grower	Kunri, Sindh
28.	Malik Allah Baksh	Chak 173 TDA, Layyah
29.	Mian Aslam, GM	Jallandar seed Corporation, RY Khan

Annexure-3: Recommended Production Technology of Brinjal

Practices	Recommended Practices
Soil selection	Loamy soil with pH range 6.0 – 7.0
Land preparation for nursery	Well prepared raised beds (15 cm height, 1.2 m width and 3 m length)
Nursery sowing	1st Crop = Mid-February 2nd Crop = Last week of June 3rd Crop = November
Land preparation for transplanting	3 – 4 ploughings and 2 planking
Planting geometry	Bed width = 100 cm and P x P = 50 cm (on one side of the bed)
Seed rate/acre	200 g
Transplanting	1st Crop = 1st week of April 2nd Crop = Last week of July 3rd Crop = Mid-February
Irrigation	Usually after 14 – 21 days interval in winter and 5 days interval in summer or as per need
Hoeing and weeding	Manually or by mulching (use of black plastic sheet on beds)
Fertilizer application (Kg/acre)	N : P : K 50 30 25
Insects/Pests	Aphids, Jassid, Whitefly, Fruit and Shoot Borer, Army worm
Diseases	Damping off, Root Rot, Southern Blight, Colar Rot
Harvesting period	1st Crop = June - September 2nd Crop = September - December 3rd Crop = April - June

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Annexure-5: Feasibility Study for Brinjal pack house

Brinjal, aubergine, or eggplant is a plant species grown for its edible fruit. The spongy, absorbent fruit of the plant is widely used in cooking in many different cuisines and is often considered a vegetable. The issue of post-harvest handling facilities for horticultural products especially brinjal has not been attended, especially for the emerging farmers. In addition, the low prices that farmers have received from local markets have convinced most brinjal growers to bypass local markets in established national markets, where demand is almost always high and prices are therefore good. In these markets, products can be sold to domestic and foreign consumers. They cannot afford to pay exorbitant membership fees and compliance with regulations and quality standards such as ISO, Hazard and Critical Control Point (HACCP) as required by both national and international retailers. For most of the interventions initiated, the development of post-harvest handling technologies in the form of fresh product depots and fresh product packaging would reduce post-harvest losses.

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

Objective:

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

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

The diagrammatic process flow is described below;

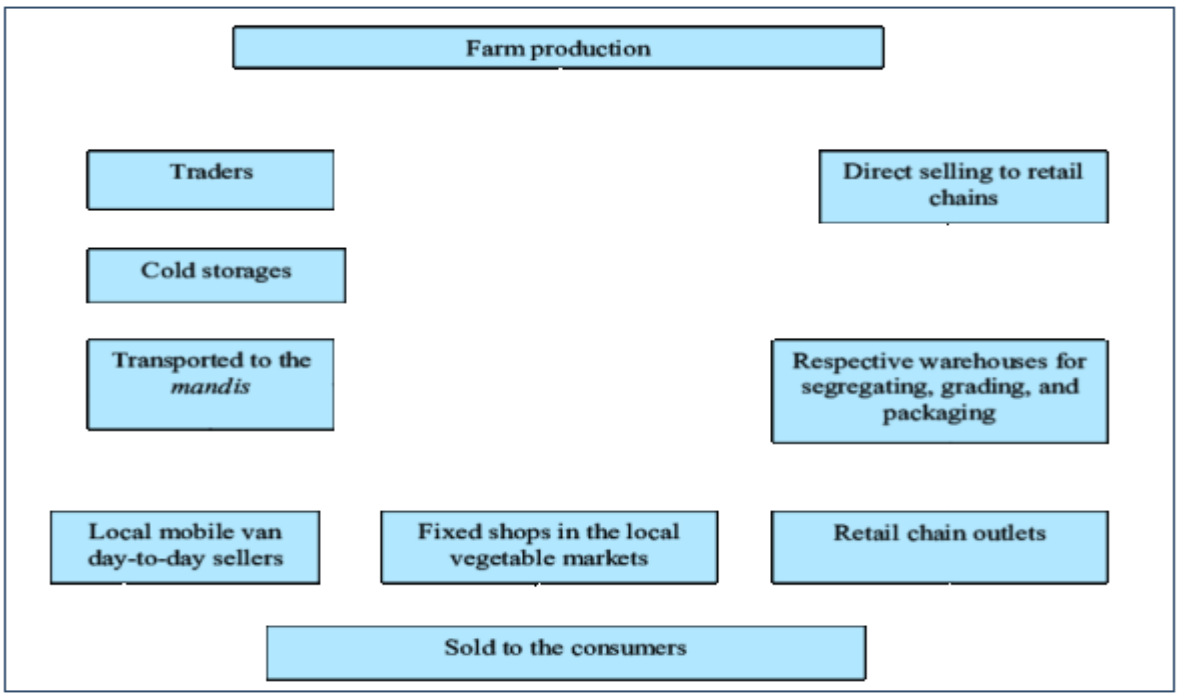

Figure 3: Process flow chart of Brinjal

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 brinjal 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 brinjal. 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 brinjal, 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 worker's 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, precooling facilities and cold storage units. The refrigeration equipment for the cold storage and chilling water for hydro-cooling often requires 3-Phase electrical power.

Step Four

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

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

Step Five

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

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

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

Figure 4: Large scale packing line

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

- A receiving area, which can include a dump tank to initially clean and cool produce.
- A washing area, which can include the dump tank and a spray washer/brusher. This can be part of a conveyor belt system that automatically moves the produce, or simply a stock tank. The water used should be chlorinated at 100 to 200 ppm (Figure 3).

Figure 5: 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 produces 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.

- Brinjal are waxed to limit water loss for the wholesale market—therefore, it needs a waxer.
- Brinjal 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, brinjal 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 brinjal.

Components of a Pack House

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

- Product arrival and pre-cleaning/sorting
- Main grading washing and packing hall
- Cold storage

Product arrival and Pre-cleaning / sorting

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

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

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

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

- Room Cooling
- Hydro-cooling
- Evaporative Cooling

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

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

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

Main grading washing and packing hall:

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

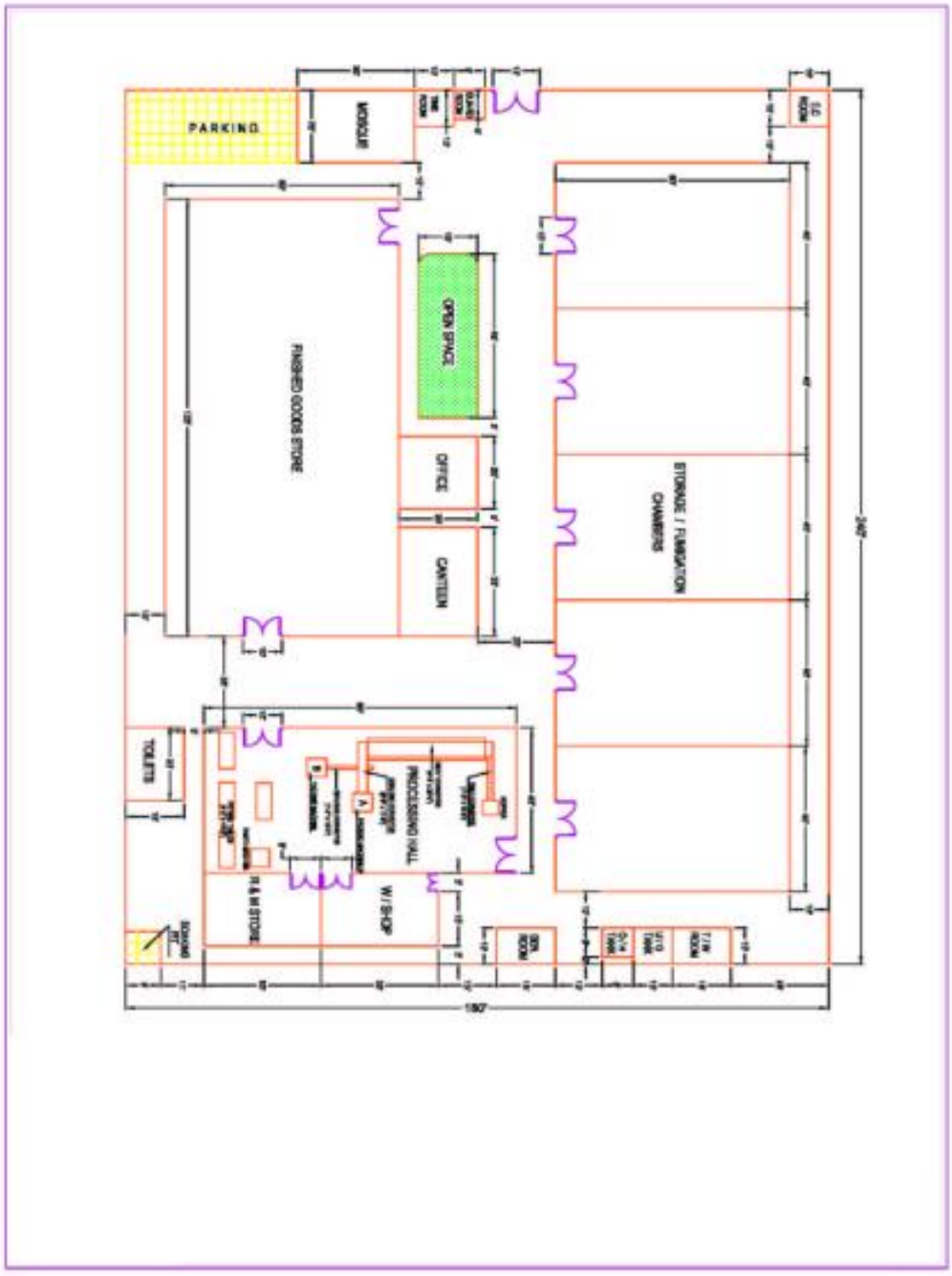

Figure 6: Map of the brinjal pack house

Machinery and Equipment:

Selection of plant and machinery is the most important decision for setting up a food processing unit. All machinery and equipment used in the processing line should have proper efficiency. All the plant and machinery should be erected in such a way that the material flow is unidirectional to avoid

cross contaminations. The machinery should not occupy more than 1/3rd of the total floor area for smooth operation of labour.

1. Chain Pulley Block

    - Capacity: 5 Ton
    - 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

14. Supper silent DEUTZ

- Solar generator (60KVA)
- Price-US$8900
- Supplier –Fujian XINHENGXIN Motor Company Limited

Table 39: Pack house project summary

Plant capacity	2 Tonnes per day; 360 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$ **39800** including installation and commissioning. The installed production capacity will be two (2) 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:

Table 40: Plant and Machinery

S. No.	Particulars	Qty.	Rate (US$)
1.	Solar generator	1	3000
2.	Chain Pulley Block	1	1000
3.	Motorized conveyor for bulk material handling	1	1000
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	1500
8.	Grading & Sorting Table	1	1500
9.	Inspection Tables	3	300
10.	Platform Type Scales (30kg)	2	800
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	900
15.	Hot Air Dryer – for Removing water applied Externally	1	4000
16.	Waxing Unit	1	2000
17.	Washer	1	4000
18.	Packaging machine, Pouch sealing machine	1	170
19.	Cold Storage	1	7000
20.	PU Building for Pack house (800 sq. ft.)	1	8000
21.	Ethylene Generator 3 nos. (Sure Ripe)	1	200
22.	Ethy-gen II Concentrate (45 cases)	1	200
23.	Gastech. Air Sampling Kit Unit 1 no. 1	1	180
24.	Ethylene Monitoring Tube - 1 Box	1	180
25.	Carbon di-oxide Monitoring Unit	1	400
26.	1 0.04 0.04 30 Additional Dryers for Removing Moisture- 1MT Per Day	1	120
27.	Pallets and Bins		1500
	Total		**39800**

Misc. Fixed Asset Costs:

Other fixed costs of US$**17680** 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 being shown in table below:

Table 41: Miscellaneous fixed asset cost

S. No.	Particulars	Qty.	Rate (US$)
1.	Office Equipment	1	1000
2.	Furniture and Fixture	1	1500
3.	Miscellaneous Accessories	1	1000
4.	Vegetable Display Crate	50	200
5.	Display Board	5	60
6.	Fire Fighting	1	70
7.	Computer with Accessories	2	600
8.	ERP System	1	10000
9.	Water Treatment Plant – 500 litres per hour	1	1000
10.	Loading Tempo	1	250
11.	Electrical Installation	1	2000
	Total		17680

Pre-Operative Expenses:

Expenses incurred prior to commencement of commercial production are covered under this head that total US$ **16421.** Pre-operative expenses include establishment cost, rent, taxes, traveling expenses and other miscellaneous expenses. It has been assumed that the funds from various sources shall be available, as required. Based on the project implementation schedule, the expected completion dates of various activities and the estimated phasing of cash requirements,

interest during construction has been computed. Other expenses, under this head have been estimated on a block basis, based on information available for similar projects.

Table 42: Pre-Operative Expenses

Sr. No.	Particular (for 1 year)	Amount (US$)
1.	Interest up to production @ 16% on term loan amount of US$ 55755 **(30% of total project cost)**	8921
2.	Electricity charges during construction period	1000
3.	Marketing Launch Expenses	1000
4.	Technology Know-how and consultancy fees	3000
5.	Training expenses	1500
6.	Travelling Expenses	1000
	Total	**16421**

Cost of raw material:

Based on a processing capacity of 2 tonnes per day considering and 180 days of working per year, the annual raw material consumption of the pack house is 360 tonnes. The cost of fresh Brinjal 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 $147/tonne. Adding US$20 per tonne transportation cost from the field to pack house, the raw material cost for pack house would be US$167.

Table 43: Cost of raw material

Particulars	Rate per tonne (US$) for the raw Brinjal at the wholesale/pack house	Qty. (Tonnes) per season	Raw material cost (US$)
Brinjal	**167**	**360**	**60120**

Land Lease Charge:

Required land is 6,000 sq. ft. which has been considered on lease @ US$200 per annum for first three years and @ US$232 for the fourth year and subsequently @5% increase every year.

Table 44: Land lease charges

S. No.	Year	Lease charges Per annum (US$)
1.	1st year	200
2.	2nd year	200
3.	3rd year	210
4.	4th year	221
5.	5th year	232
	Total	**1062**

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 gallons. Water requirements are approximately 500 gallons per day.

Table 45: Electricity and water consumption charges

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

Human Resource Cost

One 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

Table 46: Salary and wages

Sr. No.	Description	Requirement	Salary/month (US$)	Salary/annum (US$)
1.	Pack house manager	1	550	6600
2.	Accountant	1	500	6000
3.	Supervisor	1	300	3600
4.	Skilled Workers	2	500	6000
5.	Driver	1	350	4200
6.	Security Guard	1	200	2400
	Total		**2400**	**28800**

Table 47: Cost of Project

Sr. No.	Particular	Value (US$)
	Fixed costs	
1.	Plant and Machinery	39800
2.	Misc. Fixed Assets	17680
3.	Pre-operative expenses	16421
	Operating costs	
1.	Cost of raw material	60120
2.	Land lease charges	1062
3.	Electricity and water consumption	2200
4.	Salary and wages (For 180 days)	28800
5.	Margin Money for Working Capital	1500
6.	Contingencies 5% of Fixed Assets	884
	Total variable costs	**168467**

Table 48: Project income statement

Revenues	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue (US$)						
Quantity of brinjal that goes in value addition or capacity of pack house (t)		360	360	360	360	360
Price of the value added brinjal (US$/tonne)		300	300	300	300	300
Total revenues (US$)		108000	108000	108000	108000	108000

Direct variable costs							
Raw material price (US$/TONNE)			167	167	167	167	167
Raw material cost (us$)			60120	60120	60120	60120	0
Packing costs (@PKR10 per 18 kg box)			1481	1481	1481	1481	
Labour cost			38400	38400	38400	38400	
Electricity and water			2200	2200	2200	2200	
Maintenance (1% of the machinery, equipment and furniture cost)			629	629	629	629	
Land lease charges (10%) increment on annual		200	200	210	221	232	
Marketing (US$10/tonne)			3600	3600	3600	3600	
Office administration			370	370	370	370	
Total variable cost			**107168**	**107178**	**107188**	**107199**	**167**
Gross profit			**832**	**822**	**812**	**801**	**107833**
Indirect fixed cost							
Machinery		-62901					
Licensing and regulatory fee		-150	0	0	0	0	
Total		**-63051**	**0**	**0**	**0**	**0**	
Grand total cost		**-63051**	**107168**	**107178**	**107188**	**107199**	**0**
Net profit (Net cash flow)		**-63051**	**832**	**822**	**812**	**801**	**108000**
NPV	8.5%		**27437**				
IRR		**18%**					

Net Profit **= 120000**

NPV **= 27,437**

IRR **= 1%**

Project Viability:

The Internal Rate of Return of the project is estimated at **12**%, 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$ **27,437**) 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 period. This also indicates that the project is financially viable over the long term.