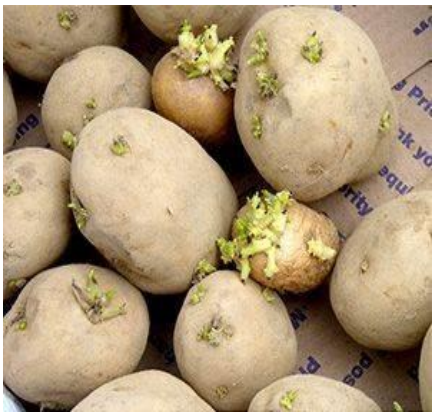
CLUSTER DEVELOPMENT BASED AGRICULTURE TRANSFORMATION PLAN VISION-2025

Potato 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 especially Mr. Yasar Saleem Khan for selecting me as commodity specialist for this task and offering outstanding cooperation, support and advice during all the stages of this project. However, the research team takes the responsibility of any shortcoming left in the report.

Dr. Khalid Farooq
Senior Author

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DISCLAIMER

This report is prepared by using the data from various published and unpublished sources and that obtained during the consultations with stakeholders.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

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ADP	Annual Development Plan
AKRSP	Aga Khan Rural Support Programme
AQSIQ	Administration of Quality Supervision, Inspection and Quarantine (of China)
CIP	International Potato Centre, Lima, Peru
CPEC	China Pakistan Economic Corridor
CO	Community Organization
FFs	Farmer Field School
FEG	Farmer Enterprise Group
GAP	Good Agriculture Practices
GB	Gilgit-Baltistan
GI	Geographical Identification
GoP	Government of Pakistan
IPPC	International Plant Protection Convention
ISPMs	International Standards for Phytosanitary Measures
ISO	International Standard Organization
KIU	Karakorum International University
Kg	Kilogram
KKH	Karakoram Highway
KP	Khyber Pakhtunkhwa
MARC	Mountain Agricultural Research Centre
MINFAL	Ministry of Food, Agriculture and Livestock
NARC	National Agricultural Research Centre
NPP	National Potato Programme
NIGAB	National Institute for Genomics and Advanced Biotechnology
NGOs	Non-Governmental Organizations
PARC	Pakistan Agricultural Research Council
PCSIR	Pakistan Council for Scientific and Industrial Research
PKR	Pakistani Rupee
PCP	Planning Commission of Pakistan
PHDEC	Pakistan Horticulture Development and Export Company
R&D	Research & Development

SWOT	Strengths, Weaknesses, Opportunities, Threats
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
US$	United States Dollar
VO	Village Organization

EXECUTIVE SUMMARY

According to the last statistical records available, the total world potato production is estimated at 388 million tonnes on an estimated area of 19 million ha with an average yield of 20 tonnes per ha. The world potato sector is undergoing major changes. Until the early 1990s, most potatoes were grown and consumed in Europe, North America and countries of the former Soviet Union. Since then, there has been a dramatic increase in potato production and demand in Asia, Africa and Latin America, where output rose from less than 30 million tonnes in the early 1960s. FAO data show that in 2005, for the first time, the developing world's potato production exceeded that of the developed world. China is now the biggest potato producer and almost a third of all potatoes are harvested in China and India.

In 1947, the potato cultivation in Pakistan was restricted to a few thousand ha and total annual output was less than 30 thousand tonnes. In the decades since independence, the potato has become the country's fastest growing staple food crop as strong gains in cultivated area and average yields have been achieved. The increase in area and yield was mainly due to better irrigation facility in Pakistan and major increase was recorded in Punjab. The agricultural statistics of 2017 shows that potato is grown on 177.8 thousand ha producing a total production of roughly 3.8 million tonnes with an average per ha yield of 22.5 which is about 12 higher than the world average. The value of the production is worth US$ 0.483 billion. The highest production of potato is in Punjab (93.6%), followed by Khyber Pakhtunkhwa (5.17%), Balochistan (1%) and Sindh (0.33%). Potato consumption in Pakistan is showing an upward trend, now annual per capita intake is over 15 kg, up from around 10 kg a decade earlier.

In Pakistan, Potato processing industry mainly comprises four segments: potato chips, french fries, potato flakes/powder and other processed products such as dehydrated chips, starch flour etc. However, potato chips continue to be the most common and popular processed product and presently constitute 85% of snack business. The utilization of raw potato by the potato processing industries has dramatically increased during 2014-17 from less than 1% to 6.3%. This major share (70%) of this is by PepsiCo Pakistan. In 2017, few new local companies also installed the processing units and their products are in the markets with the branded names of Knock out, Oye Hoye and Opa. The snacks market is estimated to be PKR30 billion/year of which branded segment is PKR20 billion/year. The snack market has grown at 25% during the last five years. For the next five years it is conservatively estimated to grow at 20%

Pakistan’s present export is about 10% of potato production in the country with the value of US$87.5 million. However, the world exports about 15% of potato production despite proximity with big markets like Middle East, China etc. However, Pakistan has not touched the flourishing international market of potato products like potato flour, chips, freezing potato etc. Tremendous potential exists if Pakistan properly incentivizes the potato processing industry in the country.

Although, Pakistan's potato yield is higher than the world average, but it is lower than the other countries like Iran, Egypt and Turkey having potato yield of around 30 tonnes per ha. Low productivity of the crop in Pakistan is due to several biotic, abiotic stresses. However, the major factor in potato poor yields is the non-availability of quality seeds at the right time and at a reasonable price. At present, less than 1-2% of quality seed is available in the country. The cost of imported seed is high at around Rs140-170 thousand per ha, whereas the certified seed production in Pakistan is limited and faces technical, economical and managerial problems. Most farmers due to shortage of funds rely on poor quality seed sources, which results poor yield especially in GB.

Potato sub-sector of the agriculture sector in Pakistan is performing relatively well, but because of the tough competition in international markets, Pakistan has to continuously analyse this sub-sector, identify constraints and gaps and suggest interventions along the value chain to further improve its competitiveness. Such interventions are considered more effective if the analysis is cluster specific because each cluster may have its own socio-economic and physical environments. The Planning Commission of Pakistan has arranged this study mainly with the aims to suggest economically viable policy, technological, and institutional interventions, estimate their feasibility, and suggest an up-gradation plan along the value chain of the potato sub-sector in each cluster to improve its competitiveness in the domestic and international market.

In Pakistan, potato is grown throughout the country, but major production (94%) is concentrated in Punjab followed by GB. Two major potato clusters in Punjab (Potato Punjab 'A' Cluster with Okara as its centre point and Potato Punjab 'B' Cluster with Chiniot as its centre point), and one cluster in GB (Potato GB Cluster with Hunza as its centre point) are identified in this study.

Several performance gaps were then identified in the production, processing and trading components of the value chain of each cluster, specifically with the technology, market structure and links. These at various levels in each cluster, includes the lack of R&D infrastructure and system to resolve the issue of stakeholders along the value chain, infrastructure and training for the supply of certified potato seed, improved value chain and its management, farmers' organization to supply potato according to the market demands, poor links with international market and less than optimal size of the processing industry.

In order to address multilevel challenges from production to product and market development, benchmarks and performance targets were set, based on global average for yield, quality and export and the interventions were designed to meet these benchmarks over the period of five years. Based on these parameters and keeping in view the gaps and constraints, specific interventions are proposed for the three potato clusters. The interventions were proposed keeping in view the cluster's salient features and weaknesses.

The proposed interventions in Potato Punjab 'A' and Punjab 'B' clusters targets at various scale, are: i) establishment of tissue culture labs and training of the staff to encourage local production of certified, disease-free and true-to-type seed, ii) training of farmers for on-farm production of improved seed which will decrease seed import, iii) provision of quality infrastructure which will enhance the quality of potato produce for export as well as in domestic market, iv) strengthening international potato links to enhance export, v) supply of

varieties for processing, vi) encouraging the potato-based processing as cottage industry in potato growing areas, and vii) promoting international links to increase export-production ratio. In GB potato cluster, however, instead of processing and potato exports, emphasis should be given on improvement in potato yield. Farmers Entrepreneur Groups (FEGs) will be organized in all the clusters and cluster infrastructure and trainings will be supplied through these groups. Moreover, these groups will ensure the quality of the produce and will be encouraged to start the contract farming with processers and exports. Special emphasis will be given on the training of farmers and other stakeholders for the production of quality potato seed and proper management of potato value chain. The impacts of these interventions are reported in the Summary Sheet given below.

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 investment cost for all cluster's Upgradation Plan is estimated to US$8.5 million.

These interventions are expected to achieve economic and social impacts, including increased productivity and production of higher quality of seed, increase in export and value addition of potato processing to generate income and employment to benefit all the stakeholders of potato clusters in Pakistan. It is estimated that the upgradation plan will increase potato production by 75.5 thousand tonnes, enhance export by 84.6 thousand tonnes worth of US$17.0 million, increase potato supplies to processing of 36.0 thousand tonnes, producing 23.2 thousand tonnes of additional french fries. This will remove the glut and stabilize the domestic market. In addition, imports of certified seed will reduce by 45% saving foreign exchange worth of US$2.59 million.

The plan will require an investment of US$8.5 million. About 50% of this investment will be provided by the government in terms of strengthening research system on potato value chain, capacity building of producers and stakeholders, importing and supplying varieties suitable for processing, subsidy on establishing tissue culture labs and setting up small-scale processing infrastructure at village level and providing interest free loans for one year. It is expected that these incentives will encourage the private sector to bring the remaining 50% investment on establishing tissue culture seed laboratories, shed houses, processing infrastructure.

The above investment, however, it will increase the operational cost of various activities along the value chain by US$38.0 million during the last year of the project. The net benefits, after deducting all the investment and operational costs, would be around US$15.1 million (undiscounted) during the last year of the project. The Net Present Value (NPV) of the Plan discounted at 8.5% per annum would be US$7.1 million generating 31% an overall IRR in the three clusters. The cluster level impacts of various interventions are produced in the Summary Sheet below.

The Up-gradation Plan has a great potential of job creation, both skilled and non-skilled, due to yield increase, establishment of tissue culture potato seed production laboratories, certified seed multiplication in the field, and increase in export, value addition, and processing activities. Each intervention will require training human resource at different

levels along with the expansion of different technical and non-technical activities and robust credit system to finance the huge additional operating costs to be incurred while implementing the Plan.

Summary Sheet of Potato cluster

Item	Punjab A	Punjab B	GB	Total
Area under cultivation in focal point (ha)	54,073	9,449	2,473	65,995
Total Production (000 tonnes)	1.270	0.202	0.035	1.507
Default yield (tonne/ha)	23.48	21.36	14.28	22.83
Area of the cluster (ha)	124167	16636	9116	149,919
Production of the cluster (000t)	2.870	0.355	0.128	3.354
Production from enhanced yield (tonne)	0	0	3712	3,712
Additional value from increased yield in (US$)			687,449	687,449
Area to be brought under the use of TC seed (ha)	2,163	756	493	3,412
Tissue culture seed to be produced with (tonne)	6,489	2,268	1,479	10,235
Increased production with use of tissue culture seed (tonne)	5,605	1,782	740	8,127
Added value with tissue culture seed (M. US$)	0.0664	0.0211	0.0137	0.1013
Acreage to be covered under rouging in year 5 (ha)	8,111	1,417	371	9,899
Total area for which rouged seed would be used (ha)	40,555	7,087	1,855	49,496
Increase in production due to use of rouged seed (tonne)	52,551	8,353	2,784	63,688
Additional value of improved seed (M. US$)	6.228	0.990	0.516	7.734
Total expected volume of potato to be exported (tonne)	72,975	23,289	-	96,264
Expected additional value of export (M. US$)	5.727	1.828	0.000	7.555
Domestic production into improved value chain (tonne)	72,975	18,631	4,436	96,042
Value due to improved VC operations (M. US$)	8.9030	2.2730	0.5412	11.7171
Additional potato production for processing (tonne)	29,078	9,244	-	38,322
Additional value to farmers in year 5 (M. US$)	0.3339	0.1061	0.00	0.4400
Quantities of Potato Chips Produced (tonne)	7,269	2,311	-	9,580
Value of Potato chips produced in year 5 (US$)	18.847	5.992	0.00	24.838
Investments (M. US$)				
Renovating the existing R&D establishment	4.000	0.500	0.050	4.550
Investment on R&D establishment	-	-	0.050	0.050
Imports and testing of processing varieties	0.800	0.134	0.009	0.943
Training and demonstration for rouging	0.203	0.035	-	0.238
Tissue culture SOPs of service providers	0.250	0.100	-	0.350
Potato growers associations and shed houses	3.000	0.250	0.100	3.350
Establishment of tissue culture labs	1.427	0.370	0.106	1.902
Renovation of existing tissue culture labs	0.019	0.012	0.015	0.046
Investment on processing	1.794	0.605	-	2.399
Improving international links	1.500	0.500	-	2.000
Training of stakeholders along the value chain	0.500	0.200	-	0.700
Interest free loan	0.389	0.118	0.014	0.521
Total Investment	**13.882**	**2.825**	**0.344**	**17.050**
Public Investment	6.661	1.210	0.113	7.984
Private Investment	6.832	1.497	0.217	8.545
Economic Analysis of all interventions (Upgradation Plan) (M. US$)				
Total production increase in 5th year (tonne)	58,156	10,135	7,236	75,527
Gross revenue (undiscounted) in 5th year	40.105	11.210	1.758	53.073
Additional operation costs in 5th year	27.261	9.321	1.394	37.975
Net cash flow (undiscounted) in 5th year	12.845	1.889	0.364	15.098
NPV	6.928	0.314	0.269	7.512
IRR	36%	15%	53%	33%

1. INTRODUCTION

The potato (*Solanum tuberosum*) belongs to the *solanaceae* family of flowering plants. It originated and was first domesticated in the Andes Mountains of South America. The potato is the world's most important root and tuber crop worldwide. It is grown in more than 125 countries and consumed almost daily by more than a billion people. Millions of people in developing countries depend on potatoes for their survival. Potato cultivation is expanding strongly in the developing world, where potato's ease of cultivation and nutritive content has made it a valuable food security and cash crop for millions of farmers. Developing countries are now the world's biggest producers – and exporter and importers – of potatoes and potato value added products.

Once harvested, potatoes can be used for a variety of purposes: as a fresh vegetable for cooking at home, as raw material for processing into food products, food ingredients, starch and alcohol, as feed for animals, and as seed tubers for growing the next season's crop. Potato produces more food per unit of water than any other major crop. Freshly harvested potato tubers contain about 79-84% moisture contents and 16-21% dry matter. The total dry matter about 60-80% is starch in the form of amylose and amylopectin. Its nutritional value can be revealed by the presence of vitamins (B1, B2 and B6), minerals (potassium, phosphorus and magnesium), pantothenic acid and riboflavin. In addition, the research activities have explored its medicinal value, the presence of soluble and insoluble fibers help in preventing constipation, protect from colon cancer and decrease absorption of dietary cholesterol which leads to lower plasma LDL cholesterol. Recent studies suggest that flavonoids, antioxidants and querceton present in potato tubers have anticancer and cardio-protective properties and also protect our human body from infectious agents and scavenge harmful, pro-inflammatory free radicals. Starch from potato tubers is extensively used in paper, wood, textile and pharmaceutical industry where it is used as binder, texture, adhesive and filler agent. Oil drilling firms make use of potato starch for washing the boreholes. Tubers may contain toxic alkaloids as solanine and chaconne. Formation of solanine in tubers is indicated by greenish discoloration with sprouts on potato skin.

1.1 Global Context

Potato can grow in almost any climate, from sea level to about 4,000 meters above sea level. There are 5,000 different varieties of potato in international center for potato (CIP)'s gene bank; half of them are from Peru. Potato is grown in over 100 countries across the world.

Globally potatoes are cultivated on 19.3 million ha supplying 388.2 million tonnes of potato with an average yield of 20.1 tonnes per ha. The per ha yield in Pakistan is about 12% higher than the world average. The farmgate prices of potato is lower in Pakistan compared to the world average suggesting that Pakistan is competitive in potato production at the farm level. However, Pakistani potato receive much lower prices in the international market than the world average export prices. Although, potato is not a staple food in Pakistan, it exports 10% of its production compared to the 15% of the world average export-production ratio. The potato trade in international market is worth of US$3.6 billion during 2016 (Table 1).

Table 1: Global vs Pakistan's potato production and trade during 2016

Parameter	World	Pakistan	Share (%)
Area (000 ha)	19302	184.0	0.95
Production (000)	388191	4142.4	1.07
Value of production (Million US$)	92741	887.4844	0.96
Yield (ton/ha)	20.11	22.52	111.97
Farm gate price (US$/tonne)	239	114	49
Quantity of international trade (000 ton)	11941	397.2	3.3
Value of international trade (Million US$)	3808	78.187	2.05
Export quantity as % of production	3%	10%	-
Export value as % of production value	4%	9%	-
Average export prices (US$/tonne)	319	197	61.72

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 global potato production has grown steadily from 305 million metric tonnes in 2001 to 374.2 million metric tonnes in 2016 with an average growth rate of 1.7% per annum (Table 2) which is much higher than the world increase in population at 1.19% suggesting that the per capita consumption of potato is increasing overtime. Most of the increase in production at global level came from per ha yield improvement while area under potato remained almost stagnant during this period.

Table 2: Trend in international potato production during 2001-16

Year	World potato Production		
	Area (000 ha)	Production (000 tonnes)	Yield (ton/ha)
2001	19438	305491	16
2002	18817	309798	16
2003	18702	307592	16
2004	18742	328179	18
2005	18753	317671	17
2006	17800	297112	17
2007	18077	314208	17
2008	18307	329395	18
2009	18813	334136	18
2010	18691	332594	18
2011	19315	373633	19
2012	19406	368345	19
2013	19293	374070	19
2014	18879	380265	20
2015	18914	376577	20
2016	19077	374252	20
Annual growth (%)	0.1	1.7	1.5

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

The increase in trade in potato based products is more spectacular. While the trade (i.e., export) of fresh potato quantities increased at the rate of 3.0% per annum, the frozen potato increased at a rate of 4.9% during 2001-16. The value of frozen potato traded has increased at even more faster rate of 7.8% per annum during this period. The quantity and value of potato flour increased at 5.1% and 7.5% per annum during the period. The export values of potato flour almost doubled during the period (Table 3).

Table 3: Trend in international trade of fresh potato, frozen potato and potato flour during 2001-16.

Year	World fresh potato		World frozen potato		World potato flour	
	Quantities	Values	Quantities	Values	Quantities	Values
	(000 ton)	Million US$	(000 ton)	Million US$	(000 ton)	Million US$
2001	8062	1424	3473	2042	226	192
2002	8103	1619	3670	2248	243	223
2003	9103	1856	3938	2640	274	276
2004	9060	2212	4260	3180	274	283
2005	8931	1879	4380	3123	309	310
2006	9750	2708	4673	3603	334	353
2007	10407	3408	5001	4686	376	504
2008	10284	3417	5131	4830	342	489
2009	10217	3059	5337	4868	343	467
2010	11368	3621	5830	5012	369	454
2011	12259	4551	6108	5855	416	564
2012	11105	3426	6300	5753	437	575
2013	12218	4593	6323	6441	417	573
2014	11799	4059	6527	6449	497	676
2015	11416	3407	6920	5940	508	593
2016	11941	3808	7352	6561	486	561
Growth rate %	**3.0**	**7.0**	**4.9**	**7.8**	**5.1**	**7.5**

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

More than a billion people worldwide eat potato. In fact, less than 50% of potatoes grown worldwide are consumed fresh. The rest are processed into potato food products & food ingredients, fed to animals and chickens, processed into starch for industrial use, and re-used as seed tubers for growing the next season's potato crop.

Potato is becoming increasingly an international commodity as its export is increasing at a much higher rate than increase in potato production. Globally, its export has reached at 11.9 million tonnes earning US$3.8 billion. The export of raw potato from Pakistan is increasing even at much higher rate of 18% and earned about US$122 million in 2016 (Table2), while the value of shipments for prepared or preserved potatoes including frozen French fries represents an additional $8.5 billion. Overall, the value of raw potatoes exports increased in

value by an average 7.0% since 2001. Total prepared or preserved potatoes shipments depreciated by 9.9% over the 2012-17 period.

The world potato sector is undergoing major changes. Until the early 1990s, most potatoes were grown and consumed in Europe, North America and countries of the former Soviet Union. Since then, there has been a dramatic increase in potato production and demand in Asia, Africa and Latin America, where output rose from less than 30 million tonnes in the early 1960s to more than 165 million tonnes in 2007. China is the largest producer of potato in the world with a production of 99.1 million metric tonnes of potatoes in 2016, accounting for 26.3% of the world's potato supply. Top 25 potato producing countries are given in (Table- 4).

Table 4: Production (2016) and consumption (2011) of potato in major Potato Producing Countries of the world.

Rank	Country	Area (000 Ha)	Production (000 Tones)	Yields (tonne/ha)	Consumption (kg/capita/year)
1	China	5815.1	99122.4	17.05	84.62
2	India	2130.0	43770.0	20.55	23.27
3	Russian Federation	2030.9	31107.8	15.32	111.45
4	Ukraine	1311.6	21750.3	16.58	139.76
2	United States	407.8	19991.0	49.02	55.62
6	Germany	242.5	10772.1	44.42	70.70
7	Bangladesh	475.7	9474.1	19.92	45.91
8	Poland	311.6	8872.4	28.47	114.72
9	France	175.2	6834.7	39.01	54.54
10	Netherlands	155.6	6534.3	42.00	93.89
11	Belarus	292.4	5985.8	20.47	185.23
12	United Kingdom	186.9	5373.0	28.75	100.84
13	Iran	161.8	5164.9	31.93	60.97
14	Egypt	184.6	5029.0	27.24	34.62
15	Algeria	156.2	4782.7	30.62	64.52
16	Turkey	144.7	4750.0	29.36	51.91
17	Peru	310.7	4400.3	14.16	81.08
18	Canada	138.2	4324.1	31.29	78.37
19	**Pakistan**	178.2	4000.4	**22.45**	**14.36**
20	Brazil	129.8	3851.4	29.66	19.22
21	Kazakhstan	186.2	3545.7	19.04	108.21

Source: FAOSTAT, Balance Sheet, Food Supply - Crops Primary Equivalent; http://www.fao.org/faostat/en/#data/CC (Go to Food Supply Quantity (Kg/capita/year)

The global potato consumption is changing from fresh potatoes to processed potatoes or better potatoes with an extra added value and other value-added forms such as super-washed and micro-wave ready. The most important processed potato product is French fries, which has a consumption of approximately 7 million metric tonnes in a year. Crisp potato is another category which is one of the most consumed products after French fries in most of the developing countries.

France, Germany, and Netherland are the major potato exporting countries of the world. Pakistan is at 9th position in the world potato exporting countries. However, as noted earlier,

Pakistan earns much lower prices than the world average export price, therefore its ranking in earning foreign exchange from potato export is much lower (Table 5)

Table 5: Major potato exporting countries of the world 2016

Rank	Country	Quantity (000 tonnes)	Country	Value (Million US$)
1	France	1847	Netherlands	677
2	Germany	1841	France	599
3	Netherlands	1626	Germany	357
4	Belgium	974	Canada	228
5	Canada	542	China	226
6	USA	489	Belgium	210
7	China, mainland	410	USA	204
8	Egypt	408	Egypt	155
9	Pakistan	397	United Kingdom	138
10	Belarus	297	Spain	136

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

The major potato markets for potato imports are Belgium, Netherland, Spain, Germany (Table 6) who are also high-end markets because they offer the highest prices for imported potato. It is worth noting that these countries are also major importer of potatoes because of different industries in these countries consume different types and quality of potatoes which, despite being major potato producers, may not be available within the country.

Table 6: Major potato importing countries of the world 2016.

Rank	Country	Quantity (000 tonnes)	Country	Value (Million US$)
1	Belgium	2001	Belgium	463
2	Netherlands	1476	Germany	276
3	Spain	729	Netherlands	257
4	Italy	638	Spain	253
5	Germany	603	USA	218
6	USA	496	Italy	205
7	Portugal	442	France	127
8	France	438	Portugal	122
9	Russia	285	Russia	108
10	UAE	261	Egypt	103

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

Potato consumption in Pakistan is showing an upward trend. Now per capita intake is over 15 kg, up from around 10 kg a decade earlier. The potato production is mainly for urban markets rather than household consumption, and the potato has become a significant source of rural income.

1.2 Potato in Pakistan

In Pakistan, at the time of independence the total area under potato cultivation was restricted to a few thousand ha and total annual output was less than 30000 tones. In the decades since independence, the potato has become the country's fastest growing food crop and resulted strong gains in cultivated area and average yields. During 2017-18, potato is grown on 176 thousand ha with a total production of roughly 4.0 million tonnes (Table-6). The highest production of potato is in Punjab, followed by Khyber Pakhtunkhwa, Balochistan and Sindh. The recent large increase in acreage in Punjab is reached by an intensification of the cultivation in existing potato growing areas, as well as by introduction of the crop in new areas.

Potato production in Pakistan has increased with an annual rate of 6.4% per annum during 2001-17 which was largely contributed by the expansion in area at the rate of 4.2%, while yield also increased at a reasonable rate of 2.2% per annum (Table 7). The increase in potato area and production was highest in Punjab followed by Sindh while both area and production has declined in KP and Baluchistan. The area decline in Balochistan was more serious mainly because of the shortage of water induced by the climate change in the province. Potato per capita consumption in Pakistan is showing an upward trend with increasing per capita intake.

Table 7: Province wise area production of potato from 2001-2016.

Year	Punjab		Sindh		KP		Baluchistan		Pakistan	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
	(000 ha)	(000 t)	(000 ha)	(000 t)	(000 ha)	(000 t)	(000 ha)	(000 t)	(000 ha)	(000 t)
2001-02	87.1	1479	0.8	7.5	9.5	119	4.1	60	101.5	1667
2002-03	91.7	1549	0.4	3	9.4	116	3.7	54.3	105.2	1722
2003-04	102.2	1762	0.3	2.5	10	134	3.3	48.3	115.8	1946
2004-05	97.1	1775	0.4	2.9	9.4	119	2.8	41	109.7	1938
2005-06	98.8	1850	0.3	2.5	9.6	125	3.3	47.5	112	2025
2006-07	104.5	1390	0.3	2.6	9.8	134	2.8	41.5	117	1567
2007-08	120.7	2407	0.3	2.7	9.6	130	2.8	41.8	133	2582
2008-09	142	2387	0.3	2.6	8.9	117	3.1	31.7	154	2539
2009-10	133.2	2783	0.4	3	9.1	121	2.3	34.6	145	2941
2010-11	127.2	2990	0.4	3.3	8.7	/113	2.2	33.5	138	3141
2011-12	148.1	3340	0.4	3.9	8.9	118	2	29.7	159	3491
2012-13	173.7	3235	0.5	4.4	8.6	120	2.2	32	185	3393
2013-14	162.6	2743	0.5	4.3	9.1	126	2.2	33	174	2906
2014-15	159.4	3839	0.5	4.4	8.7	123	2	30	170	3996
2015-16	165.5	3811	0.6	4.7	8.6	124	2	30	176	3969
2016-17	166.4	3660	0.6	5.6	9.2	143	1.5	22.4	178	3832
Annual growth (%)	**5.1**	**7.2**	**1.6**	**1.9**	**-0.9**	**-0.1**	**-5**	**-4.8**	**4.2**	**6.4**

Source: MNFS&R (2018)

In Pakistan, Potato processing industry mainly comprises four segments: Potato chips, French fries, Potato flakes/powder and other processed products such as dehydrated chips, Starch, Flour etc. (Figure-1). However, potato chips still continue to be the most common and popular processed product and presently constitute 85% of snack business. The utilization of raw material by the potato processing industries in Pakistan during 2014 was about 40 thousand tones which are hardly 1% of the total Potato production. During 2017, about 214 thousand tonnes of potatoes were processed by processing industries which is about 6.3% of total produce and out of which the major share (70%) is of PepsiCo Pakistan. In 2017 few new local companies also installed the processing units and their products are in the markets with the branded names Knock Out, Oye Hoye and Opa (Table-7) The snacks market is estimated to be Rs 30 bn/year of which branded segment is Rs 20 bn/year. The snack market has grown at 25% during the last five years. For the next five years it is conservatively estimated to grow at 20% per annum (http://www.amis.pk/files/PrefeasibilityStudies/SMEDA%20Potato%20Chips%20Manufacturing%20Unit.pdf).

Figure 1. Potato value addition and products

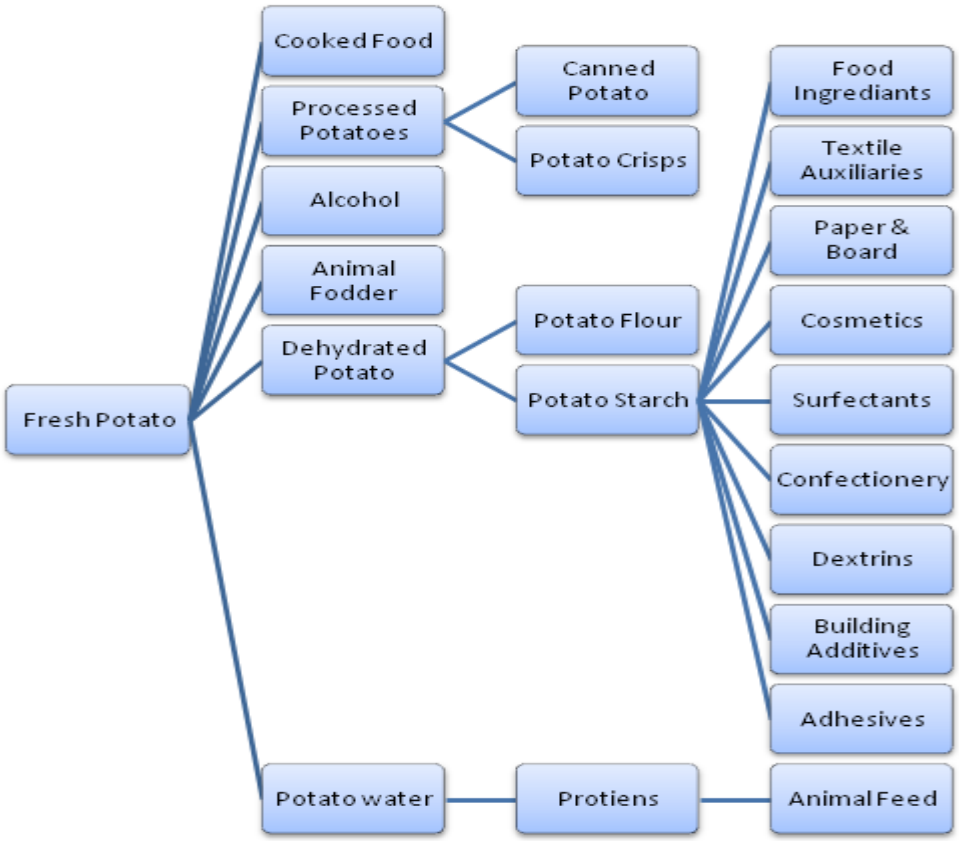


Table 8: Status of Potato used by processing industry in Pakistan during 2017.

Sr. No.	Name of companies	Brand name	Fresh potatoes used for processing (Tonnes)	Share in processing
1	PEPSI (Fritolay)	**Lays**	150000	70.1
2	Dalda Snacks	**Knock Out**	3000	1.4
3	SnackCity	**Kurleez,**	20000	9.3
4	United Snacks	**Oye Hoye**	10000	4.7
5	Tripple Im	**Supper Crips**	5000	2.3
6	Lotte Kolson	**Potato Sticks**	3000	1.4
7	Fuji Fresh & Freeze	**Opa**	3000	1.4
	Others		20000	9.3
	Total fresh potato used by processors		**214000**	

Source: information collected by visit and telephonically.

Surplus potato produced locally is exported to UAE, Malaysia, Afghanistan, Sri Lanka, Indonesia, Qatar Kuwait and Saudi Arabia. In 2017-18, 570 thousand tones potato was exported to above mentioned countries which earned about Rs.11.8 billion revenues. Pakistan export of potato increased from 272.8 thousand tonnes in 2011-12 showing an average growth rate of about 11% (Table 9 and Figure 1). However, the increase in the earning from potato export is at a much lower rate showing declining potato export prices for Pakistani potato suggesting increasing problems in the value chain of potato. Russia is another big market where demand of Pakistani potato is on rise. Export of potato from India has always been an active player in the potato export and expanding both production and export of potato internationally and regionally. The situation is thought-provoking for Pakistan, particularly.

Table 9: Export of Fresh potatoes from Pakistan during 2011-17.

Years	Quantity (thousand Tonnes)	Export value (Rs. Billion)
2011-12	272.8	6.79
2012-13	456.2	12.29
2013-14	254.8	7.99
2014-15	347.4	10.30
2015-16	402.4	8.42
2016-17	417.4	8.61
2017-18	570.3	11.81
Growth rate (%)	8.5	3.5

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

Potato is one of the principal cash crops of Pakistani farmers and the primary exportable horticulture commodities from the country. It is the fourth most significant crop in term of bulk of production. Pakistan has become self-sufficient in potato production for its domestic use and seed development. More than 95% seed supply for potato cultivation is informal. Punjab produces almost 93% of the potato crop. The acreage of Potato is increasing every year with hope of better exports and profitable returns. Enhancement in the production of potato is just due to the application of modern technologies and utilization of quality seed and new potato varieties to meet the processing and export demand.

Pakistan potato export is only in fresh use, therefore, gets a very low price. Normally world export those potatoes which are used for French fries and processing industries. This produces low prices for Pakistani potato. This suggests interventions are required in potato production in Pakistan to introduce high quality potato varieties demanded internationally which will improve the quality to meet the international standards. This can further boost potato production in the country.

A critical constraint to meet increasing demand and population growth is the non-availability of high-quality seed, from adapted varieties with acceptable levels of resistance to pest and diseases. The cost of high-quality seed is about 35-50% of the total cost of production in Pakistan. Certified seed production is limited and faces technical, economical and managerial problems. Most farmers rely on seed sources of doubtful phytosanitary conditions or produce their own seed for which they mostly do not have the proper skills and technical knowledge. Due to lack of technical skills of producing good quality seed, import of potato seed has dramatically increased during 2001-16 (Table -10). Despite this, however, data available until 2017 indicates that the amount of local domestically produced and imported certified potato seed used never exceeded 3.0% of the total seed requirements in the country.

Table 10: Import of potato seed from 2001-2017.

Year	Quantity (Tones)	Value (Million US$)
2000-1	986.1	0.55
2001-2	3776	2.07
2002-3	4210	2.316
2003-4	805	0.452
2004-5	5027	2.837
2005-6	6511	3.807
2006-7	6885	5.058
2007-8	4870	3.668
2008-9	5151	3.850
2009-10	5151	3.850
2010-11	7536	6.412
2011-12	6717	5.10
2012-13	4898	2.39
2013-14	6557	5.40

2014-15	7479	4.625
2015-16	13791	9.54
2016-17	6727	4.90
Growth rate (%)	9.4	11.1

Source: Factsheet potatoes Primeur September 2015; fruitvegfacts@gmail.com
Seed import information was also collected from FSC&RD and seed import companies

Although potato as a sub-sector of agriculture in Pakistan is performing relatively well, however, the country has never touched the booming potential of frozen potato, flour of potato, and French fries in international market. Because of the changing nature and tough competition in international market, Pakistan has to continuously analyze the performance of this sub-sector, identify constraints and gaps and suggest interventions along the value chain to further improve its competitiveness. Such interventions can be more effective if the analysis is cluster specific because each cluster may have its own socioeconomic and physical environments. Therefore, Planning Commission of Pakistan has initiated this study with the aims to suggest cluster-based economically viable policy, technological, and institutional interventions along the value chain of the potato sub-sector to improve its competitiveness in the domestic and international market.

2. GOAL AND PURPOSE

The overall goal of this study is to contribute to the cluster Development Based Agriculture Transformation Plan – V2025.

The specific Objective of the study is:

1. To identify the major cluster of potato production in Pakistan
2. To conduct a detail diagnosis and SWOT of Potato value chain in each Cluster
3. To identify technological, institutional, infrastructure and policy gap in each cluster
4. To assess the potential of potato production in each cluster
5. To suggest technological, institutional and policy intervention to achieve the cluster potential
6. To develop a frame work and feasibility of the suggested intervention

3. METHODOLOGY

The data and information related to the characteristics of different potato clusters, description of their value chain including seed supply, marketing, and processing, identifying their gaps and potentials, to suggest intervention to meet the gap and estimate the feasibility of these interventions in potato clusters were collected from the following sources:

- **Macro Data**: Relevant macro-data were collected from various published and unpublished reports of Government and non-Government organizations, research papers and internet information research, news, proceeding and reports on potato crop. See Annex-1 for the sources of data used in this study.
- **Stakeholder's consultations**: Primary information was collected through meetings, consultations, interviews, surveys, and focal group discussions using structural tools and open-end questionnaires. In some cases, telephonic calls, emails were also used to collect field information. See Annex-2 for the stakeholders consulted during the field work.
- Literature Review: literatures related to the functioning, gap and interventions in potato value chain is reviewed and synthesized. See Annex-3 for the literature reviewed in this study.

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

- Global Context of potato sector;
- Production potential and review of potato sector;
- Cost of production harvesting, processing of potato from the growers and grower's association, growers' groups
- Marketing, trading and processing from farmers, traders, wholesalers, retailers and processors
- Issue and constraints related production, input use, harvesting, temporary storage, cold storage, fresh marketing, stored potato, marketing, transportation, post-harvest losses and processing from all stockholders;
- Recommendations and benchmarks based on global parameters:

The author then used these data to first identify the potato cluster in the country and then used his subjective judgment in prescribing the characteristics of each cluster, identifying the cluster strengths, weaknesses, opportunities, and threats (SWOT), investigating the functioning of existing value chain, and quantifying the cluster potentials. The Potato Transformation Plan is also formulated which identifies sustainable cluster upgrading strategies for the development of the potato sector that can help create significant economic opportunities for producers, processors and all the stakeholders participating at different points of the value chain. Internal Rate of Return and Net Present Value of the whole package using the Model developed by CABI specifically for this purpose. A separate rate of return and business model is suggested for the key product, which is the major intervention in each cluster.

4. LITERATURE REVIEW

Potato (*Solanum tuberosum* L.) is one of the most widely produced and consumed tuberous crops in the world. The potato was originally believed to have been domesticated in Peru (South America), from where it was introduced to the rest of the world by war expeditions, shipment, and transportation (Spooner et al., 2005). Although the potato cultivated worldwide belongs to just one botanical species, *S. tuberosum*, the tubers come in thousands of varieties with great differences in size, shape, colour, texture, cooking characteristics and taste. Presently, more than 5000 potato varieties are grown in world; most of them are grown in South America (Zaheer and Akhtar, 2016). Potato crop has better nutrients, potentials for diverse uses (both in raw and processed) form and easy availability to low-income consumers. It is a rich source of water, carbohydrates, vitamins, minerals, proteins, and fats, which accounts for 75 Calories 100^{-1} g of baked potato (Zaheer and Akhtar, 2016). Potato is ranked as the third in produced and in consumption after Wheat rice and wheat and almost a billion people throughout the world consume it in different forms (Anwar et al., 2015). Potato production in the developing countries in Asia now accounts for a greater share of global output than all the industrialized countries combined (Scott and Suarez, 2012). The total world potato production is estimated at 376,827,000 tonnes in 2016 (Source: FAOSTAT, 2018). Until the early 1990s, most potatoes were grown and consumed in Europe, North America and countries of the former Soviet Union. Since then, there has been a dramatic increase in potato production and demand in Asia, Africa and Latin America, where output rose from less than 30 million tonnes in the early 1960s to more than 165 million tonnes in 2007. China is now the biggest potato producer, and almost a third of all potatoes is harvested in China and India (Source: FAOSTAT, 2018).

In Pakistan, potatoes are used largely as a staple food in many parts and serve as a domestic vegetable alone and in combination with many foods available throughout the year (Malik, 1995). A significant portion of potato is also used in processed products such as finger chips, fry chips, and salad. Generally, three crops of potato namely spring, summer and autumn are grown in different agro-ecological conditions of Pakistan ranging from plains to hilly areas (Khan and Akhtar, 2006). Potato cultivation requires fewer growing days relatively shorter than other major crops (less than 90 days) which makes it an ideal crop for farmers and well fit in cropping pattern (Zanoni, 1991). Along besides the availability of suitable environment, potato yields in Pakistan are less than to other developing countries (Source: FAOSTAT, 2017). There are several biotic and abiotic stresses which limit potato productivity ubder the climatic change scenario (Dahal et. al., 2019). High temperature at autumn planting and low temperature stress in December, drought, salinity, soil problems, improper use of fertilizers and lack of availability of quality irrigation water are some of the prevailing abiotic problems in Pakistan which affect negatively potato productivity (Malik, 1995). Likewise, low yielding varieties, different fungal, nematode, bacterial and viral diseases are biological constraints which have a drastic impact on the growth and production of potato (Majeed *et al*., 2017a). Levy et al. (2013) indicated that drought in tropical regions is the most limiting factor in potato poor yield. Drought, indeed, is escalated by fluctuation in rainfall and high temperature, which result in further evaporation and reduced availability of water to potato and other crops (Obidiegwu et al., 2015). Rai et al. (2011) suggested that salinity caused physiological abnormalities in potato consequently resulting in reduced

growth and yield. The productivity of the crop is severely affected by salinity in semi-arid regions (Katerji et al., 2003). Changing climate in various parts of the world and problems related to soils such as nutrient deficiency, particularly Nitrogen are also important abiotic factors which have a correlation with low yield and poor development of the potato crop (Hijmans, 2003; Khan et al., 2014). Among biotic constraints, viral diseases such as potato leaf roll virus (PLRV), potato virus X and Y (Solomon-Blackburn and Barker, 2001); fungal diseases like late blight and early blight, black scurf, dry rot, Fusarium wilt, powdery scab (Arora and Khurana, 2004; Sliwka et al., 2006) and bacterial disease such as common scab, soft rot, bacterial wilt, ring rot and brown rot (Czajkowski et al., 2011; Stead, 1999) have been widely reported for lower production of potato. In the plains, fungal & bacterial diseases are normally occurred in potato fields during the winter season if there is frequent humidity. On the other hand, early blight pathogen (*R. solani*) finds relatively warmer conditions (temperature range between 25 and 30°C) suitable for its growth and infection capacity and alternating period of dry and moisture help in accelerated disease progress (Kemmitt, 2002.) Late blight of potato, black scurf, and powdery scab have a general occurrence in moist conditions and low temperature (11-25°C); thus, these diseases are common in hilly areas and regions of Pakistan, which are characterized by low temperature coupled with heavy rainfall or high humidity (above80%) such as Kaghan, Naran, Swat, Kohistan and most of the northern areas. Unlike late blight and pathogens proffering low temperature, early blight disease may have an equal incidence in plains and hilly temperate regions of Pakistan. *Fusarium* wilt and dry rot of potato are less common in the plains, but prevails in northern Pakistan (Bhutta, 2008).

Several bacterial diseases also common in potato growing causing low production & main hindrance to export, poor growth of potato in the country. These diseases like common scab (*Streptomyces scabies*), bacterial wilt (*Ralstonia solanacearum*), blackleg and soft rot (*Erwinia carotovora*) are most commonly reported which have devastating effects on growth, production and post-harvest quality of potato (Ali et al., 2012; Anwar et al., 2013). Bacterial diseases of potato are prevailing in the hills as well as in the plains and their impact on crop productivity is variable in different potato growing zones. Sarwar et al., (2017) reported the wide prevalence of common scab of potato caused by *Streptomyces scabies* from different parts of Punjab province. Hussain et al., (2017) noted that black scurf of potato was a leading bacterial constraint in potato production in Gilgit Baltistan. Like other biotic constraints, different viral diseases caused potato leaf-roll virus (PLRV), potato virus S (PVS), potato virus M (PVM), potato virus X (PVX) and potato virus Y (PVY) are considered as potential threats to potato crop throughout the country (Ahmad et al., 2011; Abbas et al., 2012). The incidence of one or many of these viral diseases in potato fields in Pakistan is not persistent relevant to geographic regions where potato is cultivated. Hameed et al., (2014) argued that most frequently reported viral diseases of potato from different potato zones of Pakistan are PLRV, PVX and PVY while PVS and PVM are less common in the country. Naveed et al., (2017) stated that there are several PVY strains which account for more than 70% yield loss of the crop in Pakistan and throughout the world. More recently, Hameed et al., (2017) reported 5-10% incidence of leaf curl virus from several potato growing regions of Punjab indicating a potential limiting factor in the crop productivity. Moreover, actual yield losses of potato associated with viral diseases in Pakistan have not been documented so far from authentic sources; nevertheless, different published reports estimate it in the range of 40-83 % (Ahmad et al., 2011; Hameed et al., 2014). These constraints are likely prevailing in

Pakistan. Moreover, production losses of the crop elevate significantly due to poor management strategies during postharvest storage. This report focuses on the factors relevant to low productivity and potential management strategies necessary for the rise of potato production in Pakistan.

5. CLUSTER IDENTIFICATION AND CARACTERISTICS

5.1. Identification of Cluster

Following three clusters are identified for detail analysis in this study.

5.1.1. Potato Punjab A Cluster

This cluster is consisted of seven districts of Kasur, Okara, Sahiwal, Pakpattan, Multan, Khanewal and Vehari which contribute about 70% of Potato produced in Pakistan. The focal point of this cluster, Okara district, has highest share in potato production in the province (Table 11).

Table 11: Potato Punjab A Cluster, 2016-17.

Districts	Production (tonnes)	% Share in cluster production	Area (Ha)	% Share in cluster area	Yield (tonne/ha)
Sahiwal	522699	18	25029	20	20.9
Kasur	429179	15	19341	15	22.2
Okara	1269735	44	54077	42	23.5
Khanewal	156776	5	6885	5	22.8
Pakpattan	417546	14	18640	15	22.4
Vehari	51639	2	2497	2	20.7
Multan	47214	2	1637	1	28.8
Total	**2894788**	**100**	**128106**	**100**	

The main products of the cluster are**:**

- Table potato production for domestic use as fresh
- Table potato production to store in cold storages for domestic uses
- Potatoes supply to processing industries
- Potatoes supply to export
- Informal potato seed supply to other potato growing areas of Pakistan

The processing industries and exporter's ware houses are already exist in this cluster. This cluster can be developed for:

- Supply of quality seed, ccertified imported seed is being used by the most farmers and being sold as informal seed to the other potato growing areas of Pakistan.

- Contract potato farming for fresh potato supply to processing industries. Processing industries are used to supply quality seed (imported certified or locally basic seed multiplied on actual rates)

- Potato production for local as well as for export
- 70-80% informal seed supply to Balochistan**,** Khyber Pakhtunkhwa, Balochistan and Gilgit-Baltistan are from this cluster.

This Cluster has following characteristics:

- Most farmers have better quality seed for planting
- Mostly farm operations are mechanized
- Cold store facility is abundantly available in potato cultivated areas
- Being large and educated growers have better knowledge of crop management and input uses
- Loan facility is also available from bank and commission agents
-

5.1.2. Potato Punjab B Cluster:

It is second important cluster of potato production, consisting of 4 districts (Chiniot, Jhang, Toba Tek Sing and Faisalabad) and contribute about 9.4% of Potato produced in Pakistan. The cluster focal point, Chiniot district, has highest share in potato production in the province (Table 12).

Table 12: Potato Punjab B cluster, 2016-17.

Districts	Production (tonnes)	% Share in cluster production	Area (Ha)	% Share in cluster area	Yield (tonne/ha)
Chiniot	196512	55	9449	56	20.8
Jhang	33042	9	1146	7	28.8
T.T. Singh	105913	30	4911	29	21.6
Faisalabad	21873	6	1259	8	17.4
Total	**357340**	**100**	**16765**	**100**	

The main Products of the cluster are:

- Table potato production for domestic use as fresh
- Table potato production to store in cold storages for domestic uses
- Potatoes supply to Processing industries
- Potatoes supply to export
- Informal Potato seed supply to other potato growing areas of Pakistan

This cluster can be developed for:

- Supply of potato for export as well as for processing industry

- Early fresh table potato supply in December to big markets to fetch higher prices
- The average yields are comparable to Potato Punjab A Cluster.
- In this cluster small medium and large farmers are producing potatoes
- Small farmers normally supply potatoes in local markets as fresh produce
- Medium and large growers usually supply potatoes to processing industry, exporter and informal seed supply to local as well as to summer crop.

5.1.3. Potato GB Cluster

The whole area of GB is suitable for potato cultivation while currently main potato growing areas are: **Four** districts of Baltistan region comprising of Skardu, Shigar, Kharmang, and Ghanche, **Four** districts in Gilgit region comprising of Gilgit, Ghizer, Hunza and Nagar, **Two** districts of Diamer and Astore. It contributes about 5.13% of Potato produced in Pakistan.

This cluster presently supplying following products:

- Off-season fresh table potato supply
- Formal and Informal Potato seed supply to plains of the Punjab and KP

This cluster can be developed for:

- Most suitable for certified seed multiplication
- Off season fresh supply to main markets of Pakistan

Figure 2. Map of Pakistan Showing Potato Production areas and clusters

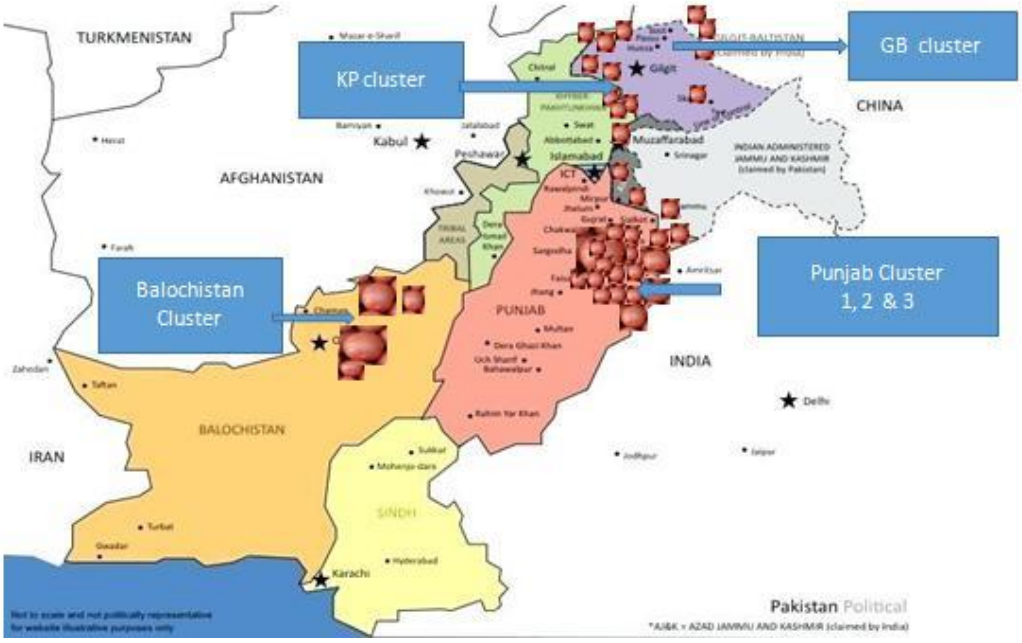
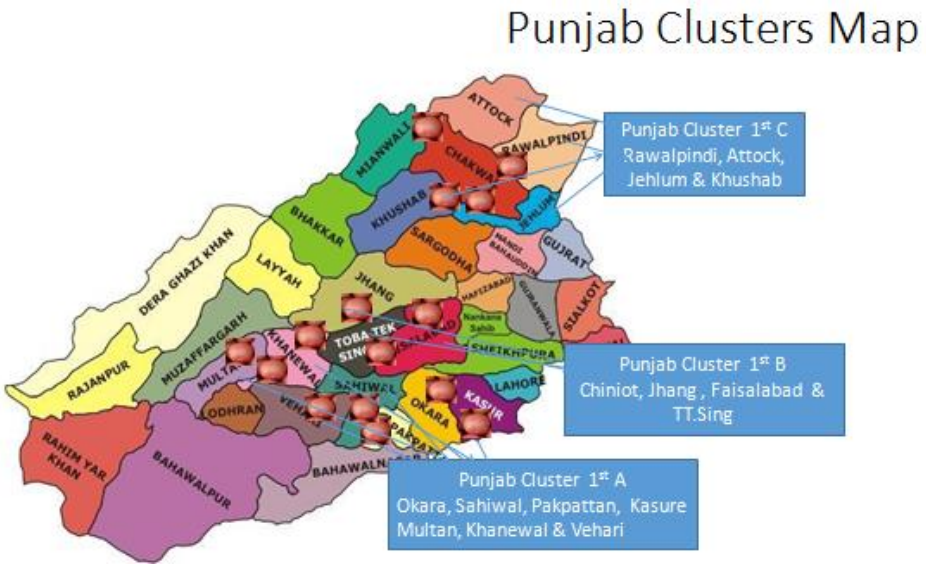


Figure 3. Punjab Clusters Map



5.2. Characterization of Clusters

The Punjab clusters, the major contributor with 90% share in total potato production of Pakistan, have the following features:

a. The processing industry exists in production areas.

b. Main exporters also having good links with producers and they develop warehouses in main potato producing areas.

c. Majority of farmers are fully mechanized.

d. Farmers have better production knowledge and ability to purchase inputs well in time.

e. Seed quality is better than all other potato clusters due to use of certified seed.

f. Crop knowledge, timely input supply and quality of seed result better yields than other clusters.

g. The cold storage facilities are also available in main potato growing areas.

h. Processing industries also provide quality/certified seed to contract growers for planting of crop. This seed is normally provided at actual rates on loan without any interest and seed price is normally deducted at the time of harvesting or collection of produce by processors

i. In Punjab harvesting time is in cool months that provide 3-4-month period to export potatoes

j. Renting land on cash basis is a common practice

k. Getting loans from commission agents for input use and selling the produce with higher commission is common.

GB cluster contribution in production is only up to 8%. But the produce comes in market during off-season, which provides extraordinary higher prices as compared to Punjab produce. There is a high demand for fresh potatoes because cold store potatoes have sweet taste when it's cooked. This sweetness is due to low temperature in storage that cause conversion of starch into sugar. Normally off-season fresh table potatoes fetch double prices.

a. The supply of fresh table potatoes from these clusters starts from August and continue up to November.

b. These clusters are having high hills areas for potato production. These High hills have suitable environmental conditions to grow potatoes and free from Aphid vector.

c. Presently GB Cluster is most suitable for seed production due to monsoon and aphid vector free areas.

d. The yield potential is higher due to long day's suitable environment, day temperature up to 30 ^{o}C, cool night, free frost and 140-150 growing days.

The characteristic and comparison of clusters are explained in detail Table-13.

Table 13: Characteristic and comparison of Potato Clusters

Salient Features	Punjab Clusters			Gilgit Baltistan
	Potato Cluster Punjab A		Potaro Cluster Punjab B	
Districts	Okara, Sahiwal, Pakpattan, Kasur, Multan, Khanewal & Vehari		Chiniot, Jhang TT sing, Faisalabad	Four Baltistan districts of Skardu, Shigar, Kharmang, and Ghanche, Four Gilgit districts of Gilgit, Ghizer, Hunza and Nagar Two districts of Diamer and Astore
Areas of the Clusters in Ha	Area (ha)	124167	16636	9116
	Production (tonne)	2870322	355374	128074
	Yield (tonne/ha)	23.11	21.36	14.05
Crop Value Rupees/100kg Million (Rs.)	@ Rs 1800/100kg Million Rs: 51795		@ Rs 1800/100kg Million Rs: 6397	@ Rs 2500/100kg Million Rs: 3202
% Share of potato area in the cropping system	70.03		9.36	5.13
Focal Areas for development	**Okara** • Area: 54077 ha. • Production: 1269 thousand Tonnes • Share in cluster 44% • Share in Pakistan 30% • Potato growers are large and fully mechanized • Informal potato seed supply to other areas		**Chiniot** • Area: 9449 ha. • Production: 196 thousand Tonnes • Share in cluster 56% • Share in Pakistan 5 % • Potato growers are large and fully	Ghizer and Astore Area: 2473 ha. Production: 34446 Tonnes Share in cluster 33.69% Share in Pakistan 1.2% • Certified seed supply to Spring crop in Punjab and KP • Fresh table potato

	• Processing industry exist in the area and having contract growers • Main export of fresh potatoes • Most farmer have own cold store facility at farm	mechanized • Informal potato seed supply to other areas • Provide potatoes for export	supply as off season produce to Punjab and KP
Altitude (m)	105-136	149-184	1500-3100
Latitude	30.15-31.12°N	30.97-31.45°N	35.22-36.26°N
Longitude	71.43-74.44°E	72.31-73.13°E	73.42-74.55°E
topography	Open, very flat, flood Plains	Flat land mostly flood irrigation	• Confined bowls plateaus, • Slopes, enclosed by high mountains and rivers • Open valleys receiving more or less sunshine, • Terraced fields, Less natural vegetation, mostly steppe Artemisia
Climate	• Hot and arid toward south • Central areas are warm and semi-arid • Warm during planting time maximum up to 35 °C during October • Mean temperature decrease during December and January up to 4 °C in January • Some time it decreases below 2 °C and cause frost injury to crop. • The highest monthly average rainfall of Autumn is 2.1 mm • Overall less than 250 mm annual precipitation	• This region has semi-arid climate with very hot and humid summers and dry cool winters. • The fog is particularly dense at night and in early morning hours. • The winter season starts in November and continues until early February. • In Chiniot side always weather favor late blight due to high humidity beside Chenab River. • Warm weather at planting time maximum up to 34 °C during October and minimum up to 6°C in January some time it decreases below 2 °C and cause frost injury to crop	• Very cold dry, continental, • Temperature decrease with increasing altitude and stay usually below 30 °C, • Frost from November to February at 1500m, and October to April at 3100m, • Rain shadow of wintery depression and les monsoon rain, • Little snow in this zone, but considerable snow in the surrounding mountains. Less than 500mm annual precipitation
Soils	• Calcareous, loams, clay loam, silt loam with weak structure. • pH 7.5-8.5, less than 1% organic matter, • water logging and salinity problems toward Kasure	• Calcareous, silt loam with weak structure • pH7.5-8.5 • Less than 1% organic matter, • Well supplied with N, P, K but some Zn deficiency, • Water logging and salinity problems	• Variable, silty/sandy loams to loams • Less than 15% clay, contain gravel and stone • pH 7-8, Less than 1% organic matter

Irrigation Structure	• Tube wells and canals irrigation in all areas • Canal water is less saline • In some areas the water table is high	• Tube wells and canals, • Canal water is less saline, • Water table are high and deep in different areas, • Some areas having salty water in case of tube wells	• Gravity-fed channels collecting melt water from glaciers, snow fields, • Springs and river, water availability depends on glacier and snowmelt. Water is loaded with silt, low saline content
Farm size	• Majority farmers are medium and large having >5 ha • Some are very large farmers, in Okara, Kasure, Pakpattan, Sahiwal, Multan and Khanewal. • Some farmers are made bigger units by renting land, average size is about 20 ha.	• Manly medium and large farmers • Some farmer made bigger unit by renting land	• Mainly small farmers • Average size is about 0.5 ha, • Mostly fields are small and scattered The uncultivated land is mainly owned by the whole community
Land Tenure	• Renting of land on cash is common • Rent rate are higher near city • The annual rent is about Rs. 65000 to Rs120000/ha.		• Mainly owners Sometime relative land with half produce
Labor	• Labor hiring is common for: • Planting • Field band preparation and cleaning water channels • Application of fertilizers, weedicide, insecticide and fungicides. Irrigation and some other look after of the crop		• Family labor, • Better-off farmers hire additional labor on cash @ Rs 300 to 500 daily for planting, weeding and harvesting. • In some area mutual exchange and field owner provide food during working hours
Credit	• Farmers use to get inputs (Fertilizer, weedicide and pesticide) on credit from commission agents • Farmers have to sell through an agent who charges 4 to 5 % commission as compared to legally allowed of 3.12%.		• Only seed is being supplied through commission agents, sub traders, local traders at the time of plantings on higher rates. • In most cases farmer pays double produce to traders on seed. • Traders do not supply quality seed to farmers. • Seed companies are used to multiplied basic seed in GB to supply certified seed to farmers in plains.
Cropping Pattern.	Following rotations are common in potato growing areas: • Potato-Maize-Green manure • Potato- maize- Coarse rice	In potato growing areas the general cropping pattern is: • Spring Maize-Course rice- potato.	• Wheat, barley maize, bean, buck wheat, alfalfa, clover and fruit trees are main crops.

	• Wheat-Dhaincha-Potato • Potato-Maize- pulses. Potato farmers are not doing proper rotation, every year planting potato on same land	• Spring Maize-pulses-potato ➢ Spring Maize-fellow–Potato ➢ Spring Maize-green manure- potato ➢ Wheat-green manure/fodder-potato	• Potato mainly grown in valleys on high altitude above 2500m. GB • Government and private seed companies introduced potato seed multiplication during 1984. • Potato is a cash crop of the area • Potato got popularity as fresh off season supply in market. • Mono-cropping area • Potato or wheat or maize or vegetables like peas and beans,
Potato varieties	Following varieties are grown: **Table potato varieties:** ***Red skinned:*** • Astrex Kroda Zina Red, Bartina, Roko, AGB Red, Paramount, Flamenco, Ronaldo, Simply Red, Rodalph ***White Skinned:*** • Sante, Mosica, Melody, Terra Gold, Lady Christal, **Processing Varieties:** • Lady Rosseta (red) Hermes, Lady Jo, Lady Claire are white **French fries**: • Asterix (Red) and Santana (white)		• Red varieties are dominant due to supply of fresh potatoes as off season produce during September, October and November. • The main varieties are: Kuroda, Roko, Asterix, Bartina, Paramount, Ronaldo, Zina Red. Private companies are multiplying (red or white) potato seed in GB to supply as certified seed to Plains of Punjab and KP.
Seed Source	**Seed supply to Punjab growers are from following:** 1. Netherlands and other European countries 2. Imported seed multiplies during Summer in GB **3.** Tissue culture labs (Public & Private). *a. 90 % seed supply is for spring crop.* *b. Multiplication in spring expose crop to viral diseases infection by aphids* *c. Seed degeneration is very quick and farmers used to replace seed after every 3 years* Seed multiplication year indicates the quality of seed **Fist year Seed** Imported Seed multiplied in spring and the produce is kept in cold store to plant in autumn	• Large farmers usually purchase imported seed to renew their seed. • Majority of medium and small farmer use to purchase seed from Okara Sahiwal • Traders of Chiniot, Jhang, Faisalabad also purchase seed from Okara, Pakpattan and Sahiwal to supply as seed to local growers. • The seed is sold with the name of first year seed or second year seed • The seed rate is also higher for first year seed than second year seed.	• Farmers are used to get seed from different sources: • **Quality seed** 10-15% imported seed provided by private seed companies for multiplication, • Agriculture Tissue culture lab, Development projects (AKRSP and economic Transformation Initiative (ETI) Gilgit-Baltistan) also provide quality seed • Whereas 80-85% seed is being provided by traders, sub trader, village level traders to the local farmers without quality concern. • Traders usually purchased seed on loan from different markets of

<table>
<tr><td></td><td>(Usually farmer do not sale this seed)
Second year seed
Autumn Produce of fist year seed
Third year seed
Autumn produce of second year seed
Note: Most farmers purchase seed for 1% of total cultivated area every year, first they multiply it in spring and then start Autumn to Autumn for three years. Every third year, the whole produce is exposed off.</td><td></td><td>Punjab on credit with partial payment of cash with the agreement that the produce will be sold through them.
• These agents supply seed to growers with different type of agreements, cash with profit, loan on return basis
• 15 to 20% farmers use to keep seed in pits or in rooms or in Cellar for next summer crop</td></tr>
<tr><td>Fertilizer rate/ Fertilizer type</td><td colspan="2"><table><tr><td rowspan="2">Required (kg/ha)</td><td rowspan="2"></td><td colspan="3">Farmers Practices (Kg/ha)</td></tr><tr><td>Large</td><td>Med</td><td>Small</td></tr><tr><td>N</td><td>130</td><td>238</td><td>214</td><td>100</td></tr><tr><td>P_2O_5</td><td>60</td><td>182</td><td>110</td><td>50</td></tr><tr><td>K_2O</td><td>230</td><td>50</td><td>120</td><td>0</td></tr></table>• FYM or city sweep application is decreasing due to spread of soil borne diseases.
• Over all the use of potash is low in areas.
• Potash is important for processing and Export
• The use of Zn, Boron is common in large and medium growers</td><td>NPK Required 80:40:140
Variable quantity of 230-460 kg/ha Nitrophose (N&P),
No potash is applied. First time NPK fertilizer was provided to potato growers for seed multiplication @ 300:150:150 kg/ha N: P: K during 2018 by GB project.
Farmer also applied FYM @ 40t/ha after every 3 years</td></tr>
<tr><td>Planting time & Harvesting</td><td colspan="2">Crops Planting Harvesting
Spring crop: Dec-Jan April-May
Main Autumn: Oct-Nov Jan- Feb</td><td>Summer crop
Planting start in last week of March around Gilgit and April-June on high hills
Harvesting start from August - October</td></tr>
<tr><td>Seed rate/ seed type/ planting method</td><td colspan="2">Spring crop: 1-1.3 t/ha (cut tubers 2-3 eyes / piece
Autumn crop: 3-3.5 t/ha
Row to Row distance: 75-90 cm
Plant to Plant distance 15-20 cm
Mechanical planting and harvesting</td><td>Summer crop:
2 t/ha, cut tubers some farmer uses higher seed rate up to 2.5 t/ha.
Row to row:
60-100
plant to plant
10-25 cm
100% manually planting
In few places ridges were made by tractor</td></tr>
<tr><td>Potato Weeds</td><td colspan="2">Annual weeds
Grass weeds Broadleaf Weeds
Aveena fatua (Jangli Jai) Trianthema partula (Itsit)
Phalaris minor (Dumbi Booti) Chenopodium spp (Bathoo)
Poa annua (choti grass) Portulaca oleracea (Kulfa)
Perennials weeds</td><td>Chauli, billi booti, piazi, Jangli Jai, Bathoo, Kurand, Jangli Halon, Khabbal, Deela, Madhna, Maina, Dumbi booti, Kulfa, jangli Palak, Makko, Baroo, Itsit, Rewari</td></tr>
</table>

	Grass weeds *Cyperus rotundus* (Deela) (Lehli) *Cynodon dactylon* (Khabbal) Palak) *Sorghum halepense* (Baroo)	**Broadleaf Weeds** *Convolvulus arvensis* *Rumex indica* (jangli *Solanum nigrum* (Makko)	
Potato Pests	Aphids, Leaf hoppers(jassids), mites, cut worms and wire worm, white fly		Cutworm, Cyst nematodes, White grubs, leafhoppers, wire worm
Potato Diseases	Potato leaf roll (PLRV), Potato virus Y (PVY), Mild mosaic , Potato virus S, Verticillium, Fusarium wilt, Powdery and Common scab, early and late blight, Rhizoctonia, Black leg, Bacterial wilt		PLRV, PVY, PVS&M, Common and Powdery scab, Black leg, Rhizoctonia, Late blight is a major problem of the area.
Harvesting	The aim of each harvesting practice is to: 1) take potatoes out of the soil at low cost 2) keep produce losses to minimum 3) work as quickly as possible • Potatoes are mainly harvested by potato diggers • Local labor is used to collect and shift to temporary storage place.		• Mostly growers cut off vines manually to use as fodder before harvesting. • Potatoes are grown on small fields and often are not linked with roads, • Manual harvesting is more practical. • Potatoes are dig by spade, Khurpa, kodal or hoes and shovels. • In the seed potatoes fields, the haulms are cut near the soil level about 15 days before harvest. • In most cases potatoes are filled in bag to send directly for sale in different markets of Punjab, KP and Karachi, Sind. • In case of seed crop harvested potatoes are shifted to grading and packing place near the field.
Yield t/ha	23.11	21.36	14.05
Post-harvest handling	• The main bulk produce of autumn crop harvested is sold in the first quartered the year (60) %. • If the crop is not sold soon after harvest, it is stored in the field in large heap, longitudinal heaps covered with a very thick layer of rice straw which protects it from the weather (frost, sunburn, rain). • The storage period in the field ranges from 1-2 months until mid-April. • Later than this, it is too hot for field storage, field losses tell April are low. 20% of produced kept in cold store as seed for next year.		• Majority of farmers use to sell whole produce directly from field without grading to pay back loan. • Few keep medium and small size tubers as seed in pits, in cellars or in rooms. • Recently under development projects many cellar was

		constructed to keep seed. There is a big store in Khyber.
Marketing	Main Markets: Lahore for red potato & Karachi for white potatoes Faisalabad, Sahiwal, Okara, Gujranwala, Multan, is also important markets. 6 types of marketing normally farmers are doing: a. 30-40 % produce is being sold through commission agents to pay pack inputs prices. b. Contract grower's sale produce directly to purchasers (Processing) c. Farmer sale produce directly in fields to exporters d. Farmers send some part of produce to local market to return taken loan for inputs e. Farmer sale as seed to traders, sub traders and farmers for planting in summer f. Farmers keep potatoes in cold store as seed for own as well as to sale at planting of next autumn g. Most large growers have own clod store, they use to keep 60% produce in cold to sale during peak prices period	The summer crop considered as off season supply of fresh potatoes to plains of Pakistan. Farmers always fetch higher prices. Following types of marketing are existing: i. Farmer after harvesting shifting potatoes on road side and local traders after bargaining on prevailing rates purchased potatoes and after payment traders transported potatoes to Lahore or Rawalpindi for sale ii. 50-60% farmers handed over produce to traders who provided seed at the time of planting (rate depend on market of Lahore) iii. Contract growers providing seed to companies for sale and big potatoes were sold like first case iv. Few farmers themselves take potatoes to down markets for sale v. 10-15 % farmers use to keep seed from produce for next summer crop
Value chain and utilization of produce	The potatoes are produce for following: • Seed multiplication for own and for sale • Production for processing industry • Production for export Production for local consumption	GB cluster produce two types of potatoes: I. Quality seed multiplication and supply to Punjab for spring crop II. Off season fresh potato supply to plains of Pakistan on premium prices

5.3. Description of Potato Value Chain

5.3.1. Potato Value Chain in Punjab Clusters

Potato Value Chain has a strong economic value in agriculture of Pakistan. Although being input intensive crop in nature, it has better rate of return for various actors when

market prices are good. The export of potato has shown a significant growth, the area under potato cultivation has expanded mainly due to the push provided by the processing industry. Potato strength is evident from the allied services sector growth of cold storages, transport, labor, packaging and food processing industry. Surprisingly, it is treated just like another value chain by formal financial sector in the country.

The growth in potato production is mainly due to the hard work of producer, technological advancement especially varieties through research institutes, and farm mechanization. The secondarily trigger came from the growth in the processing industry besides sustainable demand in growth of export for both raw and finished goods. Other drag has been provided by the expansion in cold storages, cold chains and bulk hauling transport besides establishment of primary processing technology such as grading and packing plants by processors, growers, exporters and cold store operators. Area under potato production, local consumption, processing and exports all show a steady increase.

Potato clusters in the country offer vast opportunities for expansion in meeting the local as well as export demands of table and processing potatoes and diverse seasonality in production across provinces in the country also offers availability of fresh produce year round. In addition, such diverse growing pockets in various ecoregions offer opportunity for quality potato seed production.

Informal sector has been proactive in driving finances for working capital, specially, for inputs, packing material, whereas formal sector requires appreciation and understanding of potato value chain and its entrepreneurial nature. Formal sector has also been unable to devise specific financial products in order to meet specific needs of the potato value chain. This also holds true for other agriculture value chains in the country.

The officials issuing of phytosanitary certifications is required for exports - skipping lengthy and costly inspections, and then unloading and loading at the Karachi port. Practically, this means linking fields directly to the world markets.

The real fears of farmers, however, do not come from market factors but from the government’s potato policy, which farmers say works against the potato sector. For example, whenever prices start going up, the government either bans exports or allows duty-free imports from the neighboring country India or unleashes the district administration at the retail sector to keep rates down. Farmers say they can deal with market realities, but the government should reconsider its

policy for potato crop on reality basis. The best policy of the government should be to keep off the potato market but support the sector by compiling and dissemination of relevant data to farmers and other stakeholders to help them making informed decisions related to production, storage, and trade activities.

The fluctuation in potato prices in the market during glut year create big losses to farmer's community because farmer spend Rs 13 to produce one kg potatoes and, in case the produce is kept in cold store for a certain period, the extra cold store cost of Rs 4.5 is added (Table-14). Despite recent increase in input costs, however, potato cost of production offers a competitive edge to farmers.

Table 14: Potato cost of production (autumn crop), Punjab/ha (2017-18).

Sr. No.	Activity	No or Quantity	Rate (RS)/unit	Existing cost (Rs./acre)	Cost (Rs/ha)
1	**PREPARATORY TILLAGE PLOUGHING**				
1.1	Deep ploughing	1	1096	1096	2707
1.2	Plouging/Cultivator	4	483	1932	4772
1.3	Leveling	1	548	548	1354
2	**SEED BED PREPARATION**				
2.1	Plouging	4	483	1932	4772
2.2	Planking	2	241.5	483	1193
3	**SEED AND SOWING OPERATIONS**			0	
3.1	Seed (kg per acre)	600	20	12000	29640
3.2	Seed Planting with ridger	1	1328	1328	3280
3.3	Labour charges (Man Days)	6	460	2760	6817
4	**FRAM YARD MANURE**				
4.1	Farm Yard Manure	4.0	1100	4400	10868
4.2	Labour for spreading (Man Days	3	460	1380	3409
5	**FERTILIZERS: (bag)**				
5.1	Urea	3	1350	4050	10004
5.2	DAP	2	2500	5000	12350
5.3	Potash (SOP or MOP	2	2600	5200	12844
5.4	Transportation	7	20	140	346
5.5	Fertilizer application (labor days)	1	460	460	1136
6	**PLANT PROTECTION**				
6.1	Insecticides	2	550	1100	2717
6.2	Fungicides	3	550	1650	4076
7	**IRRIGATION**				
7.1	Cleaning of water courses (M. days)	1	460	460	1136

7.2	Labour Charges for Irrigation (M. days)	2	460	920	2272
7.3	Water Charges (Canal Water)			0	0
7.4	Irrigation Charges(3Hrs)	4	1000	4000	9880
8	**INTERCULTURE**				
8.1	Chemical Weed Control & Labour	1	550	550	1359
8.2	Earthing up (Man. Days)	4	460	1840	4545
9	**HARVESTING**				
9.1	Harvesting and Handling by 10 people @460/labor (Acre)	1	4600	4600	11362
9.2	Empty Bags	95.03	110	10453	25820
10	**Transportation @Rs.1500-2000/t**	9.50	1500	14254	35209
10	**Land Rent for 6 Months @20,000/20,000 PA**	6	1666.67	10000.02	24700
11	**Agricultural Income Tax.**			49	120
12	**Management Charges for 6 Months**	6	140	840	2075
	Manager @ Rs 14000/PM for six months for 100 Acre				
	Gross Cost (Item 1 to 12)			**93425**	**230760**
	Gross Cost (US$)			**692**	**1709**
	Yield Per Acre & Per Ha (kgs).			9,503	23482
	Cost Per Kg at Farm Level			10	10
	Cost per 100 Kgs Bag at farm level			983	983

The detail flow of costs from the farmers to different value chain actors are given in Annexure 4.

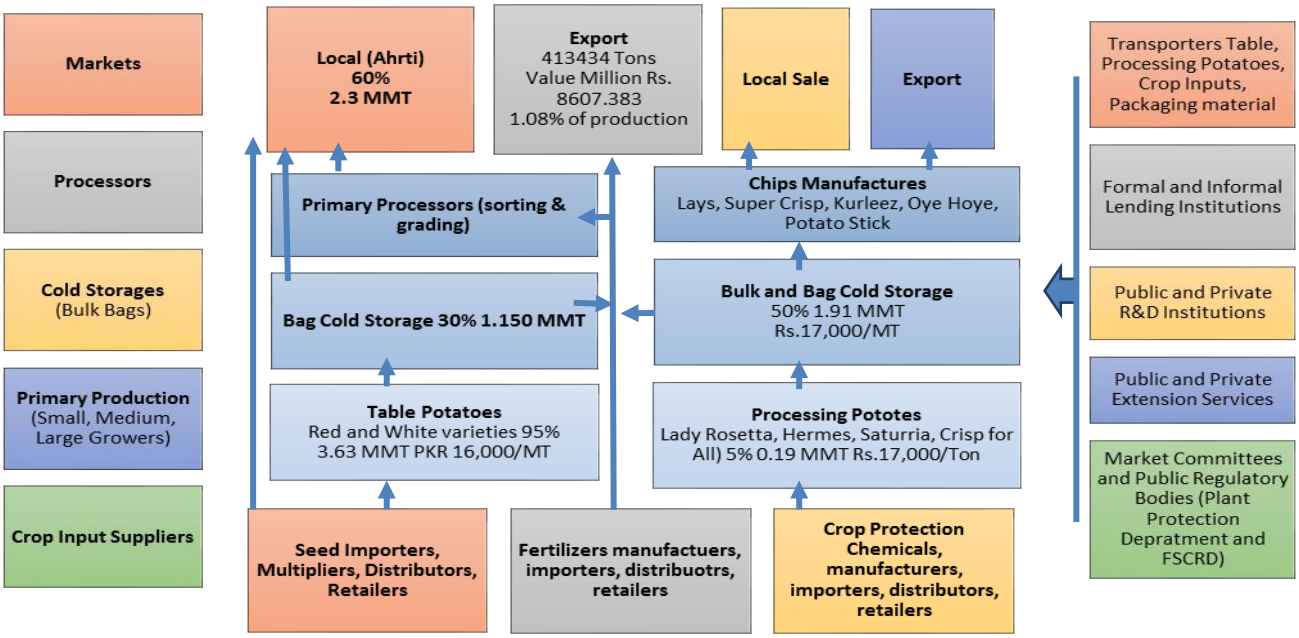
Another important area to improve is the provision of quality local potato seed. Currently, a major chunk of potato seed is imported mainly from Netherlands and India. This escalates production costs and makes the business more susceptible to market vulnerabilities.

To check on the exploitative behavior of commission agents, the formal financial sector should increase its access to small farmers and other stakeholders in the value chain including traders, processors, and market agents and simplify its procedures.

In many ways, the Punjab potato clusters value chain is better organized and farmers have been growing improved and commercial varieties for local consumption, processing industries, export and informal seed supply throughout country. The farmers have moderate levels of skills in management and appropriate technologies are used for crop production. Most of the farms are fully mechanized and others are semi mechanized. In addition to potato production, these clusters are also enjoying a leading position in the

production of hybrid Maize, Rice and off-season vegetables. The following figure shows the description of potato value chain in the province.

Figure 4. Potato Value Chain Map (2016-17)



5.3.2. Potato Value Chain GB Cluster

In GB the potato growing area start from about 4,900 feet above sea level in the lower Gilgit Valleys goes to 12,000 feet in different Valleys. Because of this elevation, the climate during the growing season produces cool nights and sunny days, providing the warmth and photosynthetic energy that the plants need to grow. The leafy canopy of the potato vine transfers energy to the tubers when the temperature drops at night. GB climate has proven ideally suited to growing potatoes. Soil type also affects the character of potatoes. Rich, sandy loams soils are suitable for potato production. The geological events that formed the mountain systems in GB are also responsible for the soil. The different valleys linked with glaciers and on both river side's areas with a light, well-drained soil, rich in the minerals helps better potato cultivation. The potato crop retains its love for mountain climates where it grows best like GB

Potatoes are one of the most important tuber crops in Gilgit Baltistan. However, the lack of market access, availability of quality seed, poor agricultural practices are the main factor of low productivity, beside these factors the continues growing potato crops on same land caused the development of soil borne diseases as an alarming threat to quality seed production in these areas.

Although potato is major cash crop, it is only a major source of living for most of the households living in the region. But unfortunately, potato seed production was not adopted as it needs special care and to follow seed production principal. In most cases the potato crop is sold as table potato on lower prices which in turn reduce the income of the growers.

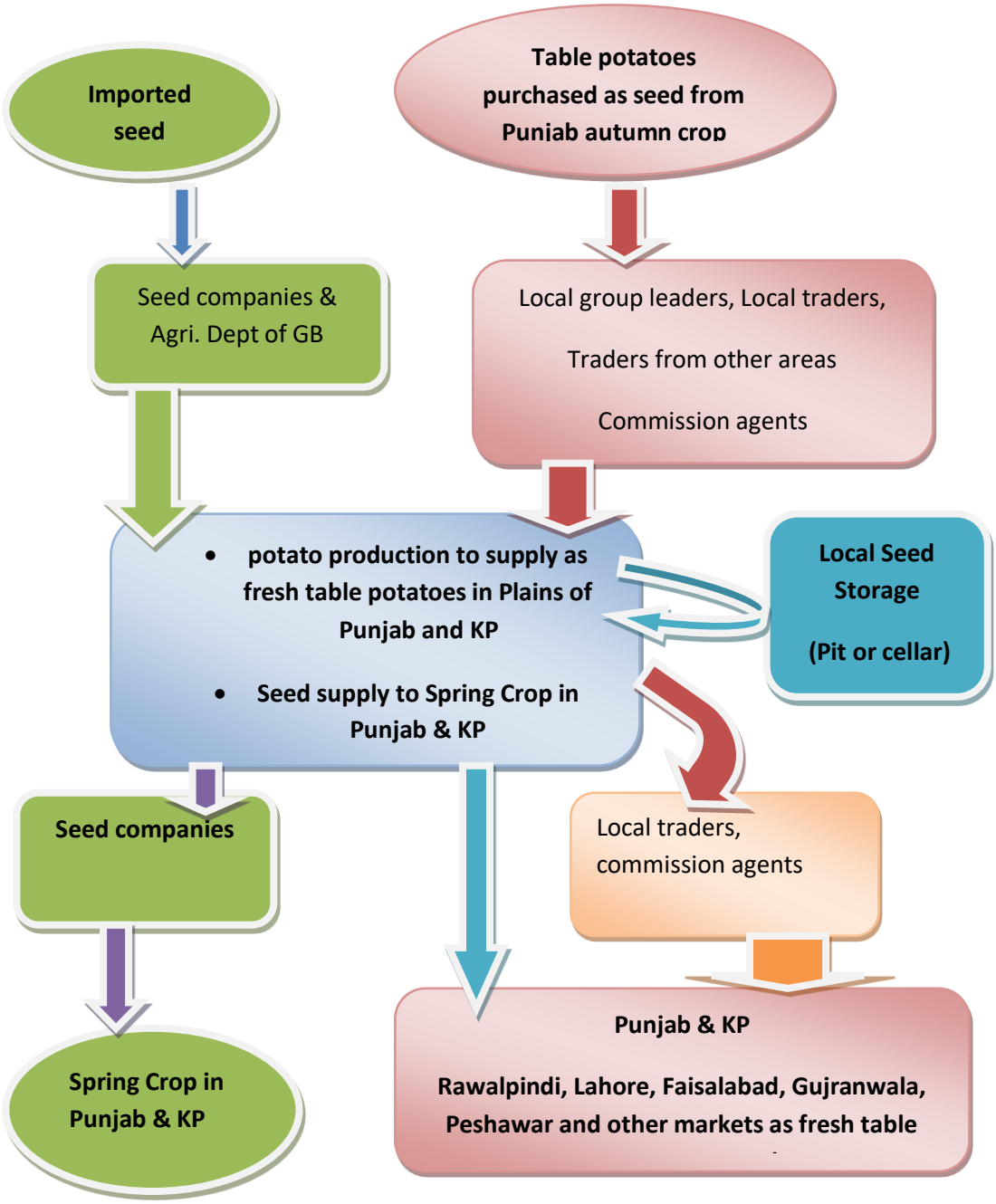
The bad practice in major potato growing areas of GB is to purchase table potatoes of unknown quality to use as seed from local agents or commission agents on loan at high rate of interest. The unknown seed sources are the main reason of low yields and as well as the spreads of soil-borne diseases in the area.

Presently few seed companies are doing seed multiplication in different valleys. The Department of Agriculture Research and extension are also multiplying quality seed in this area.

The major obstacle for seed multiplications is the high prices of table potatoes. In some year's prices of fresh table potatoes become very high, then farmers lose their interest to multiply seed crop which need some liabilities like rouging, vine killing, grading etc.

Mainly these areas are producing fresh table potatoes as off-season crop. Potato crop flow is presented in Figure-5

Figure 5. Potato value chain in GB cluster



5.4. SWOT Analysis

5.4.1. Overview

The SWOT analysis was carried out in meetings and focus group discussions conducted in major potato producing areas with the consultation and participation of different stakeholders of Potato crop. The results are organized around the value chain functions, including inputs, production, storage, and marketing; strengths and opportunities are coupled together and likewise weaknesses and threats are combined.

5.4.2. SWOT for Punjab A Cluster

The Punjab cluster has much strength and opportunities, including better communication, farm mechanization, processing industries, cold stores and well managed input supply system, educated farming community and large land holding. The major weaknesses are that farmers are not doing proper crop rotation. There are limited varieties for processing and export. Imbalance uses of fertilizers Threats include diseases and insect, such as Rhizoctonia, common scab and late blight. Abiotic stresses like high temperature at planting and frost damages in December end, sometime over production and glut in market, lowers prices making huge losses to potato growers. From Government side poor planning and negative policies and inadequate investment in research, technology development /breeding, extension, marketing, etc. As potato is an input-intensive crop, unavailability of enough liquidity with farmers and limited access to formal financial institutions resulting in borrowing from commission agents at higher than market price is a main weakness in all clusters, especially in GB. Due to weak financial institution farmers has to sell their produce immediately after the harvest at a low glut price.

In cluster A and B commission agent do not char higher rate as compare to other clusters. Commission agent provide inputs (seed, fertilizer, chemicals and empty bags to farmers. It is difficult for farmers to visit Punjab for potato seed. Due to potato mono cropping in hilly areas, farmers are used to sale whole produce to meet house hold expenses. At planting time usually farmers are not having sufficient funds or money to purchase seed and other inputs. The Table 17 presents the detailed SWOT analysis for Punjab A cluster.

Table 15: SWOT Analysis for Potato Cluster Punjab 1st Cluster A

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Environment/ climate changes	• Open, very flat, flood Plains, • Worm and semi-arid. • Mean temperature start decreasing from planting in October. • Probability of frost from December to January. • 200-1000mm annual rainfall	• Continues potato cultivation on same land resulted spread of soil borne diseases • High temperature at planting caused rotten of seed and affect germination • Mostly frost appear in last week of December and January and cause low yields	• Processing industries is existing • Contract growing with processing industries • Exporters usually purchase from farm • Potato Research and development activities present in the area	• High Temperature at planting cause rotten of seed • Development of soil borne diseases restricted quality production • Organic matter decreasing • Fog and frost during December cause the decrease in yields • Destruction of crop by late blight
	• Availability of canal & tube well water supply,	• In some areas tube well water has higher salt concentration	• Water testing facilities exist	• Water table decreasing continuously
Input Supplies	• Fertilizer, herbicides, fungicide & pesticide supply system	• Imbalance uses of fertilizers • Excessive use of insecticide and fungicide	• Loan facility is available from Banks and from Commission agents	• Increase in soil and water pollution • Soil pH increasing • Development of resistance in insect and diseases
	• Quality seed	• 95% Potato cultivation in Pakistan based on Dutch varieties • Dutch varieties seed	• Many seed companies involve in this business • Some large farmers directly import seed from	• The spread of potato diseases in Pakistan is mainly due to Dutch seed cultivation • Any time the seed supply

		supply is in spring season • Spring season is not suitable for seed multiplication due to virus vectors • Seed supply from Europe is very expensive • Local system needs to be strengthened • Limited varieties for processing and export	Europe	can be suspended by any reason • Presently no other alternate than import for quality seed • Seed degeneration is quick due to its multiplication in spring
Cluster Interaction	• Large and medium number of farmers	• Poor Interaction with research and developments • Farmers are using more inputs • Farmers have craze to use new varieties without proper testing • Political pressure for different benefits • Continues planting of potatoes on same land	• Majority farmers have better knowledge and have political access to Govt. • Most have cold store facility to store produce • Having resources to by inputs and quality seed • All are well mechanized	• Spread of soil borne dissuades due to continues planting • The excessive use of inputs caused pollution in soil and environment • Use of new varieties without testing resulting spread of diseases
Production technology	• Experienced farmers who know potato production technology for a long time	• Cost of production is very high as compared to other crops (Rs 10-13/kg) • Certified seed is very limited and highly expensive @Rs 160-180/kg • Degeneration of seed is	• Availability research and development activities at federal and provincial level • Contract farming with processing industries • Seed supply by processing industries to	• Spread of potato diseases, which reduces both yield and quality • Fluctuation in prices below than cost of production give heavy losses to farmers • Early appearance of

		very quick • Famers have to change seed after every 2nd or 3rd year • Prices always low at the time of main crop harvest • In most cases frost damage to crop at December end or start of January • Post-harvest losses are high due to its perishable nature • Imbalance use of fertilizers effect yield • Excessive use of pesticides pollute environment	contract growers • Potato cultivation is mechanized • Canal and ground water availability • most farmers have cold store facility • Exporters providing cleaning grading facilities	frost causes low yield • Working force at farms are not trained and landlords do not allow them to get training
Transport facilities	• The Road infrastructure is better to market and processing units • Washing cleaning facility with the production Area for export	• Very heavy packing (110-120kg/bag • Post-harvest losses are on higher side due to worm temperature after harvesting • After harvesting most function of packing, shifting from one place to other are manual • Limited varieties for export • Present varieties for	• All kind of transport are available • Metal road infrastructure made transportation easy • Exporter and processor provide transport to farm gate • SOPs are available to export • Packing material of jute bags and plastic bags are available easily on all places	• In case of rain and increase in temperature caused heavy post-harvest losses • Export varieties are poor in storability, delay in delivery caused heavy losses • Development of cosmetics diseases (Scab and Rhizoctonia) in the production area deteriorate quality export of potatoes • Farmers are

		export are not suitable to their poor storability • High fuel cost especially diesel	• Sometime packing material is being provided by purchasers	not adopting crop rotation
Marketing	• Higher price for processing and export varieties • Contract growing provide stable marketing • Trader provide inputs to farmers till crop harvest	• Limited varieties for processing • Processing varieties are lower in yield • Presently export verity Mosica is very poor in handling • Fluctuation in prices	• Technology available to reduce post-harvest losses • Research and extension system is available in cluster • Sprouts suppression are available	• Storage at low temperature make potatoes unfit for processing • Excessive use of nitrogen enhances post-harvest losses • Farmer bound to sale through commission agent due to loan • Sometime commission agent does not pay potato price at time • The sale of produce on higher price to traders on loan some time cause 100% loss • Sale on credit linked with next sale and sometime very late payments • Commission agent deduct extra commission at sale to recover loan
Trade/ Export	• Exporters installed automatic potato cleaning and grading plants in cluster area • Pakistan can export fresh produce	• Limited varieties for export • Delay in transportation cause poor quality and losses • Yet farmers need training	• Pakistan has nearest markets for fresh potatoes • Pakistani produce in cool weather, which allow to export potato in safe way	• Sudden bane on export by Government cause bad impact in market • Limited varieties • Heavy infestation of

	• Shipping facilities exist	to produce potatoes for different uses	• Better opportunity for frozen potatoes • Export demand exist for processing potatoes	cosmetic diseases in potato growing areas • Soil borne diseases infestation increasing due to continues planting potato on same land every year
Processing	• Food uses: fresh, frozen, dehydrated • Many values added product can be made • Non-food uses: glue, animal feed, and fuel-grade ethanol	• Desirable varieties limited • Whole supply is in Jan-April • Storage in Cold stores deteriorate the quality • Lack of capacity and resource for small scale stockholders	• Industries are available in cluster • Huge demand for processing • Big market for frozen processed potato in world • Government incentives for the import of Agriculture Machinery	• Limited varieties • Harsh environment deteriorate quality • Long storage poor the product quality • The spread of soil borne diseases in production areas
Quality Seed supply	• Most growers purchase certified seed for own crop • Being large farmers, they can afford Rs 195,000-200,000 to purchase one ha seed • Many farmers have been benefited by seed companies for Holland visits • Normally seed companies provide new varieties seed	• Direct planting of new varieties without testing under research not recommended • Farmers mostly select verities for yield, but these verities are not good during storage • Every year new varieties introduction create mess in market and quality become poor •	• Processor provide seed on loan • Farmers got opportunity to visit highly mechanized farm • These visits increase farmer knowledge • Holland visits provide training to farmers	• New diseases were introduced by Dutch seed • Some varieties are highly susceptible to diseases and insect result poor yields • New varieties some time give huge losses to farmers

	as sample to large growers • Seed samples are normally free of cost			
Informal seed Supply	• In this cluster farmers are used to purchase imported certified seed every year to renew their seed • 70-80% informal seed supply from these areas to potato growers • Processing industry also provide quality seed to contract growers	• These farmers do not sale this seed till third multiplication • Up to third multiplication quality of seed degenerated due to higher percentage of viruses • This is the main reason of low yields in other clusters • These farmers are not doing rouging to clean the seeds from virus infected plants	• Research and extension system can help farmers to demonstrate rouging • All over the world rouging is compulsory for seed multiplying farmers • By proper rouging quality of seed could be improved	• The infected seed from this cluster is the main source of potato diseases spread in other potato growing areas. • High hills are suitable for seed multiplications but due to Punjab table potatoes as seed, the infestation of soil borne diseases are very high. • The spread of diseases will limit potato cultivation
Availability of credit	• Presence of an network of financial institutions throughout Punjab	• Potato being an input-intensive crop involves big cash • The procedural difficulties in getting loans when needed	• Availability of loans from commission agents although cost is high.	• Lack of credit at harvesting forces the farmers to sell their produce at low glut-price

5.4.3. SWOT for Punjab B Cluster

The Punjab cluster B also has better communication, farm mechanization, link with processing industries & exporters, cold stores and well managed input supply system, and

large, Medium & small land holding. Seed quality is little poor as compare to Punjab cluster A. These farmers are not doing crop rotation. Threats include diseases and insect, such as Rhizoctonia, common scab and late blight. Abiotic stresses like high temperature at planting and frost damages in December end, sometime over production and glut in market, lowers prices making huge losses to potato growers. The Table 18 presents the SWOT analysis for the Punjab B clusters.

Table 16: SWOT Analysis for Potato Cluster Punjab 1st Cluster B

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
○ Environ-ment/	○ Flat land mostly ○ flood irrigation ○ Semi-arid climate ○ very hot and humid summers ○ Dry cool winters. ○ Warm weather at planting in October, maximum up to 34 °C and minimum up to 6°C in January ○ some time it decrease below 2 °C and cause frost injury to crop ○ In Chiniot side always weather favor late blight due to high humidity beside River. ○ The fog is particularly dense at night and in early morning hours	○ Continues potato cultivation on same land resulted spread of soil borne diseases ○ High temperature at early planting caused rotten of seed ○ Mostly frost appear in last week of December and January and cause low yields	○ Contract growing with processing industries ○ Exporters usually purchase from farm ○ Informal seed supply to autumn and summer crop ○ Potato Research and development activities present in the area	○ Late blight attack in November to autumn crop and in February to spring crop ○ Harsh environment at early planting cause rotten of seed ○ Development of soil borne diseases restricted quality production ○ Organic matter decreasing ○ Fog and frost during December cause the decrease in yields
	○ Availability of Canal & tube well water supply,	○ In some areas Tube well water has higher salt concentration	○ Water testing facilities exist	○ Water table decreasing continuously
○ Input Supplies	○ Fertilizer, herbicides, fungicide &	○ Imbalance uses of fertilizers	○ Loan facility is available	○ Increase in soil and water pollution

	pesticide supply system working in cluster	○ Excessive use of insecticide and fungicide ○ Less use of Potash	from Banks and from Commission agents	○ Soil pH increasing ○ Development of resistance in insect and diseases
	○ Quality seed	○ Dutch varieties seed supply is in spring season ○ Spring season is not suitable for seed multiplication due to virus vectors ○ Limited varieties for processing and export	○ Many seed companies involve in this business ○ Some large farmers directly import seed from Europe	○ The spread of potato diseases in Pakistan is mainly due to Dutch seed cultivation ○ Any time the seed supply can be suspended by any reason ○ Presently no other alternate of seed was explore ○ Seed degeneration is quick due to its multiplication in spring
Cluster Interaction	○ Small, Large and medium number of farmers in this cluster	○ Poor Interaction with research and developments ○ Farmers are using more inputs ○ Majority farmer are getting seed from other growers	○ Majority farmers have better knowledge and access to research system ○ Cold stores facilities available ○ Planting and harvesting operations are mechanized	○ Presence of soil borne restrict export ○ The excessive use of inputs caused pollution in soil and environment ○ Weather conditions favor fungal diseases attack especially late blight
Production technology	○ Experienced farmers who knows potato production technology for a long time ○ Machinery available on	○ Cost of production is very high as compared to other crops (Rs 10-13/kg) ○ Certified seed is very limited	○ Availability research and development activities at federal and provincial level ○ Contract	○ Fluctuation in prices below than cost of production ○ In most cases the heavy damage to crop by frost in

	rent	and highly expensive @Rs 160-180/kg ○ Degeneration of seed is very quick ○ Famers have to change seed after every 3rd or 4th year ○ Prices always low at the time of main crop harvest ○ Post-harvest losses are high due to its perishable nature ○ Imbalance use of fertilizers effect yield ○ Excessive use of pesticides	farming with processing industries ○ Seed supply by processing industries to contract growers ○ Potato cultivation is mechanized ○ Canal and ground water availability ○ The cold store facilities are available in most areas ○ Exporters providing cleaning grading facilities	December and January ○ Excessive use of pesticides pollute environment ○ Excessive use of nitrogen enhances post-harvest losses
○ Transport facilities	○ Road infrastructure well connected with market and processing units ○ Processors are used to buy produce on premium rates	○ Very heavy packing (110-120kg/bag ○ Post-harvest losses are on higher side due to worm temperature after harvesting ○ After harvesting most function of packing, shifting from one place to other are manual ○ High fuel cost especially diesel	○ All kind of transport are available ○ Exporter and processor provide transport to farm gate ○ SOPs are available to export ○ Packing material of jute bags and plastic bags are available easily on all places ○ Sometime packing material is being provided by purchasers	○ In case of rain and raise in temperature caused heavy post-harvest losses ○ Export varieties are poor in storability, delay in delivery cause losses
○ Marketing	○ Higher price for processing and export varieties ○ Contact growing provide stable	○ Farmers are bound to sale produce through commission agent due to	○ Marketing information is available to farmers ○ Sprouts suppression	○ Sale on credit linked with next sale and sometime very late payments ○ Commission

	marketing ○ Trader provide inputs to farmers till crop harvest ○ Most farmers have information and prices in different markets	loan facility availed, ○ Traders use to charge higher commission rate in case of loan ○ Fluctuation in prices	can use to enhance shelf life	agent deduct extra commission at sale to recover loan ○ Some lower prices give heavy losses to farmers
Trade/export	○ Pakistan has better choice to export different countries ○ Presently fresh potatoes are being exported ○ Shipping facilities exist ○ Frozen potatoes also have market	○ Limited varieties for export ○ Delay in transportation cause losses and poor quality	○ Pakistan has nearest markets for fresh potatoes ○ Pakistani produce in cool weather, which allow to export potato in safe way ○ Better opportunity for frozen potatoes ○ Export demand exist for processing potatoes	○ Sudden bane on export by Government cause bad impact in market ○ Limited varieties ○ Heavy infestation of cosmetic diseases lower quality for export
Processing	○ Fresh supply is available from December to June ○ Food uses: fresh, frozen, dehydrated ○ Many values added product can be made ○ Non-food uses: glue, animal feed, and fuel-grade ethanol	○ Desirable varieties limited ○ main supply is in Jan-April ○ Lack of capacity and resource for small scale stockholders ○ Potato for processing should be stored at 9-10°C,	○ Huge demand for processing ○ Big market for frozen processed potato in world ○ Government incentives for the import of Agriculture Machinery	○ Limited varieties ○ Harsh environment deteriorate quality ○ Long storage poor the product quality
Informal seed Supply	○ In this cluster few farmers are used to	○ Seed desecration is very quick ○ Quality seed	○ Research and extension system can	○ The infected seed from this cluster is the main source

	purchase imported certified seed every year to renew their seed ○ Mostly farmers use to purchase seed from Punjab cluster A ○ Commission agent also provide seed to farmers ○ Processing industry also provide quality seed to contract growers	is very expensive and not easily available ○ The quality of Commission agent seed is not known, sometime very bad and sometime normal	help farmers to demonstrate rouging ○ By proper rouging quality of seed could be improved	of potato diseases spread in other potato growing areas. ○ This fast spread of diseases will limit potato cultivation
Availability of credit	• Presence of an intensive network of financial institutions throughout Punjab	• Input-intensive crop involves lots of cash • The procedural difficulties in getting loans when needed	• Availability of loqans from commission agents although cost is high.	• Lack of credit at harvesting forces the farmers to sell their produce at low glut-price

5.4.4. SWOT for Gilgit Baltistan Cluster

The whole area of GB is suitable for potato cultivation and the summer season and climate favor potato seed multiplication. Irrigation facility and isolated valleys with ideal temperatures during crop season make it the better areas for seed production. But long distance from Punjab makes difficult transportation. Moreover, production areas are away from main roads which create extra transportation. The Table 17 presents the SWOT analysis for the GB clusters.

Table 17: SWOT Analysis for Potato Gilgit Baltistan Cluster.

Parameters for SWOT Analysis	Strengths	Weakness	Opportunities	Threat
Environment/ climate changes	• Summer crop considered as off season • Always fetch	• Mono cropping of potato resulted	• Suitable areas for certified seed multiplication	• Mono cropping of potato resulted

	higher prices • Suitable environment and topography for potato production • Mild summers with optimum temperatures stay usually below 30 °C, • Night Temperature always below 10°C, suitable for tuber initiation Crop time start from April to October	spread of soil borne diseases • Small farmers and not able to purchaser seed and inputs • Most field are at long distance from main road and extra cost on transport • Use of autumn produce as seed unknown quality seed result poor yields	due to height and free from virus vector • Produce considered as off season and fetch always higher prices	spread of soil borne diseases. • Flood and landslides stop movement and cause destruction of fields
	• Gravity-fed channels collecting melt water from glaciers, snow fields, • Springs and river, water availability depends on glacier and snowmelt.	• Water supply is free, but it needs proper look after. • In most cases due to land sliding and flood in river destroy water channels	• Extension, research and water management departments exist	• Water availability depends on glacier and snowmelt. • Water is loaded with silt, low saline content • Some areas suspension of water supply cause failure of crop
Input Supplies	• Fertilizer, supply system working in cluster in main towns • Seed companies use to supply fertilizers to farmers on loan	• Imbalance uses of fertilizers • Nitrogen and Phosphorus is commonly used no potash application • Prices are almost double	• Loan facility is available from Commission agents and traders but on higher rates only for seed	• Development of resistance in insect and diseases
	• Quality seed	• 70% seed	• Traders, sub	• Seed borne

	supply is better in this cluster • Seed companies, Research department use to supply certified seed for multiplication	supply is informal and of poor quality • Autumn produce from Punjab mainly 3rd time multiplied crop having more than 20% virus infection used as seed • Red skinned varieties are grown	traders, farmer groups are supplying seed to farmers • Seed companies, development projects, GB research department use to supplying quality seed	diseases are spreading in this area • Soil infestation is increasing due to mono-cropping, which will create limitation to multiply certified seed
	•	•	•	•
Cluster Interaction	• small farmers in this cluster	• Poor Interaction with research and developments • Informal seed supply through trader without quality concern	• Research and Extension system present • The planting and harvesting is manual and land preparation is by tractors	• Poor quality seed is the main reason of low yields
Production technology	• Best summer crop as off season • The best area for seed multiplication due to better weather, free from virus vector and abundant irrigation water availability	• Punjab autumn crop produce is used as seed without quality concern • Very poor quality seed is being provided by traders to farmers • Seed cutting increase the infection of viruses • Imbalance use of	• Research and Extension system available • Temperate climate, long days, bright sunshine, Day Temperature not more than 30°C and cool night make this cluster suitable for certified seed multiplication • Good Water supply	• Spread of potato diseases, which lower both yield and quality • Sometime land sliding and flooding destroyed the produce

		fertilizers effect yield		
Transport facilities	• Road infra structure to main cities exist • Transport is available and little cheaper at harvesting due to Government wheat supply to this area. These trucks charge lower rate	• Difficult transportation from field to main road • Mostly harvesting packing, shifting from one place to other are manual • High fuel cost especially diesel • RS 400-600/bag transport to Punjab	• Metal road are up to main cities • Field to road side shifting of potatoes by donkey or by jeep or by small tractor trolley cost extra amount (Rs.100-300/bag) • Packing material of jute bags and plastic bags are available easily on all place	• In case of land slide mostly roads blocked and deteriorate the quality of potatoes • Due to long travelling some time truck become out of order due to road condition and produce quality deteriorate
Marketing	• Higher price due to off season • Good link and information with all markets	• Poor yield & low quality • Marketing is stepwise (Farmer to Local trader-main trader-commission agent) decrease farmer profit • Due to loan taken for seed and inputs farmers are bound to sale potato through traders	• Research and extension systems are present but not very active • Maximum prices of produce due to its off season	• Commission agent deduct extra commission at sale to recover loan • Blockage of road for more days result price fluctuation and lower quality • Ungraded packing also lower prices
Seed supply	• Seed supply is through: i. Public & private Seed companies ii. Commission agent,	• BG seed has following weaknesses; a. There is a mixing due to ground keepers b. Poor grading and over	• Good quality seed is available in Punjab • Farmers can keep seed in local pits or caller for next crop • Farmer can improve the	• The infestation of soil borne diseases are the main hindrance to multiply quality seed

	iii. Traders & sub traders iv. Local growers' group	size and small tubers are also included during bag filling c. Rhizoctonia and common scab is on most places d. Most farmers do not keep own seed for next crop	quality of seed by rouging	

6. CHALLENGES FACED BY THE CLUSTERS

6.1. Climate Change and Water Shortage

Like many crops in agriculture, potato stands to be affected by climate change, although not all factors result in negative effects. Factors which have a major impact on crop growth and development are: increase of CO_2 and temperature, water stress (either drought or water logging), salinization, solar radiation and ozone, and accompanied with these factors an increased pressure of pests and diseases. Higher temperatures promote foliar development, delay tuberization and influence potato quality characteristics such as higher numbers of smaller tubers per plant, and lower specific gravity which is indicative of lower dry matter contents (Haverkort, 1988). However, the possible negative effects of the optimum mean daily temperature for potato production are 20 to 25 ^{0}C and optimum soil temperature for normal tuber growth is 15 to 18 ^{0}C. The tuber growth is restricted below 10^{0}C and above 30^{0}C air temperature. Potato production largely depends on minimum night temperature rather than on mean daily temperature. As soon as night temperature rises to 20^{0}C, most of the present varieties become unproductive. Low night temperature (12 to 15^{0}C) favor potato tuber production, where as in Punjab Temperature at the time of autumn planting always above 30-35 ^{0}C, which result poor emergence and rotten of seed. However, the temperature is quite favorable for potato cultivation, although occasional temperature peak during summer adversely affect the summer potato crop.

Though potato is cool season crop, it cannot withstand frost. Depending on the intensity of the frost, the foliage can be damaged, or plant killed. Potato varieties cannot survive below 0 to -1^{0}C. Autumn crop in Punjab face this low temperature during end of December or start of January. In Punjab, autumn potato crop in cluster A and B are always affected by the frost in January and result 10 to 20% low yield. Therefore, Punjab potato growers are always on risk due to change in temperature. With this respect, Summer provides ideal temperature to grow potato in all the three potato clusters.

The regular water supply is very important to get proper yields, the shortage of water during bulking time result cracking and defect in tuber shape. In Balochistan water supply is a difficult and expensive and resulting lower yield as compare to all other clusters.

6.2. Production Level Constraints

6.2.1. Biological constraint

Many constraints derive from the biological characteristics of the potato itself. These include the low multiplication rates of seed tubers, and the technical difficulties and costs associated with maintaining seed quality through successive multiplications, owing to the

potato's susceptibility to soil and seed-borne insect pests and diseases. Seed tubers are also bulky: two to three tonnes per ha is the typical seed requirement. Stringent phytosanitary restrictions limit the movement of potato germplasm, seed tubers and fresh ware potatoes. Potatoes have high fertilizer requirements but low utilization efficiency. Post-harvest, fresh potato tubers deteriorate quickly.

Due to these inherent characteristics of potato seed and lack of cold storage facilities in GB, the seed produced in summer crop in GB has to be shifted to Punjab to put it in cold storage for the use of autumn and spring crop in Punjab. This movement as well as poor packaging and transportation facilities increase the costs as well as vulnerability of potato seed to virus attack. Same is the case for potato seed movement from Potato Punjab A and B Clusters to Potato GB cluster.

6.2.2. Lack of Efficient Seed System

Potato crop future is linked with the efforts by the public and private sector to improve seed quality and promote variety development as per demand of the private sector. However, Pakistan lacks an efficient seed supply system for the rapid deployment of new, improved varieties and regular multiplication and distribution of certified seed tubers. Causal factors include the limited technical capacity of human resources, lack of managerial expertise and inadequate resource allocations to seed systems and the potato subsector in general. For example, tissue culture is the most efficient way of producing true-to-type and disease free seed, but little resources are allocated on establishing tissue culture labs, and those established earlier in the public sector are not kept functional. Private sector has not been properly attracted to establish tissue culture labs, which is very critical not only to supply healthy seed to farmers but also to propagate good agriculture practices associated with good quality seed. Moreover, not enough research is conducted to develop Standard Operating Procedure (SOPs) for producing tissue culture seed of various varieties. This constraint is found to prevail in all the three cluster.

As a result, farmer-based seed systems are still common (informal seed supply system) and many actors (farmer to farmer, trader to farmers, commission agent to farmer) are involved in the supply of planting material of limited quality over the years, and contributed to expanding cultivation of the crop. Farmer seed systems face many challenges like, poor in technical knowledge, weak managerial skill and shortage of resources. The SOPs for on-farm seed production are also not followed. Poor on-farm seed production is more common in Potato Punjab A and Potato Punjab B clusters, although poor quality seed supply from Punjab more seriously affect potato production in Potato GB Cluster.

Presently imported certified seed availability is in November and farmers are bound to multiply this seed during spring season, which is not suitable for seed multiplication due to the presence of virus vector. The multiplication of seed during spring expose to the transmission of viral diseases by aphids. Due to viral diseases seed degenerated within 3-4 multiplications

In Pakistan, powerful seed lobbies create the most serious obstacle to the development of a local seed potato industry.

Table 18: Gaps and Constraints at Production Level.

Sr. No.	Parameters	Punjab Cluster		GB Cluster
		A	B	
1	Varieties for:			
	Fresh/table use	Excellent	Excellent	Excellent
	Processing	Few	Few	No demand for processing potato variety as produce of summer crop is sold at high price as off-season fresh table potatoes on premium price.
	Frozen potato	Few	Few	
	Export	Few	Few	
	It is dire need to select new varieties to meet the future demand of Processing and export			
2	Farm size	Large/Med	Large/Med	Med/small
3	Extension services	Moderate	Moderate	Poor
4	Input Supply			
5	Seed Certified (1-3%)	1-2%	1%	2-3%
	Informal seed supply (97%)	Best	better	Poor
6	Fertilizers	Available	Available	Available in main town and expensive due to high transportation cost.
	N-use	Excessive	Excessive	Normal
	P- use	Normal	Little less than optimal	Significant less than optimal
	K –use	Less	Less	Less
7	Chemical use	Excessive	Normal	Rare
8	Mechanization	Fully	Fully	20% (land preparation only)
9	Storage facility	Good	Good	Natural storage
10	Labor input	Hired	Hired	Family or share basis

6.2.3. Diseases and insect pests

Diseases and insect pests are another major constraint. Late blight constitutes the most serious threat to increased potato production. Rhizoctonia and Common scam is available in all potato growing areas of Pakistan and its infection lowers the quality of export potatoes. Major insect pests include aphids, leaf hopper, cutworm etc. Virus loads are much higher in Punjab clusters than in Potato GB Cluster.

6.2.4. High production costs and poor financial institutions

The production of potatoes is capital-intensive, requiring the purchase of large quantities of bulky and costly seed and application of high-cost other inputs such as fertilizers and pesticides. On the other hand, the access of small farmers to formal credit institution is poor and the procedure of getting loans from these institutions are cumbersome and these institutions are plagued with corruption. Growers, especially small farmers, fall prey exploitative practices of arthies (traders) and commission agents.

6.3. Marketing Constraints

6.3.1. Price instability

Potato is a cash and input intensive crop and small-scale potato growers are vulnerable to abrupt changes in input and output prices. High seasonal and year-to-year price movements seriously affect small growers who lack the financial resources and resilience for such fluctuation. There is no proper mechanism to cope up with instability in potato market. Such instability also affects the development of long-term relationship in international market for export. Added to this is the government sensitivity of high potato prices in the country which usually results in banning the potato export and even sometime cheaper imports from neighboring countries. This kills the long-term relationship of the traders in international market which are so dearly established. On the other hand, no measure is taken when the potato prices crash within the country along with in international market.

6.3.2. Inefficiency of local markets

Potato prices are usually determined by supply and demand, not managed by the government like in cereals. The profitability of potato depends on efficient local markets and measures to control overproduction. Punjab growers have better knowledge and link with potato marketing channels. They usually send their produce to different markets for better prices. However, small farmers always dependent on ‘arthies’ and commission agents for marketing who have stronger market powers.

Ninety percent of GB potato cluster’s farmer relay on commission agents and traders due to poor information, long distance from the nearest market, high cost of transportation and smaller quantities than one truck load. These farmers are not in position to hold produce for short time, whereas commission agent and traders are in position to hold potatoes in temporary storages. In the Potato GB Cluster, emphasis is given to start seed production as main crop and table potato as second priority. Seed always has better marketing. However, seed crop in Potato GB Cluster is harvested in May, while demand for seed in Punjab comes in September. As no good storage facility is available in GB, therefore seed

grower in Potato GB Cluster have to transport the potato seed and store it in Punjab until its demand emerges. This increases the cost for the GB potato seed growers.

6.3.3. Limited access to high-value markets

Small-scale potato growers need access to profitable emerging domestic markets – such as the rapidly growing processing segment – as well as to potato export to high-end markets. However, access to domestic markets is often restricted by the marketing power of investors, while exports of processed high-price products from the developing world are constrained by trade barriers in developed countries. Small farmers neither have capacity nor skill to meet the requirements of high-value markets without the government support.

6.4. Capacity Constraints

6.4.1. Lack of capacity building initiatives

Capacity building support for the adoption of new varieties and for the integrated disease and insect pest management technologies and methodologies are generally inadequate. Programs to upgrade the skills of potato growers to produce quality potato and for other stakeholders for efficient management of value chain is needed to produce the quality potato for high-end markets.

6.4.2. Lack of farmers' organizations and entrepreneurship

Most of the government supports like fertilizer subsidies, extension services, etc. are individual farmer oriented and do not support farmers' organization into groups. Support for potato farmer groups and associations and for local entrepreneurship is lacking in Pakistan. Government should encourage through proper incentives the formulation of Farmers Entrepreneur Groups (FEGs) for collective actions to monitor and enforce regulations on pesticide use and the spread of pesticide or fertilizer residues into water supplies, which are major constraints to the sustainability of potato production systems. The FEGs can ensure the potato quality to processors as a group, will reduce the cost of potato quality certification, and improve the access to market information.

Heavy bags of 110-120 kg weight are difficult to handle and cause rotten of tubers due to different shock during shifting from one place other. Further details of constraints are given in table-18.

6.5. Constraints in Processing

6.5.1. Little potato processing

At present mainly, potato chips and French fry manufacturing are established in the value chain. Only few processors, significantly Pepsi Cola (Frito Lays), Ismail Industries (Kurleez), Dalda Snacks, United Snacks, Tripple Im, Lotte Kolson and Fuji Fresh are engaged in this business. The former company have international presence and has a loin share in whole processing in Pakistan. There are small scale potato fryers and bakery network in all big cities supplying French fries and covering the snacks market. These processors, however, failed to tap the international booming markets of French fries and snacks. No significant processing industry is involved in frozen potato and potato flour manufacturing and export. Informal small-scale potato chips manufacturing stalls are scattered throughout urban areas in Pakistan. These stalls have serious phto-sanitary issues and do not lead to any branded product for export. Proper incentives are required to establish potato chip as a cottage industry in rural areas and to tap the booming export market.

6.5.2. Unavailability of appropriate processing varieties

High dry matter is a key factor in processing. Varieties having high dry matter are important for quality products. Presently few such varieties are being grown by farmers. The seeds of these varieties are supplied by processor to selected contract growers every year, but not freely available in the market for small resource poor farmers. The supply of potato for processing is limited to only 10% of the total production, which is very low by international standards.

Second major constraint is related with cold store; if produce is stored at low temperature below 4^0C, the potatoes become sweet due to conversion of starch into sugar and quality become poor. Maintaining proper temperature in potato storage is very important to maintain the quality of potato.

In summary, an agricultural policy guiding public and private investment and sector support programs to develop pre-basic seed multiplication facilities by tissue culture labs in Punjab, and GB clusters is the key for potato sector improvement in the country. Site specific farm seed improvement campaign involving the private and public sector seed companies and famers has to be started with the help of Federal, Provincial research and extension departments. Varietal improvement research specially to enhance the potato supply for manufacturing needs to be strengthened.

Presently variety evaluation activities are being conducted in different research stations in isolation, which need to be coordinated by the industry to keep priority of export and processing industries.

To run program successfully the development of trained human resource is the key. Therefore, training of potato related staff in the public and private sector as well as for farmers and other stakeholders along the value chain must get high priority. This is especially necessary to produce the high quality seed.

Information flow regarding the forecasted demand, supply and price situation of potato in the domestic and international markets, and changing quality parameters in different international markets has to be a regular feature.

The spread of soil borne diseases in potato growing area is a threat to quality produce, especially when quality is increasingly becoming a big concern among consumers, exporters and processor. To match the supply with demand for quality potato, GAP application should be developed and promoted to farmers, by governments and the private sector. The FEGs can play a critical role in implementing the GAP in a coordinated and comprehensive way.

7. POTENTIAL AND OPPORTUNITIES

7.1. Production Potential

As stated in Section 1, Pakistan is 19th producer of potato in the world. The global average yield is 19.58 tonnes/ha during 2016, whereas in Pakistan it is 22.45 t/ha – but yield is lower than that of developed countries as USA and Holland where average per ha yield is 49.02 tones and 42.0 tonnes respectively. However, potato yield in Potato GB Clusters is even lower as compared to Punjab clusters at 14.28 t/ha. The lower yield in GB are related with seed quality and management practices.

The autumn crop share in Punjab is 92% of potato production in the country, the growing days are about 90-100 days while the summer crop growing days are always 150 days. In Europe potato yields are higher mainly due to summer season, proper use of inputs including high quality seed and farm mechanization. But in Pakistan potato summer yields are very poor mainly due to poor quality of seed and imbalance use of inputs.

Punjab cluster A & B already getting better yields as compared to GB cluster due to better quality seed, proper inputs and better cultural practices along with the application of mechanizations in most crop operations. So there is less potential of increasing yield in Punjab clusters. It is anticipated that the potentials in these clusters are 15% higher yield. The yield enhancement will entirely be related with the enhancement in seed quality both by supplying tissue culture-based virus free and true-to-type seed as well as with the improvement in the on-farm seed production.

In Potato GB Cluster, seed supply is from Punjab and 95% of the seed is 3rd or 4th year's seed, the quality of which is already deteriorated resulting in poor yield. in this Cluster, yield can be improved upto 30%. This potential can be harnessed by introducing high-yielding varieties, improved management practices and improving the seed quality as in Punjab clusters.

The 15% increase in yield in Punjab clusters from its current level can result in an additional production of 487 thousand tonnes, valued at US$ 58 million at the current wholesale prices of potato, while 30% increase in yields in GB cluster can result additional production of 13 thousand tonnes, valued at US$2.4 million.

This increase in production can be absorbed by increased demand in the cities, expected growth in e-commerce and enhanced exports. As noted earlier, lots of potential exists in international market, especially in processed potato products. Some of the increased production will also be absorbed in enhanced potato processing activities, as noted later. Increasing production potential shall result in creation of new jobs at production and processing levels. The new jobs are expected to be created at various levels from the extension of production and value chain support services.

7.2. Improving Export-Production Ratio

The Potato is the most important crop in Pakistan after cereals with a potential of earning a significant amount for foreign exchange. After meeting the domestic consumption demand and procurement of seed for the next growing season, the marketable surplus is about 1.0 million tones, with a potential to generate revenue of around US$ 0.15bn. Russia, Sri Lanka, Malaysia, Central Asia and the Middle East are big markets for the Pakistani potato.

During 2017-18, Pakistan exported only 15% of its total production, whereas as Pakistan has about 25% surplus production. This surplus production is a major issue creating glut in the market and causing heavy losses to potato producers. If prices go lower than Rs13/kg, farmer loss started. One rupee less price of potato means Rs.24700/ha loss. Therefore, our target is to increase export from 10% to 15% through proper commercial strategies in five years.

During 2017-18 Pakistan exported fresh potato about 417 thousand tonnes with a valued of US$81.97 million and it is about 10% of the total production in the country. The harvesting of autumn start in January and export of potatoes can easily start from February to May to Russia and other country. During these months there is a shortage of fresh potatoes in the said countries. Pakistan can easily enhance export by improving tuber quality through controlling soil borne diseases and introducing varieties having resistance against Rhizoctonia and Common scab. Improved interaction with international market, better information on international markets can also help to improve the export-production ratio. The Punjab clusters can significantly increase its export and we assume that its production-export ratio can be improved up to at least 13-14% within five years. This is expected to generate additional annual foreign exchange of US$21 million in the Punjab Potato A and B Clusters. The export needs proper support from Government to develop stronger links with international market. Moreover, varieties need to introduced which have characteristics highly demanded in international market.

7.3. Improvement in Quality

Low quality as reflected in the lower price for Pakistani export than the world average is presently the major problem faced by potato traders in the domestic and international markets. The use of poor-quality seed results in poor quality outputs. The second quality crisis that hits the crop is when temperature fall well below freezing point in late December and January and frost causes wilting of branches, keeping size of potato small and terminating the crop early. The third quality threat to potato crop is the appearance of late blight during autumn, spring and summer season. In most cases farmers loose, good production if late blight appears in any crop season.

These factors combined significantly reduce the quality of potato output. The above mention problems can be addressed by introducing new varieties along with better pre-

and post-harvesting harvest management practices which can help to reduce losses and improve quality. The improvement in quality is positively related with development of improved quality and certified local seed, and use of temperature tolerant and blight resistant varieties. It is very important at planting that farmers are clear in their minds what purpose (export or processing or table consumption in local markets) they are planting potato crop for. Each type of crop has different cultural practices to improve quality. The main problem is that we start thinking of export when there is over production. Everything cannot be exported and export needs continuity and consistent quality in international markets.

The quality of potato can also be greatly enhanced by improving the potato market structure and its functions, which include:

i) Conducting marketing and market surveys to determine the seasonal storage requirements for potatoes in a growing area.

ii) Branding of products for the market whether for seed, ware or processed products will help develop identities in the market and develop products, thereby helping to improve quality and farm incomes.

iii) Developing marketing sheds in the potato growing areas where potato can be properly washed, sorted, graded, and packed and marketed to market agents

iv) Properly storing the crop in specifically designed store for the crop as and when needed.

Improvement in the quality of exported potato so that it can receive at least average of international export price and raise the 5% of domestic production quality to the average of international quality will generate extra income of US$56 million. Huge opportunity of generating this additional income exists if proper varieties are introduced, balance fertilizer is used, diseases and insect are controlled, crop certification is enforced, packaging materials are properly used, and proper transportation of potatoes are introduced in the system.

7.4. Reduction in Post-Harvest Losses

One of the major concerns of agriculture in the country is high post-harvest losses. Average harvesting loss was found 5.65% of total production. Harvesting loss comprised insect damage (1.21%), rotten loss (1.40%), cutting loss (1.14%), potato remained under soil during harvesting (0.89%), and other losses (1.02%) such as off size, green potato etc. Farmer's stored produce in big heaps covered with thick rice straw to save it from rain and sun heat for a period of 2 to 3 months. In this period the storage loss was found to be 7.35%. Total pre-storage loss (harvesting, curing, cleaning and sorting) at farm level was 8.15% and total postharvest loss was found to be 15.5% including farm level storage loss (Hohain and Maih, 2009). Storage is important both for seed and ware potatoes as it helps

reduce waste and prevents processing losses if handled correctly. Good storage is required for seed, ware and processing varieties to maximize food availability and markets.

Good quality potatoes should be used for storage, thereby indicating the importance of cleaning and grading the produce prior to storage. Good cold store management are essential whether it is for small or large cold stores. All together we suggest to reduce these losses by one half which will generate an estimated revenue of US$2.9 million at the existing potato prices in Punjab clusters only. Some potential exists to reduce these losses by using good varieties with better keeping quality, training of farmers and other stakeholders along the value chain on how to properly manage the value chain, especially transportation of potato, to reduce post-harvest losses.

7.5. Improved Processing

Potato processing has great potential, currently about 214 thousand tonnes' potato is being processed in 2018 and within last 5 years the consumption of processing potato products has increased from 120 thousand tonnes. Three new processing companies launched their processed products in market during 2017. The growth rate of snack Industry is estimated at 20-30% per annum. Children, teenagers and young people like products and we have the experience that the eating habits of the target market are rapidly changing, and they like to have snacks all the time. Further potato and corn snacks are being labeled as a meal replacement and its use as a light fast food is becoming popular. We need new high yielding varieties with processing traits to meet the future demand of local consumption as well as for export, which are readily available with international companies, like PEPSICO. The present processing industry is providing new employment opportunities and processing helps in handling the excess potato crop after the harvest.

Presently about 5% of total production is being used by processing industries in Pakistan. Like export, processing also provides stability in production and better prices to farmers. Processing industries are providing following incentives to farmers:

- Quality seed on prices
- Contract to purchase on fixed rate at planting
- Collection of produce from field

Great opportunity exists to harness this potential by adopting new processing varieties which are already available with the private sector or can be made available quickly by importing and testing these varieties under the local condition. Our estimate suggests that currently only 5% of the total potato production goes into processing, while international about 25% of potato production is processed into various products like potato flour, chips, French fries (FF), etc. In Pakistan, if processing varieties are adopted on additional say 3% area, it will generate US$0.33 million as additional income to farmers and it will generate processed product worth of US$29 million. It will also absorb about 36 thousand tonnes of

fresh potato thus help in stabilizing the market. The expansion in processing industries will provide more services.

7.6. International Standards

Potatoes for export should have quality of international standards; we must adopt international quality standards at each segment of the value chain. IPPC - the International Plant Protection Convention - is the international treaty under which common standards are developed for pest control in plants and plant products across international borders. The Commission on Phyto-sanitary Measures (CPM) is the governing body of the IPPC and it has adopted several International Standards for Phyto-sanitary Measures (ISPMs) that provide guidance to contracting parties in meeting the aims and obligations of the Convention.[1] In addition, each country has its own specific standards for each crop.

Recently United Nations Economic Commission for Europe (UNECE) developed quality standards for ware potato to facilitate international trade, encourage high quality production, improve profitability and protect consumer interests. UNECE standards are used by governments, producers, traders, importers and exporters, and other international organizations. They cover a wide range of agricultural products, including table and seed potatoes, meat, cut flowers, eggs and egg products. Any member of the United Nations can participate, on an equal footing, in the activities of the Working Party. For more information on agricultural standards, please visit the website www.unece.org/trade/agr. The present revised standard for early and ware potatoes is based on document ECE/TRADE/C/WP.7/2011/8, reviewed and adopted by the Working Party at its sixty-seventh session (Aligned with the Standard Layout, 2017). Generally, potato exporters are used to follow the standard of importing country.

In summary, a new orientation is needed to be competitive in international market. If the country invests in R&D and quality infrastructure, it can generate foreign exchange and increased income for farmers, middlemen, and traders, and generate new employment in the potato growing areas in the country. Most of this employment will be for the poor in crop and value chain management processes thus bringing down poverty in rural areas.

8. PLAN, POLICIES AND STRATEGIES

8.1. The Plan

Looking at the gaps and potential and discussion with stakeholders help us to fix the targets that can be achieved through concerted efforts by designing a five-year project. The Plan of the project would be as follows:

Table 19: Target of Potato Cluster Plan

Sr. No.	Targets
1	To increase yield by 15-25% from the current base in different potato clusters.
2	To significantly reduce the import of potatoes seed.
3	To improve on-farm seed potato multiplication by positive and negative selection.
4	To enhance export-production ratio from 15% to 20%
5	To improve the value chain of potato so that Pakistani export and 5% of the domestic production can earn at least equal to the world average export price.

8.2. Policy Reforms

At the policy level, the current practice of the government of intervening the sector for the purpose of keeping potato price low for the interest of consumers by allowing potato imports, threatening the potato storage people, and/or fixing the upper limits in the wholesale markets for auction whenever prices of potato starts improving for the benefit of producers should be stopped immediately. Instead the government should clearly announce the upper and lower limits of potato prices which should be wide enough for the private sector to operate freely. Secondly, the government should realize the financial needs of the sector, and provide liquidity to small potato farmers on easy terms and make its access easy. Thirdly, as potato is a very complicated business at all levels of its value chain, and with increasing demands for food quality and safety it is becoming even more sophisticated. A program of training covering all stakeholders along the value chain to produce quality potato and handle the value chain efficiently is urgently needed. Fourthly, information about the changing demands of potato and its product and its quality parameters need to be collected regularly and mechanism should be settled to efficiently communicate the information to appropriate stakeholders. Fifthly, the government should provide support and incentive structures should be directed towards organizing farmers into FEGs. All the cluster-based structures should be owned by these groups. Vitalizing these groups would be a key element of the strategy, for achieving economies of scale access to inputs, finance, technology, and market information. The Potato GB Cluster having capacity to produce quality seed and Punjab has the potential to export ware potatoes. These groups would be established at the union council level in major potato

growing areas. Special loans would be provided on concessional terms to each group to allow them to market their produce under a brand name, help members in adopting best practices, hold trade fairs, competitions, and arrange various training events etc. They can ensure potato quality as a group thus reduce the cost of certification and monitoring and can start contract farming with processors and traders.

All these policy initiatives cannot be successful without a responsive R&D system towards its stakeholders. So there is a need to reform the system to make it resolve the issues of stakeholders. It must be independent and driven by the major stakeholders, like farmers, processors, traders, etc.

A common intervention recommended for each cluster is to form a Pakistan Potato Association (PPA) and each cluster can give local name like Okara potato association. This entity should have a website of its own and work to promote best practices, share knowledge, technology and lobby with government for enabling policies, on behalf of its members. PPA should also develop apps for marketing and represent potato growers and traders in international fairs and events.

8.3. Production Level Strategies and Programs

The primary production strategy is to narrow the yield gap with the high yielding country. Although potential can be higher, but currently the plan is to increase the yields by 15% in Potato Punjab A and B Clusters. This fifteen percent increase will be over and above the 2% increase already occurring without any intervention these clusters. Please see the EXL model to see the realization of potato yield in each cluster. For achieve these yield levels, following strategies will be adopted.

8.3.1. Renovating the potato research system

The Punjab cluster already is blessed with the services of the Potato Research Institute (PRI) in Sahiwal as well as some basic research work on potato in Vegetable Research Institute, Faisalabad. However, the institute lack sufficient resources to be engaged in the effective problem-solving research with stakeholders. Following strategies will be adopted to improve the effectiveness of the Punjab research system.

- Broaden the research agenda from breeding and agronomy to the issues along the value chain.
- Engaging stakeholders along the value chain in the private sector in identifying, broadening, planning, and implementing the research agenda of PRI.
- Providing additional funds linked with problem-solving and output-oriented research.

- Special funds for importing of hybrids, germplasm, machines, and technologies related to ware (table), export, and processing potatoes and adapt these to local conditions in VRI Faisalabad.
- Special funds for linking scientists with international potato research. This may include visit of the scientists in international potato centers and universities and inviting internationally reputed scientist to Pakistan on high-priority potato issues.

Pakistan needs potato germplasm having traits of high yields with tolerance to Fungal and bacterial diseases. Such germplasm can be obtained from International Potato Centre (CIP) and Holland. CIP being international center can help in better way to provide technical guidance and assistant. Presently potato seed importers also provide their new verities for adoptability trials. This can be further facilitated to enhance the germplasm of PRI and VRI.

8.3.2. Promotion of improved technologies

The improved and tested technologies will be promoted to stakeholders along the value chain by adopting the following strategies:

- The yield increase will be obtained by starting a campaign on the adoption of already existing new high-yielding varieties which are readily available with the public and private sectors, especially for processing and export.
- Organizing FEGs at union council levels and engaging them in promoting potato production technologies, especially related to pest control.
- Involving FEGs in demonstrating and training of farmers about pest and diseases management technologies.
- Engage trade and processing associations to demonstrate various value chain technologies

8.3.3. Development and supply of certified seed

Presently the certified seed supply is only 1-2% and very expensive, costing about PKR247000/ha. Expensive seed can make potato cultivation unviable for small farmers. Moreover, this seed is not easily available for all farmers. Therefore, Pakistan must establish own seed supply system. Potato crop propagation is through vegetative which make it vulnerable and susceptible to viral as well soil borne diseases. To overcome this weakness, establishment of new tissue culture laboratories in the private sector and renovation of existing labs will be incentivized to make them fully functional and productive to achieve given targets.

i. Tissue culture lab already exists; For example, cluster A has 7 labs, cluster B has 2 lab, GB has five, and Balochistan cluster has one labs. These labs are in the public sector and non-functional or under functional. Presently NARC (Islamabad), Punjab Seed

Corporation (Sahiwal), AARI (Faisalabad) HARS (Abbottabad) 4 labs (GB) few private labs in Punjab are producing 1-2% of quality seed which needs to be enhanced by at least 10% within next five years. The major proposed intervention is seed production through tissue culture labs which will help to increase availability of quality certified seed up to 5% in Potato Punjab A, 10% in Potato Punjab Cluster B, and 20% in the Potato GB Cluster. The higher increase in certified seed in the GB cluster is not only possible because of the smaller potato area and lower number of tissue culture lab requirement, but it is also needed to improve the seed quality for Punjab. For these objectives to achieve, Potato Punjab A Cluster will need 108, Potato Punjab B Cluster 28, and Potato GB Cluster will require 8 new tissue culture labs.

ii. In addition to establishing new tissue culture labs, the NARC, ARRI, PRS-Sahiwal, PSC-Sahiwal, RARS-Abbottabad, GB-4 labs + I in MARC will be renovated.

The public sector labs will prepare the protocol for the tissue culture seedlings and private sector will be trained for these protocols. The establishment of the private sector labs will be incentivized on cost sharing basis. Incentives will be provided on developing and supplying the tissue culture seedlings.

The own-farm potato seed production system, which is currently is the major source of seed supply, will also be strengthened by:

- On farm seed improvement by promoting proper rouging as a campaign.
- Farmers' Fields School of seed producers will be arranged through FEGs to train farmers to improve seed quality on their farms.
- Training of extension worker & service providers on quality seed production to continue the on-farm seed production on sustainable basis.

8.4. Marketing & Trading/Export Strategies

The purpose of improving the marketing and trading/export level strategies are wo-folds:

i. Improve the export-production ratio

ii. Improve the quality of the produce so that Pakistani export and 5% of the domestic production can achieve at least average international export price.

For this following strategies are proposed:

8.4.1. Improve International interaction

An information Cell will be established in PRI who will collect and analyze the data related to various markets and disseminate the information to FEGs, trade associations, and policy makers. Data will be collected on the changing quality requirements, prices, and protocols to be followed in various international markets. Forecast on expected supply

from various clusters, expected demand in various international markets, and expected prices in these markets will be estimated and disseminated to relevant stakeholders. Information on various advance and new technologies available on various aspects in major potato producing countries will be collected and disseminated.

i. Holding competition and rewards for exporters. Special competition will be held and rewards will be provided for outstanding exporters (Fresh as well as processed). These competitions will be held at the cluster level among different stakeholders, like fresh potato exporters, best processed potato exporter, best seed producers for processing and export, etc.

ii. Tours of various stakeholders will be sponsored to attend high-quality technology international conferences and exhibitions, food exhibitions, and farmers and processing industries in advance potato producing countries.

8.4.2. Improve potato value chain

One of the main problem of the potato sector is its poor value chain as reflected by the lower price of Pakistani potato exported as compared to the world average export price. To improve the potato chain so that Pakistani potato being exported and 5% of the Pakistani potato destined in local market can earn at least as much as average export price in international market, following strategies will be adopted.

8.4.3. Capacity building of stakeholders along the value chain

Handling of potato quality at each segment of its value chain is a difficult task. A slight change in temperature from the optimum required and little mismanagement can rapidly deteriorate potato quality. Therefore, to properly handle potato quality, all stakeholders along the value chain should be trained. A comprehensive training program on various aspects of potato value chain management will be initiated. Foreign consultants will be engaged in developing training manuals and training of trainers on various aspects of the value chain. At least 500 farmers, 10 processors, 10 seed producers, 5 potato seed companies, 5 storage people, and 5 traders will be trained on quality potato production and proper value chain management.

8.4.4. Incentivizing the provision of value chain infrastructure

Following infrastructure will be encouraged in the private sector to improve the quality of the value chain:

- Collection centers/shed houses at the potato producing union council levels under the management control of FEGs where basic facility of potato cleaning, washing, grading, cooling, and packing will be available. Initially the management staff and cost will be provided by the government which will be ultimately shifted to the FEGs. Farmers will be charged or any services they receive form the collection

center and the profit will be share based on the proportion of investment famers contribute. These collection centers will also serve as focal point for marketing where traders can come and buy potato according to their required quality.

- Establishment of small farm cold-storage will also be incentivized in Potato GB Cluster.

8.4.5. Develop strong linkage among clusters.

The informal 95% seed supply to summer crop is from Punjab. In most cases traders, commission agents, farmers' groups are involved in this seed supply. The profit margin of traders is related with the cost of seed. High quality seed like first multiplication of imported seed is very expensive and not easily available. Seed cost relates with number of multiplications. Diseases infection intensity is also related with no of multiplication, as more multiplication mean higher infection of viral diseases. Traders and commission agent always go for cheaper seed to earn better return. Due to this unknown source of potato seed supply to summer crop result poor yields especially in Potato GB Cluster. Potato production for export and processing need proper look after at each step of potato crop start from seed to harvest. This is only possible through contract growing. The FEGs are proposed to develop strong bridge among all actors related with production, export and processing.

8.5. Enhance Potato Processing

The seed for processing in Pakistan is imported and costly. Moreover, fast food restaurants import French fries to maintain their quality and taste of their branded products. Therefore, a program in PRI will be initiated with the help of the private stakeholders to select varieties appropriate for processing and meet the needs of the processors to make the supply chain regular with high quality to compete in international market. Processing varieties will be imported and adapted to local needs if full benefits of processing are to be obtained. The intervention will result increased supply of potato for processing.

The private processing companies make contract with large farmers and thus leave small farmers to benefit from the emerging opportunities in processing. The FEGs will be trained to produce quality processing potato to the requirement of the processors and restaurants so that the quality can be ensured at the group level and contract farming with FEGs will be promoted. The formulation of FEGs will reduce the certification costs of the farmers and monitoring costs of the processors.

Special incentives will be provided to FEGs to establish small scale potato processing cottage industries. The investment for the processing unit will be shared by the members of the FEGs and so will be the profit proportionate to their investment. Government will help the FEGs to make detailed feasibility and subsidize the unit at 20% cost.

9 Benefits and costs of clustering

9.1. Overview

The economic and financial analysis of potato clusters has been carried out by identifying the benefits of the proposed interventions and their associated costs. Cost and benefit analysis have been done in a five-year timeframe; separately for each of the three clusters. Discounted cash flow analysis has been carried out to work out the economic viability of the proposed interventions in terms of NPV and IRR.

9.2. Key Interventions, Benefits and Costs

Following five key interventions have been proposed for transformation of Potato sector of Pakistan.

i) improvement in yield by increase in yield and crop management
ii) improvement in potato yield by use of tissue culture seeds
iii) improvement in yield by on-farm seed improvement
iv) increase in potato exports
v) improvement in value chain to enhance potato price in domestic market
vi) Increase in potato supply for to processors
vii) Production of value added potato products

The expected benefits by implementing the proposed interventions have been based on certain assumptions which have been decided in discussion with potato sector experts. Expected benefits have been calculated with reference to the baseline situation of each of the three clusters. Based on the assumptions, the value addition by implementing these interventions has been calculated in a five-year timeframe.

The resources required for the implementation of the proposed interventions package includes i) additional operational costs of improved potato production, value chain development, and processing, and ii) sector development investments like R&D by government and fixed capital investment in machinery, etc. by government and private sector. The whole analysis has been based on incremental costs and benefits of the proposed interventions.

The detailed feasibility of potato chips making unit is separately estimated and explained in Appendix. For two clusters, the number of potato chips making unit required was estimated based on the estimated potato quantities that will be processed and capacity of the chips manufacturing unit. Total investment and operational costs of processing in each cluster were incorporated in the main feasibility model. However, in the following section, we just explained the feasibility of the whole package of interventions.

9.3. Punjab A Potato Cluster

9.3.1. Current Situation

The study has considered 54,073 ha of area under potato production in the focal point of Punjab a Potato cluster which is currently producing 1,269,735 tonnes of potatoes per year. Current yield in the cluster is 23.48 tonnes/ha; growing at 2.0% per annum. Following table shows the cluster's current production performance.

Table 20: Punjab A Cluster – Current Production Situation.

Potato Cluster in Punjab A – Current Situation	
Area under cultivation in cluster (ha)	54,073
Total Production (tonnes)	1,269,735
Production yield (tonnes/ha)	23.48
Annual yield growth without intervention	2.0%
Farm gate price of Potato (US$/tonne)	119

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

Table 21: Punjab A Cluster – Potato Production in No-Intervention Scenario.

	Year 1	Year 2	Year 3	Year 4	Year 5
Default yield (tonnes/ha)		24.42	24.91	25.41	25.92
Annual expected production without intervention (Tonnes)		1,320,524	1,346,935	1,373,874	1,401,351
Total value of production at farm gate (Mil US$)		157	160	163	166

9.3.2. Benefits of the Proposed Interventions

9.3.2.1. Intervention 1 – Introduction of High-Yielding Varieties and Improved Crop Management

The production yields in the two potato clusters of Punjab are already in the satisfactory range. The potential of yield improvement has thus been considered only for the potato cluster of Gilgit Baltistan which has lower yield.

9.3.2.2. Intervention 2 – Introduction of Tissue Culture Seeds

Supply of tissue culture seeds will be improved through an agricultural policy guiding public and private investment and sector support programs to develop pre-basic seed multiplication facilities by tissue culture labs. The yield enhancement will entirely be related with the enhancement in seed quality by supplying tissue culture-based virus free and true-to-type seed. It is estimated that these efforts in Punjab A cluster will increase the Potato yield by 10%. Area on which the tissue culture seed is used will be increased from 1% to 5% over a period of five years at a rate of 1.25% per year starting from the second year. Moreover, it is assumed that the potato produced from tissue culture seed will be able to get a higher price of US$ 130 per ton (10% higher). Based on these assumptions, the value of increased potato production is shown in the following table 22.

Table 22: Punjab A Cluster - Increased Potato Value by Tissue Culture Seeds.

	Year 2	Year 3	Year 4	Year 5
Percent of total area on which tissue culture seed is used (%)	1.0%	2.0%	3.0%	4.0%
Area to be brought under the use of Tissue culture seed (ha)	541	1,081	1,622	2,163
Tissue culture seed requirement (ton/ha)	3	3	3	3
Tissue culture seed to be produced (tonne)	1,622	3,244	4,867	6,489
Increase in yield due to the use of tissue culture seeds (tonnes/ha)	2.4	2.5	2.5	2.6
Increase in production due to the use of tissue culture seed	1,321	2,694	4,122	5,605
New price of potato produce (US$/tonne)	130	130	130	130
Additional value at the farm due to the use of tissue culture seed (US$)	15,651	31,927	48,849	66,434

9.3.2.3. Intervention 3 – To Improve On-Farm Seed Production

Along with the use of tissue culture seeds, on-farm seed improvement will be other important intervention to increase yield. Proper rouging will be promoted as a campaign. Farmers' Fields School of seed producers will be arranged through FEGs to train farmers to improve seed quality on their farms. Training of extension workers and service providers on quality seed production will be continued on on-farm seed production on sustainable basis. This will lead to increasing the value of the potato crop for the farmer. It has been assumed that 15% cluster area will be covered under this intervention at a rate of 3.75% per year in four years. This will lead to increase production yield by 5%. Area for which the rouged seed will be used will be five times. The intervention will occur from the second year when the results of improved value chain management practices will be realized.

Based on these assumptions, the value of increased potato production in Punjab A cluster at the existing rate of US$ 119 per ton is shown in table 23.

Table 23: Punjab A Cluster – Increased Potato Production by On-Farm Seed Improvement

	Year 2	Year 3	Year 4	Year 5
Acreage to be covered under improved on-farm seed production (%)	3.75%	7.50%	11.25%	15.00%
Acreage to be covered under rouging (ha)	2,028	4,055	6,083	8,111
Area for which rouged seed would be used-assuming one ha of rouged field can supply seed to 5 ha	10,139	20,277	30,416	40,555
Percentage increase in yield due to the use of properly rouged seed (%)	1.22	1.25	1.27	1.30
Increase in production due to the use of properly rouged seed (tonne)	12,380	25,255	38,640	52,551
Additional value of improved seed (US$)	**1,467,249**	**2,993,189**	**4,579,579**	**6,228,227**

9.3.2.4. Intervention 4 – To Increase in Exports

The proposed plan envisages increasing potato exports of the country. Pakistan currently exports 15% of the total national production of Potato which is very low. It is estimated that with focused efforts, it will be possible to export 20% of the total production of the Punjab A Potato cluster. These efforts will include sponsored tours of sector stakeholders to attend high-quality technology international conferences and exhibitions, food exhibitions, and farmers and processing industries in advance potato producing countries. Competitions and awards will be announced for leading exporters. An information Cell will be established in PRI who will collect and analyze the data related to various markets and disseminate the information to FEGs, trade associations, and policy makers. A linear export growth at the rate of 1.25% per year has been assumed to achieve the additional 5% export target in four years. Additional exports have been valued at the existing average export price of US$ 197 per ton. It is assumed that increased exports will start from the second year of interventions. Based on these assumptions, the value of increased potato exports is shown in table 24.

Table 24: Punjab A Cluster – Increased Potato Exports Value

	Year 2	Year 3	Year 4	Year 5
Present export without intervention (% of the current production)	200,824	207,683	214,780	222,122
Increase in export (%)	1.25%	2.50%	3.75%	5.00%
Total volume of potato to be exported (tonne)	16,678	34,372	53,124	72,975
Expected additional value from exports (US$)	**1,308,899**	**2,697,573**	**4,169,237**	**5,727,214**

9.3.2.5. Intervention 5 – To Improve Value Chain in Domestic Market

The improved value chain activities as highlighted in the post-harvest section and improved interaction with international market as highlighted in the previous section will improve the quality and price of Potato to be marketed in domestic market. It is assumed that 5% of the total production from the cluster will be sold at par with the export market price of US$ 319 per ton. This will be achieved in four years with the addition of US$ 30.5 per ton each year. Benefits from this intervention over four years are shown in the following table 25.

Table 25: Punjab A Cluster – Additional Value by Price Increase in Domestic Market

	Year 2	Year 3	Year 4	Year 5
Export price due to improvement in value chain (US$/tonne)	30.5	61.0	91.5	122.0
% of domestic production to be evaluated at international prices	1.25%	2.50%	3.75%	5.00%
Domestic production that will receive improved value chain operation (tonnes)	16,678	34,372	53,124	72,975
Total expected additional value of production (US$)	**508,673**	**2,096,698**	**4,860,830**	**8,902,993**

9.3.2.6. Intervention 6 – To Increase Potato Supply to Processors

Potato supply for the processing sector will be increased by creating linkages with the industry. Program will be initiated with the help of the private stakeholders to select varieties appropriate for processing that meet the needs of the processors. Processing varieties will be imported and adapted to local needs to realize full benefits of processing. FEGs will be trained to produce quality processing potato as per the requirement of the processors and restaurants so that the quality can be ensured at the group level and contract farming with FEGs will be promoted. It assumed that the share of potato supplied to processing sector will be increased from the current 5% to 7% in a period of four years at a rate of 0.5% per year. It is assumed that a higher price of US$ 130 per ton of potato will be received from the processors. Additional value obtained through this intervention is shown in the following table.

	Year 2	Year 3	Year 4	Year 5
Increased supply for processing	0.5%	1.0%	1.5%	2.0%
Additional potato production that will be supplied to processing	6,664	13,722	21,187	29,078
Total additional value of production (US$)	**76,518**	**157,546**	**243,264**	**333,856**

9.3.2.7. Intervention 7 – To Enhance Processing

Potato can be processed into different value-added products like Potato chips, French Fries, Potato flakes, etc. It is assumed that additional 2% potato production conversion into potato chips will be achieved in four years at a linear rate of 0.5% per year. Conversion factor of Potato into pulp has been considered to be 25%. It is estimated that 86 small scale plants will be required in the whole cluster to process these quantities of potato into chips by fifth year. Potato chips making plants will be provided to farmers at 30% subsidy rates to those farmers who organize themselves into Farmers Enterprise Groups (FEG) and deposit in advance 70% of the plant cost. The government will incentivize the Potato chips manufacturing. This intervention will add value to the Potato production from the cluster. Projected values of this value addition activity at a Potato chips price of US$ 2593 per ton shown in table 26.

Table 26: Punjab A Cluster - Value Addition by Potato Chips Production

	Year 1	Year 2	Year 3	Year 4	Year 5
Increased supply for processing		0.5%	1.0%	1.5%	2.0%
Additional potato production that will be supplied to processing		6,664	13,722	21,187	29,078
Quantities of Potato Chips Produced (tonnes)		1,666	3,430	5,297	7,269
Total expected additional value of production (US$)		**4,319,555**	**8,893,736**	**13,732,638**	**18,846,689**

9.3.3. Total Benefits Summary

Summary of the value of the benefits of the proposed interventions is shown in Table 27.

Table 27: Punjab A Cluster - Summary of the Value of Benefits of Interventions

Benefits Value (US$)	Year 2	Year 3	Year 4	Year 5
Value of crop management	-	-	-	-
Value of use of Tissue Culture Seed	15,651	31,927	48,849	66,434
Value of Use of On-Farm Seed Improvement	1,467,249	2,993,189	4,579,579	6,228,227
Value of Increased Exports	1,308,899	2,697,573	4,169,237	5,727,214
Value of Improved Prices	508,673	2,096,698	4,860,830	8,902,993
Value of Increased Supply to Processors	76,518	157,546	243,264	333,856
Value of Processed Products	4,319,555	8,893,736	13,732,638	18,846,689
Total Value (US$)	**7,696,545**	**16,870,669**	**27,634,396**	**40,105,413**

9.3.4. Enhanced Costs of the Proposed Interventions

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

9.3.4.1. Value Chain Improvement Costs

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 28.

Table 28: Punjab A Cluster – Value Chain Costs and Proposed Incremental Increases Cost Head

	Cost	Incremental Increase
Production Costs (excluding seed) (US$/ha)	1,490	16%
Additional cost of rouging (US$/ha)	30	
Normal Seed Cost (US$/ha)	220	
Increased Cost of Tissue Culture Seed (US$/ha) @ PKR 1 per plant and 247,000 plants per ha	1,830	
Additional Cost of Improved Value Chain (washing grading, packings storage) (US$/tonne)	50	
Chips Processing Cost (US$ per ton chips)	2,168	

Based on the above unit costs, total value chain costs for the entire cluster were calculated. It was assumed that costs will be incurred from the second year of implementation. Total planned increase in cost was distributed over four years as per the interventions in those years. Value chain costs projections are shown in table 29Error! R eference source not found..

Table 29: Punjab A Cluster – Value Chain Improvement Costs

	Year 1	Year 2	Year 3	Year 4	Year 5
Increase in cost due to improved management practices excluding seed (%)		4.0%	8.0%	12.0%	16.0%
Area on which increased cost will be applicable-(tissue culture seed+rouged area) (ha)		2,568	5,137	7,705	10,274
Increased costs due to improved management practices (US$)		152,964	0.61	1.38	2.45
Extra cost of rouging (US$)		60,832	121,664	182,496	243,329

Increased cost of tissue culture seed (US$)		871,016	1,979,472	2,969,209	3,958,945
Extra cost of improved value chain (washing, grading, packing, and storage)		1,667,781	3,437,209	5,312,383	7,297,536
Operational cost of processing including raw material costs (US$)		3,612,314	7,437,565	11,484,194	15,760,922
Total Costs (US$)		**6,364,908**	**12,975,912**	**19,948,283**	**27,260,733**

9.3.4.2. Cluster Development Interventions Costs

Punjab A Potato cluster has huge growth potential by virtue of its diverse agro ecological conditions. A mega program will be launched that will include production technology improvement in terms of pest and disease management, control of post-harvest losses, lonh terms storages and macro and micro nutrients management. Potato germplasm will be acquired that will include pre-selected varieties and clones from Europe. Yield trials will be carried out at research stations and at the farms of progressive farmers. New tissue culture labs will be established and older labs will be renovated. Training and monitoring will be carried out. Demonstrations of on-farm seed production will be carried out. Service providers will be trained for this purpose. Potato grower's associations will be formed at national and provincial levels. Potato processors and exporters associations will also be formed to promote potato and strengthen linkages between growers and policy makers.

The proposed budget for cluster development interventions in Punjab A will be US$ 5.002 million. 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.

This proposed cluster development cost will be spent in a period of four years starting from year 1. Yearly distribution of these costs will be driven by the interventions planned for that year. For example, the processing cost will be driven by the number of Potato chips manufacturing units that will be required each year to meet the set production target. Similarly, the costs of demonstration and roughing will be driven by the coverage of area planned for each year. For production level 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 30.

Table 30: Punjab A Cluster – Cluster Development Investments Cost Projections

Investment Head	Year 1	Year 2	Year 3	Year 4	Total
Renovating the existing R&D establishment (US$)	1,600,000	1,200,000	600,000	600,000	4,000,000
Imports and testing of processing varieties (US$)	320,000	240,000	120,000	120,000	800,000
Investments on training and demonstration for rouging @US$10/ha (US$)	20,277	40,555	60,832	81,110	202,774
Investment on tissue culture SOPs training of service providers (US$)	100,000	75,000	37,500	37,500	250,000
Potato growers associations and shed houses (US$)	1,200,000	900,000	450,000	450,000	3,000,000
Establishment of tissue culture labs (US$)	356,697	356,697	356,697	356,697	1,426,788
Renovation of existing tissue culture labs (US$)	7,600	5,700	2,850	2,850	19,000
Investment on processing (US$)	417,299	438,164	459,029	479,894	1,794,385
Improving international links, collection and dissemination of information (US$)	600,000	450,000	225,000	225,000	1,500,000
Training of stakeholders along the value chain for quality management (US$)	200,000	150,000	75,000	75,000	500,000
Loan	93,792	96,067	98,229	100,733	388,821
Total Investments (M. US$)	**4.92**	**3.95**	**2.49**	**2.53**	**13.88**

9.3.5. Economic Viability of Cluster Development Plan

Based on the benefits and the costs 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 table 31.

Table 31: Punjab A cluster - Economic Viability of Proposed Interventions Package

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Benefits of the Interventions (US$)	-	7,696,545	16,870,669	27,634,396	40,105,413
Total operational costs of the Interventions (US$)	-	(6,364,908)	(12,975,912)	(19,948,283)	(27,260,733)
Total investment costs of the interventions (US$)	(4,915,665)	(3,952,183)	(2,485,137)	(2,528,783)	-
Net Cash Flows (US$)	**-4,915,665**	**-2,620,546**	**1,409,620**	**5,157,330**	**12,844,680**
NPV (US$)			**6,610,692**		
IRR			**34%**		

A positive NPV of US$ 6.6 million indicates that the interventions package proposed for uplift and transformation of Punjab A Potato cluster is an economically viable proposition with an IRR of 34%.

9.4. Punjab B Potato Cluster

9.4.1. Current Situation

The study has considered 9,449 ha of area under potato production in the focal point of Punjab B Potato cluster which is currently producing 201,830 tonnes of potatoes per year. Current yield in the cluster is 21.36 tonnes/ha; growing at 2.0% per annum. Following table shows the cluster's current production performance.

Table 32: Punjab B Cluster – Current Production Situation

Potato Cluster in Punjab B – Current Situation	
Area under cultivation in cluster (ha)	9,449
Total Production (tonnes)	201,830
Production yield (tonnes/ha)	21.36
Annual yield growth without intervention	2.0%
Farm gate price of Potato (US$/tonne)	119

Potato production and its value at the current farm gate price in the next five years in a no-intervention scenario is shown in table 33.

Table 33: Punjab B Cluster – Potato Production in No-Intervention Scenario

	Year 2	Year 3	Year 4	Year 5
Default yield (tonnes/ha)	22.21	22.66	23.11	23.57
Annual expected production without intervention (Tonnes)	209,903	214,101	218,383	222,751
Total value of production at farm gate (US$)	**24,877,416**	**25,374,965**	**25,882,464**	**26,400,113**

9.4.2. Benefits of the Proposed Interventions

9.4.2.1. Benefit 1 - Increase in Production Yield by Introduction of High-Yielding Varieties and Crop Management

The production yields in the two potato clusters of Punjab are already in the satisfactory range. The potential of yield improvement has thus been considered only for the potato cluster of Gilgit Baltistan which has lower yield.

9.4.2.2. Benefit 2 - Increase in Production Yield by Tissue Culture Seeds

Supply of tissue culture seeds will be improved through an agricultural policy guiding public and private investment and sector support programs to develop pre-basic seed multiplication facilities by tissue culture labs. The yield enhancement will entirely be related with the enhancement in seed quality by supplying tissue culture-based virus free and true-to-type seed. It is estimated that these efforts in Punjab B cluster will increase the Potato yield by 10%. Area on which the tissue culture seed is used will be increased from 2% to 10% over a period of five years at a rate of 2.0% per year starting from the second year. Moreover, it is assumed that the potato produced from tissue culture seed will be able to get a higher price of US$ 130 per ton (10% higher). Based on these assumptions, the value of increased potato production is shown in the following table 34.

Table 34: Punjab B Cluster - Increased Potato Value by Tissue Culture Seeds

	Year 1	Year 2	Year 3	Year 4	Year 5
Percent of total area on which tissue culture seed is used (%)		2.0%	4.0%	6.0%	8.0%
Area to be brought under the use of Tissue culture seed (ha)		189	378	567	756
Tissue culture seed requirement (ton/ha)		3	3	3	3
Tissue culture seed to be produced (tonne)		567	1,134	1,701	2,268
Increase in yield due to the use of tissue culture seeds (tonnes/ha)		2.2	2.3	2.3	2.4
Increase in production due to the use of tissue culture seed		420	856	1,310	1,782
New price of potato produce (US$/tonne)		130	130	130	130
Additional value at the farm due to the use of tissue culture seed (US$)		**4,975**	**10,150**	**15,529**	**21,120**

9.4.2.3. Benefit 3 – On-Farm Seed Improvement

Along with the use of tissue culture seeds, on-farm seed improvement will be other important intervention to increase yield. Proper rouging will be promoted as a campaign. Farmers' Fields School of seed producers will be arranged through FEGs to train farmers to improve seed quality on their farms. Training of extension workers and service providers on quality seed production will be continued on on-farm seed production on sustainable basis. This will lead to increasing the value of the potato crop for the farmer. It has been assumed that 15% cluster area will be covered under this intervention at a rate of 3.75% per year in four years. This will lead to increase production yield by 5%. Area for which the roughed seed will be used will be five times. The intervention will occur from the second year when the results of improved value chain management practices will be realized. Based on these assumptions, the value of increased potato production in Punjab B cluster at the existing rate of US$ 119 per ton is shown in 35.

Table 35: Punjab B Cluster – Increased Potato Production by On-Farm Seed Improvement

	Year 2	Year 3	Year 4	Year 5
Acreage to be covered under improved on-farm seed production (%)	3.75%	7.50%	11.25%	15.00%
Acreage to be covered under rouging (ha)	354	709	1,063	1,417
Area for which rouged seed would be used-assuming one ha of rouged field can supply seed to 5 ha	1,772	3,543	5,315	7,087
Percentage increase in yield due to the use of properly rouged seed (%)	1.11	1.13	1.16	1.18
Increase in production due to the use of properly rouged seed (tonne)	1,968	4,014	6,142	8,353
Additional value of improved seed (US$)	**233,226**	**475,781**	**727,944**	**990,004**

9.4.2.4. Benefit 4 – Increase in Exports

The proposed plan envisages increasing potato exports of the country. Pakistan currently exports 15% of the total national production of Potato which is very low. It is estimated that with focused efforts, it will be possible to export 25% of the total production of the Punjab B Potato cluster. These efforts will include sponsored tours of sector stakeholders to attend high-quality technology international conferences and exhibitions, food exhibitions, and farmers and processing industries in advance potato producing countries. Competitions and awards will be announced for leading exporters. An information Cell will be established in PRI who will collect and analyze the data related to various markets and disseminate the information to FEGs, trade associations, and policy makers. A linear export growth at the rate of 2.5% per year has been assumed to achieve the additional 10% export target in four years. Additional exports have been valued at the existing average export price of US$ 197 per ton. It is assumed that increased exports will start from the second year of interventions. Based on these assumptions, the value of increased potato exports is shown in table 36.

Table 36: Punjab B Cluster – Increased Potato Exports Value

	Year 2	Year 3	Year 4	Year 5
Present export without intervention (% of the current production)	32,367	33,928	35,553	37,246
Increase in export (%)	2.50%	5.00%	7.50%	10.00%
Total expected volume of potato to be exported (tonne)	5,307	10,949	16,938	23,289
Expected additional value from exports (US$)	**416,523**	**859,263**	**1,329,294**	**1,827,725**

9.4.2.5. Benefit 5 – Increased Price in Domestic Market by Value Chain Improvements

The improved value chain activities as highlighted in the post-harvest section and improved interaction with international market as highlighted in the previous section will improve the quality and price of Potato to be marketed in domestic market. It is assumed that 8% of the total production from the cluster will be sold at par with the export market price of US$ 319 per ton. This will be achieved in four years with the addition of US$ 30.5 per ton each year. Benefits from this intervention over four years are shown in the following table 37.

Table 37: Punjab B Cluster – Additional Value by Price Increase in Domestic Market

	Year 1	Year 2	Year 3	Year 4	Year 5
Improvement in export price due to improvement in value chain (US$/tonne)		30.5	61.0	91.5	122.0
% of domestic production to be evaluated at international prices		2.00%	4.00%	6.00%	8.00%
Domestic production that will receive improved value chain operation (tonnes)		4,246	8,759	13,550	18,631
Total expected additional value of production (US$)		**129,497**	**534,292**	**1,239,838**	**2,272,969**

9.4.2.6. Benefit 6 – Increase in Potato Supply to Processors

Potato supply for the processing sector will be increased by creating linkages with the industry. Program will be initiated with the help of the private stakeholders to select varieties appropriate for processing that meet the needs of the processors. Processing varieties will be imported and adapted to local needs to realize full benefits of processing. FEGs will be trained to produce quality processing potato as per the requirement of the processors and restaurants so that the quality can be ensured at the group level and contract farming with FEGs will be promoted. It assumed that the share of potato supplied to processing sector will be increased from the current 5% to 9% in a period of four years at a rate of 1.0% per year. It is assumed that a higher price of US$ 130 per ton of potato will be received from the processors. Additional value obtained through this intervention is shown in the following table.

	Year 1	Year 2	Year 3	Year 4	Year 5
Increased supply for processing		1.0%	2.0%	3.0%	4.0%
Additional potato production that will be supplied to processing		2,119	4,362	6,736	9,244
Total expected additional value of production (US$)		**24,326**	**50,086**	**77,336**	**106,137**

9.4.2.7. Benefit 7 – Production of Value Added Potato Products

Potato can be processed into different value-added products like Potato chips, French Fries, Potato flakes, etc. It is assumed that additional 4% potato production conversion into potato chips will be achieved in four years at a linear rate of 1.0% per year. Conversion factor of Potato into pulp has been considered to be 25%. It is estimated that 29 small scale plants will be required in the whole cluster to process these quantities of potato into chips by fifth year. Potato chips making plants will be provided to farmers at 30% subsidy rates to those farmers who organize themselves into Farmers Enterprise Groups (FEG) and deposit in advance 70% of the plant cost. The government will incentivize the Potato chips manufacturing. This intervention will add value to the Potato production from the cluster. Projected values of this value addition activity at a Potato chips price of US$ 2593 per ton is shown in table 38.

Table 38: Punjab B Cluster - Value Addition by Potato Chips Production

	Year 2	Year 3	Year 4	Year 5
Increased supply for processing	1.0%	2.0%	3.0%	4.0%
Additional potato production that will be supplied to processing	2,119	4,362	6,736	9,244
Quantities of Potato Chips Produced (tonnes)	530	1,091	1,684	2,311
Total expected additional value of production (US$)	**1,373,238**	**2,827,425**	**4,365,770**	**5,991,588**

9.4.3. Total Benefits Summary

Summary of the value of the benefits of the proposed interventions is shown in Table 39.

Table 39: Punjab B Cluster - Summary of the Value of Benefits of Interventions

Benefits Value (US$)	Year 2	Year 3	Year 4	Year 5
Value of crop management	-	-	-	-
Value of use of Tissue Culture Seed	4,975	10,150	15,529	21,120
Value of Use of On-Farm Seed Improvement	233,226	475,781	727,944	990,004
Value of Increased Exports	416,523	859,263	1,329,294	1,827,725
Value of Improved Prices	129,497	534,292	1,239,838	2,272,969
Value of Increased Supply to Processors	24,326	50,086	77,336	106,137
Value of Processed Products	1,373,238	2,827,425	4,365,770	5,991,588
Total Value (US$)	2,181,785	4,756,996	7,755,711	11,209,543

9.4.4. Enhanced Costs of the Proposed Interventions

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

9.4.4.1. Value Chain Improvement Costs

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 40.

Table 40: Punjab B Cluster – Value Chain Costs and Proposed Incremental Increases Cost Head

	Cost	Incremental Increase
Production Costs (excluding seed) (US$/ha)	1,936	19%
Additional cost of rouging (US$/ha)	30	
Normal Seed Cost (US$/ha)	220	
Increased Cost of Tissue Culture Seed (US$/ha) @ PKR 1 per plant and 247,000 plants per ha	1,830	
Additional Cost of Improved Value Chain (washing grading, packing's storage) (US$/tonne)	50	
Chips Processing Cost (US$ per ton chips)	2,168	

Based on the above unit costs, total value chain costs for the entire cluster were calculated. It was assumed that costs will be incurred from the second year of implementation. Total planned increase in cost was distributed over four years as per the interventions in those years. Value chain costs projections are shown in table 41.

Table 41: Punjab B Cluster – Value Chain Improvement Costs

	Year 2	Year 3	Year 4	Year 5
Increase in cost due to improved management practices excluding seed (%)	4.68%	9.36%	14.04%	18.73%
Area on which increased cost will be applicable- (tissue culture seed+rouged area) (ha)	543	1,087	1,630	2,173
Increased costs due to improved management practices (US$)	49,243	196,972	443,187	787,889
Extra cost of rouging (US$)	10,630	21,260	31,890	42,521
Increased cost of tissue culture seed (US$)	304,395	691,807	1,037,710	1,383,614

Extra cost of improved value chain (washing, grading, packing, and storage)	477,654	985,374	1,524,390	2,095,975
Operational cost of processing including raw material costs (US$)	1,148,398	2,364,491	3,650,963	5,010,586
Total Costs (US$)	**1,990,321**	**4,259,905**	**6,688,141**	**9,320,584**

9.4.4.2. Cluster Development Interventions Costs

Punjab B Potato cluster has huge growth potential by virtue of its diverse agro ecological conditions. A mega program will be launched that will include production technology improvement in terms of pest and disease management, control of post-harvest losses, lonh terms storages and macro and micro nutrients management. Potato germplasm will be acquired that will include pre-selected varieties and clones from Europe. Yield trials will be carried out at research stations and at the farms of progressive farmers. New tissue culture labs will be established and older labs will be renovated. Training and monitoring will be carried out. Demonstrations of on-farm seed production will be carried out. Service providers will be trained for this purpose. Potato growers associations will be formed at national and provincial levels. Potato processors and exporters associations will also be formed to promote potato and strengthen linkages between growers and policy makers.

The proposed budget for cluster development interventions in Punjab B will be US$ 2.764 million. 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 42.

This proposed cluster development cost will be spent in a period of four years starting from year 1. Yearly distribution of these costs will be driven by the interventions planned for that year. For example, the processing cost will be driven by the number of Potato chips manufacturing units that will be required each year to meet the set production target. Similarly, the costs of demonstration and roughing will be driven by the coverage of area planned for each year. For production level 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 42.

Table 42: Punjab B Cluster – Cluster Development Investments Cost Projections

Investment Head	Year 1	Year 2	Year 3	Year 4	Total
Renovating the existing R&D establishment (US$)	200,000	150,000	75,000	75,000	200,000
Imports and testing of processing varieties (US$)	53,600	40,200	20,100	20,100	53,600
Investments on training and demonstration for rouging @US$10/ha (US$)	3,543	7,087	10,630	14,174	3,543

Investment on tissue culture SOPs training of service providers (US$)	40,000	30,000	15,000	15,000	40,000
Potato growers associations and shed houses (US$)	100,000	75,000	37,500	37,500	100,000
Establishment of tissue culture labs (US$)	92,477	92,477	92,477	92,477	92,477
Renovation of existing tissue culture labs (US$)	4,800	3,600	1,800	1,800	4,800
Investment on processing (US$)	146,055	146,055	146,055	166,920	146,055
Improving international links, collection and dissemination of information (US$)	200,000	150,000	75,000	75,000	200,000
Training of stakeholders along the value chain for quality management (US$)	80,000	60,000	30,000	30,000	80,000
Loan	29,200	29,056	28,840	31,344	118,439
Total Investments (US$)	**949,675**	**783,474**	**532,402**	**559,314**	**2,824,864**

9.4.5. Economic Viability of Cluster Development Plan

Based on the benefits and the costs 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 43.

Table 43: Punjab B cluster - Economic Viability of Proposed Interventions Package

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Benefits of the Interventions (US$)	-	2,181,785	4,756,996	7,755,711	11,209,543
Total operational costs of the Interventions (US$)	-	(1,990,321)	(4,259,905)	(6,688,141)	(9,320,584)
Total investment costs of the interventions (US$)	(949,675)	(783,474)	(532,402)	(559,314)	-
Net Cash Flows (US$)	**-949,675**	**-592,009**	**-35,310**	**508,256**	**1,888,959**
NPV (US$)		**217,182**			
IRR		**13%**			

A positive NPV of US$ 0.314 million indicates that the interventions package proposed for uplift and transformation of Punjab B Potato cluster is an economically viable proposition.

9.5. GB Potato Cluster

9.5.1. Current Situation

The study has considered 2,473 ha of area under potato production in the focal point of GB Potato cluster which is currently producing 35,324 tonnes of potatoes per year. Current yield in the cluster is 14.28 tonnes/ha; growing at 1.0% per annum. Following table shows the cluster's current production performance

Table 44: GB Cluster – Current Production Situation

Potato Cluster in GB – Current Situation	
Area under cultivation in cluster (ha)	2,473
Total Production (tonnes)	35,324
Production yield (tonnes/ha)	14.28
Annual yield growth without intervention	1.0%
Farm gate price of Potato (US$/tonne)	185

Potato production and its value at the current farm gate price in the next five years in a no-intervention scenario is shown in table 45.

Table 45: GB Cluster – Potato Production in No-Intervention Scenario

	Year 2	Year 3	Year 4	Year 5
Default yield (tonnes/ha)	14.57	14.72	14.86	15.01
Annual expected production without intervention (Tonnes)	36,030	36,391	36,755	37,122
Total value of production at farm gate (US$)	**6,672,311**	**6,739,034**	**6,806,425**	**6,874,489**

9.5.2. Benefits of the Proposed Interventions

9.5.2.1. Benefit 1 - Increase in Production Yield by Introduction of High-Yielding Varieties and Crop Management

New improved potato varieties will be introduced that will have higher yields. Campaigns will be started to increase adoption of already existing high-yielding varieties which are available with public and private sectors. Farmers Enterprise Groups will be used for engaging the farmers and demonstrating the use of improved potato production technologies. It is estimated that with the proposed interventions, there will be 10%increase in yield. This will be done over a period of four years which means that 2.5% increase will be realized in each year from first year to fourth year. Based on these assumptions, the value of increased potato production at the new improved price of US$ 185 per ton is shown in the following table 46.

Table 46: Increased Potato Yield by Renovated Orchards

	Year 1	Year 2	Year 3	Year 4	Year 5
Yield increased over five years	2.50%	5.00%	7.50%	10.00%	2.50%
Increase in yield due to yield improvement (tonne/ha)	0.36	0.74	1.11	1.50	0.36
Additional production from enhanced yield (tonne)	901	1820	2757	3712	901
Expected additional value from increased yield (US$)	**166,808**	**336,952**	**510,482**	**687,449**	**166,808**

9.5.2.2. Benefit 2 - Increase in Production Yield by Tissue Culture Seeds

Supply of tissue culture seeds will be improved through an agricultural policy guiding public and private investment and sector support programs to develop pre-basic seed multiplication facilities by tissue culture labs. The yield enhancement will entirely be related with the enhancement in seed quality by supplying tissue culture-based virus free and true-to-type seed. It is estimated that these efforts in GB cluster will increase the Potato yield by 10%. Area on which the tissue culture seed is used will be increased from 0.1% to 20% over a period of four years at a rate of 5.0% per year starting from the second year. Moreover, it is assumed that the potato produced from tissue culture seed will be able to get a higher price of US$ 204 per ton (10% higher). Based on these assumptions, the value of increased potato production is shown in the following table 47.

Table 47: GB Cluster - Increased Potato Value by Tissue Culture Seeds

	Year 1	Year 2	Year 3	Year 4	Year 5
Percent of total area on which tissue culture seed is used (%)		5.0%	10.0%	14.9%	19.9%
Area to be brought under the use of Tissue culture seed (ha)		123	246	370	493
Tissue culture seed requirement (ton/ha)		3	3	3	3
Tissue culture seed to be produced (tonne)		370	739	1,109	1,479
Increase in yield due to the use of tissue culture seeds (tonnes/ha)		1.5	1.5	1.5	1.5
Increase in production due to the use of tissue culture seed		180	363	549	740
New price of potato produce (US$/tonne)		204	204	204	204
Additional value at the farm due to the use of tissue culture seed (US$)		**3,324**	**6,715**	**10,174**	**13,701**

9.5.2.3. Benefit 3 – On-Farm Seed Improvement

This intervention will not be applicable in GB potato cluster.

9.5.2.4. Benefit 4 – Increase in Exports

There will be no exports from GM potato cluster

9.5.2.5. Benefit 5 – Increased Price in Domestic Market by Value Chain Improvements

The improved value chain activities as highlighted in the post-harvest section and improved interaction with international market as highlighted in the previous section will improve the quality and price of Potato to be marketed in domestic market. It is assumed that 10% of the total production from the cluster will be sold at par with the export market price of US$ 319 per ton. This will be achieved in four years with the addition of US$ 30.5 per ton each year. Benefits from this intervention over four years are shown in the following table 48.

Table 48: GB Cluster – Additional Value by Price Increase in Domestic Market

	Year 1	Year 2	Year 3	Year 4	Year 5
Improvement in export price due to improvement in value chain (US$/tonne)		30.5	61.0	91.5	122.0
% of domestic production to be evaluated at international prices		2.50%	5.00%	7.50%	10.00%
Domestic production that will receive improved value chain operation (tonnes)		945	1,997	3,160	4,436
Total expected additional value of production (US$)		28,812	121,810	289,104	541,173

9.5.2.6. Benefit 6 – Increase in Potato Supply to Processors

No additional potato from GB cluster will be supplied to processors.

9.5.2.7. Benefit 7 – Production of Value Added Potato Products

No additional potato from GB cluster will be used for value added potato products.

9.5.3. Total Benefits Summary

Summary of the value of the benefits of the proposed interventions is shown in Table 53.

Table 49: GB Cluster - Summary of the Value of Benefits of Interventions

Benefits Value (US$)	Year 2	Year 3	Year 4	Year 5
Value of crop management	166,808	336,952	510,482	687,449
Value of use of Tissue Culture Seed	3,324	6,715	10,174	13,701
Value of Use of On-Farm Seed Improvement	125,106	252,714	382,861	515,587
Value of Increased Exports	-	-	-	-
Value of Improved Prices	28,812	121,810	289,104	541,173
Value of Increased Supply to Processors	-	-	-	-
Value of Processed Products	-	-	-	-
Total Value (US$)	324,050	718,191	1,192,621	1,757,909

9.5.4. Enhanced Costs of the Proposed Interventions

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

9.5.4.1. Value Chain Improvement Costs

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 50.

Table 50: GB Cluster – Value Chain Costs and Proposed Incremental Increases Cost Head

	Cost	Incremental Increase
Production Costs (excluding seed) (US$/ha)	1,231	35%
Additional cost of rouging (US$/ha)	30	
Normal Seed Cost (US$/ha)	220	
Increased Cost of Tissue Culture Seed (US$/ha) @ PKR 1 per plant and 247,000 plants per ha	1,830	
Additional Cost of Improved Value Chain (washing grading, packings storage) (US$/tonne)	50	

Based on the above unit costs, total value chain costs for the entire cluster were calculated. It was assumed that costs will be incurred from the second year of implementation. Total planned increase in cost was distributed over four years as per the interventions in those years. Value chain costs projections are shown in table 51.

Table 51: GB Cluster – Value Chain Improvement Costs

	Year 2	Year 3	Year 4	Year 5
Increase in cost due to improved management practices excluding seed (%)	9%	17%	26%	35%
Area on which increased cost will be applicable-(tissue culture seed+rouged area) (ha)	216	432	648	864
Increased costs due to improved management practices (US$)	22,952	91,809	206,571	367,237
Extra cost of rouging (US$)	2,782	5,564	8,346	11,129
Increased cost of tissue culture seed (US$)	198,466	396,932	595,398	793,864
Extra cost of improved value chain (washing, grading, packing, and storage)	47,233	99,844	157,980	221,792
Operational cost of processing including raw material costs (US$)	-	-	-	-
Total Costs (US$)	**271,433**	**594,149**	**968,296**	**1,394,022**

9.5.4.2. Cluster Development Interventions Costs

GB Potato cluster has huge growth potential by virtue of its diverse agro ecological conditions. A mega program will be launched that will include production technology improvement in terms of pest and disease management, control of post-harvest losses, lonh terms storages and macro and micro nutrients management. Potato germplasm will be acquired that will include pre-selected varieties and clones from Europe. Yield trials will be carried out at research stations and at the farms of progressive farmers. New tissue culture labs will be established and older labs will be renovated. Training and monitoring will be carried out. Demonstrations of on-farm seed production will be carried out. Service providers will be trained for this purpose. Potato growers' associations will be formed at national and provincial levels. Potato processors and exporters associations will also be formed to promote potato and strengthen linkages between growers and policy makers.

The proposed budget for cluster development interventions in GB will be US$ 0.347 million. 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.

This proposed cluster development cost will be spent in a period of four years starting from year 1. Yearly distribution of these costs will be driven by the interventions planned for that year. For example the costs of demonstration and roughing will be driven by the coverage of area planned for each year. For production level 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 52.

Table 52: GB Cluster – Cluster Development Investments Cost Projections

Investment Head	Year 1	Year 2	Year 3	Year 4	Total
Investment on R&D establishment (US$)	20,000	15,000	7,500	7,500	20,000
Renovating the existing R&D establishment (US$)	20,000	15,000	7,500	7,500	20,000
Investments on training and demonstration for rouging @US$10/ha (M. US$)	927	1,855	2,782	3,710	927
Investment required on potato grower's associations and cold storage (M. US$)	40,000	30,000	15,000	15,000	40,000
Investment on new tissue culture labs (M. US$)	26,422	26,422	26,422	26,422	26,422
Investment to renovate the existing four tissue culture labs	6,000	4,500	2,250	2,250	6,000
Loan	5,520	4,140	2,070	2,070	13,800
Total Investments (US$)	**118,869**	**96,917**	**63,524**	**64,452**	**343,762**

9.5.5. Economic Viability of Cluster Development Plan

Based on the benefits and the costs 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 53.

Table 53: GB cluster - Economic Viability of Proposed Interventions Package

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Benefits of the Interventions (US$)	-	324,050	718,191	1,192,621	1,757,909
Total operational costs of the Interventions (US$)	-	(271,433)	(594,149)	(968,296)	(1,394,022)
Total investment costs of the interventions (US$)	(118,869)	(96,917)	(63,524)	(64,452)	-
Net Cash Flows (US$)	**-118,869**	**-44,300**	**60,517**	**159,874**	**363,888**
NPV (US$)	**257,554**				
IRR	**49%**				

A positive NPV of US$ 0.269 million indicates that the interventions package proposed for uplift and transformation of GB Potato cluster is an economically viable proposition.

9.6. Conclusion

Many people and communities, mainly in rural areas, do not have physical or financial access to food year-round. Undernourishment causes a downward spiral of bad health that frequently ends in death. Finding new ways to ensure food security is therefore important. One promising approach is increased potato cultivation. Potatoes are either consumed directly or they are processed to give products such as chips and French fries, mashed and canned potatoes. Value addition of potato contributes to crop diversification, improves the farmer's income and nutrition and provides value export and additional employment.

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

10. Programs and Plans

Potato crop constraints of production, seed supply, export, processing and marketing were discussed in detail in this report. Keeping in view the importance and potential of crop in Pakistan, to achieve the export, processing potential a series of interventions are suggested as part of the V2025 of Government of Pakistan. Potato crop discussed the gaps and constraints of production, seed, export, marketing, value addition. These all constraints gave the recommendations for cluster development in all regions; and estimated the economic and social impact of the cluster development interventions that shall set new frame conditions at production, processing, and marketing level of potato value chain in Pakistan. In support of the findings and recommendations presented in previous sections, the following plans and programs are proposed for further value addition.

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

10.1. Organization & Networking of Stakeholders

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

Table 54: Program for Organization and Networking of Stakeholders

S#.	Area of Action	Purpose	Institutions to be involved	Priority
1. Federal and Provincial potato Sector				
1.1	• Pakistan Potato Growers Association (PPA) • Members: i. 10 % from Public (Research, Extension) ii. 10 % from Private Sector (Marketing, Processor, export & Importer) iii. 80% from Growers	Organization of Potato farming, research, extension, exporter, processing and marketing community for collective action	NPP will act as secretary, All potato stakeholders and farming community	Medium to long terms
1.2	• Cluster base Potato Entrepreneur Groups	Improve coordination	Provincial departments,	Medium to long

	• Potato (local) seed producer growers association (Formal & Informal potato seed producers) • Potato Marketing, Processing, Importer Association	between the stakeholders of Potato value chain	NGOs, Private Sector	term

10.2. Program for Research Reform

The following program indicative areas for further research to strengthen the Potato cluster in Pakistan are proposed.

Table 55: Program for Research Reform

S#.	Identification of Areas for Further Research	Research Purpose/ Priority	Indicative Research Institutions
1	Research & development	**Technology development for:** ➢ Production of table & seed ➢ Control of insects & diseases ➢ Input use (Fertilizers & micronutrients ➢ Storage studies ➢ Post-harvest losses	NPP- NARC, Islamabad Agriculture Research GB, HARS, Abbottabad ARI, Quetta PRS, Sahiwal
2	Potato varieties Development	Varieties for: ➢ Processing ➢ Export ➢ Resistance to diseases & insect ➢ Better yield with qualitative traits ➢ Short duration ➢ Tolerance to heat and cold ➢ Better storability	NPP- NARC, Islamabad Agriculture Research GB, HARS, Abbottabad ARI, Quetta PRS, Sahiwal
3	Establishment of New Tissue culture Labs Punjab Cluster A= 8 Punjab Cluster B =2	Certified seed production ➢ Each Lab will produce 25000 plants and 100,000 tubers in green house per year	NIGAB, NPP- NARC, FSC&RD, Islamabad Potato Growers
4	Renovation of old labs	NARC Islamabad, PSC, Sahiwal, AARI, Faisalabad HARS, Abbottabad, PRS, Balochistan, GB 4 labs and MARC (total=10) Rs.2.5 for each Each Lab will produce 25000 plants and 100,000 tubers in green house per year	NIGAB, NPP- NARC, FSC&RD, Islamabad
5	Tissue culture Lab related staff Training and Lab monitoring	Lab Related staff 3-4 person from each lab (Private and Public) will be trained	NIGAB, NPP- NARC, FSC&RD, Islamabad

		Strict monitoring of all Labs	
6	A. On form seed production, ddemonstration & FFS.	Punjab Cluster A& B, GB on priority basis and all other cluster as demonstration	Provincial research and FSC&RD
	B. Training of service providers (300)		NPP, NARC
	C. Rouging as campaign	Year 1= 5000 Ha Year 2= 10,000 ha Year 3= 20,000ha Year 4= 40,000ha Year 5= 60,000ha	300 Service providers Farmers Area research institute will supervise FSC&RD
7	*Potato growers' associations*	Federal and Provincial Potato farmers All other stakeholders from market, export, import, processing	Supervising by NPP, NARC

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

11. Annexures

Annex 1. Macro Data Sources

1. FAOStat.org: http://www.fao.org/faostat/en
2. Agriculture Statistics of Pakistan (2015-16), Ministry of National Food Security and Research, Pakistan: http://www.mnfsr.gov.pk/frmDetails.aspx
3. Gilgit-Baltistan Agriculture Statistics Survey Report (2014), Agriculture Statistics Cell, Department of Agriculture, Gilgit-Baltistan
4. https://en.wikipedia.org/wiki/International_Potato_Center.
5. hortsci.ashspublications.org/content/42/5/1200.full
6. https://fr.wikipedia.org/.../Central_Potato_Research_Institute
7. https://icar.org.in/.../icar-central-potato-research-institute-org
8. https://icar.org.in/.../icar-central-potato-research-institute-org
9. https://indigoprojects.eu/stakeholder/56
10. www.informationvine.com/Research+Institute
11. https://www.natureindex.com/...potato-research-institute
12. https://vidwan.inflibnet.ac.in/profile/8850
13. Ministry of National Food Security and Research. Accessed from: http://www.mnfsr.gov.pk/pubDetails.aspx
14. Applicable discount rate set by SBP accessed on 25-Oct-2018 from the following web link:

Annex 2: Feasibility Study of Potato Chips Production Unit

Project Concept

Potatoes can be processed into many values added products like potato flakes, dehydrated mashed potatoes, potato flour, frozen French fries, frozen mashed potatoes, frozen diced potatoes and fried potato chips. Except potato chips, other mentioned value-added products are either the industrial products to be used in manufacturing of other products or are semi-cooked frozen products. Potato chips represent the value-added consumer product which can be manufactured at household level or small scale/cottage level with small investment. The chips are commonly served as snack, side dish or appetizer. Potato chips hold a prominent place in the snack food and convenience food market of the world.

Potato chips/crisps are thin slices of peeled or unpeeled potatoes that have been deep fried in oil/fat. Chips or crisps are also produced by baking the thin potato slices. The basic chips after preparation are more commonly salted. However, different flavors, spices and herbs are also used to produce additional flavors of potato chips. Although potato chips are a good source of niacin, calcium, vitamin C, carbohydrates, fat and food energy, their nutritive value can be improved substantially by fortification.

Potential Market

Potato chips represent a popular value-added consumer product in the local market. There are number of potato chips producers in the local market; some of which are large known brands. Apart from these, there is a large number of producers who make this product on small scale to be sold as commodity product in the local market. The potato chips marketed under famous brand names carry a high-quality image in the market and are thus sold at relatively higher prices. The market of potato chips is mostly concentrated in urban centers; however, over the years, the product has also gained popularity in less urbanized areas.

The proposed potato chips production unit will sell its product in peri-urban and rural markets in the vicinity of the unit. The entrepreneur may also explore the possibility of selling its product in the existing urban markets. However, for that, he will have to deal with the presence of the existing players in that market; before he may be successful in grabbing a share of that market. Heavy marketing cost will be required for advertising and promotion to create a visibility of the new product in the urban markets. The potato chips produced by the proposed unit will be transported to market and sold through the existing general retail outlets and bakeries.

Potato Chips Production Process

Process Flow

Potatoes are manually fed to the abrasive peeler where washing and peeling is simultaneously done. The washed and peeled potatoes automatically move to the slicing machine which converts the whole potatoes into slices. The slices are washed on the conveyer by water sprinkling. For lesser consumption of frying oil and better-quality chips, the washed slices are passed through the dryer where blowing air partially dries the wet slices. The slices are fed to the fryer and fried in the oil at temperature of 170-190 C. After frying, the chips are manually weighed and fed to the packing machine for filling and sealing of the packs. The sealed packs are packed in larger cardboard packing boxes for transporting to the retail outlets to be sold to the consumers. Process flow chart of potato chips production is shown in Figure Figure 6.

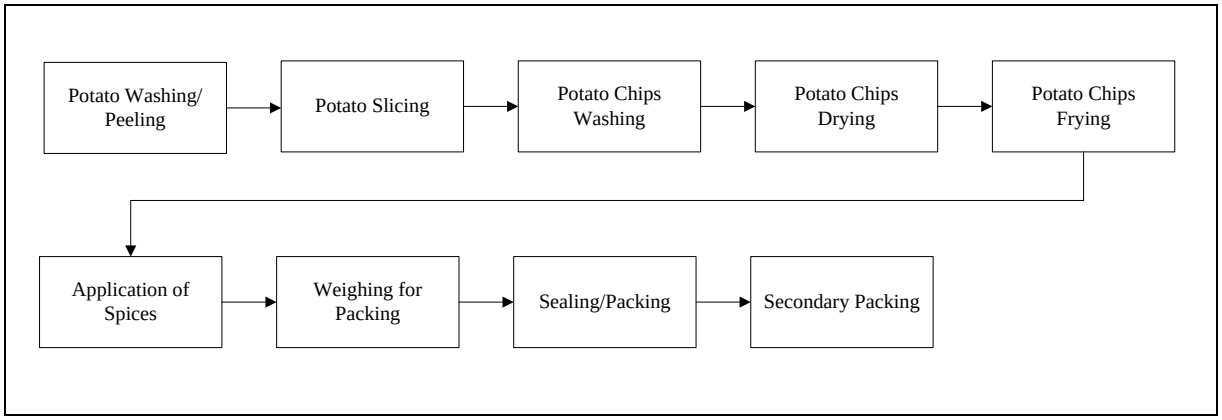


Figure 6 – Potato Chips Production Process Flow

Project Cost

Total project cost of the proposed potato chips production unit is PKR 2.96 million. Major items of project cost are listed.

Project Cost Details

Cost Item	Cost (PKR)
Machinery & Equipment	2,00,000
Office Equipment & Furniture	37,000
Pre-operating expenses	118,000
Capital Investment	**2,155,000**
Working Capital	810,567
Total Project Cost	**2,965,567**

The project is assumed to be fully financed with shareholder's equity; without any debt financing.

Land and Building

The proposed project will be established in a rented building with a covered area of around 1500 sq. ft. It is assumed that electricity and water connections will be available in the space rented for the project. Thus, the costs of electricity and water connected have not been included in the project cost. In case, these facilities are not available at the selected location, the costs of obtaining the connections of these two utilities will have to be added in the project cost.

Machinery and Equipment

The feasibility study of potato chips production unit has been based on locally manufactured machinery. This has been done to keep the capital cost of the project lower to keep it within the reach of smaller investors in the rural areas. Total cost of the required machinery and equipment is PKR 2.25 million.

Machinery and Equipment Cost

Sr.No	Name of the Machine	No.	Unit Cost (PKR)	Total Cost (PKR)
1	Potato Chips Making Plant (Washer/Peeler, Slicer, Dryer, Fryer, Spicer, Packing Machine)	1	2,000,000	2,000,000
	Total			**2,000,000**

Other Project Cost Items

- Office equipment and furniture has been included at a total cost of PKR 37,000.
- Pre-operating expenses include those expenses which have to be incurred before the business becomes operational. The costs included under this head are business registration/licensing, machinery transport, machinery erection and commissioning, personnel, routine administration and project's promotion. Pre-operating costs have been worked out to be PKR 118,000.
- Working Capital calculation includes the cost of one month supply of potatoes, frying oil, electricity bill, fuel, packing material and the staff salaries. Machinery spares equal to 1% of machinery cost and petty cash of PKR 100,000 have also been included in the working capital. With these assumptions, total working capital requirement has been calculated to be PKR 810,567.

Revenues and Costs

Revenues

Revenues will be generated by selling potato chips in printed aluminum-lined packs. It has been assumed that the project will produce 6000 40 grams packs of potato chips per day. It is assumed that the project will operate at this capacity from the first year. Operating at 360 days per year, the project will be able to produce 2.16 million packs of potato chips per year.

At a selling price of PKR 14 per pack, project's revenues for the first year will be PKR 30.24 million. No growth in selling price has been assumed over the five-year period.

Revenue Calculations

	Year 1	Year 2	Year 3	Year 4	Year 5
Production (packs)	2,160,000	2,160,000	2,160,000	2,160,000	2,160,000
Price (PKR/pack)	14.0	14.0	14.0	14.0	14.0
Revenues (PKR)	**30,240,000**	**30,240,000**	**30,240,000**	**30,240,000**	**30,240,000**

Costs

Potato Cost

Potato is the major cost of potato chip production unit. At 6000 40-grams packs per day, total requirement of potatoes will be 345,600 kg. This has been calculated on the assumption that four kg potatoes will be required for producing one kg potato chips. Potato's cost has been assumed considered to be PKR 17.5 per kg. At this rate, total cost of potato will be PKR 6.048 million. No growth has been assumed in the cost of potato.

Potato Cost Calculations

	Year 1	Year 2	Year 3	Year 4	Year 5
Packs (40 g) per year	2,160,000	2,160,000	2,160,000	2,160,000	2,160,000
Chips in the pack (kg)	86,400	86,400	86,400	86,400	86,400
Potato Requirement per year (kg)	345,600	345,600	345,600	345,600	345,600
Potato Cost (PKR/kg)	17.5	17.5	17.5	17.5	17.5
Potato Cost (PKR)	**6,048,000**	**6,048,000**	**6,048,000**	**6,048,000**	**6,048,000**

Other Costs

- Potato chips will be fried in vegetable oil which constitutes the other important cost. 50 kg oil will be required to fry about 100 kg chips. At a rate of PKR 200 per kg, total cost of oil comes out to be PKR 8.64 million.
- Processing cost includes the cost of fuel for frying the potato chips. This has been assumed to be PKR 4.0 per kg of chips. Total processing cost for the whole year to produce 86,400 kg potato chips comes out to be PKR 346,600. No inflationary factor has been considered in the processing cost over five years.
- Potato chips will be packed in 40-gram plastic Aluminum lined packs. The cost of this pack has been assumed to be PKR 2.0 per pack. At this rate, total cost of potato chips packs was calculated to be PKR 4.32 million. These packs will be packed in larger cardboard packing that will hold 36 packs. The cost of one such

packing box was taken to be PKR 40 and the total cost of these large packing boxes was found to be PKR 2.40 million. Total packing cost per year was found by adding these two costs to be PKR 6.72 million. Packing cost has been assumed to remain constant for five years.

- Building Lease cost has been assumed to be PKR 20,000 per month.
- Electricity cost has been worked out on the basis of an electricity connection of 8 KVA. Electricity cost for the first year has been calculated to be PKR 184,408.
- Plant maintenance cost has been assumed to be 1% of machinery cost. Maintenance cost during the first year has been calculated to be PKR 22,500.
- Marketing cost includes the cost of transporting the potato chips to retail outlets and the cost of creating product awareness and promotion. It has been assumed to be PKR 5,000 per day or PKR 150,000 per month. Marketing cost during first year is calculated to be PKR 1,800,000.
- Administration cost includes the cost of travelling, office stationery, telephone and refreshment. Administration cost during first year of operations is calculated as PKR 94,800. No inflationary factor has been considered during five years.
- Depreciation cost has been calculated using straight line method. A life of ten years has been assumed for machinery and equipment and five years for office equipment. Pre-operating expenses have been amortized over a period of five years.

Human Resource Cost

The proposed milk pasteurization unit will need small workforce; including a machine operator, machine helper and a security guard. The activities of production management, administration, bookkeeping and marketing will be carried out by the entrepreneur himself/herself.

Human Resource Requirement

Designation	No.	Salary (PKR/month)	Total (PKR/month)	No. of Months	Salary per Year (PKR)
Producton Supervisor	1	25,000	25,000	12	300,000
Machine Workers	2	20,000	40,000	12	480,000
Helpers	5	15,000	75,000	12	900,000
Watchman	1	15,000	15,000	12	180,000
Total Staff	**9**		**155,000**		**1,860,000**

Projected Financial Statements

Projected Profit & Loss Statement

Projected Income Statement

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues	**30,240,000**	**30,240,000**	**30,240,000**	**30,240,000**	**30,240,000**
Direct Costs					
Potatoes	6,048,000	6,048,000	6,048,000	6,048,000	6,048,000
Frying Oil	8,640,000	8,640,000	8,640,000	8,640,000	8,640,000
Processing Cost	345,600	345,600	345,600	345,600	345,600
Packing Cost	6,720,000	6,720,000	6,720,000	6,720,000	6,720,000
Direct Labor	780,000	780,000	780,000	780,000	780,000
Direct Electricity	161,608	161,608	161,608	161,608	161,608
Maintenance	20,000	20,000	20,000	20,000	20,000
Total Direct Cost	**22,715,208**	**22,715,208**	**22,715,208**	**22,715,208**	**22,715,208**
Gross Profit	**7,524,793**	**7,524,793**	**7,524,793**	**7,524,793**	**7,524,793**
Indirect Costs					
Building Lease	240,000	240,000	240,000	240,000	240,000
Indirect Labor	180,000	180,000	180,000	180,000	180,000
Fixed Electricity	22,800	22,800	22,800	22,800	22,800
Depreciation	207,400	207,400	207,400	207,400	207,400
Amortization	23,600	23,600	23,600	23,600	23,600
Marketing	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
Office Administration	94,800	97,200	97,200	97,200	97,200
Licensing/Regulatory Fee	5,000	5,000	5,000	5,000	5,000
Total Indirect Costs	**2,573,600**	**2,576,000**	**2,576,000**	**2,576,000**	**2,576,000**
Net Profit	**4,951,193**	**4,948,793**	**4,948,793**	**4,948,793**	**4,948,793**

Projected Balance Sheet

Projected Balance Sheet

ASSETS	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Current Assets						
Cash	100,000	4,463,127	9,785,870	14,964,560	20,143,194	25,321,771
Raw material	432,000					
Advance Processing Charges	109,767					
Accounts Receivables		1,764,000	1,764,000	1,764,000	1,764,000	1,764,000
Spare Parts inventory	20,000	21,000	22,050	23,153	24,310	25,526
Total Current Assets	**661,767**	**6,248,127**	**11,571,920**	**16,751,712**	**21,931,505**	**27,111,297**
Fixed Assets						
Land	-	-	-	-	-	-
Building & Civil Works	-	-	-	-	-	-
Processing Machinery	2,000,000	1,800,000	1,600,000	1,400,000	1,200,000	1,000,000
Utility Machinery	-	-	-	-	-	-
Laboratory Equipment	-	-	-	-	-	-
Office Equipment & Furniture	37,000	29,600	22,200	14,800	7,400	-
Net Fixed Assets	**2,037,000**	**1,829,600**	**1,622,200**	**1,414,800**	**1,207,400**	**1,000,000**
Other Assets						
Pre-operating Expenses	118,000	94,400	70,800	47,200	23,600	-
Contingencies						
Total Other Assets	**118,000**	**94,400**	**70,800**	**47,200**	**23,600**	**-**
TOTAL ASSETS	**2,816,767**	**8,172,127**	**13,264,920**	**18,213,712**	**23,162,505**	**28,111,297**

LIABILITIES	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Current Liabilities						
Accounts Payables		404,167	548,167	548,167	548,167	548,167
Short term loan						
Other Current Liabilities						
Total Current Liabilities	**-**	**404,167**	**548,167**	**548,167**	**548,167**	**548,167**
Long Term Liabilities						
Lease payable						
Long term debt	-	-	-	-	-	-
Long term debt	**-**	**-**	**-**	**-**	**-**	**-**
Equity						
Paid up Capital	2,816,767	2,816,767	2,816,767	2,816,767	2,816,767	2,816,767
Retained Earnings		4,951,193	9,899,985	14,848,778	19,797,570	24,746,363
Total Equity	**2,816,767**	**7,767,960**	**12,716,752**	**17,665,545**	**22,614,337**	**27,563,130**
TOTAL LIABILITIES	**2,816,767**	**8,172,127**	**13,264,920**	**18,213,712**	**23,162,505**	**28,111,297**

Projected Cash Flow Statement

Projected Cash Flow Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Operating Activities						
Net Income		**4,951,193**	**4,948,793**	**4,948,793**	**4,948,793**	**4,948,793**
Depreciation		207,400	207,400	207,400	207,400	207,400
Amortization		23,600	23,600	23,600	23,600	23,600
Change in raw material inventories	(432,000)	432,000	-	-	-	-
Change in advance processing charges	(109,767)	109,767				
Change in spares inventory	(20,000)	(1,000)	(1,050)	(1,103)	(1,158)	(1,216)
Change in Accounts Receivables		(1,764,000)	-	-	-	-
Change in Accounts Payables		404,167	144,000	-	-	-
Cash from operations	**(561,767)**	**4,363,127**	**5,322,743**	**5,178,690**	**5,178,635**	**5,178,577**
Financing Activities						
Short term debt principle repayment						
Long term debt principle repayment		-	-	-	-	-
Addition to short term debt						
Additions to long term debt	-					
Issuance of shares	2,816,767					
Net cash from financing activities	**2,816,767**	-	-	-	-	-
Investing Activities						
Capital Expenditure	(2,155,000)					
Cash from investing activities	**(2,155,000)**	-	-	-	-	-
Net Cash	**100,000**	**4,363,127**	**5,322,743**	**5,178,690**	**5,178,635**	**5,178,577**
Cash balance brought forward	-	100,000	4,463,127	9,785,870	14,964,560	20,143,194
Cash investment in securities		-	-	-	-	-
Cash available for appropriation	100,000	4,463,127	9,785,870	14,964,560	20,143,194	25,321,771
Dividend	-	-	-	-	-	-
Cash carried forward	**100,000**	**4,463,127**	**9,785,870**	**14,964,560**	**20,143,194**	**25,321,771**

Financial Feasibility

The proposed project of potato chips production unit is found to be financially viable with a positive NPV of PKR 5.1 million. NPV, IRR and payback period are shown in **Error! R eference source not found.**.

Financial Feasibility Indicators

NPV (PKR)	**12,124,049**
IRR	**165.61%**

Profitability Ratios

	Amount (PKR)	Percent
Sales	30,240,000	100.0%
Direct Costs	22,715,208	75.1%
Gross Profit	7,524,793	24.9%
Indirect Costs	2,573,600	8.5%
Net Profit	4,951,193	16.4%

Annex 3.List of Stakeholders Consulted

The following stakeholders were consulted during this feasibility study exercise

#	Name	Title	Location	Contact
1.	Mr. Asghar Ali	Director, DoA	Gilgit	0306 3069900
2.	Dr. Fazal ur Rehman	Director, DoA (research)	Gilgit	03445152269
3.	Mr Masood Qamar Qureshi	DG, FSC&RD	Islamabad	Landlines: 092 51 926 0126, 092 51 926 1822 Fax: 092 51 926 0234 Email: dg.fscrd@yahoo.com Website: www.federalseed.gov.pk
4.	Dr shah zaman	Tissue culture Lab	Gilgit	0345 4726005
5.	Mr. Abdul Khabir	ETI, Gilgit	Gilgit	03018800068 03555409010
6.	Raza Ali	Member Village Organization Astana	Skardu	0346 8483365
7.	Dr Abbas Ali	Agri Ext	Skardu	03555183828
8	Mr Shahid Kareem	ASF. Skardu	Skardu	03175677793
9	M. Aamir	Farmer	Okara	03006953272
10	Mr Nazir Ahmed	Farmer	Okara	03458471180
11	Eng Ehsan Bari	HZPC Seed	Lahore	031444077799
12	Mr Farooq Khan	PEPSICO (Lays)	Lahore	03008421958
13	Mr Shaheen	Candy land	Lahore	03218286588
14	Ch. Maqsud Jatt	Sec. Okara Potato Soc	Okara	03336982641
15	Mian M. Saddique	President Okara Potato society	Okara	03027536297
16	Ali Mardan	Jalander seed	Pakpattan	03468280971

17	Rana Tariq	Grower	Gujra	03008651356
19	Haji Saleem	Haji seeds	Chiniot	03007709172
20	Haji Irshad	Farmer	Chiniot	03336719788
21	Mr. Shahid Riaz	NPP	Islamabad	03125655445
22	Mr. Asif ur rehman	Tissue culture Lab HARS	Abbottabad	03335031237
24	Dr Syed Ijazul Hussan	Director PRS	Sahiwal	03006931708
25	Mr Naeem Bhatti	Seed importers	Lahore	03218473410

Annex 4: List of Data and Literature Reviewed

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Annex 5: Flow of Costs and Returns at Value Cain Level

Autumn crop is the main crop which has above90 % share. In Punjab cluster 3 type of marketing:

1. Farmers are bound to sale in market through commission agent who provided loan for inputs.
2. Farmer has not taken any loan and he is free to sale at any market. Normally farmers are used to sale 50-60% as fresh and remaining produce being kept is cold store for seed as well for sale at high prices.
3. The contract growers have to hand over produce to processor who provided seed for planting desirable varieties
4. Exporter and Stockists are used to purchase produce from the fields. Exporter usually did cleaning, washing, sorting and grading, after this he has made packing according importer desire. Stokists usually kept potato in cold store and waiting for better prices.

Flow of Costs and Returns on Potato (autumn) Value Chain Level

Costs/Returns	Grower/Farmer	Stocklist	Retailer	Total
Cost/Kg (PKR)	Farm gate Production cost	Raw Material (Potato): 16.50 Transportation and storage: 4.5 Transportation from cold store to market. 1	Transportation+ place rent + labor + shopping bags: 2	
Total Cost/Kg (PKR)	13.19	22	26	61.19
Cost Flow	21.56%	35.95%	42.49%	100
Sale Price /KG (PKR)	Ave. Selling Price: 16.50	Ave. Selling Price: 24	Ave. Selling Price: 30	70.5
Net Return (PKR)	Net Returns: 3.31	Net Returns: 2	Net Returns: 4	
Return Flow	23.40%	34.04%	42.55%	100

At every step, a bit of value is added. In absolute terms, the returns of farmer are one of the lowest – though responsible for the production, but farmers sell their produce without any value addition that vouches the highest returns. Hence, the Retailer who adds highest value to the potato earns highest returns and he delivers potatoes to end consumers. Retailer always enjoy better return because he purchases on running rate, whereas producer and stocklists some time faced heavy losses if prices decreases/ fluctuation of prices.

Farmers of summer crop generally avail better prices due to off season. Only few farmers bring their produce direct to market, otherwise mostly farmers are used to sale their produce at own village on prevailing prices. Due to following reason farmers are used to sale at farm. Sometime farmers them self-pay labor from field to road or traders must pay

I. If seed is on loan, then farmers have to handover produce to traders

II. Small holding and mostly produce is not a truck load

III. Sometime market prices become low and profit margin less, farmer cannot take potato back, whereas trader can stock and wait for better price

Table 56: Flow of Costs and Returns on Potato (summer) Value Chain Level

Cost/Return	Farmer	Trader1	Trader 2	Retailer	Total
Cost Rs/kg	Farm gate production cost	Collection at one point, loading, transport 20+potato collection=1, repair, rebadged=1	Transport to market 24+ Trans 5	Market to shop, shopping bag grading, 32+ trans=1+shop+ Shopper=1	
Cost Rs/kg	16.77	22	29	34	101.77
Cost Flow	**16.48**	**21.62**	**28.50**	**33.41**	**100**
Sale price per kg	20	24	31	40	
Net Return	3.23	2	3	6	14.23
Return flow	**22.70**	**14.05**	**21.08**	**42.1644**	**100**

Annex 6: Feasibility study for the production of Virus Free Potato seed through tissue Culture

Potato is an important fruit crop of Pakistan cultivated over an area of 80,000 acres. New plantations are done through suckers which carry diseases with planting materials. There is dire need for disease free planting materials for new plantations. Through tissue culture technology disease free potato plants will be produced all-round the year. These plants are uniform, true to type and mature early as compared to suckers and give more yields. The proposed business can be done in Central Punjab, Southern Punjab and GB. Punjab and GB Potato growers/farmers are the target market for potato seed. The proposed project will provide direct employment and numbers of labour will be involved when required. Indirectly number seed growers/ farmers will be involved for seed production plantations.

Objective

The objective of the pre-feasibility study is primarily to facilitate potential entrepreneurs in project identification for investment. The project pre-feasibility may form the basis of an important investment decision and in order to serve this objective, the document/study covers various aspects of project concept development, start-up, and production, marketing, finance and business management. The document also provides sectoral information, brief on government policies and international scenario, which have some bearing on the project itself. The purpose of this document is to facilitate potential investors in potato tissue culture by providing them a holistic as well as a micro view of business with the hope that such information as provided herein will help the potential investors in crucial investment decisions. The need to come up with pre-feasibility reports for undocumented or minimally documented sectors attains greater imminence as the research that precedes such reports reveal certain thumbs of rules; best practices developed by existing enterprises by trial and error, and certain industrial norms that become a guiding source regarding various aspects of business set-up and it's successful management. Apart from carefully studying the whole document one must consider critical aspects provided later on, which form basis of any Investment Decision.

CRITICAL FACTORS

The following factors should be considered prior entering the seed production business:

- Maintenance of phyto sanitary environment and quality assurance of the product.
- Experienced growers/ manpower

INSTALLED AND OPERATIONAL CAPACITIES

For this project it is assumed that the cycle will start from utilizing 20,000 in vitro potato plants/ cultures to be supplied by tissue culture labs. Annual production will be increase 1:5 and product will be high quality potato seed.

GEOGHRAPHICAL POTENTIAL FOR INVESTMENT

Central Punjab, Southern Punjab and Gilgit Baltistan are suited for this business

POTENTIAL TARGET MARKET

All potato growers of the above mentioned districts will be target market for this business.

PRODUCTION PROCESS FLOW

Following production process is generally followed:

FLOW CHART

20000 Tissue cultured ELISA tested plants Stabled in green house in October. Harvesting 100,000 nucleus seed in January

⇩

Plantation of 100,000 Nucleus seed in June at Northern Area on 1 acre. Harvesting 500,000 in August

⇩

Plantation of 500,000 pre- basic I seed in Nov in Punjab on 5 acres. Harvesting 5000,000 Pre-basic II in January and sell @ Rs.1/tuber to the growers.

PROJECT COST SUMMARY

All the figures in this financial model have been calculated for the production of virus free potato seed through tissue culture of 5000000 seed/tuber production in the first year.

Lab Equipment's and tool

The cost of lab & machinery is estimated at US$ 1985 including installation and commissioning. The installed production capacity will be 5000000 potato seeds annually. The cost estimates for lab & machinery has been worked out based on the cost figures available from recent orders paced for similar items in the recent past, duly up potato to cover the price escalation in the intervening period. These costs are given in the following tables:

Lab Equipment's

S. No.	Particulars	Qty.	Rate (US$)
2	Pipes (21 US$ per unit)	60(no)	1244
3	Green Net (Unit cost 186 US$/ roll)	3 Roll	556
4	Others		0
	Total		**1985**

Misc. Fixed Asset Costs:

US$ 2050 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:

Miscellaneous fixed asset cost

S. No.	Particulars	Qty.	Rate (US$)
1.	Office Equipment	1	500
2.	Furniture and Fixture	1	500
3.	Miscellaneous Accessories	1	500

4.	Fire Fighting	1	50
5.	Computer with Accessories	2	500
	Total		**2050**

Pre-Operative Expenses:

Expenses incurred prior to commencement of commercial production are covered under this head that total US$ 7632. 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 potato of various activities and the estimated phasing of cash requirements, interest during construction has been computed. Other expenses, under this head have been estimated on a block basis, based on information available for similar projects.

Pre-Operative Expenses

Sr. No.	Particular (for 1 year)	Amount (US$)
1.	Interest up to production @ 16% on term loan amount of US$ 7961 **(30% of total project cost)**	1274
2.	Marketing Launch Expenses	300
3.	Technology Know-how	300
4.	Training expenses	300
5.	Travelling Expenses	100
	Total	**2274**

Cost of raw material:

Based on a capacity of 5000000 potato seeds annually taking into account and 220 days of working per year, the consumption of the lab is 500000 potato seeds. The cost of raw material is US$ 3703 annually. Adding US$10 per ton transportation

Cost of raw material

Particulars	Rate of 500000 potato plants as raw material (US$) annually	Qty. per annum
Tissue culture lab	3703	500000
Transportation charges	500	
Fertilizer	3000	
Total	**7203**	

Land Lease Charge:

Required land is 6,000 sq. ft. In which (1500 sq. ft.) is covered under building. This building will be considered on lease @ US$100 per annum for first two years and @ US$232 for the fifth year and subsequently @5% increase every year.

Land lease charges

S. No.	Year	Lease charges Per Annum (US$)
1.	1st year	100
2.	2nd year	100
3.	3rd year	105
4.	4th year	110
5.	5th year	115
	Total	**530**

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 2.2 Kw is deemed appropriate. The expense on water supply, treatment and distribution has been suitably considered, based on the tariff by water and sanitation agency (WASA) for per month consumption of water tariff of @ 92.82 PKR/thousand gallons. Water requirements are approximately 100 gallons per day.

Electricity and water consumption charges

S. No.	Description	Amount Per Annum (US$)
1.	Power Consumption	1000
2.	Water Consumption	100
	Total	**1100**

Human Resource Cost

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

Salary and wages

Sr. No.	Description	Requirement	Salary/month (US$)	Salary/annum (US$)
	Lab in charge	1	300	3600
	Lab supervisor	1	200	2400
	Technically Skilled Workers	2	300	3600
	Lab assistant	1	150	1800
	Total		**950**	**11400**

Cost of Project

Sr. No.	Particular	Value (US$)
Fixed costs		
1.	Lab Equipment's	1985
2.	Misc. Fixed Assets	2050
3.	Pre-operative expenses	1973
Operating costs		
4.	Cost of raw material	7203
5.	Land lease charges	530
6.	Electricity and water consumption	1100
7.	Salary and wages	11400
8.	Packaging (Cost 100kg bag Rs 100/bag)	667
9.	Marketing Cost	300
10.	Margin Money for Working Capital	500
11.	Contingencies 5% of Fixed Assets	100
	Total variable costs	**27808**

Project Income Statement

Feasibility of potato tissue culture lab						
Revenues		**Year1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenue (US$)			**5,000,000**	**5,000,000**	**5,000,000**	**5,000,000**
Capacity of the tissue culture lab			**5,000,000**	**5000000**	**5000000**	**5000000**
Capacity of potato tissue culture lab (acre for which potato seedlings can be supplied)			**20**	**20**	**20**	**20**
Price of tissue culture plant (Rs. 1 per plant)			0.007407407	0.007407407	0.007407407	0.007407407
Revenues (US$) from tissue culture lab			**37037**	**37037**	**37037**	**37037**
Variable Costs						
	Land lease charges		530	530	530	530
	Electricity and water consumption		1100	1100	1100	1100
	Salary and wages		11400	11400	11400	11400
	Packaging (Cost 100kg bag Rs 100/bag)		667	667	667	667
	Depreciation		1583	1583	1583	1583
Total variable cost			**15280**	**15280**	**15280**	**15280**
Gross profit			**21757**	**21757**	**21757**	**21757**
Indirect fixed cost						
Machinery		-13211				
Licensing and regulatory fee		-200	0	0	0	0
Total		**-13411**	**0**	**0**	**0**	**0**
Grand total cost		**-13411**	**15280**	**15280**	**15280**	**15280**
Net profit (Net cash flow)		**-13411**	**6478**	**6478**	**6478**	**6478**
NPV	**8.5%**		**7,196**			
IRR			**33%**			

Project Viability

The Internal Rate of Return of the project is estimated at 33%, 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$ 71, 96) 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.