FINAL REPORT

Lot 2: Potato Value Chain Analysis

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Contents

EXECUTIVE SUMMARY

Potato is considered as the most important cash crop in Bhutan with pronounced production in Wangdue, Haa, Bumthang, Chukha, Monggar, Trashigang and Trashiyangtse. Most households in Bhutan grow potatoes either for export markets or for their own home consumption. It is one of the most widely cultivated crop next to rice maintaining a superior standing in productivity, nutritional and dietary value with adaptability qualities to the changing environmental conditions accompanied by good management practices. The crop by its versatile characteristics thrives well in Bhutan's agro-climatic conditions ranging from high alpine elevations of 4,500 m to the sub-tropical plains of 200 m.

Potato varieties commonly grown in Bhutan are *Desiree, Khangma Kewa Kaap, and Yusi Maap*. However the lack of varietal diversity in Bhutan is noteworthy. The producers could benefit immensely from introduction of new potato varieties suitable for different potato agro-ecologies ranging from 300 to 4,500 m above sea level.

Overview of Potato Industry in Bhutan

Potato Production and Productivity: Potatoes are mostly produced under rain fed conditions at the elevation range of 2,000-3,500 m. Most households grow potatoes in <1 hectare of land and commercial production is limited to areas within 1-5 km radius distance from the road.

Potato production and harvested area shows dramatic increase since 1970. During the 70s the area cultivated with potato increased by 10-20% every year and amounted to 5,982 ha (production of 61,133 MT) in 2007 compared to 760 ha in 1970.

Production increased from 2009 to 2016 at a CAGR of 4% in 7 years. However, the year on year production growth has been erratic.

Overall, there has been remarkable increase in productivity over the last three decades. The average national yield of potato for 1981-82 was 2,740 kg/acre, which increased to 4,140 kg/ acre in 2007 (DoA, 2007).

However, over the last eight years or so, potato yield remained in the range of 3,340 to 4,740 kg/ acre and the growth in productivity has been erratic year on year. Potato experts in the country argue the yields have more or less stagnated due to degenerated nature of potato varieties in the country and late blight susceptibility and infection of the commonly grown varieties. On the other hand, most farmers cite seed degeneration, limited supply of new seeds and limited access to fertilizers and finance as major challenges behind productivity issue.

Bhutan's productivity figures, when compared with other countries in the region, are one of the lowest in case of potato.

The potatoes produced in Bhutan undergo five basic operations (a.) Input selection, (b.) Land preparation and planting, (c.) Fertilization/ weeding, (d.) Plant protection – guarding from wild animal damages and application of pesticide, if needed, and (e.) Harvesting.

Post-harvest activities: Once the potatoes are brought to the store after the harvest process is complete, multiple post-harvest activities are performed, such as sorting, grading, packing, storing, loading, transportation, unloading, and storing. Most of these functions are undertaken by the growers themselves, with assistance from other family members and very rarely hired labour.

Processing: Bhutan imports most of the processed potato products, such as chips and potato snacks, from India, Thailand and other countries in the region. Small quantities of homemade potato chips are available in grocery shops, restaurants and small stalls in some parts of the country. However lately, commercial chips brands, such as Happy Chips and Bhutan Chips, are readily available in different outlets in Thimphu.

Apart from chips, there are no other processed products made from potatoes. French fries, commonly served by most small and big restaurants/ bars and hotels, are generally imported in 5-10 kg frozen bags. NPHC has not explored training in French fries processing so far.

Consumption: Potato requirement in the domestic market is increasing annually due to the increase in consumption levels. The per capita annual consumption of potato in Bhutan is estimated to be 40 kg/person, which is expected to increase to 60kg/person by 2020 (Nidup et al, 2007). This level of consumption is much higher than the average annual consumption in Asia (24 kg/person).

About 3-12% of the total potato production is consumed through local markets in Bhutan. In addition to that, farmers/ producers keep aside a certain part of their production for household consumption.

Marketing channels for Bhutanese Potato: Auction yards are the leading marketing channels for Bhutanese potato, followed by vegetable and weekend markets. Additionally, potatoes are supplied to schools and institutions with boarding facilities, military mess (RBG, RBA, RBP, etc.), and National Seed Corporation (NSC).

Potato exports and imports: Auction yards are central to potato exports from Bhutan. The introduction of the auction yard system in 1980 provided a mechanism to optimise the interaction between potato growers and buyers. Today, about 53-60% of the total potato production in Bhutan is auctioned through the auction yards.

Farmers prefer the auction yards (AYs) at the bordering towns of Phuentsholing (FCBL and SAM's) and Samdrup Jongkhar (FCBL's) as they can buy their essentials and household items at cheaper rates from the neighbouring Indian markets.

Compared to its exports, the quantity of fresh potatoes imported by Bhutan is relatively much smaller. In 2016, quantity of imported potatoes comprised of only 9% of the total production, while the percentage was 12 and 10 percent in 2015 and 2014 respectively.

Almost 100% of the imported potatoes come from India. There is considerable open trade between India and Bhutan. From June to November, Bhutan exports its potatoes to India, whereas from December to May, it imports Indian potatoes, although in much lesser quantities than those exported.

Value Chain Findings

Flow of Potato Volumes along Different Marketing Channels: The sale of potato through auction yards is the most preferred channel for potato producers, especially the commercial and the large-scale producers. Hence the percentage of potatoes auctioned out of the total production in Paro and Wangdue go beyond 74%, followed by Bumthang, Thimphu, Haa, and Trashigang auctioning about 48-64% of their total production in 2016. Trashiyangtse and Chukha auctioned about 43% and 40% of their production respectively in 2016. Dzongkhags such as Samdrup Jongkhar and Lhuentse on the hand auctioned only 1.5% and 8% of their potato production respectively.

Overall, Bhutan auctioned about 53-60% of its total potato production through the FCBL auction yards at Phuensholing and Samdrup Jongkhar and SAM auction yard at Phuensholing over the last three years (2014-16).

Of the remaining 40-47% of the production, it can be deduced about 15-17% is retained for seeds, 3-12% sold in the domestic/ farmers' market and the remaining 12-18% is a combination of post-harvest (PH) losses, household (HH) consumption and gift giving.

Use of potato as inputs for processing or sale to processors is very low in Bhutan. The potato utilization by processors is included in the percentage of potatoes sold in the domestic market.

Value Addition and Value Capture along the Value Chain: Value is added in potato processing/ marketing in four different scenarios in Bhutan. Producers have options of selling to (A.) Auction yards, (B.) Domestic market places, such as vegetable markets, CFM, local shops, etc., (C.) Collection/ grading agent, such as NOB Bhutan, and (D.) Commercial chips companies.

A value addition map was developed to depict and analyse the prices in Nu/kg at each node of the chain. For example, in 2016, the traders at auction yards bought potato at an average price of Nu. 23.6/kg from the producers and sold at an average price of Nu. 26.6/kg to the retailers in India and Nepal, who further sold at Nu. 31.2 kg to the final consumers. This means that there was an average value of Nu. 9/kg added. The percentage share of value is expressed as a fraction of margin to the consumer price.

On the other hand, when producers sell to processors or logistics/ collection centres, the value is more evenly spread among the chain actors. In case of NOB Bhutan, producers received lower than average market/ auction prices; however their profitability remains unharmed because the post-harvest costs were negligible and NOB provided the producers with inputs, such as seeds and fertilizers.

In case of commercial chips companies, it is noteworthy how processing generates additional value in great proportions and how all value chain actors manage to receive attractive prices. The percentage share of value for each actor is expressed as a fraction of margin to the consumer price.

Costs and Gross Margins: Producers obtained gross margins of Nu. 5-12/kg through sale of potatoes in 2016 (the calculation of cost of production and post-harvest costs are exhibited in Annex III).

The report has extensive tables to exhibit the net income per actor for an acre of potato production. The gross income for each actor also greatly depends on the scale of potatoes they are working with. For example, the potato bidders/ traders in the auction yard may seem to earn only Nu. 2.38/ kg of potatoes; however some of the biggest bidders trade in 20-30 MT of potatoes per day, making their annual income from potato trading in the range of Nu. 5-8 million (contingent on prevailing potato demand and prices in India and Nepal). On the other hand, the producers' margin in case of direct sale to domestic consumers seems lucrative at Nu. 12.5/ kg, however producers from most dzongkhags cannot manage to sell even one MT in their local farmers' market.

Hence the cost benefit analysis underlies the importance of (a.) value chain actors that provide access to market, and (b.) value addition along the chain, to attract better margins and scale for the farmers.

Potato Value Chain Institutions Horizontal and Vertical Linkages: Established linkages in the potato value chain include relationships between producers and auction yards, auction yards and the registered bidders, and producer members and the farmer groups (FGs).

Auction yards in Bhutan have come a long way in registering increasing number of potato bidders and providing assured market access and payment terms for the producers.

The potato FGs, on the other hand, need to expand their objective beyond improved access to agricultural inputs and credit. There is a need to form stronger FGs/ cooperatives to pool in resources for sorting, grading, and packaging functions and realise bargaining capabilities with transporters and auction yard bidders. Involving logistical service providers, such as NOB Bhutan, or having a FG/ cooperative engage in logistical business can significantly lower the post-harvest costs for the producers.

The relationship between the MoAF extension officers (EOs) and the producers are semi-strong. The potato producers sometimes get in touch with their EOs for assistance with input procurement and technical support. EOs, on the other hand, play a significant role in feeding information on producers' needs to DoA and its agencies, such as NSC, NPPC and NPHC.

However, the producers-EOs relationship could to be further strengthened so that extension staff can provide additional support services, such as disease forecasts and spray schedules, seed delivery/ accessibility and market information on real time demand and prices. Farmers should also be educated by the EOs on the value chain dynamics and farm economics.

Weak linkages in the value chain comprise of producer relationships with commission agents, logistics centre such as NOB Bhutan, processors, and middlemen. Overall producers prefer to keep their marketing options open; if the auction prices are trending high during a particular year, they tend to diverge from their understanding with processors/ logistics centres/ middlemen. Centres such as NOB Bhutan are trying to increase the producers' commitment by supplying agricultural inputs early during the plantation season.

Even though auction prices may appear relatively higher for a particular year, in some cases, it makes more economic sense for the producers to sell to processors especially when the post-harvest costs and transportation charges to auction yards are high. Hence it becomes essential for the producers to understand the value added by the actors along the chain and economics behind each marketing channel.

In addition to existing linkages, there is a need to establish new linkages along the value chain especially at the input and marketing phases. At input supply level, private agro-input suppliers or seed dealers can expedite the delivery of new seeds to the producers.

Moreover, FCBL needs to establish linkages with importers in Indian regions beyond the neighbouring towns and other countries, such as Nepal and Bangladesh, to expand the export market for Bhutanese potatoes.

Potato Value Chain Governance: The section on value chain governance refers to role of RGoB agencies/ regulatory institutions that influence the activities ranging from potato production to its end consumption. In case of potato, these include: (i) Overall Coordination and Leadership under DoA, (ii) Development of potato commodity chain by National Potato Program (NPP) (iii) Quality Inspection by BAFRA, (iv) Registration and Regulation of FGs and Coops by DAMC, and (v) Facilitation of Organized Potato Export through AYs.

SWOT Analysis:

Strengths:

- Most inputs are made locally available
- Climatic conditions & topography are suitable for potato farming
- Farmers' willingness to sell to processors
- High level integration in the VC
- Well established auction facilities and infrastructure

Opportunities:

- Nearly-organic nature of farming offers good potential for quality seed production for domestic & export markets
- Harvest season coincides with peak prices in India
- Strong demand for quality seeds in neighbouring Indian states
- Rising demand for organic produce in India
- Strong demand for chips produced from Bhutanese potatoes in home and overseas market
- Willingness of consumers to pay relatively higher prices
- FCBL's e-auction facilities
- Possibility of exporting potatoes directly to Nepal, where demand for is Bhutanese potato is very high

Weaknesses:

- Inefficiencies in input ordering and delivery system
- Shortage of new-generation potato seeds and varieties
- Small land holdings, scattered farms, & low productivity
- High cost of production and transportation
- Poor grading/ sorting methods
- High PH losses
- Lack of availability of potatoes suitable for chips
- Lack of technical know-how on potato specifications and suitability
- No labs for testing and quality checks
- Unutilized capacity
- Concentrated Indian buyers from the same region

Threats:

- Seed degeneration
- High incidence of blight and PTM
- Cheaper, imported chips brands widely available in the market
- High dependence on the volatile Indian market

Conclusions

Based on the industry overview and value chain mapping, following conclusions were drawn –

- Bhutan experiences one of the lowest productivities in the South Asian region
- Cost of production for potato in Bhutan, as reported by DoA, is very high
- Poor post-harvest handling results in high losses
- Despite high costs, buyers are dissatisfied by current post-harvest practices
- Overall the potato industry in Bhutan is hugely dependent on the volatile Indian market
- Seed potato demand from Indian states of West Bengal and Assam is consistently high
- Nepal is an excellent market for Bhutanese potatoes
- A very small portion of the total potato production undergoes processing in Bhutan
- Producers lack understanding on farm and marketing economics and they hardly enjoy the benefits of group enterprise
- Producers do not evaluate the additional costs of selecting auction yards over other marketing channels and they are not exposed to real-time market information
- There has been no backing for setting up cold storage for the potato value chain
- Lack of tissue culture laboratory and adequate infrastructure

Recommendations

The findings from the SWOT analysis and the conclusions sections were used to identify potential interventions that could be initiated by RGoB agencies and other value chain service providers:

In the short term, it will be imperative to enhance production and productivity, and maximize value addition through improvement in post-harvest practices and increased support to processing industries. These can be achieved with the help of following interventions –

- Training on effective use of fertilizers and FYM, and integrated pest management measures
- Raise awareness among potato growers on post-harvest handling techniques and value addition along the chain
- Strengthening the input/ service market to boost production
- Increase support to commercial chips companies
- Research and development into easy processing options such as French fries
- Encourage group enterprises and private agri-businesses

In the medium term, the focus should be on introducing efficient models for post-harvest activities and marketing, expanding to new markets, and improving stakeholder coordination –

- Construction of collection centres and market sheds at strategic locations to reduce PH losses, strengthen transportation and storage
- Explore direct export options to Nepal
- Explore expansion of Indian markets/ buyers beyond towns in Assam and West Bengal
- Strengthening research and infrastructure development for generation of new potato varieties
- Establishment of a 'potato value chain forum' to ensure coordination of all potato-related initiatives undertaken by any stakeholder

The **vision for the long term** is to have reduced the cost of production and marketing, and introduce new potato processing options. The interventions include –

- Roll out a plan for nation-wide distribution of new seeds
- Minimize cost of production and post-harvest costs
- Explore R&D into other processed potato products, such as dehydrated potato, potato starch, etc.
- Update price and demand information dissemination system for farmers

LIST OF ACRONYMS

AY	Auction Yard
BAFRA	Bhutan Agriculture and Food Regulatory Authority
BDBL	Bhutan Development Bank Limited
BEA	Bhutan Exporters Association
BNPP	Bhutan National Potato Program
BOIC	Business Opportunity and Information Centre
BPDP	Bhutan Potato Development Program
CA	Commission Agent
CIP	International Potato Centre
DAMC	Department of Agricultural Marketing and Cooperatives
DANIDA	Danish International Development Agency
DAO	Dzongkhag Agriculture Officer
DoA	Department of Agriculture
DRC	Department of Revenue and Custom
EOs	Extension Officers
EU	European Union
EU-TCP	European Union Technical Cooperation Project
FCBL	Food Corporation of Bhutan Limited
FGs	Farmer Groups
FYM	Farm Yard Manure
FYP	Five Year Plan
HH	Household
Kg	Kilogram
Km	Kilometre

Mil	Million
MoAF	Ministry of Agriculture and Forests
MoEA	Ministry of Economic Affairs
MT	Metric Tonnes
NPHC	National Post Harvest Centre
NPP	National Potato Program
NPPC	National Plant Protection Centre
NSC	National Soil Centre
Nu.	Ngultrum
P/ling	Phuentsholing
PDP	Potato Development Programme
PH	Post-harvest
PP	Polypropylene
PTM	Potato Tuber Moth
Qty.	Quantity
R&D	Research and Development
RDC	Research and Development Centre
RGoB	Royal Government of Bhutan
RNR	Renewable Natural Resources
RSEBL	Royal Security Exchange of Bhutan Limited
SAM	Sersang Agricultural Marketing (SAM)
SJ	Samdrup Jongkhar
SNV	Netherlands Development Organisation
UNDP	United Nations Development Program
VC	Value Chain
VCA	Value Chain Analysis

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1. INTRODUCTION AND BACKGROUND

1.1. Project Background

Bhutan is a small mountainous country where more than 60% of the total population lives in rural areas practicing subsistence agriculture, rearing livestock, and using different varieties of forest produce. The country has an area of 38,394 sq. km and is situated on the southern slopes of the Eastern Himalayas. The country is landlocked between China in the north and India to the east, south and west. The physical feature of Bhutan is characterized by high rising rugged mountains and an intricate network of deep valleys, ravines and depressions earmarking watercourses, drainage basin, waterfalls, human settlements, glacial lakes and moraine. The most dominant land cover is forests, making up 70.46% of the land area while shrubs account for 10.43%, cultivated agricultural land and meadows account for 2.93% and 4.10% respectively. Snow cover constitutes 7.44% while bare areas constitute 3.20%[1]. Degraded areas, water bodies, built up areas, marshy areas and non-built up areas constitute less than 1% each[2].

Development in Bhutan is guided by the philosophy of Gross National Happiness (GNH) which is based on the concept of sustainable development. This philosophy advocates that development should be planned and implemented in a holistic and balanced manner by integrating social, spiritual, economic and environmental realities of development.

Agriculture is a priority sector in Bhutan as it represents the main source of livelihood and income for two-thirds of the population and, most notably, the poorest segments of the society. The RNR is the primary sector comprising of agriculture (crops), livestock (includes honey and fishery) and forestry sub-sectors. It provides employment for over 60% and 77% of the national and rural total work force respectively[3].

Among agricultural crops, potato has been and continues to be a significant cash crop for Bhutan. Relatively high productivity, nutritional attributes, wide adaptation, easy cultivation and storage, easy preparation, among other qualities, are what makes potato special.

In a step to further the professionalization of potato industry in Bhutan, a study on potato value chain was commissioned under the leadership of Department of Agricultural Marketing and Cooperatives (DAMC), Ministry of Agriculture and Forests (MoAF).

[1] Annex 2, Terms of Reference of MoAF-EU proposal

[2] MoAF, 2011a

[3] Labour Force Survey 2015

1.2. Objectives of the Study

The key objective of this consulting assignment is to strengthen the Bhutanese potato value chain in order to enhance production and income for the farmers, reduce losses, ensure efficiency in value addition activities, and increase market linkages, through identification of new opportunities and addressing the existing constraints.

The scope of work is to build a comprehensive report on potato value chain, including recommendations on feasibility aspects of setting up value addition plant for potato on an industrial scale, and training materials for stakeholders, to strengthen the value chain.

1.3. Methodology

This report has employed the value chain and SWOT analytical methods to achieve its objectives. The value chain approach is a framework which uses both the functional and economic analysis (at market prices) of an identified value chain (FAO, 2005). The functional analysis was used to define the actors in the potato value chains while the financial analysis was used to analyze the economic returns of the different actors in the value chain(s).

In the functional analysis, different actors in the chain and the roles they play in the chain were identified. The functional analysis involved: a) identification of physical flows, b) identification of technical functions of the chain, c) identification of agents and quantification of physical flows.

The financial analysis of the potato value chain was a data intensive approach which involved identification of the inputs used in the value chain as well as the resulting output(s) and attaching economic values to them. The aim of financial analysis was to determine: a) revenue generated by each value chain agent, b) cost benefit analysis for the value chain actors, c) profitability of the value chain, d) the margins between agents, and e) attempt to identify any inefficiencies in the chain.

The internal and external situation analysis can produce a large amount of information, much of which may not be highly relevant. The SWOT analysis therefore served as an interpretative filter to reduce the information to a manageable quantity of key issues. The SWOT analysis classified the internal aspects as strengths or weaknesses and the external situational factors as opportunities or threats. Strengths served as a foundation for building a competitive advantage by value chain actors, whilst weaknesses are the constraints internal to the chain. By understanding these four aspects of the potato value chain, actors can better leverage their strengths, correct their weaknesses, capitalize on opportunities and mitigate potential threats.

1.3.1. Data Sources

Both primary and secondary data sources were used in this study. The main sources of secondary data included: Department of Agriculture (DoA) publications, interviews with Food Corporation of Bhutan (FCBL) and Sersang auction yards, Department of Revenue Customs (DRC) and RNR Statistics, potato chips businesses, BOB Bhutan, and development agencies previously involved

in value chain analysis (VCA) studies.

More specifically, the following information on potato in Bhutan was assembled from the below secondary sources:

- Agriculture Statistics, Department of Agriculture (DoA), 2009 – 2016
- Auction yard potato volume and value, 2006 - 2017
- Bhutan Trade Statistics, Department of Revenue and Customs, Ministry of Finance, 2015, 2016 and H1 2017
- Bhutan Potato Development Program publications
- DoA cost of production publication
- Potato value chain studies by MoAF and SNV, 2009
- Public and private sector players (including market leaders) that influence the flow of trade
- Underlying policies, institutional, and infrastructural issues that affect the competitiveness of the potato value chain
- Current and planned interventions of governments and development agencies in the sector

With respect to primary data, the following potato-specific data was collected:

- Costs, production, sales volumes, values and margins
- Inputs and products' prices and trends
- Types of facilities and services offered/ that are available, for the sector as well as the terms and conditions for accessing these. These were collected from buyers/processors.
- Data on support services to the potato value chain, trade volumes, costs and margins, constraints and opportunities was also collected. This data were especially collected from processors, traders and retailers.
- Other value chain institutions like market information providers, input suppliers, and technical assistance providers also provided data on nature of services they provide, their target recipients, the constraints they face in providing these services and any unexplored opportunities.

1.3.2. Data Collection from the Field

Field visits were conducted in select districts as shown in Table below. The dzongkhags were selected upon discussion with the DAMC, guided by the following criteria:

- Districts where the production of potato is significant by volume; and/or
- Districts with significant trade of potato;
- Areas where the market competiveness/ processing/ consumption of potato is significantly high
- District which has strong potato farmer groups (FGs)/ cooperative in the sector

Table 1: List of Districts Selected for Potato VCA

Selected dzongkhag	***Sample geogs***	***Rationale for selection***
Bumthang	Chhoekhor and Chummy	Significant potato production and home to Phuntsho Rabten Kewa Detshen farmer group (FG)
Wangdue	Phobjhika and Dangchu	Significant potato production in Phobjhika. Bhutan's first state of art potato processing and cold-storage center is located in Nobding.
Chhukha	Chaapchha and Phuentsholing	Significant potato producing areas and FGs in Chaapchha. Major potato traders and auction yards based in Phuentsholing.
Thimphu	Thimphu Thromde	Significant processing and marketing activities. Most DoA and potato program officials are based here.
Paro	Luni geog	National Post Harvest Center

From each of the dzongkhags, sample geogs were selected by DAMC and individual respondents were interviewed along the value chain[4]. Their details are exhibited in the tables below:

Table 2: Distribution of Respondents for Primary Data Collection on Potato

Sl. No.	***Dzongkhag***	***FGs/ Producers***	***Processors***	***Traders***	***Public/ Private Officials***	***Total***
1.	Bumthang	5	1	2	2	10
2.	Wangdue	3	1	1	1	6
3.	Chhukha	8	-	4	1	13
4.	Thimphu	-	2	3	5	10
5.	Paro				1	1
Total:						**40**

[4] Sample questionnaire is attached in Annex I

Table 3: List of Respondents for Primary Data Collection on Potato

Dzongkhag	***List of Respondents***
Bumthang	• Potato producers and members of the Phuntsho Rabten Kewa Detshen FG • Potato chips producers • Farm shop(s) in town • Retailers in town • Extension Officer • Rural Enterprise Development Corporation Limited (REDCL) official
Wangdue	• Producers from Phobkhika and Nobding area • National Seed Corporation (NSC) official • Extension Officer(s) • Administration head and staff at NOB Bhutan
Chhukha	• Producers and FGs from Chaapchha • Senior officials at FCBL and Sersang auction yards • Bhutan Exporters Association (BEA) • Truck drivers, auctioneers, buyers and traders
Thimphu	• Potato Program Officials • DoA officials • Happy Chips • Bhutan Chips • Sellers in local vegetable markets/Sunday markets and the Centenary Farmers Market • Middlemen
Paro	• National Post Harvest Center (NPHC)

1.3.3. Data Analysis

The data for the different value chain actors were entered in spread sheets and cleaned for any outliers. The first step of the analysis involved descriptive statistics which were conducted to aid in characterising potato production, consumption and marketing in Bhutan.

The second step involved functional and financial analysis of the potato value chain. The functional analysis of the value chain involved mapping of the value chain, identification of the roles of the different actors at different stages and quantification of volumes of potato along the value chain. The flow of volumes along the chain is an important function; however we had to base this quantification on estimates based on the findings from the field.

The third step was to undertake a financial analysis of the value chain which involved attaching prices to the various quantities of outputs and inputs along the value chain. The aim of this analysis was to determine the financial returns to the different agents of the value chain and also determine the value added at each stage of the chain.

Finally, a SWOT analysis of the potato value chain was conducted. Factors that influence the internal workings of the chain were categorised into strengths and weaknesses, while those influencing the chain from outside were categorised as opportunities and threats. The aim was to determine the factors that make the chain competitive so as to capitalize on them but also identify those that may weaken or threaten the chain so that their effects could be mitigated.

1.3.4. Limitations

Below are a few limitations encountered during the study, due to the nature of work and the potato industry in Bhutan:

The coverage of geographies had to be limited on sampling basis. The consultants limited their field work to Bumthang, Wangdue, Chhukha, Thimphu and Paro. Other potato producing areas, such as Monggar, Trashigang, etc., were excluded from the field itinerary because a comprehensive value chain analysis for Eastern dzongkhags was conducted by MoAF in 2009.

Most of the actors were not willing to disclose information related to costs of operations and revenues which would help determine more accurate gross margins. Margins for processors, wholesalers and retailers were difficult to calculate as their revenues, costs and volumes were unavailable. Most potato producers are not in habit to calculate their revenue and costs. Hence the calculated gross margins only provide estimates based on the imperfect information collected from the field.

Different stakeholders had conflicting calculations on potato cost of production. The estimated cost of production for potato provided by multiple stakeholders differed significantly. Based on consensus during the preliminary stakeholder meeting, the economic analysis in the report is based on the production and post-harvest costs provided by Department of Agriculture (DoA).

Similarly, data published on dzongkhag-wise production, auctioned v. exported quantities, and local consumption are inconsistent and incomplete in some cases.

Information on quantity of flows from one agent to another was unavailable. After we were able to map the players in the value chain and define their technical functions, a quantification of the amount of potato were trading would have been most helpful. However, due to unavailability of data, mapping of volumes among channels had to be based purely on guesstimates.

Traders are not formally organized into small, medium and large scale traders. Inadequate definition of these categories resulted into wide ranges. There are no wholesalers defined by the market. Based on the data collected from interviews and market visits, auction yards and few traders/ middlemen could only be deduced as wholesalers in the value chain.

2. POTATO PRODUCTION AND PRODUCTIVITY IN BHUTAN

2.1. Background of Potato in Bhutan

Potato is considered as the most important cash crop in Bhutan with pronounced production in Wangdue, Trashigang, Haa, Bumthang, Chukha, Monggar, Trashigang and Trashiyangtse. Most households in Bhutan grow potatoes either for export markets or for their own home consumption[5]. It is one of the most widely cultivated crop next to rice maintaining a superior standing in productivity, nutritional and dietary value with adaptability qualities to the changing environmental conditions accompanied by good management practices. The crop by its versatile characteristics thrives well in Bhutan's agro-climatic conditions ranging from high alpine elevations of 4,500 m to the sub-tropical plains of 200 m.

Bhutan has favourable conditions for the production of high quality potato for in-country consumption and as well as for export. In the past four decades, potato cultivation has increased very fast and brought important changes to the mountain communities of Bhutan, especially during the period of Bhutan National Potato Program (BNPP, 1984 – 1995). Potato is the single commodity grown in all 20 Dzongkhags[6]. The main potato production areas are concentrated in the altitude range of 1500 m to 3500m. It is the most important cash crop for households above 2500m altitude and also the most important coping mechanism during food shortages (Agri. Statistics, 2009). 22% of the rural households are involved in its production contributing more than any other horticultural crops to rural household income (RNR Census, 2000).

Potato farmers in Bhutan mostly sell their produce at auction yards in towns located at the Indian border. Potatoes reach the Indian market when prices are at their peak. Hence Bhutanese potato producers manage to receive relatively good prices (depending on the market situation in India). Access to Indian markets act as huge motivator for potato production; however that option opened up only in 1960s when the road construction had initiated. As soon as road access was realized, potato immediately became the most important cash crop for the higher regions of Bhutan with very fast adoption rates[7].

2.1.1. Evolution of Potato in Bhutan

The introduction of the potato in the Himalayan region and farther northward may be connected with the administration of Warren Hastings, Governor of the British India Company (Nunn and Qian 2011). When Hastings sent George Bogle on the memorable mission to Bhutan and Tibet in 1774, he instructed his emissary to plant some potatoes at every halting place, in order that a

[5] Roder, Nidup & Chettri, et al., 2008

[6] National Potato Program

[7] Roder, 2004a

valuable new product might be introduced into Bhutan. It is quite certain that potatoes were known in India in the 18th century, as Hastings was much interested in their propagation (Nunn and Qian 2011).

Potato was believed to have been introduced into India in the 16th century, and good crops were reportedly seen in northern India as early as 1617 (Roderet al. 2008). From there, it may have reached some parts of Bhutan in the 17th century. Markham (1879) provides the earliest documented evidence of the introduction of potatoes in Bhutan. As noted above, Bogle seems to have planted potato as he travelled from Buxa Duar through Chhapcha to Thimphu in 1774. After reaching Jaigugu, Bogle reported, "I planted ten potatoes" in an area that must have been about a mile from Pachu–Chinchu (Thimchu) in 1774 (Markham 1879). He also reports planting 15 potatoes on arrival at Muri-jong (which Turner called Murichom), which was 18 miles from Chukha. However, it is quite possible that potato may have reached parts of Bhutan earlier, as it was already widely cultivated in northern India.

The tuber grew fairly easily and the Bhutanese took an immediate liking to it, so that in 1776 the Dzongpon of Punakha even asked Bogle to send more as they had eaten the whole harvest without saving any seeds. The Dzongpon sent Bhutanese pears to Bogle as a gift (Phuntsho 2013). It is widely believed that potato spread gradually through most parts of the country in the 18th and 19th centuries (Joshi and Gurung 2009).

However, the modern era of Bhutanese potato production dates back roughly to the fifth decade of the 20th century, when the farmers around Chhapcha first started regularly planting and exporting potatoes to India (Joshi and Gurung 2009).

2.1.2. Potato Progress under Planned Development

The area under cultivation and yield for potato increased dramatically in Bhutan after the establishment of the Department of Agriculture (DoA) in 1961. It started to increase at a rapid rate in the late seventies when production areas became accessible to the Indian markets. The phenomenal increase from 1965-1975, with a 3-fold jump in the production area was largely possible due to the farmers' own initiative (Roder et al, 2008).

During the second 5-year plan (1966–1971), it was proposed to augment the staff in Yusipang with the appointment of an assistant horticulturist specializing in potato growing and to start applied research on fruit, potato, vegetable, and flower seed production (Bhutan 1967).

In 1975, under the third 5-year plan (1971–1976), Lhapchethanka Farm at an elevation of 2743 m was purchased for potato seed multiplication (Bhutan 1972). European varieties of potatoes were introduced through a Swiss project in Bumthang and remain important to date (Bonday Farm n.d.). In 1977, intensive potato cultivation as a second crop became popular in villages, resulting in the marketing of potatoes in June/July, still practiced now.

Under the fifth 5-year plan, the Potato Development Programme (PDP) was to continue to conduct adaptive research on potatoes in collaboration with the International Potato Centre (CIP) and Helvetas (Bhutan 1981). A Rural Development Project at Bumthang dealt mainly with

activities related to germplasm introduction and testing, seed production, mechanized planting, and weeding. There was also a dramatic increase in production from 1965 to 1980, due to the construction of access roads starting in 1961.

Under the sixth 5-year plan (Bhutan 1987), the CIP country program continued with further introduction of germ plasm and testing, seed multiplication, marketing studies, and training. The work of the Bhutan National Potato Programme (BNPP) focused mainly on germplasm introduction, seed multiplication, and training.

This period also saw the commencement of the Food Corporation of Bhutan's (FCBL) managed auction yard system. Horticultural crops, such as oranges, apples, potatoes, cardamom, ginger, chilies, vegetables, and processed fruit products, were exported to India, Bangladesh, Singapore, and Japan. The recent increase in these exports has resulted in a surplus in agricultural trade (excluding livestock products) (Bhutan 1992). In 1985, Bonday Farm produced 250 kg of tissue-cultured pre-basic potato seed and sold it to Bhutan National Potato Program (BNPP).

Especially in the 1980s and 1990s, the potato crop became important as a reliable cash crop for farming communities. In 2004, the Bhutan Potato Development Programme (BPDP) was initiated.

A summary of RGoB initiatives and projects, which greatly influenced potato development in the country, are listed in the table below.

Table 4: RGOB Initiatives and Projects that have boosted potato production[8]

Year	RGoB Initiatives/ Projects	Impact
1960	Creation of Government Structure and Road Construction	Access to market
1961	Establishment of Department of Agriculture	Technical services, marketing policies & structure to facilitate input supply
1974-83	Rural Development Project, Bumthang which mainly dealt with activities relating to germplasm introduction and testing, seed production, mechanized planting and weeding	Availability of improved cultivars, technologies and technical advice which form basis for high yields
1977-81	UNDP/DANIDA Project with major focus on seed multiplication	
1981-87	CIP country programme whose activities involved germplasm introduction and testing, seed multiplication, marketing studies and training	

[8] Potato in Bhutan, MoAF and SNV, 2009

1983-95	Bhutan National Potato Programme which focused mainly on activities involving germplasm introduction, seed multiplication and training	
1980	FCBL Managed Auction Yard System	Farmers' confidence that a market would be available
2004 onwards	Bhutan Potato Development Programme (BPDP)	Capacity building and technology development for increasing production and strengthening of marketing linkages

2.1.3. Potato Varieties in Bhutan

Although the potato cultivated worldwide belongs to just one botanical species, *Solanum tuberosum*, the tubers come in thousands of varieties with great differences in size, shape, colour, texture, cooking characteristics and taste. Potato varieties commonly grown in Bhutan are *Desiree*, *Khangma Kewa Kaap*, *Yusi Maap* and *Kufri Jyoti* (*Kufri Jyoti* now discontinued).

Desiree, a Dutch variety released in 1988 for cultivation, is the most popular red-skinned variety grown in the country covering most of the total acreage under potato cultivation.

Khangma Kaap (a CIP clone), a white potato variety, was later released in 2002. The two most recent additions were *Nasephey Kewa Kaap* and *Yusi Maap* released in 2014 and 2017 respectively.

Most studies indicate that Bhutanese farmers and consumers prefer the red skin variety *Desiree* because of its excellent keeping/storing quality, ability to reap better prices and better taste. Recent efforts to capitalize on the export potential for seed potato may lead to the adoption of other varieties, especially the white varieties mentioned above. *Yusi Kaap* is preferred by the growers due to its higher yield potential compared to the other varieties.

Details of the four notified potato varieties under cultivation in Bhutan and their characteristics are listed in Table 5. However the lack of varietal diversity in Bhutan is noteworthy. The producers could benefit immensely from introduction of new potato varieties suitable for different potato agro-ecologies ranging from 300 to 4,500 m above sea level.

Table 5: Origin and varietal characteristics of the four released potato varieties[9]

Characteristics	***Desiree***	***Khangma Kewa Kaap***	***Nasephey Kewa Kaap***	***Yusi Maap***
Variety/Breeding line name	CIP 800048	CIP 378015.13	CIP-393077.159	CIP 392797.22
Year of release	1988	2002	2014	2017
Releasing Agency	BNPP	RDC-Wengkhar	National Potato Prog.	National Potato Prog.
Yield Potential (t/ac)	15.0-18.0	16.0-20.0	39-45	11.6-17.2
Maturity (DAS)	90	100-105	160-180	120-140
Recommended Agro-ecology (MASL)	1000-2000	600-2500	Across all AEZ	Mid-High Altitude
Other Characteristics	Preferred for table consumption & French fries; longer shelf life and good taste	Matures early		

2.2. Potato Production and Productivity

2.2.1. Production

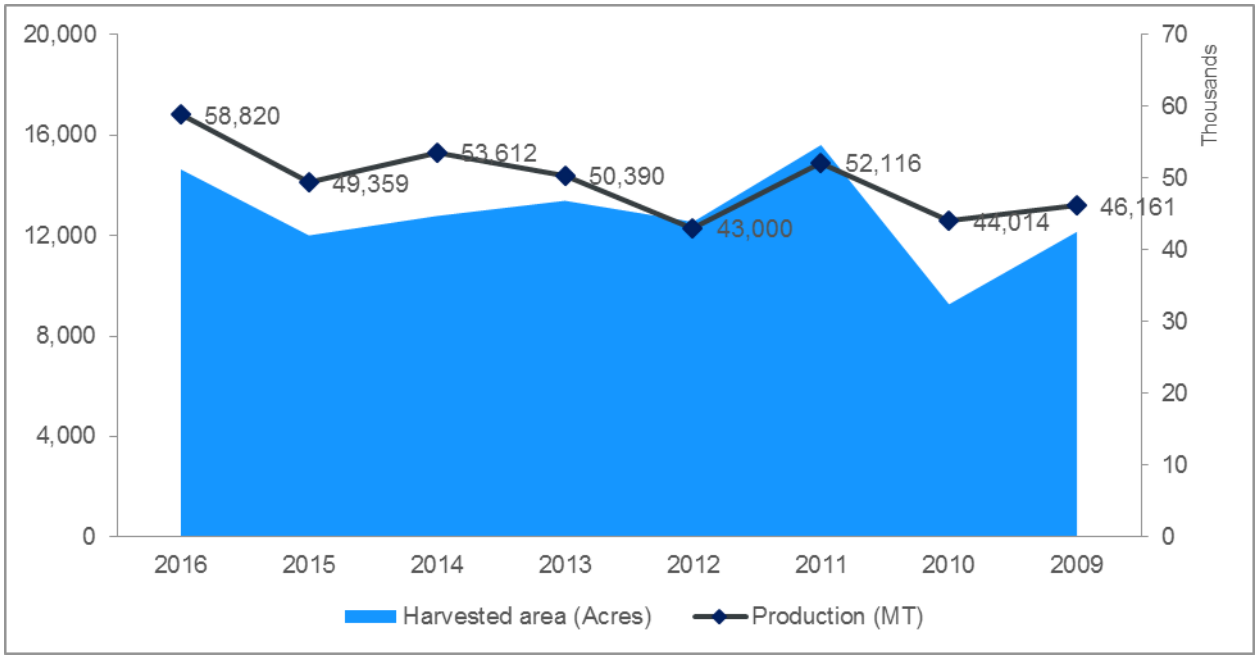
Potatoes are mostly produced under rain fed conditions at the elevation range of 2,000-3,500 m. Most households grow potatoes in <1 hectare of land and commercial production is limited to areas within 1-5 km radius distance from the road (Roder et al, 2008).

Potato production and harvested area shows dramatic increase since 1970. During the 70s the area cultivated with potato increased by 10-20% every year and amounted to 5,982 ha (production of 61,133 MT) in 2007 compared to 760 ha in 1970.

Production increased from 2009 to 2016 at a CAGR of 4% in 7 years. However, the year on year production growth has been erratic.

[9] Improved Crop Varieties in Bhutan, DoA, MoAF, November 2017

Figure 1: Potato production and harvested area in Bhutan, 2009-2016[10]



The four dzongkhags of Wangdue, Chhukha, Trashigang and Monggar experienced an annual production of over 5,000 metric tonnes (MT) each in 2016[11], accounting for over 60% of the national potato production. All the four dzongkhags, except Monggar, have managed to consistently produce over 5,000 MT over the last four years, with Wangdue leading the production trends year on year.

The table below shows the production and cultivated area by dzongkhag in order of highest to lowest potato production per dzongkhag in 2016.

[10] Agriculture Statistics, Department of Agriculture (DoA), 2009-2016

[11] Agriculture Statistics, Department of Agriculture (DoA), 2016

Table 6: Potato production and harvested area by dzongkhags in Bhutan, 2013-2016[12]

Dzongkhag	**2016**		**2015**		**2014**		**2013**	
	Area (Acres)	Production (MT)	Area (Acres)	Production (MT)	Area (Acres)	Production (MT)	Area (Acres)	Production (MT)
Wangdue	2,831	13,722	2,232	11,766	2,631	16,820	2,235	14,165
Chhukha	1,112	8,841	920	6,927	918	6,061	817	5,378
Trashigang	1,878	7,259	1,588	5,561	1,797	5,356	1,922	6,400
Monggar	2,588	5,492	1,903	4,920	2,045	4,975	2,166	5,170
Bumthang	710	4,931	629	4,364	836	6,019	622	4,005
Paro	984	4,444	799	3,875	754	3,601	689	2,678
T/yangtse	786	2,856	502	2,115	594	2,107	763	3,055
P/gatshel	517	1,998	509	1,378	570	1,375	582	1,185
S/ Jonghkar	909	1,859	674	1,288	718	1,364	1,119	2,047
Haa	334	1,794	488	2,365	418	1,873	555	2,491
Lhuentse	408	1,606	413	1,089	338	1,183	341	1,106
Thimphu	259	1,195	320	2,079	202	1,297	238	1,058
Trongsa	281	1,000	118	340	113	377	130	507
Gasa	138	569	80	277	67	187	63	189
Tsirang	312	325	320	259	241	240	594	261
Samtse	144	270	110	211	111	220	81	108
Dagana	177	239	156	180	120	159	161	171
Punakha	81	165	37	91	71	118	76	186
Zhemgang	98	147	80	109	121	187	89	137
Sarpang	90	110	130	164	120	93	148	93
Bhutan	**14,638**	**58,820**	**12,008**	**49,359**	**12,785**	**53,612**	**13,391**	**50,390**

In Eastern Bhutan, Khaling was the first major production area initiating production in the early seventies. After villages became accessible by road, most households in the east had adopted potato cultivation.

Potato has become the most extensively cultivated crops in Bhutan; it comprises of over 34% of the total cultivated area under vegetables[13].

[12] Agriculture Statistics, Department of Agriculture (DoA), 2009-2016

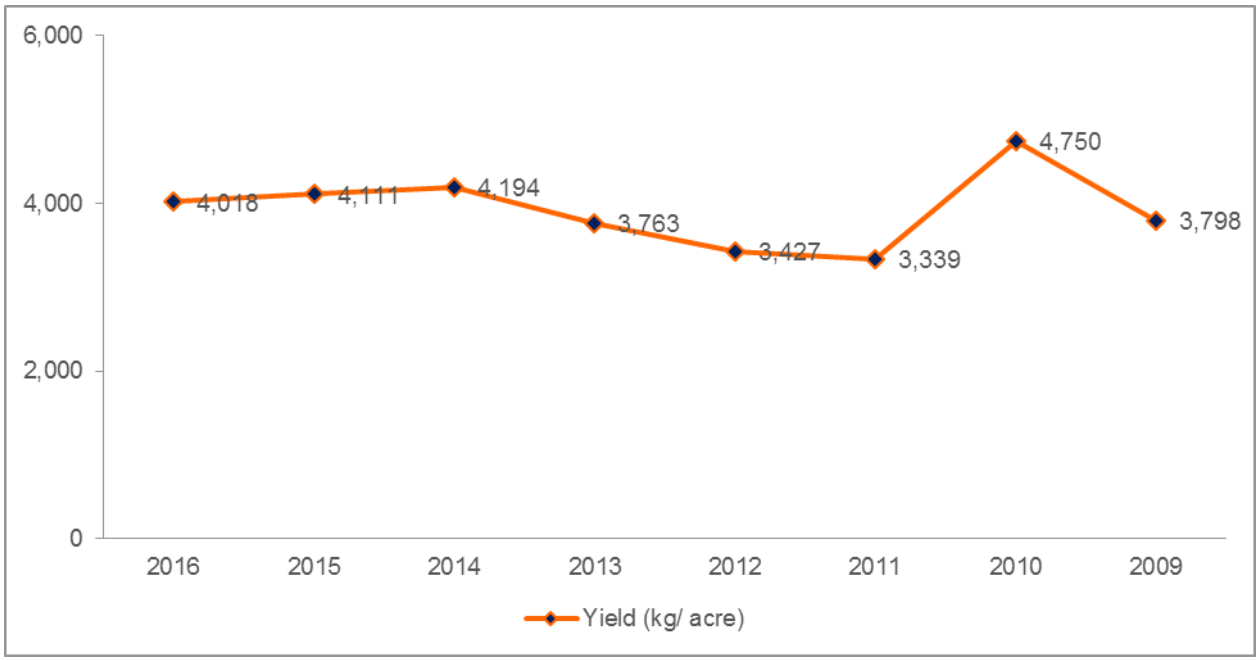
[13] Calculations based on 'Vegetable cultivated area (acres)' in RNR Statistics, 2013 and 2015

2.2.2. Productivity

Overall, there has been remarkable increase in productivity over the last three decades. The average national yield of potato for 1981-82 was 2,740 kg/acre (Scott, 1983), which increased to 4,140 kg/ acre in 2007 (DoA, 2007).

However, over the last eight years or so, potato yield remained in the range of 3,340 to 4,740 kg/ acre and the growth in productivity has been erratic year on year, as exhibited in the figure below. Potato experts in the country argue the yields have more or less stagnated over the last ten years due to degenerated nature of potato varieties in the country and late blight susceptibility and infection of the commonly grown varieties. On the other hand, most farmers cite seed degeneration, limited supply of new seeds and limited access to fertilizers and finance as major challenges behind productivity issue[14].

Figure 2: Potato Yield in Bhutan, 2009-2016[15]



However, some dzongkhags such as Chhukha, Bumthang, Haa and Wangdue have consistently outperformed other dzongkhags in terms of yield due to the presence of productivity conscious commercial growers, high soil moisture content and the fact that potato is grown as summer crop in these favourably located areas.

Dzongkhags such as Gasa have low productivity because of its use of zero fertilisers and pesticides due to its declaration of being 100% organic. On the other hand, dzongkhags such as

[14] Interview with potato farmers and FGs

[15] Agriculture Statistics, Department of Agriculture (DoA), 2009-2016

Sarpang, Samtse and Tsirang located in the subtropical area, focus less on potato production compared to other crops.

Table 7: Yield (Kgs/acre by dzongkhags in Bhutan, 2013-2016[16]

Dzongkhag	**2016**	**2015**	**2014**	**2013**
Chhukha	7,954	7,529	6,601	6,581
Bumthang	6,943	6,935	7,200	6,439
Haa	5,374	4,846	4,480	4,485
Wangdue	4,847	5,272	6,393	6,338
Thimphu	4,618	6,496	6,419	4,454
Paro	4,515	4,850	4,777	3,888
Gasa	4,114	3,454	2,814	3,004
Lhuentse	3,936	2,638	3,501	3,242
Trashigang	3,864	3,503	2,981	3,331
Pemagatshel	3,861	2,706	2,412	2,037
Trashiyangtse	3,632	4,216	3,547	4,002
Trongsa	3,553	2,893	3,342	3,904
Monggar	2,122	2,585	2,432	2,387
Punakha	2,051	2,428	1,663	2,431
S/ Jongkhar	2,044	1,910	1,900	1,829
Samtse	1,871	1,918	1,985	1,340
Zhemgang	1,499	1,371	1,536	1,542
Dagana	1,352	1,154	1,329	1,060
Sarpang	1,213	1,264	773	630
Tsirang	1,042	810	997	439
Bhutan	**4,018**	**4,111**	**4,194**	**3,763**

Potato is grown mostly under rain fed conditions and the crop is sown between the months of January – March, and harvested from May – August depending on the altitude.

2.2.3. Productivity Performance across the Region

In 2016, the national potato productivity was reported by the DoA at 4,018 kg/ acre.

[16] Agriculture Statistics, Department of Agriculture (DoA), 2009-2016

Examples of productivity level (kg/ acre) in other countries of the region (based on secondary research) are approximately 9,122 for India, 9,505 for Pakistan, 6,192 for Sri Lanka, 5,509 for Nepal, and 7,801 for Bangladesh (calculation details and sources laid out in Annex II).

As evidenced from the figures above, Bhutan's productivity is one of the lowest in the region. A number of actions have been taken in the past for increasing the productivity level with enhancing the access to irrigation, extension and high yielding inputs, such as fertilisers and improved seeds. However, the productivity continues to be lower than most countries in the region.

Based on discussions with producers and other stakeholders, most commonly cited reasons for low productivity include seed degeneration (more specifically the varietal degeneration of the most popularly grown *Desiree*), late blight susceptibility and infections, high incidence of pests and diseases in certain areas, inability of farmers to use of recommended levels of fertilisers (due to inadequate access and the financial crunch), and poor farm management practices in some cases.

Although yield per acre is relatively low, the per capita production of potato is very high in Bhutan compared to other countries in the region. The sloping land, rugged topography and rain fed conditions provide better options for growing potato than cultivating rice or other irrigation demanding crops. Farmers in Bhutan may take advantage of these conditions with their highly developed farming skills to give higher yields.

2.3. Potato Production Process/ Activities

The potatoes produced in Bhutan undergo five basic operations (a.) Input selection, (b.) Land preparation and planting, (c.) Fertilization/ weeding, (d.) Plant protection – guarding from wild animal damages and application of pesticide, if needed, and (e.) Harvesting.

The activity calendar differs significantly among potato farmers based in temperate zone versus those based in subtropical regions.

Input selection: Most of the interviewed farmers reported using seeds from the last harvest and applying farmyard manure mixed with commercial fertilizers to enrich the soil.

Most farmers in Bhutan use stored seed potatoes from the preceding harvest. Potato producers, on an average, retain 15-17% of their production for seed purposes (Table 8).

Table 8: Potato sold v. Retained for seeds relative to the total production (percentages)[17]

	2016	2015	2014	2013	2012
Seed retention/ Production (%)	15.5%	15.0%	17.0%	16.8%	15.6%
Sold/ Production (%)	64.2%	59.7%	64.6%	60.6%	58.6%
Balance (%) = Self consumption + PH Losses	20.3%	25.3%	18.3%	22.6%	25.8%

While most farmers use their own seeds, some of them purchase seeds from neighbouring famers and the National Seed Centre (NSC), on rare occasions. Additionally, certain processors, such as NOB Bhutan and commercial chips companies, also distribute new seeds to farmers from time to time.

Between 2014 and 2015, the National Seed Centre in Paro had supplied 172,637 kg of potato seeds to the farmers[18]. However, only 5-7% of the farmers use certified seeds of improved varieties. The seed replacement ratio (SSR) stands at 10% (Nidup & Tshering, 2007).

Interviewed producers reported procuring fertilizers from commission agents (CAs), nearest local supplier(s), and markets in Thimphu and Phuenstholing. Below are the input prices per the NSC.

[17] Agriculture Statistics, Department of Agriculture (DoA), 2012-2016

[18] Value Chain and Market Analysis of Renewable Natural Resources Products Report, MoAF, GEF & UNDP Bhutan, 2016

Table 9: Potato seeds and fertilizer prices[19]

Potato Seeds	**2015 Price per kg (Nu.)**	**2016 Price per kg (Nu.)**	**Bag capacity**
Desiree (red)	26	22	50 kg bag
White varieties	25	21	50 kg bag
Fertilizers	**2015 Price per bag (Nu.)**	**2016 Price per bag (Nu.)**	**Bag capacity**
Urea (46% N)	785	895	50 kg bag
Urea (46% N)	165	190	10 kg bag
Suphala (NPK 15:15:15)	1490	1690	50 kg bag
Suphala (NPK 15:15:15)	605	690	20 kg bag
SSP (16% P_2O_5)	770	895	50 kg bag

In certain areas, some producers are also apply insecticides purchased in 100gm concentrate packets to be mixed in specified liquid proportions prior to spraying.

Overall, there are not many traders or private enterprises engaged in importing, wholesaling or retailing inputs (such as seeds, fertilizer, pesticides, etc.) to the potato growers except the government owned farm shops, and supplies made by NSC and National Plant Protection Centre (NPPC). None of the interviewed farmers reported purchasing inputs from the one-stop farm shops, a recent government initiative for sale and distribution of agricultural inputs.

Land Preparation: Depending on the terrain, farm size and the access to resources, potato growers use power tillers and/ or bullocks for tilling their land. The trend among farmers is gradually moving from bullocks to power tillers or a combination of both for land preparation. Although majority of the farmers who use power tillers either rent tillers on hourly/ daily basis or use on sharing basis along with other members of the farmer group (FG).

All production systems are highly labour intensive as most of the work is done manually. Small plots, sloping land and the widely used crop intercropping system limit the opportunities for mechanized production.

Fertiliser Usage and Irrigation: The production of potato depends on the application of farm yard manure (FYM) for fertilizer requirements. The use of inorganic fertilisers is an emerging trend in Bhutan.

As per the field survey, a growing number of farmers and FGs are purchasing fertilizers from commission agents (CA). Urea with SSP and Suphala are the most commonly purchased fertilizers. Quite a few of the interviewed farmers also used leaf mould as fertilizers.

[19] NSC website

The rate of fertilizer application and choice between organic versus inorganic fertilizers is not uniform; farmers use it arbitrarily based on their judgment and the availability of resources.

The table below exhibits fertilizer recommendations, by dzongkhag, published by DoA.

Table 10: Fertilizer dosage recommendations for select dzongkags, DoA

High yielding varieties - Fertilizer Recommendation(Kg/acre)

DZONGKHAGS	LOW RESOURCE FARMERS (High-return)			HIGH RESOURCE FARMERS (High-profit)		
	N	**P2o5**	**K2o**	**N**	**P2o5**	**K2o**
Thimphu	28	20	8	40	28	12
Chhukha	24	16	8	32	20	12
Wangdi	28	24	8	40	32	12
Bumthang	24	28	12	32	36	16
Gaylegphu	24	20	8	32	24	16
Chirang	32	24	8	40	32	12
Tashigang	32	24	8	36	32	12
Paro	28	28	8	40	32	12
Haa	24	16	8	32	24	12

- Entire dose of SSP and MOP to be used at basal dressing.
- Half the urea to be used as a basal dressing.
- Remaining half of the urea to be used as top dressing.
- Top dressing to be carried out at first weeding/ earthing up when plants are about 15 cms (6 inches) high.
- Use 3-4 tonnes/acres of FYM/compost at land preparation for best results.

As potatoes are generally grown under rain-fed conditions, irrigation is not required. Only in certain areas where potato is grown as a winter crop, irrigation is provided.

Crop protection: Damage of crops by wild animals is a serious problem for potato growers in Bhutan. Although with RGoB initiatives of electric fencing, the percent of production lost to wild animals has dropped from 6% in 2006[20] to about 2-3% in 2014-2016[21].

[20] Bhutan Food Security Strategy Paper, 2006

[21] Agriculture Statistics, Department of Agriculture (DoA), 2014-2016

Table 11: Estimated Potato area and quantity lost to the wild animals by dzongkhags[13]

Dzongkhag	2016		2015		2014	
	Area Lost (Acres)	Qty. Lost (MT)	Area Lost (Acres)	Qty. Lost (MT)	Area Lost (Acres)	Qty. Lost (MT)
Bumthang	12	75	7	57	12	42
Chhukha	84	52	33	86	30	132
Dagana	2	1	2	0.6	5	0.87
Gasa	2	5	0.8	0.2	0.1	0.14
Ha	36	111	53	163	47	141
Lhuentse	15	107	11	11	14	16
Monggar	78	66	69	50	57	74
Paro	66	245	64	198	113	199
P/gatshel	5	5	27	28	4	6
Punakha	3	3	2	0.5		
S/Jongkhar	13	17	13	16	8	13
Samtse	3	5	0.2	0.4	0.5	0.4
Sarpang	3	2	2	2	0.6	0.2
Thimphu	1	15	1.4	7	10	27
Trashigang	110	117	69	108	57	101
T/yangtse	51	133	33	72	27	58
Trongsa	41	79	22	37	6	5
Tsirang	14	12	9	3	14	8
Wangdue	214	1,008	82	245	72	244
Zhemgang	0	0	0.1	0.1	0.18	0.11
Bhutan	**753**	**2,056**	**502**	**1,083**	**476**	**1,069**

While the actual yield loss may not be significant, except for small, individual farmers, the economic opportunity lost due to the need for guarding the field is considerable (Roder et al, 2007). Guarding against wildlife damage adds significantly to the total cost of potato production, as growers have to guard the crop for 4-5 months.

Pest and Disease: Late blight is one of the most important diseases of potato in Bhutan. The pathogen is capable of destroying an entire unprotected potato crop within one to two weeks under certain weather conditions. Losses can be largely avoided through intensive management, although fungicides are often required. Late blight appears every year in all major potato-growing areas. It is most severe above 2000 m where wet conditions occur in the first 80 day of

potato growth. It has also been reported as a pest of tomatoes at higher altitudes when grown later in the season (Zhemgang) and in greenhouses (Haa)[22].

Early blight is a fungus that, like late blight, can also defoliate and even destroy unprotected potato crops. However, treatment is not often required. Early blight co-occurs with late blight, but it is more prevalent in warmer conditions, so also extends down to lower altitude areas such as Tsirang and Sarpang. Although ubiquitous, it rarely causes widespread defoliation in the open air. It can cause severe defoliation of seed potato production in greenhouses.

More than 90% of the interviewed potato farmers reported of potato blight and seed degeneration as constraints to productivity. Most of these farmers were unaware of the differences between early and late blight and the right techniques to manage blight. Access to the right type of fungicide was also cited as a constraint.

Few of interviewed farmers from Chapcha reported to have lost 20-50% of their harvest to potato blight in 2017.

Per the previous studies, Potato Tuber Moth (PTM) is also one of the more severe problems experienced in the Eastern Bhutan. Most growers covered potato with ferns, artemisia, banana or vitex leaves to prevent PTM, while other use ash, lemongrass oil or cannabis extract to fight against PTM. Only a few growers use chemicals like Mancozeb, Cypermethrin (0.5ml/litre), Linear Alkybenzene, Sulfonate Sodium Salt, Cocamido Propyl Betane, Sodium Lauryl Ether Sulfate, etc.

Harvesting: Harvesting takes place after potato tubers reach maturity. The rate of maturity of potatoes depends on the growing conditions. Generally, most cultivars are ready for harvest between four to five months from planting. The potato growers determine the maturity of the tubers by taking random samples to test for skin firmness. Another way to check this is when the haulm turns yellow or dies (sign of maturity). Matured tubers are less likely to damage during harvesting and post-harvest handling, while immature ones are subjected to mechanical injuries like skin peeling, bruising etc.

The large growers use bullocks and power tillers to dig the ridges while harvesting. In doing so, some of the potatoes remain covered with soil and thus remain unpicked, serving as host for pest and diseases in the next cycle.

Small-scale harvesting is mostly done by household members using a long handled spade or a hoe to unearth the plant and shake the soil from the tubers.

Most farmers collect the tubers in the basket and bring to the store immediately after harvest.

[22] National Plant Protection Center (NPPC) website

2.4. Post-Harvest Activities

Once the potatoes are brought to the store after the harvest process is complete, multiple post-harvest activities are performed, such as sorting, grading, packing, storing, loading, transportation, unloading, and storing. Most of these functions are undertaken by the growers themselves, with assistance from other family members and very rarely hired labour.

Curing and cleaning: Tubers are unearthed through use of small farm tractors and manually by human labour. Tubers are left on the earth surface to cure and allowing the skin to toughen while excess earth drops off upon drying. Past studies (Nidup & Tshering, et al., 2007) report that less than 10% of farmers' practice curing and cleaning before storage resulting into increased risk of deterioration during storage. Minimal curing is done as it is time consuming, and efforts to bring a mechanical cleaner/ grader to the farmers' field may not be practical as quantities produced by farmers are not large enough to meet the additional cost.

Sorting and Grading: All the interviewed potato farmers reported they carry out sorting and grading of potatoes at two levels –

- Preliminary sorting: The potato farmers first separate damaged and undamaged tubers, and throw away diseased/ damaged/ rotten produce
- Secondary sorting: Once the rotten harvest is discarded, the farmers manually separate the potatoes based on (a.) colour - red and white; and (b.) size - seed, small, medium and large.

However, the sorting practice doesn't meet the requirements of Indian buyers at the auction yard[23]. The interviewed Indian buyers reported they almost always have to engage in sorting and re-packaging after the purchase from Bhutanese sellers at the auction yard.

Nonetheless, entities such as NOB Bhutan and FCBL auction yards are making investments into new grading equipment, adding value in the potato chain.

Packaging: Based on the colour and size, potatoes are packaged in separate bags. All the interviewed potato farmers package their sorted produce in jute or perforated polypropylene (PP) bags of 50 kg each. However, the farmers prefer to pack about 60-75 kg per back to save on the transportation costs (the transportation charges are applied per bag, not per kg). Farmers pay nearly Nu. 25 for the brown, jute bags, while the PP bags cost them about Nu. 18 each.

Potatoes from Eastern Bhutan are generally packaged in perforated PP bag, sometimes resulting in rotten produce by the time they reach the auction yards. On the other hand, the jute bags are considered better packaging option as they absorb moisture.

Storage: Most of the growers use the ground floor of their houses as a potato store; however some FGs had also built separate sheds[24]. Due to the potato cultivation at high altitudes and cool

[23] Interview with FCBL officials and Indian traders at the auction yard

[24] Interviews with potato farmers and FGs

temperatures in most parts of Bhutan, the ongoing at-home storage conditions (until sold in the local market and/ or auction yards) seem to work.

Most ware potato are sold by the producers within 1-2 months after harvest. Potatoes are stored for a maximum period of 4-5 months mainly for seed purposes and home consumption and for sale. Storing methods used by the Bhutanese farmers vary depending on the design of the houses and climatic conditions.

However, most of the interviewed farmers were unhappy about the suboptimal size of their storage area. Others complained of losses from rodent and potato rotting as other issues in storage.

Farms located in higher altitudes (> 2300 m) did not suffer as much storage damages as the ones located in lower altitudes with warmer temperatures.

Transportation: Trucks are the most common mode to transport potato from the farms to the auction yards. Producers without road access to the field may use tractor, power tiller or horses to carry the potato to a road point.

Most potato growers sell their harvest at the nearest auction yard, transporting it themselves or through a middlemen. Most producers prefer to travel to the border towns themselves to sell their produce and also make wholesale purchases for household items from India. They carry potato bags from their fields or stores to the road head on their back or on tractors or horses. Once they find a truck at the road head which is going down to the auction yard, they negotiate the price and load the potatoes. The price is fixed on a per bag basis, which ranges from Nu. 50-210 per bag[25] depending upon the distance.

As weighing facilities are not available in villages, it is difficult to charge transportation fee on a per kg basis. To save on transportation costs, potato growers tend to put in 60-75 kg potatoes in a perforated bags of 50 kg capacity. However, overloading causes damage to the tubers in some cases ultimately fetching them lower prices.

In some cases, select large-scale farmers act as middlemen who collect potatoes from fellow producers and transport along their own potato to the auction-yard. Sometimes truck owners also play the role of bulk buyers, acting as middlemen, collecting potatoes from the road-head and selling them at the auction yard.

A number of respondents indicated challenges in the current transportation system. Sometimes their wait times at the road point are very high, and on other occasions they feel the transportation charges are not reasonable. For example, few potato farmers from Chapcha (merely about 70 km from the Pheuntsholing auction yard) spend about Nu. 100 per bag on transportation, including Nu. 40 per bag from their farm/ storage to the road point and Nu. 60 from road point to the auction yard. Potato producers from Bumthang, on the other hand, pay over Nu. 200 per bag as transportation charges.

Additionally, farmers have to incur unloading costs at the auction yards of about Nu. 5 per bag.

[25] Interview with farmers from Bumthang, Chapcha and Phobjhika

While most famers prefer to sell their produce as soon as their post-harvest sorting and packaging is complete, some have learned to wait and inquire the prices received by fellow producers at the auction yard. Poor households generally find it more difficult than wealthier households to store their potatoes for a long period of time due to their urgent need for cash.

2.5. Processing

Bhutan imports most of the processed potato products, such as chips and potato snacks, from India, Thailand and other countries in the region.

Small quantities of homemade potato chips are available in grocery shops, restaurants and small stalls in some parts of the country. However lately, commercial chips brands, such as Happy Chips and Bhutan Chips, are readily available in different outlets in major towns.

Happy Chips and Bhutan Chips have managed to use Bhutanese, red potatoes for production however with very distinct specifications and from certain locations. However the success rate is assumed to be better with ChipsSona variety, which DoA and very few famers are able to supply. Other Bhutanese chips manufacturers include Bhutan Crispy (Jamena) and Zimzim (Phuensholing).

Most chips companies incur relatively high cost of production as they cannot benefit from economies of scale.

In addition to these commercial processing enterprises, there are few household level enterprises which produce potato chips, pack in polythene bags (150-250 gram/pack) and sell at prices ranging from Nu.10 to Nu.20 in the local market. National Post Harvest Centre (NPHC) has trained and supplied equipment to some growers and FGs to make chips at home.

Apart from chips, there are no other processed products made from potatoes. French fries, commonly served by most small and big restaurants/ bars and hotels, are generally imported in 5-10 kg frozen bags. NPHC has not explored training in French fries processing so far.

2.6. Potato Consumption in Bhutan

Potato requirement in the domestic market is increasing annually due to the increase in consumption levels. The per capita annual consumption of potato in Bhutan is estimated to be 40 kg/person, which is expected to increase to 60 kg/person by 2020 (Nidup et al, 2007). This level of consumption is much higher than the average annual consumption in Asia (24 kg/person).

The price of potato is relatively low compared to other vegetables in Bhutan especially in summers. Potato is well preferred by children in Bhutan and is very compatible with chili. Furthermore, potato can be easily stored. The overall trend therefore seems promising for domestic consumption in Bhutan.

The table below outlines the potato production, sales and consumption statistics over the last 5 years. About 3-12% of the total potato production is consumed through local markets in Bhutan.

In addition to that, farmers/ producers keep aside a certain part of their production for household consumption.

Table 12: Potato production, sales and consumption statistics, 2012-2016[26]

	2016	2015	2014	2013	2012
Production (MT)	58,820	49,359	53,612	50,390	43,000
Qty Sold (MT)	37,762	29,466	34,653	30,548	25,180
Sold (%)	64.2%	59.7%	64.6%	60.6%	58.6%
Auctioned Qty (MT)	30,895	28,151	31,965	26,022	25,315
Balance Qty (Sold-Auctioned) = Local Market Consumption	6,867	1,315	2,688	4,526	
Local Market/ Sold (%)	18%	4%	8%	15%	
Local Market/ Production (%)	12%	3%	5%	9%	

Use of potato as inputs for processing or sale to processors was negligible in case of potatoes – the local market consumption figure above (3-12%) also includes potato consumed by the commercial processing enterprises. Only one of the interviewed FGs in Bumthang reported using about 20% of their total production for processing potatoes into chips for sale in local markets.

2.7. Marketing Channels for Bhutanese Potato

Auction yards are the leading marketing channels for Bhutanese potato, followed by vegetable and weekend markets. Additionally, potatoes are supplied to schools and institutions with boarding facilities, military mess (RBG, RBA, RBP, etc.), and National Seed Corporation (NSC).

2.7.1. Auction Yards (FCBL and SAM)

FCBL started supported potato marketing in 1973 when it established a support price and began buying potato directly from the farmers. The introduction of the auction yard system in 1980 provided a mechanism to optimise the interaction between potato growers and buyers. Today, about 53-60% of the total potato production (Table 14) in Bhutan is auctioned through the auction yards.

Farmers prefer the auction yards (AYs) at the bordering towns of Phuentsholing and Samdrup Jongkhar as they can buy their essentials and household items at cheaper rates from the neighbouring Indian markets.

[26] Agriculture Statistics, Department of Agriculture (DoA), 2012-2016 and Data from FCBL and SAM AYs

Initially several make shift auction yards were operated but today Phuentsholing in the West (bordering the Indian State of West Bengal) and Samdrup Jongkhar in the east (bordering the Indian State of Assam) are the two most crucial centres for potato exports. Between the two, Phuentsholing is the most active and vital outlet for potato marketing, receiving about 80% of the total quantity auctioned over the past few years (Table 13).

Producers can bring their potato produce and other fruits and vegetables to the auction yard. Any trader who registers with the auction yard is allowed to participate in the auction. Potatoes are auctioned from June to December every year.

Since 2014, farmers have an option of a private auction company called Sersang Agricultural Marketing (SAM). SAM is also based in Phuentsholing and auctions potatoes from 8:30-9:30 am, before the FCBL auction begins at 9:30. Auction prices generally trend similar to that of FCBL's[27].

2017 experienced record auction of over 33,400 MT of potato, valued at over Nu. 469.74 million, sold through the FCBL and SAM auction yards, inclusive of 1,147.1 MT (valued at Nu. 17.28 million) sold through FCBL's newly introduced e-auction facility[28].

Following 2017, second highest quantity of 31,965 MT was auctioned in 2014, followed by 30,991 MT in 2009, valuing Nu. 836.4 Mn. and 490.8 Mn. respectively[29].

Table 13: Relative comparison of potato volume auctioned from the 3 AYs, 2014-2017 [30]

Year	Total Auctioned (MT)	FCBL P/ling AY (MT)	FCBL SJ AY(MT)	Sersang (SAM) AY (MT)
2017	33,437	20,790	7,580	5,067
2016	30,895	19,375	6,436	5,084
2015	28,151	17,025	5,575	5,551
2014	31,965	20,277	6,301	5,387

Based on the auction data above, it can be deduced that FCBL Phuentsholing Auction Yard accounts for majority of the potato auctioned in Bhutan (60-63%), while FCBL Samdrup Jongkhar Yard and SAM Auction Yard account for about 16-20% each.

[27] Interview with Singye Dukpa, SAM

[28] FCBL Auction data from Phuentsholing and Samdrup Jongkhar

[29] FCBL Auction data from Phuentsholing and Samdrup Jongkhar

[30] Auction data from FCBL and SAM

Auction volumes compared to production figures exhibit that 53-60% of the potatoes produced are auctioned in one of the three auction yards in Bhutan (Table 14).

Table 14: Quantity Auctioned v. Produced, 2014-2016[31]

Auction trends	Total Production (MT)	Total qty. auctioned (MT)	Qty auctioned/ Production (%)
2016	58,820	30,895	53%
2015	49,359	28,151	57%
2014	53,612	31,965	60%

Potato auction quantities, value and prices vary year on year depending on potato production, location of the auction yard, and demand and fiscal trends in India (Table 15 and Figure 3).

Table 15: Potato Auction Volume and Value Trends, 2006-2017[32]

	Phuentsholing AY		**S/Jongkhar AY**		**SAM AY**	
Year	Qty. auctioned (MT)	Auction Value (Nu. Mn.)	Qty. auctioned (MT)	Auction Value (Nu. Mn.)	Qty. auctioned (MT)	Auction Value (Nu. Mn.)
2006	17,233.84	196.34	3,412.45	31.44	-	-
2007	18,778.61	200.63	2,837.75	30.75	-	-
2008	16,685.75	109.44	4,347.82	29.06	-	-
2009	24,334.88	401.54	6,656.66	89.31	-	-
2010	21,161.92	236.48	3,175.61	34.59	-	-
2011	17,672.96	192.09	5,522.83	55.60	-	-
2012	19,148.90	298.08	6,165.72	84.09	-	-
2013	20,221.89	337.22	5,799.92	78.12	-	-
2014	20,277.25	548.27	6,300.98	140.59	5,387.13	147.55
2015	17,025.25	292.13	5,574.58	81.90	5,550.89	91.68
2016	19,374.54	460.88	6,436.28	123.63	5,084.12	123.71
2017	20,790.00	297.21	7,579.75	102.09	5,066.82	70.44

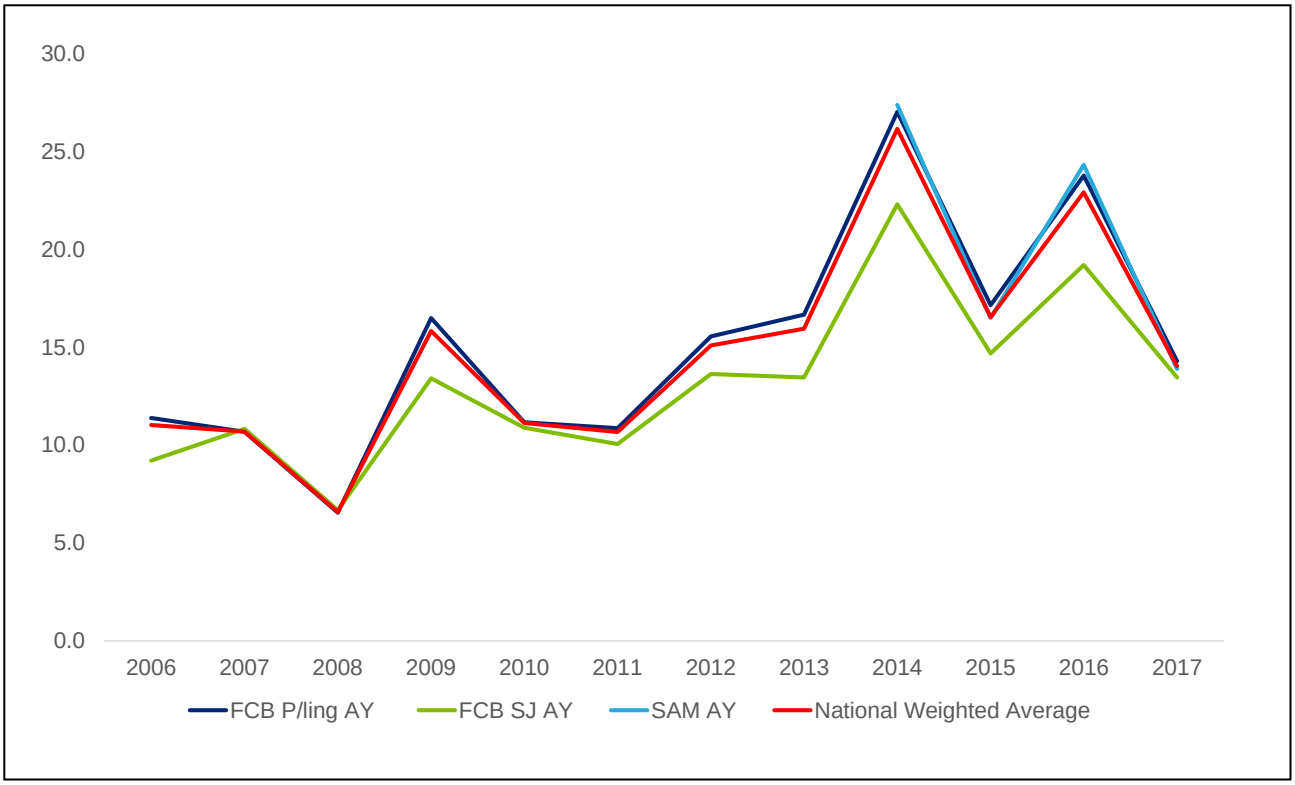
[31] FCBL Auction data from Phuentsholing and Samdrup Jongkhar

[32] FCBL Auction data from Phuentsholing and Samdrup Jongkhar

The average auction price from 2006 to 2017 was Nu. 14.7/ kg of potato. During this period, the highest average auction price was recorded in 2014 at Nu. 26.2/ kg while the lowest was in 2008 at Nu. 6.6/ kg.

Additionally it should be noted that the auction prices in Phuentsholing always trend higher than the auction prices at Samdrup Jongkhar AYs (due to higher demand at Phuentsholing AY from traders in the bordering towns of Bengal). Hence the national auction price averages tend to be lower than that of Phuentsholing auction prices (Figure 3).

Figure 3: Variability of potato auction prices, 2006-2016[33]



2.7.1.1. Traders at Auction Yards

The traders at the auction yards are mostly Indian merchants who purchase in bulk and sell the produce in the major border towns of West Bengal and Assam or export to Nepal. These traders are also involved in the import of seed potatoes during the months of November and December every year. Auction yards are the most commonly used market outlets for trade of Bhutanese potatoes.

Most of these traders purchase in bulk and sell in major border towns in northern West Bengal and Assam, such as like Panitanki, Falakatta, Siliguri, Coochbehar, Kolkata, Barpetta, Rangia,

[33] FCBL and SAM Auction data from Phuentsholing and Samdrup Jongkhar

and Nalbari. More recently, some of the large traders have started exporting a significant portion of their purchase to Nepal.

Earlier the Indian traders provided Bhutanese potato to processing industries (such as Pogo, Haldirams, etc.) in India for production of potato chips. However, the demand from such processing plants in India has drastically declined as they have switched to Indian potatoes for production[34].

The merchants/ traders also expressed dissatisfaction with the existing grading and packaging practices adopted by the Bhutanese potato producers. Most of these merchants engage in a subsequent round of grading and re-packaging after their purchase at the auction yard, which calls for additional storage space and labour cost at their end.

2.7.2. Vegetable/ Weekend Markets

All Dzongkhag capitals and emerging urban centres have vegetable markets. Local, Bhutanese produce as well as imported produce from India are sold at the larger weekend markets, such as Centenary Farmers' Market (CFM), Thimphu. Individual farmers and traders/ retailers (who purchase from other potato farmers) sell their products at these markets. Potato is also sold at local grocery stores in bigger towns/ cities.

In general, potato sold at these weekend and retail markets during the months of January - May are mainly imported from India, while those offered during the other months are mostly locally produced.

About 8-18% of the total potato sales accounts for quantity sold in the local markets in Bhutan (Table 12). In terms of percentage of the total production, the farmers'/ weekend market outlets account for 3-12% of the total potato produced in Bhutan (Table 12).

The sellers at these weekend markets are farmers selling their own produce or traders who buy from other farmers. Very little information is available on such traders, as all the interviewed producers sold directly at the AYs or local markets.

These vegetable markets provide opportunities for producers and traders/ vendors to sell vegetables few days every week. Potato is always sold along with other vegetables and is the vegetable purchased in the largest quantities.

In terms of prices, Bhutanese potatoes manage to attract higher prices compared to imported, Indian potatoes in the vegetable markets in Bhutan, mainly due to higher consumer trust (Table 16).

[34] Interviews with Indian traders at the auction yards at Phuensholing

Table 16: Relative potato prices (local v. imported) at CFM, Thimphu, 2011-2015[35]

Potato Prices (Nu./kg)	Bhutanese potatoes	Imported potatoes
2011	20.89	18.1
2012	24.6	21.82
2013	32.1	25.8
2014	43.08	32.13
2015	-	29

Also, average prices received by farmers by selling at local vegetable markets (retail prices) is of course higher than the average auction prices (wholesale prices) as exhibited in the table below.

Table 17: Relative potato prices (local market v. auction yards), 2013-2016[36]

Potato Prices (Nu./kg)	National Average*	AYs	Retail Prices
2013	19	15.96	24
2014	23	26.17	25
2015	20	16.54	
2016	24	22.92	28.8

* Average prices of potato (Nu/kg) received by farmers, 2013-2016 per RNR Statistics, 2016

2.7.3. Middlemen (Intermediaries/Transporters/Large Producers)

Middlemen provide marketing channels for the potato farmers in three ways –

- Intermediaries who buy from farmers and sell to larger wholesalers who do not have the time to carry out small purchases from local markets or from scattered farms
- Truck drivers who purchase potatoes from one or more producers and subsequently transport and sell them at the auction yards keeping a small margin in between
- Large, commercial producers who buy potatoes from neighbouring, small-scale producers to combine with their produce for auction purposes

[35] Bhutan RNR Statistics, PPD, MoAF, 2016

[36] Bhutan RNR Statistics, PPD, MoAF, 2015 and 2016, and Data received from FCBL and SAM AYs

However, the involvement of middlemen/intermediaries is not very high in potato business. Most farmers prefer to auction their own produce or sell directly at the vegetable markets unless their scale of production is substantially low.

2.7.4. Institutional Buyers

Institutional buyers in Bhutan include boarding schools, and mess at Royal Bodyguard of Bhutan (RBG), Royal Bhutan Army (RBA), and Royal Bhutan Police (RBP). They generally purchase potatoes in bulk for several weeks from producers.

2.7.5. National Seed Corporation (NSC)

The National Seed Corporation (NSC) has its network of Registered Seed Growers (RSG) who sell their seed potatoes to NSC under the buy-back program.

2.8. Potato Import and Exports

2.8.1. Potato Exports

FCBL is central to all potato exports in Bhutan. Although it is commonly believed that all the potatoes auctioned through the FCBL are exported to India, it is possible that some of the auctioned quantities are bought by traders in Bhutan to sell to schools, institutions and major mega hydro-power project settlements[37]. This seems to be the only plausible explanation for the difference between the export figures published by Department of Revenue and Customs (DRC), Ministry of Finance and the auctioned figures provided by the FCBL and SAM auction yards.

Also, none of the stakeholders in the potato value chain could validate the viability of exports to Nepal and Bangladesh.

Table 18: Difference between potato exported and auctioned quantities, 2014-2016[38]

(All quantities in MT)	Total qty exported	Export to India	Export to other countries	Share of India in total exports (%)	Other export destinations	Total qty auctioned	Total qty auctioned *Less* qty exported
2016	24,460	24,443	17	100%	Nepal	30,895	6,435
2015	19,908	19,889	19	100%	Bangladesh	28,151	8,243
2014	26,849	26,641	208	99%	Bangladesh	31,965	5,116

[37] Commodity Chain Analysis of Potato in Bhutan, 2006

[38] Data from AYs and Bhutan Trade Statistics, Department of Revenue and Customs, Ministry of Finance

2.8.2. Potato Imports

Compared to its exports, the quantity of fresh potatoes imported by Bhutan is relatively much smaller. In 2016, quantity of imported potatoes comprised of only 9% of the total production, while the percentage was 12 and 10 percent in 2015 and 2014 respectively.

Almost 100% of imported potatoes come from India. There is considerable open trade between India and Bhutan. From June to November, Bhutan exports its potatoes to India, whereas from December to May, it imports Indian potatoes, although in much lesser quantities than those exported.

Table 19: Potato import statistics, 2014-2016[39]

	Total qty imported (MT)	Unit price (Nu.)	Qty Imported from India (MT)	Value imports India (Nu. mil)	Qty imported from other countries (MT)	Value imports other countries (Nu. mil)
2016	5,469	14.89	5,469	81.44	0.02	.01
2015	6,010	10.06	6,010	60.46		
2014	5,272	15.27	5,272	80.49		

2.8.3. Analysis of Potato Import and Export markets

India: India is Bhutan's main trading and development partner. Most of the potatoes from Eastern Bhutan are supplied to the Indian state of Assam through the auction yard in Samdrup Jongkhar, while the potatoes from rest of Bhutan are sold through Phuentsholing auction yard to West Bengal. Almost all bidders in the FCBL and SAM auction yards come from India. They buy the bulk quantity, grade as per the requirements of their clients, repack and transport the potatoes to nearby cities in Assam and West Bengal, and parts of Nepal.

Over the last 11 years (2006 to 2017), India has roughly imported about 20-33 million kg of potatoes from Bhutan annually. However India has made tremendous progress in potato production and is among the fastest-growing potato exporters globally since 2012[40].

West Bengal is the country's second-largest potato producer, with about an annual production of 11 million MT[41]. Nearly 40% of the state's production generally gets exported to other states[42].

[39] Bhutan Trade Statistics, Department of Revenue and Customs, Ministry of Finance

[40] http://www.worldstopexports.com/potatoes-exports-by-country/

[41] https://www.potatopro.com/india/potato-statistics

However Bengal continues to remain dependant on Uttar Pradesh, Punjab and Bhutan for seed potatoes. Over the last couple of years, Bhutan has in fact become preferred choice for potato seeds, more so for farmers in Northern Bengal, mainly due to fewer hazards in importing from the Indo-Bhutan border which is hardly 100 km from Jalpaiguri and Cochbehar districts. These districts contribute around 30% to West Bengal's total output[43]. Moreover, Bhutanese seeds have outperformed Punjabi seeds in terms of yield.

The state of Assam on the other hand has an annual import requirement of about 2-2.5 million MT of potatoes[44]. Assam is also very well connected to the other north-eastern states and presents a huge potential market for Bhutanese potatoes. Currently the potatoes bought by Indian traders from the Sandrup Jongkhar auction yard only reaches select towns in Assam.

Overall, given the different seasonal production cycle, Bhutanese potatoes enjoy an excellent market in India. In most parts of India, the bulk of potatoes are grown during the winter season under short-day conditions and are harvested from January to March; whereas in Bhutan, potatoes are grown as summer crop with seed planting in March and peak harvesting in July. From September to November there is a high demand for Bhutanese potatoes in India.

Additionally, Bhutan's advantageous agro-ecological conditions also offer excellent opportunities for the export of potatoes that can be used as seeds in India. There is a huge demand for Bhutanese seed potatoes in the neighbouring cities of West Bengal and Assam. The seed potato demand for West Bengal and Assam is significantly higher than what Bhutan is currently able to meet. However, the question of the sale of this genetic material, developed and maintained at a high standard at cost to the RGoB, should be considered[45].

Nepal: Potato is Nepal's second staple food crop, after rice, and per capita consumption is estimated to be 51 kg a year, one of the highest for South-Asian countries (FAO, 2008). Nepal imports a substantial quantity of potatoes via Indian traders during the time of potato harvesting in Bhutan. The price offered for potatoes in Nepal during August-October is higher than the price of potatoes in Bangladesh, Bhutan and India. Most of the interviewed Indian traders exported Bhutanese potatoes to Nepal and fetched better prices than in Indian States.

If access for agro-trade was improved and business relations strengthened, potato from Bhutan could enjoy an excellent market in Nepal.

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[42] https://economictimes.indiatimes.com/markets/commodities/west-bengals-potato-farmers-in-trouble-as-other-states-grow-their-own/articleshow/46628935.cms

[43] https://economictimes.indiatimes.com/news/economy/agriculture/northern-bengal-potato-sector-under-trouble/articleshow/60369353.cms

[44] https://www.thehindubusinessline.com/news/national/assam-aims-for-selfsufficiency-in-potato-production/article7039732.ece

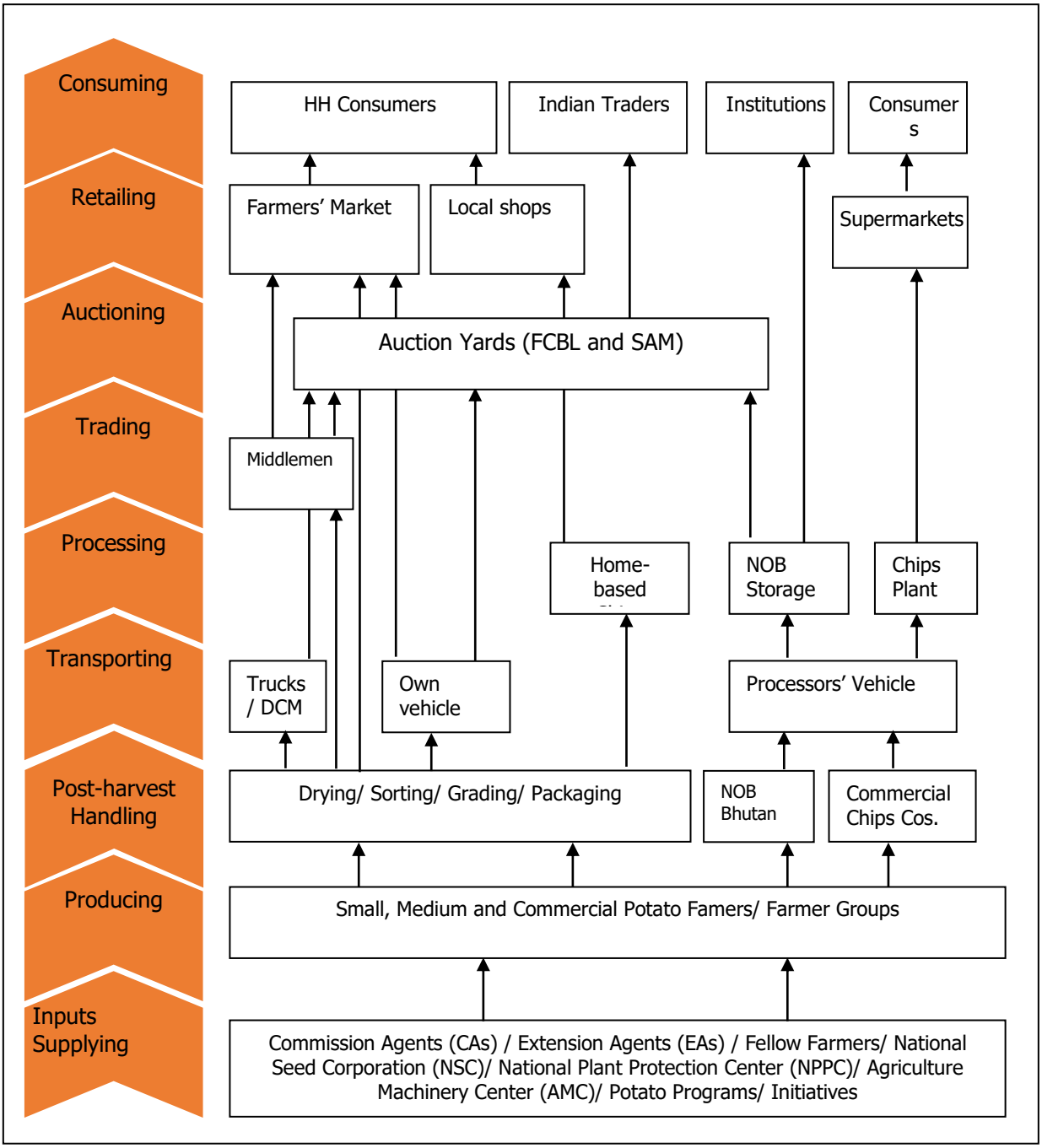
[45] Potato in Bhutan – Value Chain Analysis, S. Joshi and B. Gurung, 2009

3. VALUE CHAIN ANALYSIS

3.1. Core Processes within the Potato Value Chain

The key activities and processes that enable potato to reach the final consumer is mapped below:

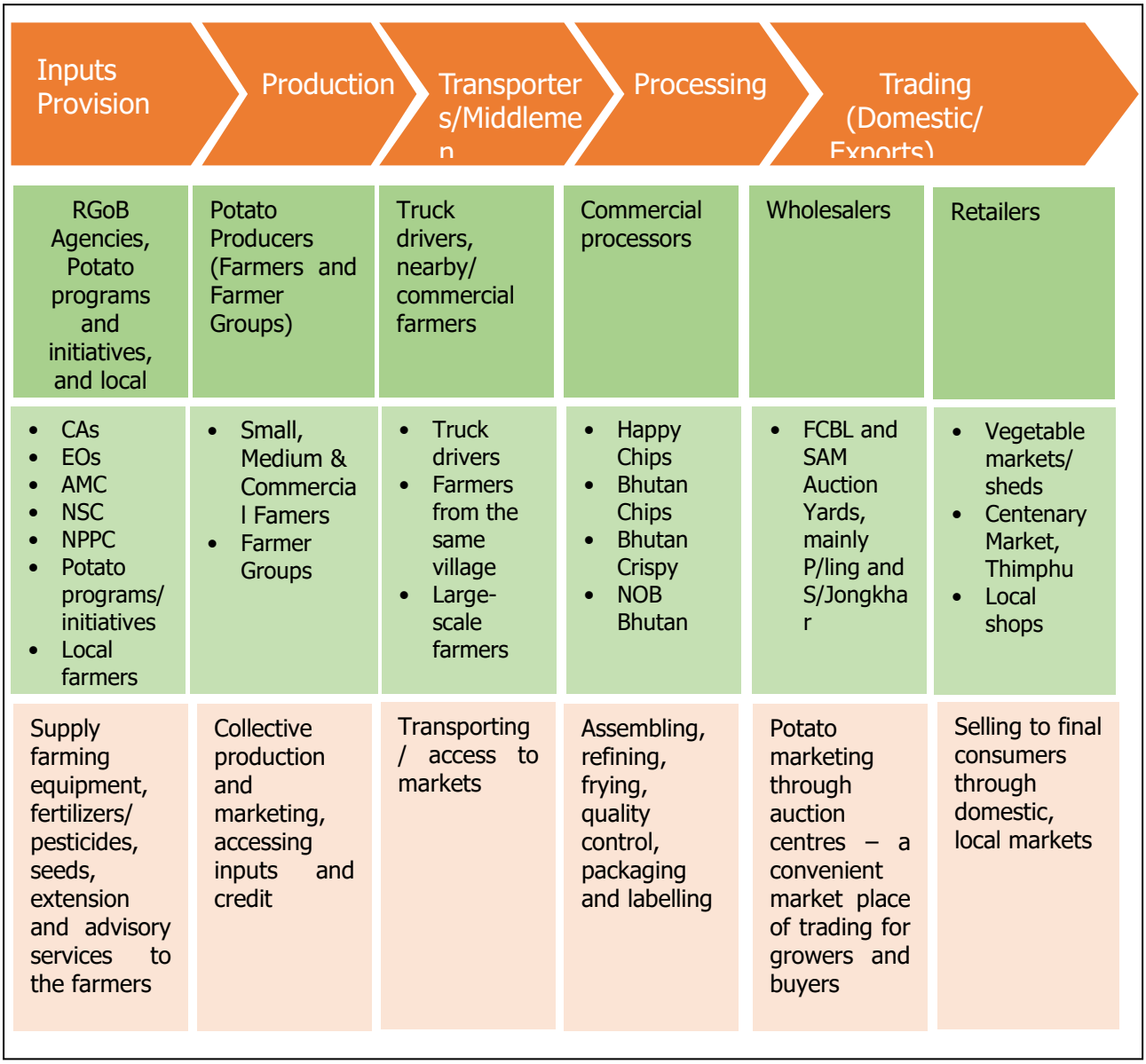
Figure 4: Potato Value Chain Core Processes



3.2. Value Chain Actors and Functions

The main actors in the potato value chain are: input suppliers, producers, processors, transporters, middlemen, auction yards/ exporters, retailers at farmers' market and consumers:

Figure 5: Potato Value Chain Core Actors and Functions



Inputs suppliers: Most potato farmers in Bhutan use their own seeds and farm yard manure. There are not any traders or private companies engaged in importing, wholesaling or retailing inputs (seed, fertilizer, pesticides, etc.) to the potato growers. Inputs are mainly sourced from National Seed Corporation (NSC) through commission agents (CAs) or through extension officers (EOs).

Commission Agents (CAs): The system of Commission Agents (CAs) was introduced in 1989 and is the main channel for the sale and distribution of agricultural inputs. Commission Agents are identified and appointed by the Dzongkhags and are responsible for the distribution of seeds, saplings, fertilisers, agricultural tools and small machineries. The cost of transportation for the supply of most inputs to the farm is subsidized by the government. The CAs receives 10% of the value of inputs distributed to the farmers as commission from the government.

However, the performance of CAs is far from what they are expected to do (Gurung, 2005). The majority of CAs does not have much knowledge of farming and lack motivation to deliver information to the farmers with the seeds (Nidup et al, 2007). A survey conducted by Nidup et al (2007) showed that 18% of the CAs visit the farms once a year, whereas an astounding 81% never made any farm visits. Especially the farmers who live in remote areas, far away from a road head, do not receive a timely supply of fertilisers, seeds and chemicals (van der Wal and Wangchuk, 2002).

As the number of farmers using certified seeds, chemical fertilisers and other services is limited, the system operated at present does not seem lucrative for CAs. Thus, there is a need to assess and review the system to strengthen the input supply mechanism (Gurung, 2005).

Extension Officers (EOs): There are 205 geogs in Bhutan, with RNR EOs (also called Extension Workers or Extension Agents) in every geog. These EOs are supposed to provide updated information, promotional seed and pesticides on a cash-and-carry basis, technological awareness and training to the farmers[46].

Producers: Potato producers can be classified into small, medium and large scale, with respective farm sizes of less than an acre, 1-3 acres, and more than 3 acres[47].

Additionally the producers can also be classified into individual producers and Farmer groups (FGs).

FGs are formed by a group of farmers in the same geog to access to equipment subsidies and credit, and training from the government. In some cases, the members of FG may together lease land for the purposes of collective production, processing and marketing (e.g. Phuntsho Rabten Kewa Detshen FG). In other cases, individual members of the FG own their separate lands and organize themselves in a group to pool other resources and access agricultural subsidy and credit.

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[46] According to 2009 VCA, EOs are overloaded with different tasks, look after number of agricultural crops and most of them lack exposure and knowledge of modern potato production technologies. Moreover, some EOs are supposed to look after large geogs with far flung villages and households making it difficult for a single person to cater to the needs of the most farm.

[47] Department of Agriculture (DoA) classification

Transporters/ middlemen: Once the producers complete their harvest and post-harvest activities, their biggest concern is marketing their produce. Some producers wait for pricing information from FCBL and/ or fellow producers, while others move to auction yards (AYs) as soon as their packaging is complete.

The produce is mostly carried to AYs in trucks, wherein the drivers charge a certain fee per bag, depending on the distance. On some occasions, a large commercial producer or a middlemen will buy the harvested potatoes from the producer for sale at the AYs or farmers' market.

Processors: Processors could be (a.) individual farmers or FGs processing a part of their harvest into potato chips based on the training received from NPHC, or (b.) commercial chips companies, mostly based in Thimphu or Phuentsholing, supplying chips to retailers and supermarkets for domestic consumption.

Wholesalers: Auction yards (AYs) act as the biggest wholesaler in the potato market. Farmers or middlemen sell their potatoes to registered bidders (mostly, Indian traders) through the AYs. 60% of the total potato production in Bhutan is sold through the AYs at Phuentsholing and Samdrup Jongkhar.

Retailers: Retail sales are transacted through weekend/ farmers' markets, middlemen and local shops.

Consumers: In addition to the domestic consumers, Bhutanese potato is popular among and consumed by Indians, residing in the bordering towns of Bengal and Assam, and people in Nepal. Bhutanese potato reach Nepal through the Indian bidders/ traders who purchased potatoes at the AYs in the Phuentsholing and Samdrup Jongkhar.

3.7. Flow of Potato Volumes along Different Marketing Channels

The sale of potato through auction yards is the most preferred channel for potato producers, especially the commercial and the large-scale producers. Hence the percentage of potatoes auctioned out of the total production in Paro and Wangdue go beyond 74%, followed by Bumthang, Thimphu, Haa, and Trashigang auctioning about 48-64% of their total production in 2016. Trashiyangtse and Chukha auctioned about 43% and 40% of their production respectively in 2016 (Table 20).

Dzongkhags such as Samdrup Jongkhar and Lhuentse on the hand auctioned only 1.5% and 8% of their potato production respectively (Table 20). The possible reasons could be (a.) relatively lesser production, (b.) difficult access from Lhuentse, and (c.) informal/ unrecorded trade across borders in Samdrup Jongkhar.

Table 20: Dzongkhag-wise distribution of potatoes auctioned v. produced (in kgs), 2016[48]

Dzongkhag	Qty FCBL Phuen. AY	Qty FCBL SJ AY	Qty SAM AY	Total Auctioned	Total Production	Qty Auctioned/ Produced (%)
Paro*	4,847,977	63	769,930	5,617,970	4,444,000	126.42%
Wangdi	7,795,912		2,422,130	10,218,042	13,722,000	74.46%
Bumthang	3,050,002	2,065	122,370	3,174,437	4,931,000	64.38%
Thimphu	385,773		254,030	639,803	1,195,000	53.54%
Haa	637,952		248,330	886,282	1,794,000	49.40%
Trashigang	26,924	3,411,038	66,250	3,504,212	7,259,000	48.27%
Tashiyangtse	19,985	1,197,791	19,730	1,237,506	2,856,000	43.33%
Chukha	2,424,366	287	1,132,990	3,557,643	8,841,000	40.24%
Mongar	25,820	1,346,230	33,560	1,405,610	5,492,000	25.59%
Pamagatsel	2,048	357,112	4,880	364,040	1,998,000	18.22%
Trongsa	117,269		8,200	125,469	1,000,000	12.55%
Lhuentse	35,337	93,143		128,480	1,606,000	8.00%
Zemgang	4,864			4,864	147,000	3.31%
S/Jongkhar	-	28,546		28,546	1,859,000	1.54%
Overall Bhutan						**53%**

** The quantity of auctioned potatoes is higher than reported production for Paro possibly because sometimes producers from other dzongkhags misrepresent their produce to be from Paro to fetch better prices at the AYs.*

Overall, Bhutan auctioned about 53-60% of its total potato production through the FCL auction yards at Phuensholing and Samdrup Jongkhar and SAM auction yard at Phuensholing over the last three years (2014-16).

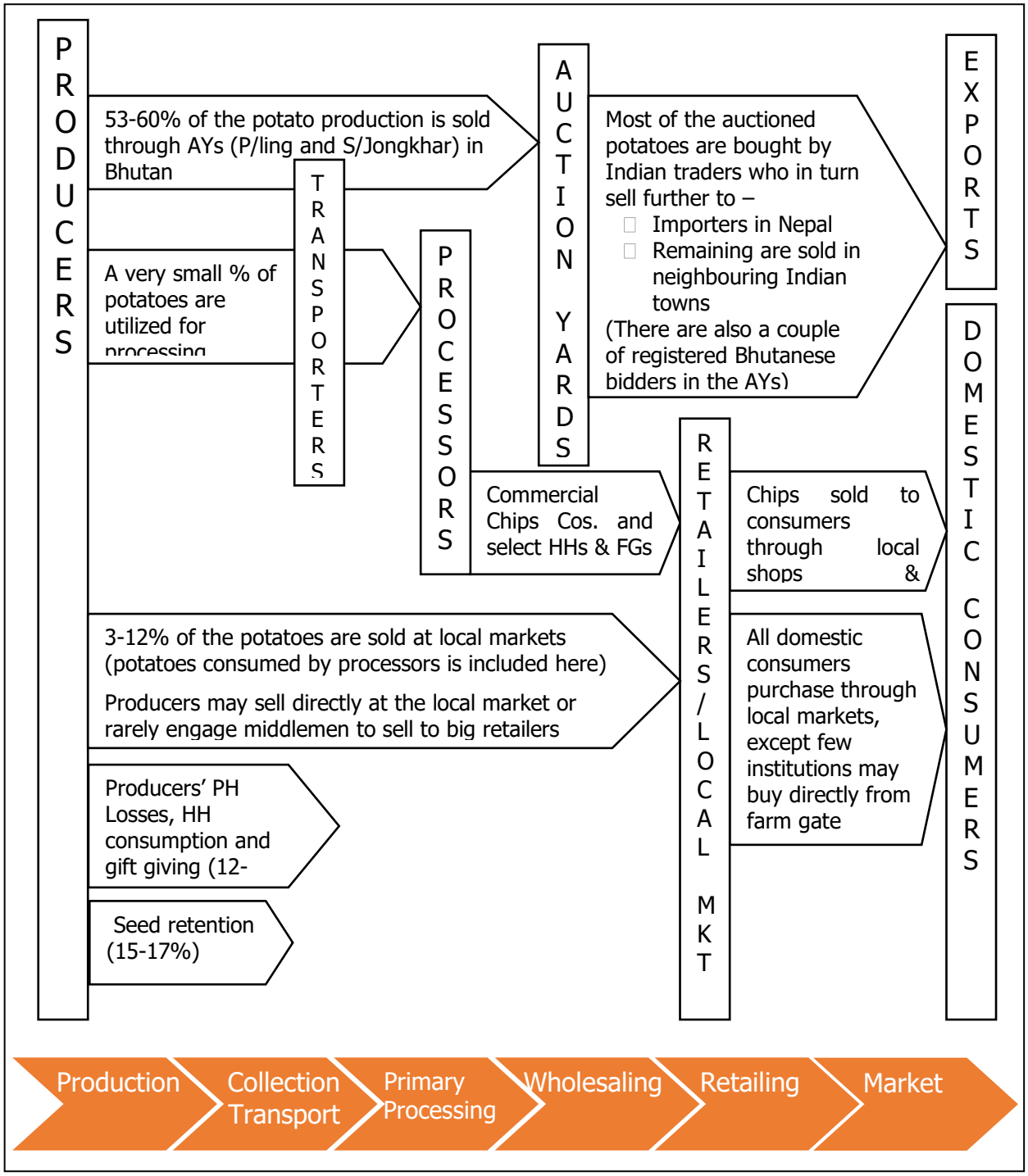
Of the remaining 40-47% of the production, it can be deduced about 15-17% is retained for seeds, 3-12% sold in the domestic/ farmers' market and the remaining 12-18% is a combination of post-harvest (PH) losses, household (HH) consumption and gift giving[49] (Table 8 and Table 12).

[48] Data from auction yards and Bhutan Trade Statistics, Department of Revenue and Customs, Ministry of Finance

[49] However the numbers are generalized figures based on interviews and analysis from primary and secondary data

Use of potato as inputs for processing or sale to processors is very low in case of potatoes. The potato utilization by processors is included in the percentage of potatoes sold in the domestic market.

Figure 6: Volume flows of Potato along different Channels

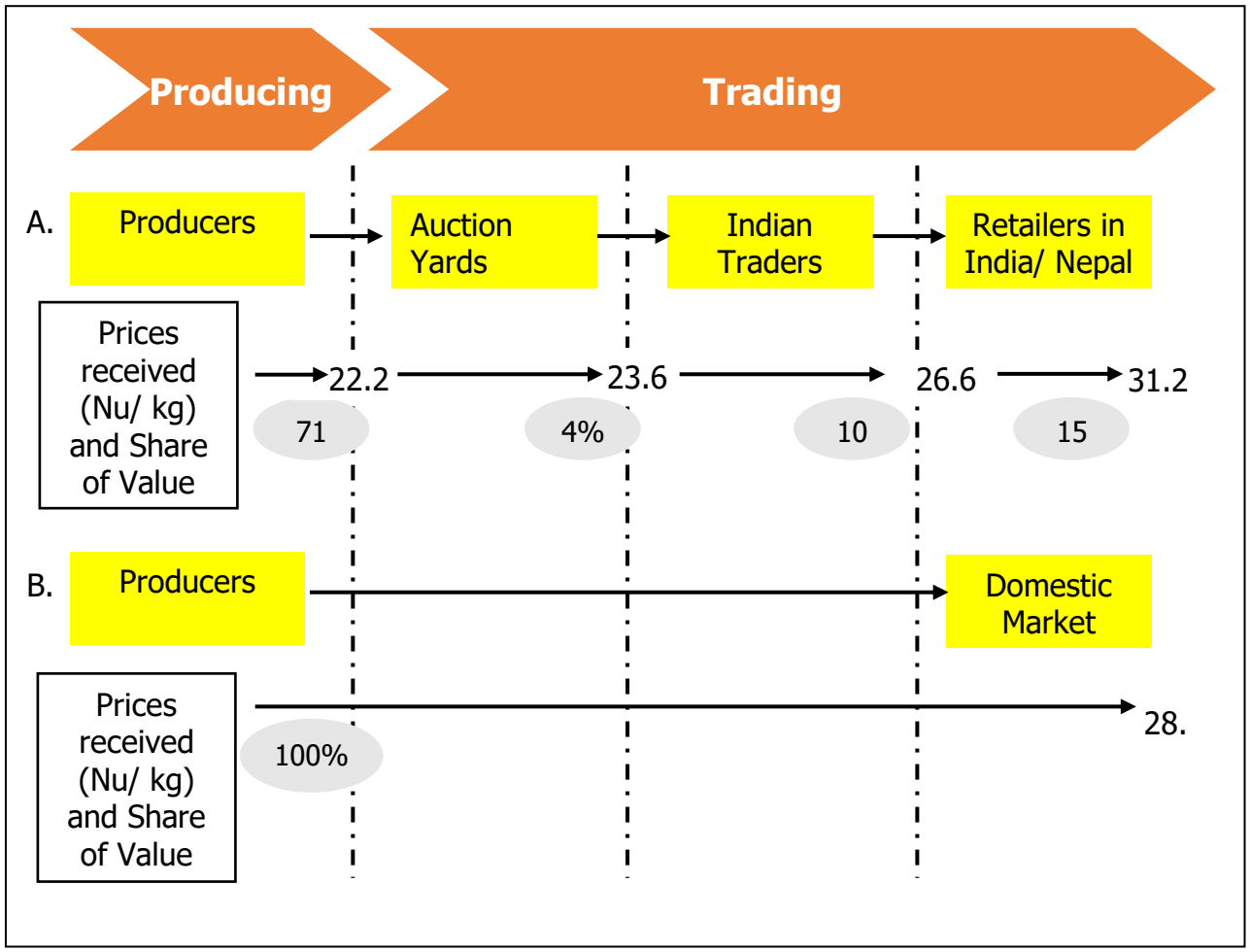


3.4. Value Addition and Value Capture along the Value Chain

Value is added in potato processing/ marketing in four different scenarios in Bhutan. Producers have options of selling to (A.) Auction yards, (B.) Domestic market places, such as vegetable markets, CFM, local shops, etc., (C.) Collection/ grading agent, such as NOB Bhutan, and (D.) Commercial chips companies.

The figures below depict the prices in Nu/kg at each node of the potato chain. For example, in 2016, the traders at auction yards bought potato at an average price of Nu. 23.6/kg from the producers and sold at an average price of Nu. 26.6/kg to the retailers in India and Nepal, who further sold at Nu. 31.2 kg to the final consumers. This means that there was an average value of Nu. 9/kg added. The percentage share of value is expressed as a fraction of margin to the consumer price.

Figure 7: Potato Prices and Share of Value Map (producers to traders/ consumers)[50]

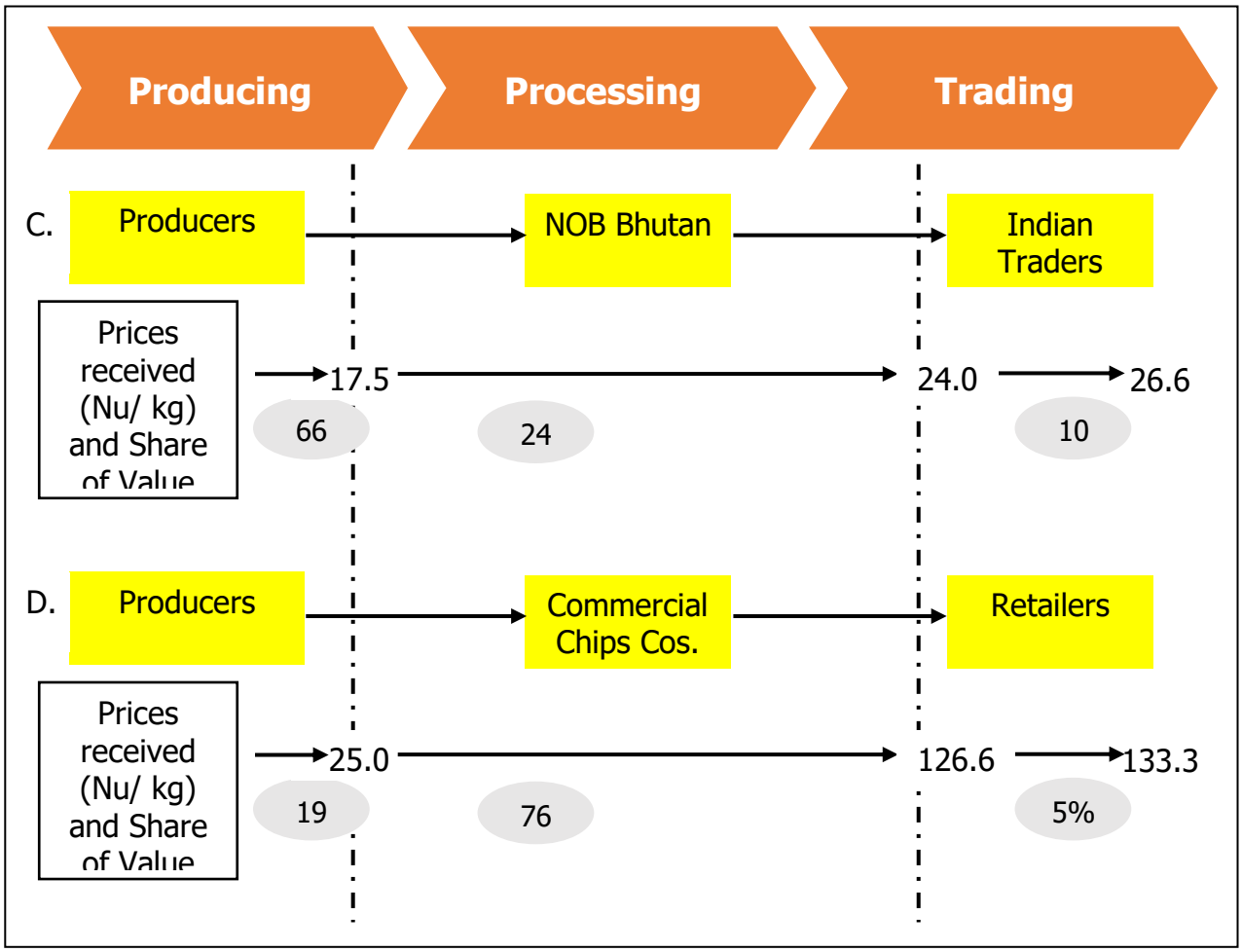


[50] The prices for the calculation of the value shares are averages based on 2016 data and interviews with value chain actors

On the other hand, when producers sell to processors or logistics/ collection centres, the value is more evenly spread among the chain actors. In case of NOB Bhutan, producers received lower than average market/ auction prices; however their profitability remains unharmed because the post-harvest costs were negligible and NOB provided the producers with inputs, such as seeds and fertilizers.

In case of commercial chips companies, it is noteworthy how processing generates additional value in great proportions and how all value chain actors manage to receive attractive prices. The percentage share of value for each actor is expressed as a fraction of margin to the consumer price.

Figure 8: Potato Prices and Share of Value Map (producers to processors/ logistics centre)[51]



[51] The prices for the calculation of the value shares are averages based on 2016 published data and interviews with value chain actors

3.5. Costs and Gross Margins

Profitability of potato to different actors of the value chain is summarized in the tables 21-24 below. Farmers obtained gross margins of Nu. 5-12/kg through sale of potatoes in 2016 (the calculation of cost of production and post-harvest costs are exhibited in Annex III).

The tables below also calculate the net income per actor for an acre of potato production (except in case of sale in the local farmers' market where net income is calculated on MT basis[52]).

However, in reality, the gross income for each actor also greatly depends on the scale of potatoes they are working with. For example, the potato bidders/ traders in the auction yard may seem to earn only Nu. 2.38/ kg of potatoes; however some of the biggest bidders trade in 20-30 MT[53] of potatoes per day, making their annual income from potato trading in the range of Nu. 5-8 million (contingent on prevailing potato demand and prices in India and Nepal). On the other hand, the producers' margin in case of direct sale to domestic consumers seems lucrative at Nu. 12.5/ kg, however producers from most dzongkhags cannot manage to sell even one MT in their local farmers' market.

Hence the cost benefit analysis below underlies the importance of (a.) value chain actors that provide access to market, and (b.) value addition along the chain, to attract better margins and scale for the farmers.

Table 21: Gross Margins and Cost benefit analysis (producers to auction yards)

	Potato Producers	Auction Yards	Traders in India
Selling Prices (Nu./ kg)	22.23		26.61
Variable/ Direct costs (Nu./ kg)	16.35 (Cost of production (Nu. 14.46) plus post-harvest costs (Nu. 1.89))		24.23 (cost of potatoes purchased plus sorting, repackaging and transportation costs)
Gross Margins (Nu./ kg)	5.89	1.38 (3% fee from the producers + 3% from the bidders)	2.38
Gross Income (Nu./ Acre)[54]	23,652.02	5,526.93	9,545.93

[52] In case of producers selling directly at local markets, it is unlikely that a single producer can sell his entire yield per acre at the local market due to limited demand/ population

[53] Interview with a leading potato bidder at the FCBL Phuentsholing AY

[54] Yield/ acre = 4,019 kg (in 2016)

Table 22: Gross Margins and Cost benefit analysis (producers to domestic consumers)

	Potato Producers selling directly at local market
Selling Prices (Nu./ kg)	28.8
Variable/ Direct costs (Nu./ kg)	16.35 (Cost of production plus post-harvest costs)
Gross Margins (Nu./ kg)	12.47
Gross Income (Nu./ MT[55])	50,127.58

In case of NOB Bhutan, as exhibited in the table below, NOB earned much lower gross margin of Nu. 0.24/kg from sale of potatoes in 2016. It was mainly because the centre was in its first year of operations. Once such centres are more established, they can establish direct relationships with buyers and negotiate better prices and also achieve economies of scale in activities such as sorting, packaging and transportation.

Also NOB Bhutan has huge overheads in form of salaries, depreciation of equipment, administration and maintenance costs. But other collection centres need not necessarily make huge capital investments at one go like NOB Bhutan did.

Table 23: Gross Margins & Cost benefit analysis (producers to NOB Bhutan/ collection centres)

	Potato Producers	**NOB Bhutan**
Selling Prices (Nu./ kg)	17.50[56]	24.0
Variable/ Direct costs (Nu./ kg)	11.57 (80% of cost of production; zero post-harvest costs)	23.76 (cost of potatoes purchased plus sorting, packaging and transportation costs plus cost of inputs supplied to the producers)
Gross Margins (Nu./ kg)	5.93	0.24
Gross Income (Nu./ Acre)	23,852.50	964.56

[55] Net income, in case of producers selling directly at local markets, is calculated per MT (instead of per acre) because it is unlikely that a single producer can sell his entire yield per acre at the local market due to limited demand/ population

[56] The selling prices for producers may appear low but the profits are lucrative because NOB Bhutan provides assistance in input procurement by supplying seeds and fertilizers to the producers

On the other hand, in case of potato processors/ commercial chips companies, the gross margins of Nu. 68/kg seems exorbitantly higher on the face of it. However, the overheads at the processors' end are extremely high due to the depreciation of equipment, rent of the processing and storage unit, packaging, carriage and advertising/ promotion cost and staff salaries.

Moreover, the processors producing chips from Bhutanese potatoes are new entrants facing very stiff competition from cheaper, imported brands and unpredictability of processing qualities of Bhutanese, *desiree* variety. For example, interviews with the chips companies revealed that chips tend to burn more often during winters as the potato water and sugar content increase during the winters. Similarly, one of the interviewed processors reported that potatoes from one region in Haa worked well for chips production, while potatoes from another neighbouring region in Haa weren't suitable for frying at all.

Also, since most processors are operating at relatively low capacity, they do not benefit from economies of scale.

Table 24: Gross Margins and Cost benefit analysis (producers to Commercial chips Cos.)

	Potato Producers	**Commercial chips companies**
Selling Prices (Nu./ kg)	25.0[57]	126.58
Variable/ Direct costs (Nu./ kg)	14.46 (cost of production; zero post-harvest costs)	58.40 (cost of potatoes purchased plus processing and packaging cost)
Gross Margins (Nu./ kg)	10.54	68.19
Gross Income (Nu./ Acre)	42,375.00	274,045.56

Additionally, the table below exhibits the gross income comparison for a producer when he/ she sells a MT of potatoes to one the four marketing channels available in Bhutan.

[57] Potato processors/ commercial chips companies pay relatively higher prices for potatoes because they only buy high quality potatoes, with certain specifications, from farmers at select locations.

Table 25: Comparative analysis of producers' income from potato sales (Nu./MT)

Marketing Option	Gross Margin (Nu./kg)	Gross Income (Nu./ MT)	Notes on Scale and other factors
Auction Yards	5.89	23,652.02	High scale although the prices vary year on year depending on the production and fiscal trends in India
Local farmers' market	12.47	50,127.58	Limited quantities due to limited demand potential in the local markets
NOB Bhutan	5.93	23,852.50	High scale although the future of NOB Bhutan's operations are unknown at this point
Commercial chips Cos.	10.54	42,375.00	High potential; only for high quality potatoes from select locations and with certain specifications

Analysis of the gross margins and scale of operations of other actors (apart from producers) along the potato value chain show that all factors held constant, potato business is most profitable for commercial chips companies (who are at very nascent stage of operations in Bhutan) and bidders at the auction yards (who are all based outside of Bhutan).

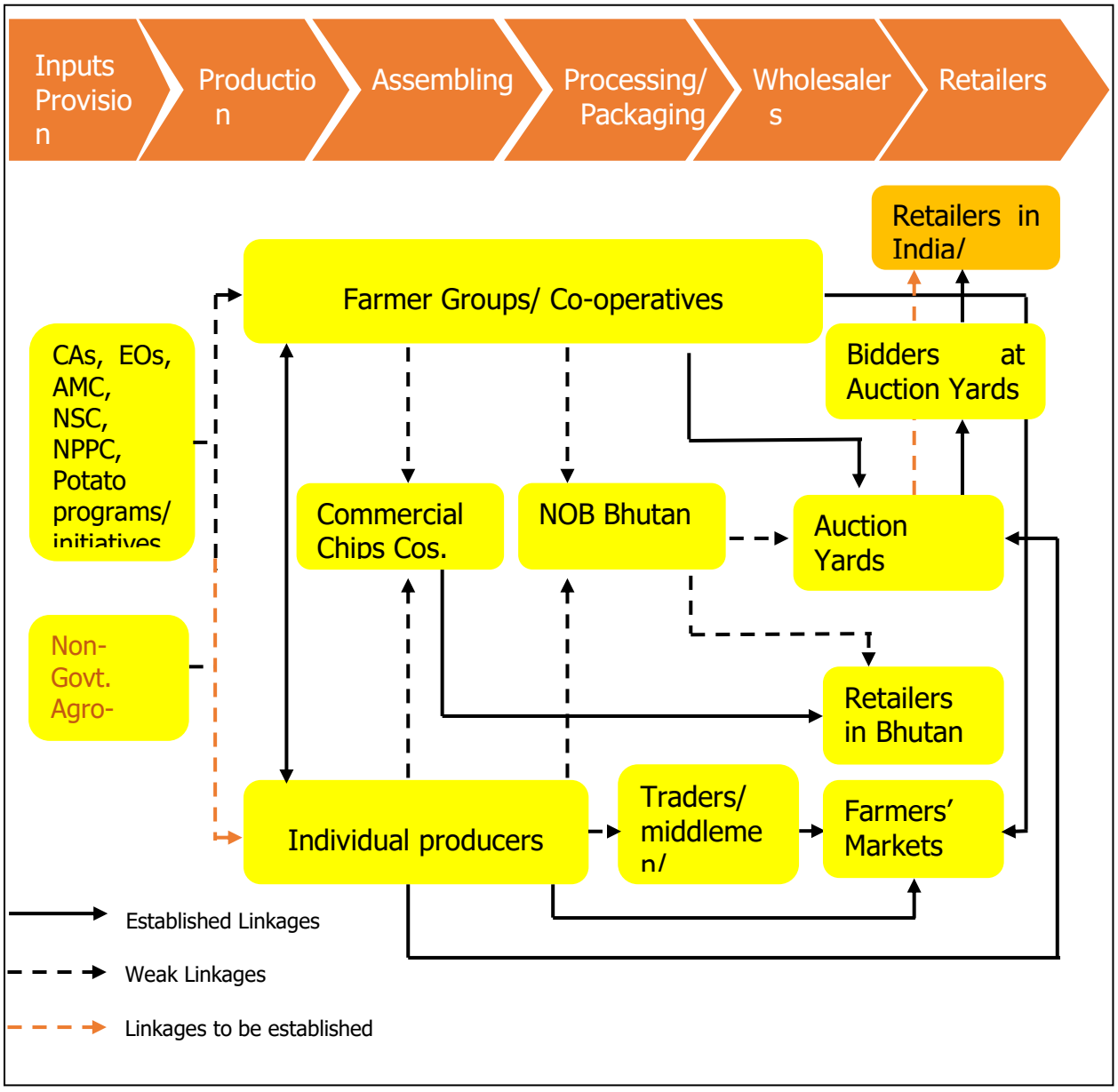
3.6. Potato Value Chain Institutions Horizontal and Vertical Linkages

Established linkages in the potato value chain include relationships between producers and auction yards, auction yards and the registered bidders, and producer members and the farmer groups (FGs).

Auction yards in Bhutan have come a long way in registering increasing number of potato bidders and providing assured market access and payment terms for the producers.

The potato FGs, on the other hand, need to expand their objective beyond improved access to agricultural inputs and credit. There is a need to form stronger FGs/ cooperatives to pool in resources for sorting, grading, and packaging functions and realise bargaining capabilities with transporters and auction yard bidders. Involving logistical service providers, such as NOB Bhutan, or having a FG/ cooperative engage in logistical business can significantly lower the post-harvest costs for the producers.

Figure 9: Map of Value Chain Institutions Horizontal and Vertical Linkages



The relationship between the MoAF extension officers (EOs) and the producers are semi-strong. The potato producers sometimes get in touch with their EOs for assistance with input procurement and technical support. EOs, on the other hand, play a significant role in feeding information on producers' needs to DoA and agencies, such as NSC, NPPC and NPHC.

However, the producers-EOs relationship could to be further strengthened so that extension staff can provide additional support services, such as disease forecasts and spray schedules, seed delivery/ accessibility and market information on real time demand and prices. Farmers should also be educated by the EOs on the value chain dynamics and farm economics.

Weak linkages in the value chain comprise of producer relationships with commission agents, logistics centre, such as NOB Bhutan, processors, and middlemen. Overall producers prefer to

keep their marketing options open; if the auction prices are trending high during a particular year, they tend to diverge from their understanding with processors/ logistics centres/ middlemen. Centres such as NOB Bhutan are trying to increase the producers' commitment by supplying agricultural inputs early during the plantation season.

Even though auction prices may appear relatively higher for a particular year, in some cases, it makes more economic sense for the producers to sell to processors especially when the post-harvest costs and transportation charges to auction yards are high. Hence it becomes essential for the producers to understand the value added by the actors along the chain and economics behind each marketing channel.

In addition to existing linkages, there is a need to establish new linkages along the value chain especially at the input and marketing phases. At input supply level, private agro-input suppliers or seed dealers can expedite the delivery of new seeds to the producers.

Moreover, FCBL needs to establish linkages with importers in Indian regions beyond the neighbouring towns and other countries, such as Nepal and Bangladesh, to expand the export market for Bhutanese potatoes.

3.7. Potato Value Chain Governance

The section on value chain governance refers to role of RGoB agencies/ regulatory institutions that influence the activities ranging from potato production to its end consumption. These institutions/ organizations are able to exert control along the chain and/ or enforce parameters for chain operations and quality.

3.7.1. Overall Coordination and Leadership under DoA

Department of Agriculture (DoA), one of the biggest departments under the Ministry of Agriculture and Forests (MoAF), aims to ensure food security and increase farmers' income through improved farm management, enhanced access to markets, farm inputs, and roads.

The Department works in collaboration with 20 Dzongkhag Agriculture Officers (DAOs), 20 Assistant Dzongkhag Officers (ADAOs), and 205 Extension Officers (EOs) across 20 Dzongkhag in Bhutan to support the farming communities to increase production and productivity and manage local resources.

Additionally, central programs under DOA, such as Agriculture Machinery Centre (AMC), National Post Harvest Centre (NHPC), and National Seed Centre (NSC) and National Plant Protection Centre (NPPC) provide necessary agriculture inputs, extension and research services for the farming community. The functions/ details of each of these programs are listed below.

Agricultural Machinery Centre (AMC): The AMC is involved in farm mechanization through the procurement and supply of farm machines, such as power tillers, tractors, potato diggers, planters, reapers, threshers, weeders, etc. Some machines like tractors and power tillers obtained through Japanese grants are subsidized, but their numbers are limited. AMC also conducts R&D

of small tools and equipment, and imparts training to farmers on the use and maintenance of farm machines.

National Seed Centre (NSC): The National Seed Program was established in 1984 as the National Seed and Plant Protection Programme (NASEPP) under Ministry of Agriculture. NASEPP was responsible for producing and supplying certified seeds and plants. It recommended and released various plant and seed varieties to the farmers. In 1995, NASEPP was corporatized and instituted as Druk Seed Corporation (DSC). However, as DSC was unable to sustain itself financially; it was renamed as the National Seed Centre (NSC) in 2010 and put under DoA, MoAF.

Currently NSC has both commercial and social mandate. It functions as the 'National Seed Grid' to meet the farmers' demand for quality certified seeds and plants of recommended and released varieties. Besides this, it also provides agricultural inputs, including fertilizers and herbicides at a subsidised and affordable price to the Bhutanese farmers.

In case of potato, NSC is the apex program dealing with the production and distribution of potato seeds to the farmers, through its regional farms and facilities, and a network commission agents (CAs) based in the dzongkhags.

National Plant Protection Centre (NPPC): NPPC, located at Semtokha, Thimphu provides plant protection services on pest, diseases, weed and insects that affect agriculture yield. It functions as the premier institution on plant pests and diseases in the country and has the national mandate of functioning as a National Referral & Coordination Centre for all plant protection activities. Main activities include information management (surveillance & pest database), pest risk analysis (PRA), research and development (entomology, pathology, weed science, plant protection products, vertebrate pests), laboratory services, advisory services and regional & international coordination and collaborative functions.

NPPC is the only agency authorized to import and distribute agro-pesticides in Bhutan. Misuse of agro chemicals in potato farms is minimal in Bhutan due to strict control over import of highly toxic chemicals. Integrated Pest Management (IPM) is a guiding principle, which is influenced by strong organic pest management approach. Chemicals are used as a last option. This is due to government's focus on promoting organic approach and also due to religious sentiments of farmers in Bhutan.

National Post Harvest Centre (NPHC): A post-harvest management program was initiated in 1997, which helped establish the National Post Harvest Centre (NPHC) under the MoAF. The main objective of the program is to enhance market value of agriculture crops and reduce postharvest loss. NPHC has its head office in Paro, with four branch offices in Dagapela, Goling in Zhemgang, Lingmethang and Pemagatshel to reach out to various regions in the country.

In case of potatoes, NPHC assists producers by (a.) building storage sheds for select farmers, and (b.) training on chips processing, and on sorting, storing, and packaging techniques.

Since 2010, NPHC has constructed 400 sheds for seed storage across Bhutan. Locations for shed construction are shortlisted in the potato growing regions based recommendations from the DAOs.

Similarly NPHC provides subsidized equipment and training for processing potato chips to select household and farmer groups (FGs).

3.7.2. Advancing Potato Supply Chain by NPP

The National Potato Program (NPP) has the mandate to provide leadership for development of the potato commodity supply chain. The program has the goals to develop cost-effective and sustainable potato production technologies that would contribute to achieving food and nutrition security, enhancing sustainable rural livelihood through increased potato production and also to increase the contribution of the RNR sector to the GDP of the country. The development objectives of the potato program are to increase the production and productivity of the potato commodity through:

- Supply of seed of newly released varieties to NSC for improvement of the seed production system, distribution and seed replacement ratio
- Identification, release and diffusion of disease resistant, drought tolerant and micro nutrient dense varieties
- In consultation with lines agencies develop and recommending integrated plant nutrient management practices for specific region
- In consultation with lines agencies develop and promote IPM practices for specific pests and diseases
- In consultation with lines agencies promote of post-harvest technologies (processing, packaging, etc.) and improved potato stores to reduce post-harvest losses
- In consultation with lines agencies promote of micro irrigation in potato seed farms
- Promote farm mechanization for labour intensive operations
- To institutionalize the potato program for further development into a National Potato Research & Development Centre

Specific Terms of Reference of National Potato Program

- Act as focal point for the potato commodity
- Develop short, medium and long term strategies for research, development and extension of potato crop in consultation with relevant agencies
- Lead in the identification of research and development needs of potato commodity
- Analyse available information and provide policy guidelines to DoA/ MoAFs for overall development of the commodity
- Facilitate and support production of basic (Micro & mini-tubers) through tissue culture & *Aeroponic* system and foundation seeds
- Conduct research trials for evaluation of new potato varieties/clones following international (CIP) protocol, and data analysed using statistical methods
- Develop new potato varieties that are high yielding, drought tolerant, LB resistant and nutrient-dense (especially Fe & Zn)
- Submit proposal for formal release of new promising varieties based on research data
- Promotion/Demonstration and trainings on new technologies (new varieties, IPM, IPNM, Post-harvest technologies, etc.) to farmers and extension personnel

- Conduct need based research on emerging national issues in potato (pest/diseases, nutrient management, post-harvest, etc) in collaboration with relevant agencies
- Ensure coordination amongst key stake holders in planning, implementation and evaluation of plans and programs
- Facilitate flow of information, inputs and expertise for smooth functioning of planned activities
- Provide technical advice and assistance to extension personnel, researchers, input providers and others as and when required
- Work closely with the Department of Agriculture Marketing and Cooperatives in developing market for potato
- Take a lead role in identifying inputs supply gaps for potato program and work towards bridging the gaps
- Be involved in the development and deployment of human resources working on potato in consultation with MoAF's HRD
- Liaise and network with national, regional and international organisations for exchange of germplasms, expertise and technical information
- Review project proposals emanating from other agencies and provide expert views
- Develop relevant proposals for national and donor funding
- Take a lead role in the monitoring and evaluation of field activities
- Assess current status of the commodity by collecting relevant information, build reliable database, analyse data and prepare periodic reports for dissemination of information

3.7.3. Quality Inspection by BAFRA

Bhutan Agriculture and Food Regulatory Authority (BAFRA), MoAF, strives to contribute towards the national goal of food self-sufficiency by safeguarding Bhutan's farming system from exotic pests and diseases and ensuring quality farming inputs through effective enforcement of standards and regulations.

BAFRA implements RNR related legal instruments, such as the Plant Quarantine Act, Seed Act, Pesticide Act, Livestock Act, Food Act, National Biosafety Framework, Forest and Nature Conservation Act, Biodiversity Act, and their secondary and tertiary legislations. It also implements sanitary and phytosanitary (SPS) measures effectively to protect the health and life of humans, plants and animals including the environment from risks of entry, establishment and spread of exotic pests and diseases. BAFRA also functions as the Competent Authority (CA) for implementation of the Biosafety Act for safe transfer, handling and use of Living modified Organisms (LMOs), Genetically Modified Organisms (GMOs) and their products.

BAFRA also functions as a National Food Inspectorate to ensure that food is of good quality and safe for human consumption. It regulates and promotes the quality of agriculture inputs (seeds, agro-chemicals, livestock, veterinary biological, etc.).

It also facilitates development of agro based industries to promote trade and market access through standardization and implementation of quality assurance systems.

In case of potatoes, BAFRA inspects and certifies the quality of potatoes imported from other countries and exported from Bhutan. BAFRA also makes site visits and carries out regular inspection of the processing units, both informed and ad-hoc.

BAFRA also inspects, assesses and provides organic certification of potatoes produced by select FGs or in certain regions.

3.7.4. Registration and Regulation of FGs and Coops by DAMC

The Cooperatives Rules and Regulations of Bhutan, 2010, covers all aspects of cooperative development such as registration, monitoring, mediation and conciliation as well as the provision of legal advice and services related to research, education and information. It also covers the registration of informal FGs. Within the MoAF, the Department of Agriculture Marketing and Cooperatives (DAMC) was created in 2009 to effectively implement the Cooperative (Amendment) Act of Bhutan, 2009.

FGs and cooperatives are considered as significant means of increasing the economies of scale, cooperation and good governance within the farming communities. As of mid-2017, DAMC had registered 182 farmer groups engaged in agriculture, 114 engaged in livestock enterprises, 32 engaged in forest enterprises and 2 non-RNR groups. Altogether, there are 329 registered farmer groups in the country and 10 agriculture farmer cooperatives, 27 livestock cooperatives, 3 forestry related cooperatives and 10 non RNR related cooperatives registered with the DAMC.

Additionally, DAMC has established vegetable/ farmers' market in major towns and marketing sheds along major highways in Bhutan to provide potato producers and farmers local sales outlet for their products.

3.7.5. Facilitation of Organized Potato Export through AYs

FCBL and SAM auction yards play significant role in potato export through efficient and effective operations of the Auction Yards (AYs). Only registered bidders are allowed to purchase Bhutanese potato at the AYs. The AYs charge 3% commission each from producers and bidders.

Auction yard regulations/ procedures are described in Annex IV.

3.8. Other Service/ Assistance Providers in Potato Value Chain

The strength of any value chain is exemplified by the service providers that support it and the specificity of their operations. In addition to the institutions/ agencies mentioned in the governance section, BPDP played a key role in advancing the potato industry in Bhutan.

Bhutan Potato Development Program (BPDP): BPDP was established in 2004 as the National Potato Program under the Department of Agriculture (DoA) with the objective to facilitate, develop, optimise and provide leadership on potato production, in order to achieve food security

and enhance sustainable rural livelihoods through increased production and cash income generation.

The services of BPDP as the National Potato Program included the following:

- Identify and develop potato varieties with market potential for seed export and processing qualities
- Develop and support a pragmatic yet sustainable seed production and distribution system leading to seed export through producer groups
- Develop and disseminate appropriate strategies to increase and maintain yields
- Introduce and develop improved production technologies to reduce labour requirements
- Develop and introduce new models for marketing seed and consumption potatoes
- Optimise soil fertility management and conservation
- Minimise loss in yields and labour due to weed, disease, insects and wildlife pests.
- Develop extension information materials and train farmers/extension agents
- Build, collaborate and coordinate relations with research centres, extension and other relevant institutions within and outside the country

BPDP also provided training and technical assistance, information and documentation, facilitation of groups and information exchange through organising workshops, exposure visits, etc. BPDP published a number of studies on potato production and marketing.

Apart from BPDP (now NPP) and DoA initiatives, **private agricultural businesses** (such as NOB Bhutan) offer a logistics centre to support potato farmers by creating a vibrant market place in Nobding (relatively closer to the farms) and adding value by provision of sorting, grading, packaging and transportation facilities. After packaging and labelling, the potatoes are either stored in the storage or sold directly to Indian or Bhutanese consumer base.

NOB Bhutan works closely with several farmer groups in and around the Phobjikha valley. In addition to providing knowhow and distribution and logistical services for the farmers, Nob Bhutan provides inputs, such as seeds and fertilizers, to these producers.

The company was established in 2014 and started its operations in 2016. Nob Bhutan enjoys Foreign Direct Investment Status in Bhutan.

Similarly, processors/ chips producers, such as **Happy Chips and Bhutan Chips**, offer lucrative market for high-quality potato producers. Additionally, these chips companies add intensive value in the value chain by processing high-valued finished products.

In addition to the agricultural and market access support, producers seek financial services from RGoB initiatives such as the launch of **Rural Enterprise Development Corporation Limited (REDCL)** (previously BOIC). REDCL provides fund for agricultural activities on a low interest rate of 4% per annum and without any collateral requirement. The loan principal amount can range from Nu. 100,000 to 500,000 while processing time ranges from one to two months.

Larger-scale producers also apply for loans from banks such as **Bhutan Development Bank Limited (BDBL)**. The Bank's main focus is on the promotion of agricultural, industrial and commercial development of the country.

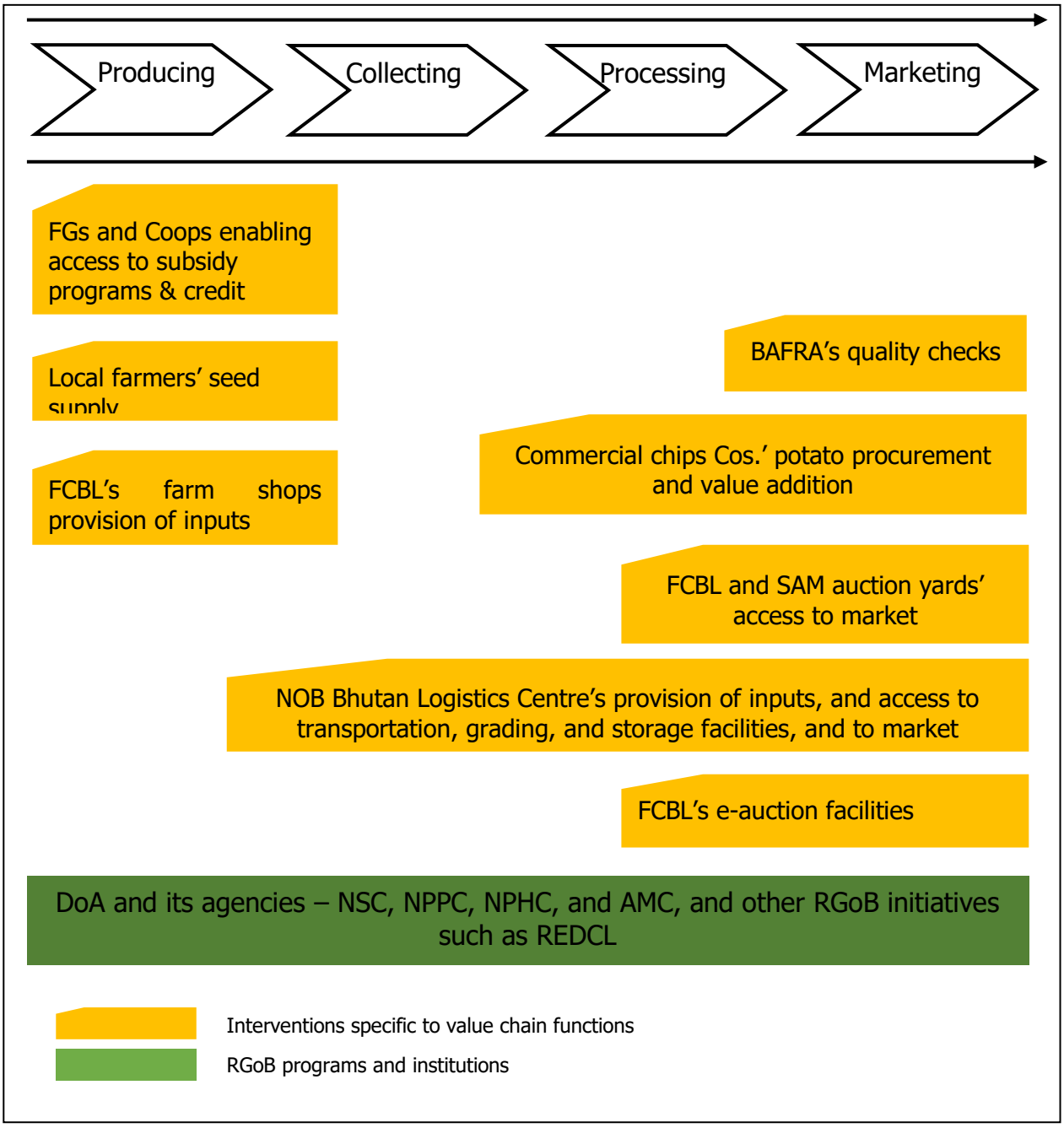
Table 26: Summary of Value Chain Service Areas and Providers

Service Area	**Service Providers**
Overall coordination and leadership for assistance in input procurement and post-harvest activities	DoA, its central programs, such as NSC, NPPC, NPHC and AMC, and dzongkhag and extension network across the country.
Advancing Potato Industry	National Potato Program (NPP)
Access to Inputs	CAs, EOs, AMC, NSC, NPPC, Potato programs/ initiatives, local farmers, NOB Bhutan
Training (technical skills)	NPPC, NPHC, Potato Program, and EOs
Access to Market	FCBL Auction Yards, SAM Auction Yards, DAMC's marketing sheds and farmers' market, Traders at Farmers' Markets/ Wholesalers, NSC, Institutional Buyers, NOB Bhutan, Commercial Chips companies, such as Happy Chips and Bhutan Chips
Access to Finance	REDCL and BDBL
Quality inspection	BAFRA

3.9. Ongoing Interventions in the Potato Value Chain

Below is a map on ongoing services/ interventions provided by various entities along the potato value chain:

Figure 10: Map of Ongoing Interventions in the Potato Value Chain



In addition to operating auction yard facilities, FCBL is also mandated to run farm shops, with the objectives of (a.) buyback of agricultural produce, (b.) making access of RNR inputs, such as seeds, fertilizers, tools and implements and animal feeds, and (c.) making access of foods and essential commodities (FCBL goods) at affordable price. While (b.) and (c.) are fully implemented, (a.), i.e. buyback, has been done on trial basis only.

FCBL also collaborated with the Royal Security Exchange of Bhutan Limited (RSEBL) in 2016 to develop an auctioning system on which the commodities can be traded online mainly to hasten and ease the existing auctioning methodology. The auctioning system is known as the 'Online Commodity Exchange or e-Auctioning'.

The e-auction facility was initiated with the primary objectives of increased commodity margins for the Bhutanese farmers, promotion of efficient market channels through transparent price discovery process and standardization of the goods, increased volume by integrating produce of smallholders, and reduced transaction cost.

In the e-auction system, grading and packaging is done at the auction yard using automated graders, thereby reducing the post-harvest grading costs for the farmers. Producers also enjoy the advantage of taking back and recycling their bags.

In 2017, 1,147 MT of potatoes, valued at Nu. 17.3 million, were auctioned through the e-auction facilities.

Details on the e-auction performance and feedback is covered in Annex V.

In addition to FGs and NOB Bhutan, companies, such as Happy Chips, also provide support to the farming community in Bhutan (especially farming members of the Happy Green Cooperative) by means of market access and training on know-how to produce potatoes and spices at the required standards.

4. SWOT ANALYSIS FOR THE POTATO VALUE CHAIN

Table 27: SWOT analysis for the potato value chain

Strengths			
• Most inputs are made locally available	• Climatic conditions & topography are suitable for potato farming	• Farmers' willingness to sell to processors • High level integration in the VC	• Well established auction facilities and infrastructure
Opportunities			
• Nearly-organic nature of farming offers good potential for quality seed production for domestic & export markets	• Harvest season coincides with peak prices in India • Strong demand for quality seeds in neighbouring Indian states • Rising demand for organic produce in India	• Strong demand for chips produced from Bhutanese potatoes in home and overseas market • Willingness of consumers to pay relatively higher prices	• FCBL's e-auction facilities • Possibility of exporting potatoes directly to Nepal, where demand for is Bhutanese potato is very high
Inputs Suppliers	Producers	Processors	Wholesalers & Retailers
Weaknesses			
• Inefficiencies in input ordering and delivery system • Shortage of new-generation potato seeds and varieties	• Small land holdings, scattered farms, & low productivity • High cost of production and transportation • Poor grading/ sorting methods • High PH losses	• Lack of availability of potato suitable for chips • Lack of technical know-how on potato specifications and suitability • No labs for testing and quality checks • Unutilized capacity	• Concentrated Indian buyers from the same region
Threats			
• Seed degeneration	• High incidence of blight and PTM	• Cheaper, imported chips brands widely available in the market	• High dependence on the volatile Indian market

5. CONCLUSIONS

Bhutan experiences one of the lowest productivities in the South Asian region. Compared to India, Pakistan, Bangladesh and Nepal, Bhutan's potato productivity is one of the lowest (Section 2.2.2). Some of the constraints leading to low productivity include damage of potatoes by disease and pest (mainly late blight and potato tuber moth infestation), unavailability of quality seeds and other farm inputs (fertilisers and FYM in some cases), lack of appropriate storage facilities for seed potatoes, limited land holding and sloping topography, moisture stress and soil unproductiveness, high labour cost or shortage of labour, etc.

Most of these constraints are inter-linked. Small plots and sloping topography limit the options for mechanization and result in high labour costs. The high labour requirement is further amplified by the requirement for guarding fields against wildlife crop depredation. Small land holdings, degenerated seeds and sketchy access to inputs result in low productivity.

Cost of production for potato in Bhutan, as reported by DoA, is very high. The cost of potato production vary between area to area and farmer to farmer depending upon weather conditions, soil type, the level of farmers' cultivation knowledge, etc. At a national average, the cost of production is reported by DoA at Nu. 14.5/kg.

The high cost of production is a result of (a.) relatively lower yield, 4,018 kg per acre, as reported in 2016, and (b.) high cost of inputs, such as seeds and fertilizers, and labour cost from land preparation to harvesting activities.

Poor post-harvest handling results in high losses: Lack of group enterprise, pest and disease problems (mainly PTM), lack of appropriate storage, rough handling during transportation, loading and unloading all lead to high post-harvest losses.

Despite high costs, buyers are dissatisfied by current post-harvest practices. Drying, curing and cleaning methods not practiced by most producers. Moreover, in most cases, the sorting/ grading and packaging techniques are not per the buyer specifications. Producers are under the misconception that the auction yard price offered on graded potato does not match the additional cost involved in carrying out this function. However, auction yards and traders are confident that the improved grades can fetch higher prices.

Overall the potato industry in Bhutan is hugely dependent on the volatile Indian market. From 2014 to 2016, almost 53-60% of Bhutan's potato production was sold to Indian traders through auction yards. Although the Indian markets have been able to provide excellent market for Bhutanese potatoes in the past, it is noteworthy that India has made tremendous progress in potato production. Excess production in major potato producing states of India sometimes leads to glut in the market. Additionally, the political and fiscal trends in India hugely affects prices and bidders' payment capabilities.

Also the distribution of Bhutanese potato is concentrated around the Indo-Bhutan border towns. The market is yet to realize the potential from bigger cities in West Bengal, Assam and other north-eastern states.

Bhutanese potatoes are regularly used as seed potatoes in Indian states of West Bengal and Assam and their demand as seeds is consistently high. Potato production areas in Bhutan at elevations above 2800 m have excellent environments for seed production with the advantages of absence of vectors for virus transmission, absence of important seed born disease, especially bacterial wilt, and excellent storage conditions.

Hence a large proportion of the potato sold in the auction yards is used as planting material by potato growers in the northern districts of West Bengal and parts of Assam. Potato growers from these areas have been using Bhutanese potatoes as seeds for decades.

Nepal is an excellent market for Bhutanese potatoes: Nepal imports a substantial quantity of potatoes via Indian traders during the time of potato harvest in Bhutan. The price offered for potatoes in Nepal during August-October is higher than the price of potatoes in Bhutan and India. Interviews with auction yard bidders revealed that some of them exported more than 50% of their purchase to Nepal.

A very small portion of the total potato production undergoes processing in Bhutan: Bhutan imports most of the processed potato products, such as chips and potato snacks from India, Thailand and other countries in the region. Small quantities of homemade potato chips are available in grocery shops, restaurants and small stalls in some parts of the country. Although lately, commercial chips brands, such as Happy Chips and Bhutan Chips, have managed to use Bhutanese, red potatoes for chips production however with very distinct specifications and certain locations.

Producers lack understanding on farm and marketing economics and they hardly enjoy the benefits of group enterprise: Most of the interviewed producers were not aware of their costs of production and net income from potato marketing. Moreover, most potato producers are not organized in a group or co-operative. Hence producers of all scale undergo individual post-harvest handling and they transport their produce to the auction yard for long distances, without understanding the consequences of high post-harvest and marketing costs. Furthermore, the individualistic nature of potato growers lead to seeking of short-term solutions based only on their individual needs as opposed to developing initiatives that promote competitiveness for a number of fellow producers within a market chain in the medium or long term.

Producers do not evaluate the additional costs of selecting auction yards over other marketing channels and they are not exposed to real-time market information: In case of potatoes, most producers consider auction yards as most profitable and appropriate market for their produce. Most of them do not consider their volume, cost of transportation, and demand scenario before selecting a marketing channel.

Moreover, most producers rely on word-of-mouth to assess price scenario at the auction yards, which is not always reliable and real time. At a certain time period, a sudden peak in the price at the auction yard triggers most farmers to rush their consignment to the auction market resulting to a temporary over supply. Such temporary glut at the auction yard results in longer waiting time, extra accommodation and meal costs for producers, and lower bid prices.

Also the producers are slow to learn about and adopt innovative solutions such as FCBL's e-auction initiative and the grading and packaging advantages it offers.

There has been no backing to setting up of cold storage for the potato value chain: Based on stakeholder feedback, no case could be built in favour of establishing cold storage for potatoes. Bhutanese potatoes are sold in Indian markets shortly after harvest thanks to their different seasonal production cycle. In most parts of India, the bulk of potatoes are grown during the winter season under short-day conditions and are harvested from January to March; whereas in Bhutan, potatoes are grown as summer crop with seed planting in March and peak harvesting in July. From September to November there is a high demand for Bhutanese potatoes in India.

During the months of January to May, potatoes potato sold at the weekend and retail markets in Bhutan are mainly imported from India. However, potato imports constitute a small percent compared to total production and exports from Bhutan. Moreover, most consumers seem averse to the idea of consuming more expensive, cold stored, Bhutanese potatoes when there are fresh, cheaper, imported ones are readily available in the market.

Lack of tissue culture laboratory and adequate infrastructure: National Potato Program has been collaborating with the International Potato Centre (CIP, Lima) to evaluate new potato clones for new varietal development. According to the Seed Act of Bhutan 2002 and International Treaty on Plant Genetic Resources for Food and Agriculture, the new clones imported from CIP are in in-vitro form and multiplied in tissue culture laboratory of the NSC-Paro however in the absence of proper tissue culture laboratory facility with NPP. NSC is mandated for mass production of basic seed potato (micro & mini tubers) to meet the domestic seed demand. They are currently constrained by inadequate laboratory facilities and skilled HR capacity to produce sufficient basic seed (micro & mini tubers) of released varieties. Because of this, they are facing problem to produce enough materials (micro & mini tubers) of new germplasm for research on varietal evaluation in the field.

Interviews have revealed a modest tissue culture laboratory, with basic equipment at RDC Yusipang, is vital to expand the research work on potato germplasm evaluation and varietal development for strengthening the potato commodity in Bhutan.

6. RECOMMENDATIONS

6.1. Matrix of Proposed Interventions

In this section, the findings from the SWOT analysis and the conclusions sections were used to identify potential interventions that could be initiated by RGoB agencies and other value chain service providers.

Table 28: Matrix of proposed interventions

	Short term	**Short – medium term**	**Long term**
Factors internal to the Value Chain	• Training on effective use of fertilizers and FYM, and integrated pest management measures • Raise awareness among potato growers on post-harvest handling techniques and value addition along the chain	• Construction of collection centres and market sheds at strategic locations to reduce PH losses, strengthen transportation and storage • Explore direct export options to Nepal • Explore expansion of Indian markets/ buyers beyond towns in Assam and West Bengal	• Roll out a plan for nation-wide distribution of new seeds • Minimize cost of production and post-harvest costs
Factors external to the Value Chain	• Strengthening the input/ service market to boost production • Increase support to commercial chips companies • Research and development into easy processing options, such as French fries • Encourage group enterprises and private agri-businesses	• Strengthening research and infrastructure development for generation of new potato varieties • Establishment of a 'potato value chain forum' to ensure coordination of all potato-related initiatives undertaken by any stakeholder	• Explore R&D into other processed potato products, such as dehydrated potato, potato starch, etc. • Update price and demand information dissemination system for farmers

6.2. Outline of Potential Interventions

6.2.1. Potential Short-term Interventions:

In the short term, it will be imperative to enhance production and productivity, and maximize value addition through improvement in post-harvest practices and increased support to processing industries. These can be achieved with the help of following interventions –

Training on effective use of fertilizers and FYM, and integrated pest management measures. Training from the respective DoA agencies and the extension officers on (a.) overall farm management techniques, such as effective use of farm machinery and fertilizers and FYM, and (b.) plant protection initiatives from pests, can lead to increased yield and production.

The technical experts at DoA and its agencies need to develop capacity on topics such as use of the appropriate amount of fertilizer and FYM, the right type and dose of pesticide, improved harvesting techniques, etc.

Raise awareness among potato growers on post-harvest handling techniques and value addition along the chain. Inadequate knowledge and awareness results in high post-harvest losses and inefficiencies in the value chain. More effort is needed on capacity development on producers' understanding of the value chain and farm economics, and post-harvest techniques, including cleaning, sorting, grading, packing and arrangement for safe transportation. Simple post-harvest practices can make go a long way in improving prices and reducing post-harvest losses.

Strengthening the input/ service market to boost production. This is a critical intervention that can result in increased producers' access to farm inputs and services leading to high profitability. Physical products, such as seeds, fertilisers, pesticides, packaging materials, as well as market services, such as as soil testing, cultivation services, pest management, information, financial, storage and transportation services need to be developed and strengthened for desirable growth of the potato industry. The Ministry should also consider exploring additional input delivery mechanisms.

Also, the potato sector must consider attracting investment into R&D and tissue culture laboratory for institutionalizing the National Potato Program (NPP) as centre of excellence. This will aid in identification, release and dissemination of high yielding, disease resistant, drought/ heat tolerant and micro nutrient dense varieties through intensified evaluation of potato clones.

Increase support to commercial chips companies. The relatively new chips companies, such as Happy Chips and Bhutan Chips, represent a strong market potential for Bhutanese potato producers. However, such enterprises are require assistance from government agencies and potato experts in areas such as –

- *Desiree* varieties from which region are more suitable for commercial chips production
- Know-how on management of sugar and water content of *desiree* especially during winter months

- Access to specific chips-suited potato variety such as *K ChipsSona*
- Establishment of lab capabilities to test potatoes' suitability for frying, etc.

Research and development into easy processing options such as French fries. Processing potatoes hold great potential as exhibited in Section 3.4 of the report. So far Bhutan has only explored processing potatoes into chips. No research has gone into establishment of a processing plant focused on French fries, a product that is hugely imported by various restaurants, cafes, hotels and bars in packets of 5 or 10 kg from India and/ or Thailand.

However, detailed feasibility study needs to conducted to assess (a.) suitability of *desiree* variety for French fries production, (b.) domestic and export demand potential for French fries produced in Bhutan, and (c.) economic aspects of setting a French fries plant, including the set-up costs, projected income statement and cash flows and internal rate of return (IRR).

Encourage group enterprises and private agri-businesses. To further efficiency in the potato value chain, the industry requires (a.) development of potato-specific, business-minded, farmer groups (FGs) and cooperatives (Coops) and expansion of scope of existing groups, and (b.) involvement of private sector organisations in the potato business.

(a.) At present, each farmer is involved in marketing of their own produce grown on a limited production area, which is not cost effective for farmers in terms of production and marketing. In order to assure a consistent supply of the required quantity (at least a truckload) of potatoes in one place, it is necessary to focus on group enterprise by formation of potato producers groups. Additionally, the existing potato groups should consider expanding their scope beyond access to subsidy programs and finance.

(b.) At input supply level, private agro-input businesses, for supply of high-quality seeds and fertilisers, should be attracted into the potato industry. There is also need for businesses providing support services, such as disease forecasts and spray schedules, seed delivery/ accessibility and market information. As for the delivery of potatoes from the farm to the auction yard, there is potential for logistical service providers focusing on post-harvest activities and/ or transportation services.

Establishment of competent FGs and agri-businesses also pave the path for successful operations of collection or logistics centres that capitalize on economies of scale.

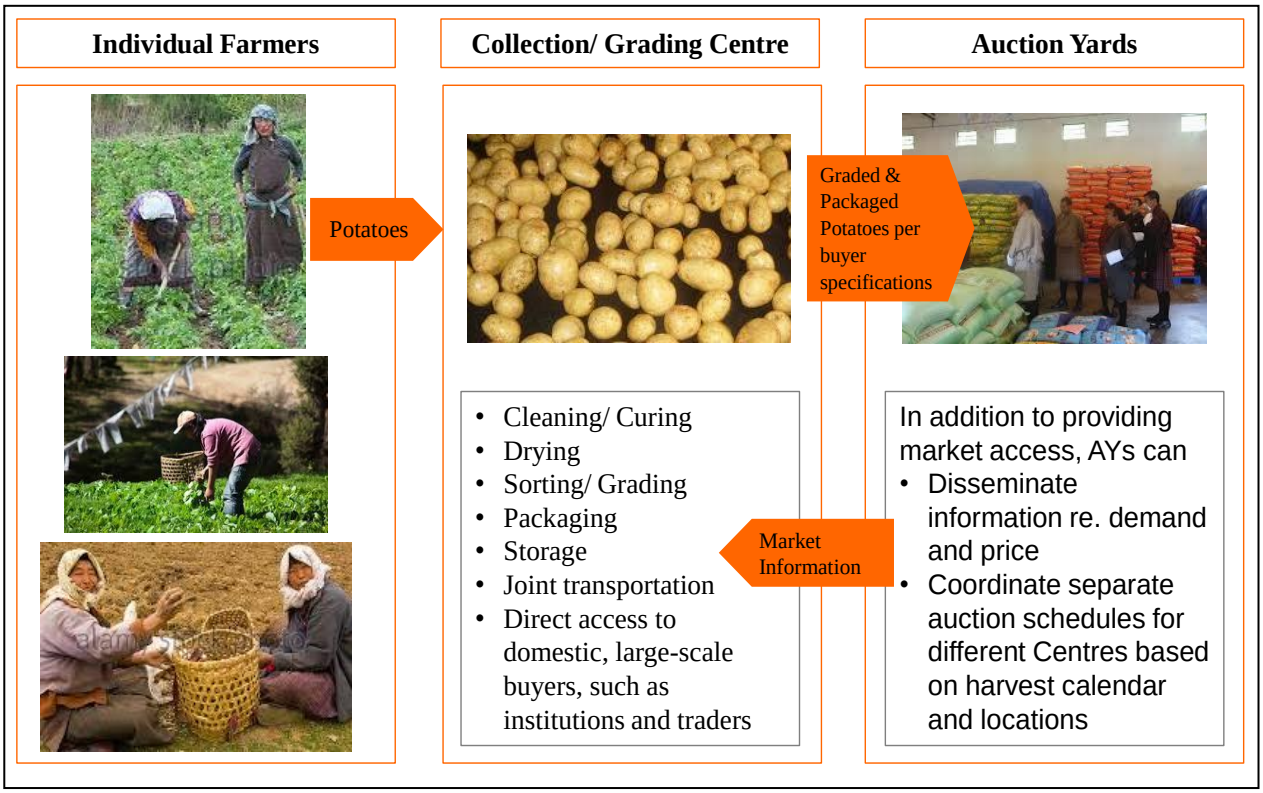
6.2.2. Potential Medium-term Interventions:

In the medium term, the focus should be on introducing efficient models for post-harvest activities and marketing, expanding to new markets, and improving stakeholder coordination –

Construction of collection centres and market sheds at strategic locations to reduce post-harvest losses, strengthen transportation and storage: Most of the potato growers in Bhutan are smallholders, working on isolated farms far from the markets. Hence most producers incur significant costs in post-harvest activities (sorting, grading, packaging, etc.) and transporting

their potato bags to the auction yard. Establishment of Collection/ Grading Centres can act as value adding intermediary between producers and buyers in the potato chain.

Figure 11: Concept of Collection/ Grading Centres at strategic locations



Establishment of such Centres at strategic locations (in major potato producing regions) offers following advantages –

- Promotion of appropriate curing, cleaning and post-harvest handling techniques
- Economies of scale by sorting/ grading, packaging and transporting in bulk
- Farmers' post-harvest costs are significantly reduced
- Information dissemination (on price, timing, demand, etc.) from the AYs becomes much easier as they need to coordinate with a few strategically located centres rather than numerous, scattered farmers from all over the country
- Bargaining power increases with the auction bidders/ Indian traders
- Value addition and employment generation within Bhutan

However, there is a lesson to be learned from NOB Bhutan's experience. Making huge investments, all at one go, in the short run may create excessive pressure on the management/ investors. Hence the plan should be to start small, maybe begin with manual handling, until significant scale is achieved.

The Centre could run as a business enterprise or a farmer Cooperative, such as BeCoB or Amul.

Explore additional export options to Nepal and Indian markets beyond towns in Assam and West Bengal: India has proved to be an excellent market for Bhutanese potatoes so far. However the potatoes from Bhutan only reach select destinations in Bengal and Assam. Moreover, growth in India's potato production and export capabilities, and fiscal changes, such as demonetization, leads to volatility in demand and price for Bhutanese potato.

Hence it becomes imperative to introduce bidders/ buyers in auction yards from beyond the towns near Indo-Bhutan border in Assam and West Bengal. Traders from Guwahati, Assam's capital city, could play a significant role in distribution of Bhutanese potatoes to consumers all over the north-eastern states of India.

Additionally, it is important for Bhutan to reduce its dependence on India for all potato exports. Since consumers in Nepal already have a taste for Bhutanese potatoes, direct export options from Bhutan to Nepal should be worked out.

Strengthening research and infrastructure development for generation of new potato varieties: The most popularly produced *desiree* potato in Bhutan has undergone varietal degeneration (at least 20-25 generations) making it susceptible to viruses, late blight, chronological ageing, and so on. Hence generation of new potato varieties is the key to solving the potato low yield in the Kingdom. Additional varieties also help stakeholders venture into innovative and much-needed processing practices in the country.

Strengthening investment into research and infrastructure development for National Potato Program is vital to generation of new potato varieties. Significant investment areas include tissue culture laboratory and research into potato germplasm to generate high yielding, late blight resistant and nutrient-dense varieties.

Establishment of a 'potato value chain forum' to ensure coordination of all potato-related initiatives undertaken by any stakeholder: To coordinate stakeholder efforts for the promotion of the value chain, a 'Potato VC Forum' could be introduced whereby all the stakeholders are apprised of all potato-related initiatives. This ensures circulation of all relevant information and documents among all stakeholders and avoid duplication of efforts, if any.

6.2.2. Potential Long-term Interventions:

The vision for the long term is to have reduced the cost of production and marketing, and introduce new potato processing options. The interventions include –

Roll out a plan for nation-wide distribution of new seeds: NSC's seed multiplication and distribution plan calls for an expansion strategy to fulfil the growing needs of domestic potato producers and importers from India. This may include expanding the base of registered seed growers in selected strategic areas, investing in superior seed potato production techniques, training of farmers and extension officers in appropriate seed production, and collaborating with private agri-businesses. Additionally NPP should distribute seeds of new potato varieties that are potentially more blight resistant and suitable for processing.

Minimize cost of production and post-harvest costs: The potato cost of production is expected to reduce in the long term with increased yield from better-quality/ new seeds, improved farm management techniques and cost-effective post-harvest undertaking in groups/ coops. This will potentially lead to competitiveness in newer export markets and higher margins for domestic producers.

Explore R&D into other processed potato products such as dehydrated potato, potato starch, etc.: Once commercial potato chips and French Fries processing options are established, NPHC should consider research and development into suitability of Bhutanese potatoes for processing other products such as dehydrated potato, potato starch, etc. This could potentially encourage investment of private businesses and foreign capital in the potato value chain.

Update price and demand information dissemination system for farmers: The auction yards in the long term, in collaboration with DAMC, should be able to relay real-time price and demand information to producer groups/ collection centres to avoid over supply at the auction depot creating temporary glut.

ANNEX I: SAMPLE QUESTIONNAIRE FROM THE FIELD VISITS

I (a). Questionnaire for Potato Producers in the Field:

General issues, including technology

1. What are the general perspectives of beekeeping business in your region? From the point of view of –
    a. Income –
    b. Cost –
    c. Effort –
    d. Other notes –
2. Production area?
3. Yield per harvest?
4. Annual income from potato production:
5. Estimated annual cost of potato production:
6. What production practices are common in the region?
    a. Do you use power tiller or bullocks?
    b. Extent of fertilizer use?
    c. How do you protect from wildlife?
7. What seeds are used?
    a. What are the advantages and disadvantages of the input practices in your region?
8. How do you store your seeds?
9. What potato varieties are common in your region?
10. How are diseased produce handled?
11. How are inputs equipment sourced?

Items	Source	Price
Seeds		
Labor		
Equipment		
Others		

12. How do you obtain technical assistance?

Providers	Program details	Success/ Failure (benefits received)
Extension agents		
NGOs		
Exporters		
RGoB		
Cooperatives		

13. In your opinion, what are the main technological problems and what could be done to increase the efficiency of potato production in your region?

Potato

1. Do you sort your produce? On what basis?
    a. Size?
    b. Color?
    c. Type?
2. In what quantity do you bag your produce?
    a. How do you ensure the weight per bag?
3. What labeling practices are common?
4. Where do you store your harvest?
    a. For how long?
    b. How much do you pay for storage?
    c. Is the space optimal?
    d. Storage conditions?
5. How much quantity and money is lost in wastage?
6. Is any special care regularly taken in sorting, storing and transporting produce to ensure quality? If not, why?
7. Are premium prices paid for better/ sorted produce?
8. How do you package potato for
    a. sale in open markets
    b. sale to middlemen or to auction yards?
9. Are there any sector programs aiming to improve production quality? What are your views regarding this type of initiative? What would be the conditions to ensure farmers' participation?

Market

10. How do you transport your produce?
    a. How much is spent on transportation?
11. Do you have processing options in your region?
12. To which market agents do you sell to –

Buyers	Price per kg	Payment terms
Direct consumers		
Intermediaries		
Auction yards		
Middlemen		

13. In your opinion, what are the advantages and disadvantages of the current system of pricing and payments?

Protection from wildlife and pests and diseases

14. What pests and diseases are common in your region?
15. What prevention measures are adopted?
    a. How are infected produce handled?
    b. What measures are adopted to protect from pests and diseases?
    c. How much money is spent on protection from diseases?
16. How does the produce health affect profits and competitiveness?
17. Is loss to wildlife a big issue?

a. Wild pigs or other animals too?
b. How much produce (in qty. and Nu.) on an average is lost to wildlife?
c. Prevention measures?
d. Prevention costs?

18. What is being done by the institutions (public and private) in order to improve protection from wildlife and pests and diseases in your region?

Government programs

Existing initiatives	Focus areas	Advantages/ disadvantages

Taxes and exemptions

19. Which types of taxes are paid by farmers? In which way do these taxes interfere in production/ processing/ input purchases?

Credit availability and access

20. How are farmers financing their operations and investments (self-financing or reliance on financial agents)? Examples of other financial agents? Rate of interest?
21. If there is no access to credit, specify the reasons. (Risk perceptions of the activity by the official lenders, level of indebtedness precluding further loans, etc.).
22. What are financial agencies/banks supplying credit (National Development Bank, commercial banks, private banks, other)? Are there special credit conditions under government programs?
23. What types of credit do farmers need most or have had more access to (working capital, investment credit, others)? What have been the main effective uses of credit resources?

I (b). Questionnaire for Processors:

Technology (current level; identification of bottlenecks; suggestion of policies)

1. List of installations/ equipment / processes
2. How do the installations compare to industry benchmarks
3. Are there regular investments in R&D? Are there partnerships for R&D?
4. The location issue (how your location influences your performance)
5. Are there any foreseen investments?
6. By-products processing (if not processing, how by-products are being disposed?)
7. The issue of quality: perceptions of the respondent
8. Level of idle capacity (how much and why)/scale issues (size versus operational costs). What is the ideal capacity of the plant, considering economies of scale?

Value Chain

1. Players
2. Value added at each level
3. General issue (general evaluation of system efficiency)
4. Sources of product acquisition and governance structure
5. Payment practices (pricing, live weight, other, grace period).

6. Are there any programs for quality improvement
7. Average distances from suppliers, type and costs of transport (who is responsible for transport, supplier or buyer?).
8. Efficiency of transport system (type of vehicle, losses, out-sourcing versus own fleet).
9. Other inputs (electric power, water, other)
10. Are there monitoring/technical assistance programs for suppliers

Quality

1. Are there systems of quality management?
2. Are you satisfied with the systems in place?
3. Aspects of food safety management?
4. What certifications you think the present state could be eligible for?

Management

1. Are there managerial systems for cost control?
2. How is the administrative efficiency evaluated?
3. Is there formal strategic planning?
4. Financial data available (cash flow, investment analysis, other)
5. Credit (operating/investment/exports) availability and access
6. Marketing strategies (brands, media, other)

Market

1. Product primarily sold to?
2. General issue (trends, evaluations, other).
3. Main product(s) and by-product(s) sold
4. Main markets (local, regional, national, international, institutional).
5. Governance structures (vertical integration, contracts, and partnerships).

I (c). Questionnaire for Traders at Auction Yards:

1. Where is potato purchased from and at what price?

Potato purchased	**Location**	**Avg. Qty.**	**Transport costs**	**Purchase Price**	**Selling Price**
FCBL AY					
SAM AY					
S/J AY					

2. Are there any other costs you have to incur while purchasing potato?
3. What costs are incurred from potato purchase at AYs to selling them to next users?
4. Who do you generally sell the potatoes to?
5. Who are the buyers in Indian market?
6. Any sale to potato processing plants in India?
7. How does Nepal market account into your sales?
8. Does the price remain uniform all throughout the year? What price do you sell during the off seasons?
9. Challenges with Bhutanese potatoes?
10. Do you receive any customer feedback on the potato sold?

ANNEX II: POTATO PRODUCTIVITY ACROSS THE REGION[58]

Sno	Country	Production (Mn Tones)	Cultivated Area ('000 hectares)	Yield (Tones/Hectare)	Consumption (Mn Tones)	PerCapita Consumption (kg)	Population (Mn)	Year of Reference
1	India	47	2085	22.5	32.17	24.3	1324	2016
2	Pakistan	4	170.3	23.5	3.75	19.4	193.2	2016
3	Sri Lanka	0.08	5.38	15.3	0.18	8.36	21.2	2014
4	Nepal	2.8	205.7	13.6	2.33	80.5	28.9	2014
5	Bangladesh	8.9	461.7	19.3	7.6	46.4	163	2014

58 Pakistan: https://www.potatopro.com/news/2017/pakistan-proposes-national-potato-institute-seed-potato-import-reduced-50-percent

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https://www.potatopro.com/news/2016/potato-farmers-rangpur-bangladesh-enjoy-record-amount-potatoes-and-good-prices

ANNEX III: UNIT COST OF POTATO PRODUCTION AND POST-HARVEST

III (a) Cost of Production – DoA Figures

Potato cost of production

Average yield in 2016: kg/ac		4019	
Items	**Nu./acre**	**Unit cost**	**Remark**
Cost of materials			
Seed	22950	22950	850kg/ac @Nu.27/kg (NSC rate)
FYM	7500	7500	1500kg/ac @ Nu.5/kg (generalized estimated cost)
Fertilizer (Urea, SSP & MoP)	4550	4550	Based on current selling price of NSC; (Urea, SSP & MoP) @40:32:24 kg/ac (N:P:K) based NSSC recommendation
Tools and equipments	1500	1500	Basic farm tools @lumpsum
Labour			
Main field preparation	4500	4500	10 mandays/ac. @ Nu.450/day
FYM & fertilizer application	2700	2700	6 mandays/ac @ Nu.450/day
Planting	3600	3600	8 mandays/ac. @ Nu.450/day
Weeding and earthening up	5400	5400	12 mandays, 2 weeding @ Nu.450/day
Harvesting	5400	5400	12 mandays/ac @ Nu.450/day
Total cost of production (Nu./ac.)	**58100**		
Unit cost (Nu./ kg)	**14.5**		

III (b) Post-harvest Cost – DoA Figures

Potato post-harvest cost

Average yield in 2016: kg/ac		4019	
Items	**Nu./acre**	**Unit cost**	**Remark**
Sorting and grading	3600	3600	8 mandays/ac. @ Nu.450/day
Storage	1000	1000	Temporary storage
Packaging	1500	1500	50 kg bag @ Nu.15/bag for 5000 kgs
Local transportation	1500	1500	1 DCM load@Nu.1500 (local estimate)
Total cost of production (Nu./ac.)	**7600**		
Unit cost (Nu./ kg)	**1.9**		

ANNEX IV: AUCTION YARD REGULATIONS/ PROCEDURES

Selected details of the FCBL auctioning process for potato include[59]:

- FCBL owns the auction facility and facilitates the auction system through management and provision of facilities like storage and truck parking.
- FCBL acts as guarantor to the sellers for sales payment.
- FCBL has a team of experienced professionals managing the day to day functions of these auction yards
- After arrival each grower is given a Lot Card, as an acknowledgment for the receipt of goods based on which auctioning is done. The goods are stacked in the auction yard.
- At the time of auctioning randomly selected bags are slit open to allow buyers to assess quality.
- The lot is given to the highest bidder. Weighing of each bag is done after the bidding process. Producers who are not satisfied with the bid can retain their merchandise.
- After billing is completed, goods are delivered to the bidders. FCBL collects payments from the buyers against the bills. A 24 hours grace period is given to potato buyers for clearance of bill amount. Longer periods are allowed for selected bidders cleared for credit.
- FCBL charges a service charge of 6% (3% each to growers and buyers)
- The system provides a mechanism to optimize the interaction between potato growers and buyers. Although the process does add to the cost (6% commission about 1% for loading and unloading, 1-5% damage through loading and unloading and 1-8 days waiting by seller for payments), it is clearly appreciated by both.

[59] Marketing Bhutanese Potato, Roder, W., K. Nidup and S. Wangdi, 2007

ANNEX V: DETAILS ON POTATO E-AUCTION PERFORMANCE

Grading of the Potatoes and Symbols

The Red and White potatoes were graded into four different sizes in 2016 as tabulated below:

Sl. no	Potato Type	Size	Symbols	Description
Red				
1	Desiree	Large	PODEL	Potato Desiree Large
2		Medium A	PODAM	Potato Desiree Medium Type A
3		Medium B	PODBM	Potato Desiree Medium Type B
4		Small	PODES	Potato Desiree Small
White				
5	Yeshey Kaap	Large	POYEL	Potato Yeshey kaap large
6		Medium A	POYAM	Potato Yeshey kaap Medium Type A
7		Medium B	POYBM	Potato Yeshey kaap Medium Type B
8		Small	POYES	Potato Yeshey kaap Small

The grading of the potatoes was executed through the newly procured grading machine funded by RSEBL. It is learnt that the grading machine has a grading capacity of 10 MT per hour.

E- Auction Prices

As of 10th August 2016, it was found that the prices fetched through the e-Auction were better than the prices fetched through the normal auction process.

The price differences in the same sized potatoes usually occurred due to the following factors.

- Non-uniformity of the potato size: It is been observed that some large sized potatoes are abnormally bigger than other large potatoes.
- Quality of the potato: It is been observed that in some lots of same sized potatoes, quality of the potato differs which is found to affect the auction price.

- Location/ Origin of potato: It is been found that the potatoes from Chapcha are more preferred than the potato from Bumthang and Wangdue due to better taste, looks and good germinating and yielding precedence.

Feedback from the Growers

Interviewing the growers who participated in the e auctioning, submitted the following feedbacks:

- That henceforth it will more convenient for the farmers as they no more have to segregate/sort their potatoes. The growers reported that it is very difficult, tedious and more time consuming while executing sorting.

- That the prices fetched through the online auctioning were more than the normal auctioning, which was unexpected, and they are very glad to receive higher price.

- That unlike the normal auction, they can retain their gunny bags in the e auctioning. The growers normally have to buy gunny bags for bagging of their potatoes, which needs to be surrendered along with the potatoes in the normal auctioning process.

- The growers also informed that the billing processes are also faster as well as the payment. In the normal auction, it is found that minimum of one and half days are taken to prepare bills where as in the e auctioning process, it is found that after the trade confirmations are completed the bills are generated there upon.

- That the chances of buyers colliding with each other during the bidding hour are impossible unlike in the normal auctioning process.

- That the e-Auctioning platform is better than the present auctioning process and that it should continue.

Feedback from the Bidders/Buyers

Intimating with the buyers/bidders on the new auctioning platform, submitted the following comments.

- That, it is difficult to bid online due to inexperience and lack of computer knowledge. Moreover, they also informed that as the online commodity platform is newly introduce in Bhutan as well as new to them, presently it is difficult to get along with it. Nevertheless, they also feel that they will be able to understand and learn henceforth with more of their participation.

- That they are able to get well graded and quality potato through this online commodity platform unlike in the normal auction process which the bided potatoes requires regarding, sorting and packing incurring additional labour expenses.

- That the potato price on the online commodity exchange platform can be paid higher comparing to the normal auctioning process due to the assurance of the quality and grading.

- That the only matured potato should be graded in the machine to avoid damages. It is been observed that the machine damages in-matured potatoes during the sorting and grading. Therefore, buyers suggested executing the e-Auctioning process by FCBL and RSEBL from September month that is after *Bishokarma* puja in view of the following additional reasons.

    - That due to sudden release of the cold stored potato in India, potato price will be affected and that it will not be appropriate to execute e-Auctioning at this time. The potatoes from cold store are sold at 16/- per kg and Bhutanese potato at 23 per kg in Siliguri, with the difference mainly occurring due to the good taste of the Bhutanese potatoes. Moreover, it was found that the sales of Bhutanese potatoes are very minimal compared to the India potato because of which the prices are affected. The cold stored potatoes are most likely to exhaust from September, which would allow price of Bhutanese potatoes to pick up gradually.

    - That due to improper cure of potato by the farmers at the moment, auction prices are affected and that to fetch better price in the auction, potatoes from late September are likely to arrive with proper cure as most of the farmers might have harvested the potatoes by August end which would have given adequate time for curing of the potatoes at source.

ANNEX VI: TRAINING MATERIALS FOR EXTENSION STAFF

Per the terms of reference (ToR), the consultant was required to submit training materials that can aid in strengthening of the potato value chain. The training needs were identified in the Conclusions and Recommendations section of the value chain report.

VI (a) Training Background

The Department of Agriculture (DoA), through its dzongkhag and extension network, and agencies, such as AMC, NSC, NPPC, and NPHC, provides awareness and training to potato producers on farm management and post-harvest techniques.

However there is little understanding on the potato value chain, its respective actors and value created by each, farm economics and margins captured by producers through different marketing options.

Hence it was recommended that the findings of the value chain analysis be disseminated to all extension staff and relevant stakeholders during national and regional workshops organized by DAMC. In addition to the value chain recommendations, the following training materials, based on the report findings and international best practices, shall be disseminated to the extension staff.

VI (b) Gaps Analysis

Based on the stakeholder and producer interviews, it was realized that most potato-related training in Bhutan is focused on fertilizer and pest management practices. Here is a summary of our findings on training practices for potato management in Bhutan –

Training Area	Existing training material/ practices	Gaps in Training Areas
Potato Production	• Integrated Pest Management (IPM) of Potato Tuber Moth (PTM) in Bhutan • Fertilizer Recommendations for Potato for major potato producing dzongkhags	• More practical training on identification of potato pests and diseases and the right management techniques for each • Implementation of recommended fertilizer dosages through extension staff
Potato Post-harvest Handing and Marketing	No materials on marketing/ post-harvest were discovered during the stakeholder interviews	Techniques on how to add value for producers though – • Understanding of value chain and farm economics • Formation of group enterprises/ collection centres to maximize efficiencies in sorting, packaging and transporting • Superior post-handling and marketing techniques

As mentioned earlier in the report, producers can capture much more revenue in the value chain if they improve their post-harvest practices. Currently, the potatoes sold by the producers at the auction yards undergo a subsequent round of drying, grading and re-packaging by the bidders/ Indian buyers. If the Bhutanese producers can ensure their potatoes are appropriately dried, graded and packaged in no more than say 50-52 kg bags, the prices fetched for their produce can be higher.

VI (c) Training Objectives:

Trainees/ extension staff would have previously learned from the report dissemination about the potato value chain, its actors and their functions and linkages, and existing challenges in the value chain and how to address them.

The following training materials aim to provide further information on post-harvest practices, formation of group enterprises and calculation of farm economics.

IV (d) Resource Materials:

1. Application of the value chain learning:

Once the extension officers have understood the value chain and economics at a national level, it will be valuable for them to conduct a similar exercise at local levels and customize the learning accordingly. The objectives of mapping the value chains at local level and its application include:

- Identifying dzongkhag/ geog-wise constraints along the value chain
- Exploring existing/ opportunities for local processors, business enterprises, FGs/ Coops, etc.
- Exploring the right marketing channel, with maximum margins, for potato marketing at geog or collection center level
- Encourage formation of group enterprises to solve common issues and achieve economies of scale

The extension staff could use templates from the value chain report to develop their value chain maps and identify challenges at local level.

Additionally, the extension staff should also be able to educate farmers on farm economics, mainly cost of production and post-harvest cost calculations. They can potentially use the following templates for calculation of cost of production and marketing, and breakeven price –

Table 1: Template for calculation of production and marketing costs, & break-even price

Particulars	Unit	Unit cost	Qty.	Amt.	Remarks
A. Input Costs					
Seeds	kg	27	850	22950	850kg/ac @Nu.27/kg (NSC rate)
FYM	kg	5	1500	7500	1500kg/ac @ Nu.5/kg (generalized estimated cost)
Fertilizer (Urea, SSP & MoP)	kg			4550	Based on current selling price of NSC; (Urea, SSP & MoP) @40:32:24 kg/ac (N:P:K) based NSSC recommendation
Tools/ equipment rental	hour	150	10	1500	Basic farm tools @Nu. 150/ hour for 10 hours
B. Labour costs					
Main field preparation	days	450	10	4500	10 mandays/ac. @ Nu.450/day
FYM & fertilizer application	days	450	6	2700	6 mandays/ac @ Nu.450/day
Planting	days	450	8	3600	8 mandays/ac. @ Nu.450/day
Weeding and earthening up	days	450	12	5400	12 mandays, 2 weeding @ Nu.450/day
Harvesting	days	450	12	5400	12 mandays/ac @ Nu.450/day
C. Post-harvest and marketing costs					
Sorting and grading	days	450	8	3600	8 mandays/ac. @ Nu.450/day
Storage		1000		1000	Temporary storage
Packaging	bags	15	100	1500	50 kg bag @ Nu.15/bag for 5000 kgs
Local transportation	bags	15	100	1500	1 DCM load@Nu.1500 (local estimate)
Total cost of production and marketing (Nu.)				**58100**	
D. Yield	kgs			4019	
E. Breakeven price (Total cost/ yield in kg)	**Nu./kg**			**14.5**	Producers should be able to sell their produce over the breakeven price to be profitable from potato enterprise

2. Formation of Group Enterprise/ Collection Centres at Strategic Locations

A group enterprise/ FG has much higher probability of success when the members of the group come together to solve similar problems. The most common problems with potato farmers are high costs of inputs and marketing. So, it is better to work in a group for collectively purchasing inputs, such as seeds, fertilizers, pest, etc., and marketing their produce. It is evident that a single farmer will have to incur significantly higher post-harvest costs if they work individually. Hence farmers can join hands working together by bringing their produce at the collection centers to sell through the appropriate marketing channel.

Although it is imperative that farmer groups (FGs) and/ or Cooperatives (Coops) be managed in a more business-like manner, not like social clubs or charity organizations. They should provide aim to maximize income and/ or minimize costs for farmers. Regular dialogues among farmers, cooperatives and market authorities should be undertaken to resolve problems. For success, the farmers' orientation should be on improving productivity and quality.

What is a Collection Centre?

Collection centers are market sheds at strategic locations constructed to reduce post-harvest losses, strengthen transportation and storage. Most of the potato growers in Bhutan are smallholders, working on isolated farms far from the markets. Hence most producers incur significant costs in post-harvest activities (sorting, grading, packaging, etc.) and transporting their potato bags to the auction yard. Establishment of Collection/ Grading Centers can act as value adding intermediary between producers and buyers in the potato chain.

Advantages of marketing from a Collection Centre/ as a FG/ Coop:

- Collection in one place so that post-harvest practices of cleaning, curing, sorting, grading, packaging and transportation can be applied on a relatively significant volume and economies of scale can be achieved
- Regular and timely supply to the most appropriate marketing channel
- Price fluctuation can be managed if there are agreements with processing enterprises, such as Happy Chips and Bhutan Chips, or if there is regular communication with the nearest auction yards
- Ease in information communication about price, volume and others
- Cost of production can be reduced by procuring all necessary inputs using common transport
- Transportation and marketing costs can be reduced
- Easy access of funds and other support services by the government and donors
- More funds can be gathered from the members if big plans are envisioned
- Traders/ buyers could potentially be attracted to buy directly from the collection Centre, if the volumes, quality and buyer relationships are well maintained

- Post-harvest loss can be minimized
- Provision of capacity building and training from the processing company
- Bargaining power improved

Points to be considered for successful management of cooperatives and groups:

- For successful management of cooperatives and groups, a capable manager is required. Capable manager should be recruited and trained for successful operation of regular business operation.
- Cooperatives should be able to network and coordinate with the other cooperatives. Few similar activities could be done together to minimize cost and to expand market.
- Cooperatives should be capable to update themselves with the market information.
- Should be able to prepare marketing plan and implement activities
- There should be transparency in activities, roles and responsibilities, cash-flow and day-to-day transactions.
- There should be proper management of accounting, assets, etc. and proper communication to all members.
- There should be regular monitoring of progress and achievements.

3. Post-harvest practices:

This section does not attempt to cover the technical details of post-harvest handling, rather the best practices on maintaining quality, maximizing shelf life, and supplying produce according to buyer's specifications and demand. The following practices are based on international and Bhutanese guidelines on post-harvest handling –

a. Storage

Proper storage of potatoes will minimize the risk of microbiological, chemical and physical contamination. The grounds around a potato storage facility should be kept in a condition that will control, reduce, or minimize the risk of food contamination. Grounds maintenance includes, but is not limited to:

- Removal of litter and waste, and cutting weeds or grass within the immediate vicinity of the storage facility that may constitute an attractant, breeding place, or harbour for pests
- Ensuring cross ventilation: If there is no cross ventilation or heat in the place where the potatoes are stored, then due to its own respiratory system it causes decrease in oxygen and increases in carbon dioxide causing post-harvest loss.
- Avoiding direct sunlight: Potatoes are advised to be stored in the dark.

b. Cleaning, drying and curing

Cleaning: Proper cleaning is important to maintain its water contents and quality. It removes unwanted dirt and sand and makes it attractive and fresh. In case of potato, it is advised to wash properly with chorine water[60]. In Bhutan, few farmers have wrong perception that if the vegetables are cleaned with water it quickly is spoilt.

Drying and Curing: It is done to preserve fruits and vegetables by making the outer layer harder by drying. The Indian traders, after purchase of potatoes from the auction yards, generally let the potatoes dry on the ground of a storage facility, under ceiling fans, for at least 24 hours.

Drying is used mainly on bulbs in order to extend shelf and storage life. Most root crops respond to warm, moist conditions after harvest by thickening and hardening their skins. This provides protection against dehydration and infection. Wound healing occurs. This is called curing and it significantly improves storage life of potatoes.

c. Sorting and Grading

In the storage/ collection facility, harvested potatoes should be sorted and graded in a manner that minimizes sources of potential microbiological, chemical and physical contamination. The best practices are:

- During sorting and grading, foreign materials (e.g., stones) and crop debris (e.g., stems and leaves) should be separated from marketable potatoes.
- Foreign materials, culls and debris should be discarded in a manner so as to not attract pests such as insects and rodents.

[60] RAMCO's training module in collaboration with SNV

- Potatoes that may have become contaminated should be discarded
- Top-quality produce can be selected for transport to distant markets
- Lighting should be good in the sorting area

Once the damaged, diseased and mechanically injured potatoes are separated, the produce should be graded according to colour and size –

- Size – large, medium, and small
- Colour – red and white
- Use – table potatoes and seed potatoes

d. Packaging

Graded potatoes should be packed separately to facilitate marketing to consumers with differing quality requirements. Best practices include –

- Packaging material and size: Potato should be packed in 50 kg nylon perforated bags or jute bags, depending on availability
- Standardized weight: The jute or PP bags should not be over stuffed with potatoes. Every 50 kg bag should NOT have more than 52 kg of graded potato.
- Do not reuse poor quality packaging materials with many holes. There will be loss during transportation due to fall.

e. Transportation

Potatoes are transported from storage/ packaging facilities through trucks or DCM. Transportation conditions should be managed to minimize the risk of contamination. To minimize the potential for contamination, the cargo area of vehicles transporting potatoes should be clean and in good condition. The best practices include:

- The truck's cargo area should be inspected before loading each trailer / shipping unit, to ensure that it is clean, in good condition and free of objectionable odour.
- Potatoes should be loaded in the trailer / shipping unit in a manner that minimizes physical damage.
- Do not stomp on the sacks filled with the agricultural produce. It will get damaged and lose its quality. Labourers usually neglect this aspect during transportation.
- Do not overload when transporting from one place to minimize cost in transportation. This causes damage to the crops.

f. Market Selection and Timing

Marketing involves finding out what customers want and when, and supplying it to them at a profit. It is very important to select the right marketing channel and timing to sell the produce.

Marketing therefore involves identifying the right buyers, understanding what product specifications buyers want (red or white/ table or seed/ small, medium or large), when they want which variety (e.g., seed potatoes have much stronger demand in Nov. - Dec. while table potatoes are bought from May - Dec. at the auction yards), selecting the right market channel (local farmers' market v. auction yards v. processors) and making enough profit to continue their business.

In case of potatoes, producers can select one or more from among the following marketing channels based on proximity to the market, demand estimation, pre-existing price agreements, ongoing prices, and cost of marketing:

- Phuentsholing Auction yards (FCBL or SAM) and Sandrup Jongkhar Auction Yard
- Vegetable/ Weekend Markets
- Middlemen (Intermediaries/Transporters/Large Producers)
- Institutional buyers such as boarding schools, and mess at Royal Bodyguard of Bhutan (RBG), Royal Bhutan Army (RBA), and Royal Bhutan Police (RBP)
- National Seed Corporation (NSC)

Along with the right channel, it is also very important to understand the right timing for potato marketing. For example, in case of sale at auction yard, it is important to have regular communication with the auction yard (directly or through extension staff) to understand when producers should bring what grade and type of potatoes.