EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET

MD. JULFIKER MOIN

A DISSERTATION FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

AGRICULTURAL EXTENSION & INFORMATION SYSTEM

DEPARTMENT OF AGRICULTURAL EXTENSION & INFORMATION SYSTEM

SHER-E- BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207, BANGLADESH

DECEMBER, 2018

EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET

By

MD. JULFIKER MOIN

Reg. No. 00993

A Dissertation

Submitted to the faculty of Agriculture,

Sher-e-Bangla Agricultural University, Dhaka

In partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

IN

AGRICULTURAL EXTENSION & INFORMATION SYSTEM

SUBMITTED TO

DEPARTMENT OF AGRICULTURAL EXTENSION & INFORMATION SYSTEM

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

SHER-E-BANGLA NAGAR, DHAKA-1207, BANGLADESH

DECEMBER, 2018

Defense Date: 16 February, 2020

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SEMESTER: JULY- DECEMBER, 2018

Certificate of Approval

**…..…….. **	**…….**
Prof. Dr. Muhammad Humayun Kabir	**Prof. Dr. Mohammed Shofi Ullah Mazumder**
Member, Advisory Committee	Member, Advisory Committee
Department of AEIS, SAU	Department of AEIS, SAU
……..	**……**
Prof. Dr. Md. Nazrul Islam	**Prof. Dr. Md. Sekender Ali**
Member, Advisory Committee	Chairman, Advisory Committee
Department of Horticulture, SAU	Department of AEIS, SAU

Department of Agricultural Extension & Information System
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

CERTIFICATE

This is to certify that the dissertation entitled **"EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET"** submitted to the department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Agricultural Extension & Information System, embodies the result of a piece of bona fide research work carried out by **Md. Julfiker Moin, Registration No.00993** under my supervision and guidance. No part of the dissertation has been submitted for any other degree or diploma.

I further certify that any help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by the Author.

Dated: 16 February, 2020
Dhaka, Bangladesh

.....
Prof. Dr. Md. Sekender Ali
Chairman, Advisory Committee
of the Concerned PhD Student
Department of Agricultural Extension & Information System
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

DEDICATION

DEDICATED TO

THIS DISSERTATION IS LOVINGLY DEDICATED TO MY PARENTS. THEIR SUPPORT, ENCOURAGEMENT AND CONSTANT LOVE HAVE SUSTAINED ME THROUGHOUT MY LIFE.

DECLARATION

It is hereby declared that except otherwise stated, this Dissertation is entirely the own work of the present researcher under the guidance and supervision of the Advisory Committee and has not been submitted in any form to any other University for any degree.

The Researcher

December, 2018

BIOGRAPHICAL SKETCH

The author was born on 07 August 1981 at Village- Baher Char, P.O- Baher Char, Upazila- Daudkandi, District- Cumilla, Bangladesh. He came from a reputed and enlightened Muslim family. He passed the Secondary School Certificate (S.S.C) examination from Govt. Laboratory High School, Kotbari, Cumilla Sadar South, Cumilla in 1997 and Higher Secondary Certificate (H.S.C) examination from Notre Dame College, Dhaka in 1999. He obtained the degree of Bachelor of Science in Agriculture (Honours) in 2004 (held in 2006) and the degree of Master of Science in Agricultural Extension in 2009 bearing registration number 00993, from Sher-e-Bangla Agricultural University, Dhaka- 1207, Bangladesh.

He is a Life Member of Bangladesh Agricultural Extension Network (BAEN), General Member of Krishibid Institution of Bangladesh (KIB), General Member of Sher-e Bangla Agricultural University Alumni Association (SAUAA).

The Researcher

ACKNOWLEDGEMENT

The author expresses his gratefulness to Almighty Allah who enables him to continue higher education as well as complete the research work successfully and to submit the dissertation for the degree of DOCTOR OF PHILOSOPHY (PhD) in Agricultural Extension & information system, Sher-e-Bangla Agricultural University, Dhaka.

The author expresses his sincere and heartfelt gratitude, deep appreciation and regards to the **Chairman of his PhD Research Advisory Committee Professor Dr. Md. Sekender Ali,** Department of Agricultural Extension & Information System, Sher-e-Bangla Agricultural University, Dhaka for his guidance, constructive criticism, constant stimulation and encouragement throughout the study, without which this work would not have come to the present shape. His scholarly suggestion and affection behaviour has been a fountain of great inspiration for the author.

The researcher also humbly desires to express his deepest and most sincere gratitude to **Professor Dr. Md. Nazrul Islam**, Honourable Member of Advisory Committee of the Research work for his continuous co-operation, constant supervision, constructive criticism and creative suggestions in the preparation of dissertation manuscript.

The researcher would like to express his heartfelt appreciation, indebtedness and gratitude to the Member, Advisory Committee, **Professor Dr. Mohammed Shofi Ullah Mazumdar**, Department of Agricultural Extension & Information System, Sher-e-Bangla Agricultural University (SAU), Dhaka for his valuable advice and suggestions, active co-operation, meticulous attention in every sphere of the research work and for helping him to improve the manuscript.

The author desires to express his gratefulness to **Professor Dr. Muhammad Humayun Kabir,** Honourable Member of Advisory Committee of the Research work and **Chairman,** Department of Agricultural Extension & Information System, Sher-e-Bangla Agricultural University, Dhaka, who served as an Advisor of this advisory committee. He took keen interest to this piece of research and provided creative suggestions, constructive criticism and guidance.

The researcher records his heartfelt appreciation and profound gratitude to **Professor Dr. Rafiquel Islam**, **Professor M. Zahidul Haque, Professor Md. Mahbubul Alam, PhD, Professor Dr. Ranjon Roy, Professor Md. Abul Bashar, Professor Mohammad Zamshed Alam, Kh. Zulfikar Hossain, Assistant Professor** and **other teachers** of the Department of Agricultural Extension & Information System for their valuable suggestions and co-operation throughout the whole period of the research work.

The researcher records his heartfelt appreciation and profound gratitude to **Professor Md. Shadat Ulla,** Ex-Vice chancellor**,** Sher-e-Bangla Agricultural University; **Professor Dr. Kamal Uddin Ahamed**, Vice-Chancellor, Sher-e- Bangla Agricultural

University; **Professor Mohammad Hossain Bhuiyan**, Department of Agricultural Extension & Information System, Sher-e- Bangla Agricultural University; **Professor Dr. A. S. M. Ziaul Karim,** Department of Agricultural Extension Education, Bangladesh Agricultural University (BAU), Mymensingh; **Professor Dr. Md. Monirul Islam**, Department of Agricultural Extension Education, Bangladesh Agricultural University (BAU), Mymensingh and **Professor Dr. Shonia Sheheli,** Department of Agricultural Extension Education, Bangladesh Agricultural University (BAU), Mymensingh for their valuable suggestions and co-operations throughout the whole period of the research work.

I express my sincere gratitude to the Ministry of Science and Technology, Government of the People's Republic of Bangladesh for providing National Science and Technology Fellowship (NST Fellowship) for conducting this research work.

Heartfelt thanks and appreciation are also expressed to Bangladesh Fruits, Vegetables and Allied Products Exporter's Association (BFVAPEA) Officials for their benevolent help and co-operation in data collection during the interview of the respondents and the respondent farmers of the study area for their co-operation and patience and providing of information during data collection.

I extend my heartfelt thanks to all of my classmates, PhD fellows of the Department of Agricultural Extension & Information System, Sher-e-Bangla Agricultural University, Dhaka who created brotherhood relationship and inspired me to achieve the target.

The deepest appreciation is also extended to officers and staff of the Department of Agricultural Extension & Information System, and officers and staff of the Pro-vice Chancellor's Office, Sher-e-Bangla Agricultural University, Dhaka.

The author tendered his indebtedness to his father Md. Amir Hossain and mother Anjuman Ara Begum for special care and affection that reflects the author's educational life all along. The author highly indebted to his all elder brothers, sister, sister-in law, brother-in law, nephew, niece and relatives for their blessing, inspirations, co-operation in all phases of this academic pursuit from beginning to the end.

Lastly, the researcher owes his heartiest thanks to those who helped him in different ways and means to complete this research work.

The Researcher

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ACRONYMS AND SYMBOLS USED

AICC	Agriculture Information and Communication Center
AEIS	Agricultural Extension & Information System
AEO	Agricultural Extension Officer
AVRDC	Asian Vegetable Research and Development Center
BBS	Bangladesh Bureau of Statistics
BCIP	Bangladesh Country Investment Plan
BDHS	Bangladesh Demographic and Health Survey
BFVAPEA	Bangladesh Fruits, Vegetables & Allied Products Exporter's Association
BARI	Bangladesh Agricultural Research Institute
BRRI	Bangladesh Rice Research Institute
DAE	Department of Agricultural Extension
DAM	Department of Agricultural Marketing
EI	Effects Index
EPB	Export Promotion Bureau
EUREPGAP	Euro-Retailer Produce Working Group Good Agricultural Practices
FAO	Food and Agriculture Organization
FFS	Farmer Field School
FY	Fiscal Year
FYP	Five Year Plan
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GO	Government Organization
GED	General Economics Division
HRC	Horticulture Research Center
IBM	International Business Machines Corporation
HEIS	Household Income Expenditure Survey
HORTEX	Horticulture Export Development Foundation
ICT	Information and Communication Technology
MDG	Millennium Development Goal
MoA	Ministry of Agriculture
MoC	Ministry of Commerce
MOU	Memorandum of Understanding
NARS	National Agricultural Research System
NGO	Non-Governmentl Organization
NFP	National Food Policy Plan
PFI	Problem Faced Index
PHL	Post-harvest Loss
PPP	Public Private Partnership
SAAO	Sub Assistant Agriculture Officers
SAU	Sher-e-Bangla Agricultural University
SDG	Sustainable Development Goal
SPSS	Statistical Package for the Social Sciences
TSS	Toxic Shock Syndrome
UNESCO	United Nations Educational, Scientific and Cultural Organization
UAO	Upazila Agriculture Officer

UI	Use Index
USA	United States of America
USDA	United States Department of Agriculture
VCA	Value Chain Analysis
WB	World Bank
WDI	World Development Indicators
WHO	World Health Organization
'a'	Surface Hunter Redness
alum	Aluminium
approx.	Approximate
BDT	Bangladeshi Taka
AAS	Average Appropriateness Score
β	Beta
CIPC	3-Cholorisopropyly-N-Phynle Carbamate
CA	Controlled Atmosphere
CO_2	Carbon Dioxide
CV	Co-efficient of variance
df	Degree of freedom
EC	Evaporative Cooler
eg.	exempli gratia (for example)
et al.	et all (and other people)
etc.	et cetera (and the rest)
g	Gram
H_o	Hypothesis
i.e.	id est (that is)
kcal	Kilo Calorie
kg	Kilogram
kGy	Kilogray
L	Surface Hunter Lightness
MA	Modified Atmosphere
MENA	Methyl ester of a-Napthaleneacetic Acid
MH-40	Maleic Hydrazide
µl	Microlitre
ml	Milliliter
NaOCL	Sodium Hypochlorite
O_2	Oxygen
PE	Polythene
ppm	Parts Per Million
SD	Standard Deviation
RH	Relative Humudity
sq.km	Square Kilometer
sq. mile	Square Mile
TCNB	2,3,4,6 Tetra Nitro Benzene
Tk./tk.	Taka
USD	United States Dollar
TV	Television
viz.	videlicet (namely)
%	Percent
$^{\circ}C$	Degree Celsius
$^{\circ}F$	Degree Fahrenheit

EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET

MD. JULFIKER MOIN

ABSTRACT

The study was conducted to determine the extent of effects of using selected post-harvest practices as perceived by the farmers and explore the contribution of the selected characteristics of the farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. The study was conducted in three upazilas namely Belabo, Raipura and Shibpur under Narsingdi district in Bangladesh. A total of 717 farmers of these three upazilas are actively producing and exporting Bitter Gourd, Brinjal and Teasel Gourd with the help of Bangladesh Fruits, Vegetables and Allied Products Exporter's Association (BFVAPEA) which constituted the population of the study. By using sample size formula, 250 farmers founded the sample of the study. Proportionate random sampling technique was used for selecting sample farmers from farmers' group formed by BFVAPEA in different villages of different unions of these three selected upazilas. Finally 91, 75 and 84 farmers were included for Bitter Gourd, Brinjal and Teasel Gourd respectively as the sample. Data were collected from a sample of 250 farmers during August 01, 2019 to November 30, 2019 by using an interview schedule. Nineteen (19) selected characteristics of the farmers were considered as the independent variables. Effects of using selected post-harvest practices to strengthen vegetable export market was the dependent variable. Majority (83.60%) of the farmers perceived that the use of selected post-harvest practices was medium to high effective to strengthen vegetable export market. Stepwise multiple regression analysis indicated that the whole model of 19 variables explained 35.90 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market as perceived by the farmers. But since the standardized regression co-efficient of 6 variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these 6 variables. Results of stepwise multiple regression analysis showed that use of selected vegetables post-harvest practices, knowledge on selected vegetable post-harvest practices, exportable vegetables production, experience in exportable vegetables production and extension contact had significant positive contribution whereas problems faced in vegetable value chain had negative contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Path analysis indicated that knowledge on selected vegetable post-harvest practices had the highest total indirect effect followed by extension contact, use of selected vegetables post-harvest practices, experience in exportable vegetables production and exportable vegetables production on their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Problems faced by the farmers had negative total indirect effect on their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Finally, it was found that use of selected post-harvest practices was effective to strengthen vegetable export market.

CHAPTER 1

INTRODUCTION

1.1 General background of the study

1.1.1 Country overview and economy

Bangladesh has a rich historical and cultural past; the land, the rivers and the lives of the common people combined have formed a rich heritage. It appeared on the world atlas as an independent and sovereign state named Bangladesh on December 16, 1971 following victory at the War of Liberation (from March 25 to December 16, 1971). Bangla is the mother tongue of Bangladesh. But to establish Bangla as the mother language, Bangalees had to sacrifice their lives. A number of People were martyrized in February 21, 1952 to establish the rights of mother language. In recognition of their supreme sacrifice, UNESCO declared 21st February as the "International Mother Language Day" throughout the world. Bangladesh lies in the north eastern part of South Asia between 20°34' and 26°38' north latitude and 88°01' and 92°41' east longitude. The country is bounded by India on the west, north and north-east while Myanmar on the south-east and the Bay of Bengal on the south. The area of the country is 56,977 sq. miles or 147,570 sq. km. The limits of territorial water area of Bangladesh are 12 nautical miles and the area of the high seas extending to 200 nautical miles measured from the base lines constitutes the economic zone of the country. Bangladesh won in Arbitral Tribunal/PCA more than 1,18,813 square kilometers of waters comprising territorial sea, exclusive economic zone extending out to 200 NM across sizable area, and also have undeniable sovereign rights in the sea bed extending as far as 354 NM from Chittagong coast in the Bay of Bangal with all the living and non-living resources. To achieve an equitable result, the tribunal awarded Bangladesh 19,467sq km of area out of total disputed area of 25,602 sq.km (approx.). (BBS, 2018[a]).

Bangladesh enjoys generally a sub-tropical monsoon climate. While there are six seasons in a year, three namely - winter, summer and monsoon are prominent. Winter which is quite pleasant begins in November and ends in February. In Winter there is not usually much fluctuation in temperature which ranges from minimum of 7°C-13°C (45°F-55°F) to maximum of 24°C-31°C (75°F-85°F). The maximum temperature recorded in summer is 37°C (98°F) although in some places this occasionally rises up

to 41°C (105°F) or more. Monsoon starts in July and stays up to October. This period accounts for 80% of the total rainfall. The average annual rainfall varies from 1429 to 4338 millimeters. (BBS, 2018[a])

Except the hilly regions in the north-east, south-east and some areas of high land in the northern part, the country consists of plain and fertile land. A network of rivers exists in the country of which the Padma, the Jamuna, the Teesta, the Brahmaputra, the Surma, the Meghna and the Karnaphuli are prominent. All those rivers have 230 tributaries with a total length of about 24140 kilometers. The alluvial soil is thus continuously being enriched by heavy silts deposited by rivers during the rainy season. Of the total area of Bangladesh, forest lands account for almost 21.05% of its geographical surface. The Sundarban is the largest mangrove forest in the world. It lies at the southern part of the Ganges delta and is spread across the coastal areas of Bangladesh and West Bengal of India. The section of Sundarban that belongs to Bangladesh has been listed in the UNESCO world heritage. The Sundarban is known for its wide range of fauna. Sundarban is the home of the world famous 'Royal Bengal Tiger'. (BBS, 2018[a]).

Bangladesh is mainly an agricultural country. Agriculture is the single largest producing sector of the economy and contributes about 10.98% to the total Gross Domestic Product (GDP) of the country. This sector also accommodates around 40.6% (in 2016-17) of labour force. GDP growth rate of Bangladesh mainly depends on the performance of the agriculture sector. Due to natural calamities like flood cyclone, drought, loss of production in both food and cash crops are almost a regular phenomenon. Yet in recent years, there has been a substantial increase in food grain production. Agricultural holding in Bangladesh is generally small but use of modern machinery and equipment is gradually increasing. Rice, jute, sugarcane, potato, pulses, wheat, tea and tobacco are the principal crops of Bangladesh. Crop diversification programme, credit supply, extension work, research and input distribution policies pursued by the government are yielding positive results. The country is now on the threshold of attaining self-sufficiency in food grain production (BBS, 2018[a]).

Principal seasonal crops and fruits of the country are Paddy, jute, wheat, tobacco, pulses, oil seeds, spices, vegetables, jack-fruit, banana mango, coconut. Principal

exports products are Readymade garments & knitwear, frozen fish, jute & jute goods, pharmaceutical products, tea, leather products, handicrafts, chemicals. (BBS, 2018[b])

1.1.2 Vision 2021 of Bangladesh

Vision 2021 is a perspective plan to build Bangladesh a middle income and technology based country by 2021. The main perspective plans are:

2010: 100 percent net student enrolment at primary level

2011: Supply of pure drinking water for the entire population

2012: Self-Sufficiency in food

2013: Each house brought under hygienic sanitation

2013: Attain 8 percent annual growth rate and this will be increased to 10 percent in 2017 and sustained

2013: Bangladesh generates 7000 Megawatt of electricity which will be further increased to 8000 Megawatt in 2015. Steps will be taken to increase power generation capacity assuming that the demand for power will reach the level of 20,000 Megawatt in 2021

2013: Free tuition up to degree level

2014: Bangladesh attains full literacy

2015: Living accommodation for the entire population

2021: Contribution of agriculture, industry and service sector to GDP will stand at 15, 40 and 45 percent respectively in place of 22, 28 and 50 percent as a percent

2021: Unemployment reduce to 15 percent from the present rate of 40 percent

2021: Labour in agriculture comes down to 30% from 48% at present

2021: Labour in industry is 25% from 16% and in service 45% from 36% at present

2021: Poverty rate comes down to 15% from 45% at present

2021: Bangladesh knows as a country of educated people with skills in information technology

2021: 85% of the population have standard nutritional food

2021: Poor people ensured a minimum of 2122 kilo calories of food

2021: All kinds of contagious diseases eliminated

2021: Longevity increases to 70 years

2021: Infant mortality comes down to 15 from 54 per thousand at present

2021: Maternal death rate reduced to 1.5% from 3.8%

2021: Use of birth control methods increased to 80% (GED, 2015)

1.1.3 Strategy for agriculture under the 7th Five Year Plan (FY2016-FY2020)

In keeping with the stylized facts of development, the share of agriculture in Bangladesh's GDP has been on a secular decline for the past four decades. This trend is part of the qualitative transformation process of Bangladesh's Economy (Figure1.1). While there has been an accompanying declining trend in agricultural employment along with rising wages, almost half of the national work force continues to be employed directly or indirectly in the agriculture sector. Marginal farmers and landless farm workers also constitute a major part of the population below the poverty line in Bangladesh. As such, the strategic importance of agriculture in meeting basic food demand and providing livelihood for a substantial part of the population deserves added and focused attention. (GED, 2015)

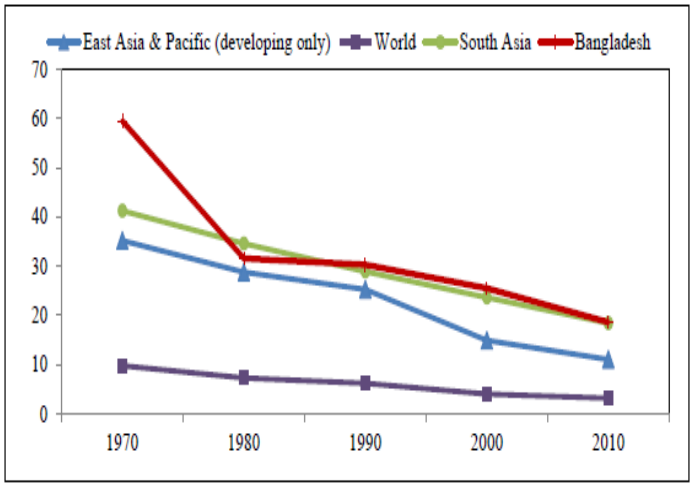

Figure 1. 1 Trend in Agricultural Value Added as a share of GDP (%) Source: World Bank, WDI, 2012

According to Seventh Five Year Plan, the Government set up targeted GDP for the fiscal year 2016, 2017, 2018, 2019 & 2020 is 7.0, 7.2, 7.4, 7.6 & 8.0 whereas the contribution of Agriculture sector in GDP will be 3.21, 3.28, 3.34, 3.39 & 3.49 respectively (GED, 2015). However Agriculture sector GDP growth rate (%) of Crops & Horticulture will be 1.47, 1.42, 1.42, 1.41 & 1.40 respectively (MoA). % of agriculture budget allocated in the agricultural research is 4.83, 5.55, 6.38, 7.33 & 8.43 as of GDP respectively. (MoA). Exports as of % GDP (Goods & Services) will be 17.7, 15.6, 15.7, 15.9 & 16.2 (EPB, MoC, 2015).

The major issues and challenges facing Bangladesh agriculture during 7th Five Year Plan and beyond will be promoting the use of agricultural technology with supportive policies, reforms, regulations and incentives in place for raising productivity and profitability; increasing diversification of production in line with consumption diversification to promote nutrition; increasing private sector participation in the

agriculture and improving agro-processing value chains; reducing instability of production; increasing resource use efficiency; reducing loss of arable land; minimizing yield gap; maintaining food security, safety and quality; expanding irrigation and farm mechanization through appropriate technology; and developing resilience to climate change impacts (GED, 2015).

1.1.4 Crop sub-sector strategies under the 7th Five Year Plan (FY2016-FY2020)

The development vision for agriculture under the 7th Five Year Plan is to ensure food and nutritional security, enhancement of sustainable intensification and diversification of climate resilient agricultural production with increased commercialization, increase productivity and real income of farm families in rural areas on a sustainable basis, livelihood improvement through technological innovations and use, strengthening of research and extension system, developing supply chain extension, value addition of agricultural products, and linking farming community with markets, both local and global. Encourage wider women participation in homestead based agricultural production, post-harvest management, agro/food processing, marketing and decision making for ensuring women empowerment. Promote farmer's right through digital repository by achieving farmer's indigenous innovations, farmer's creativity under intellectual property laws and protect their intellectual properties and establish a database for indigenous technologies owned by the rural farming community.

1.1.5 Agricultural research under the 7th Five Year Plan (FY2016-FY2020)

The National Agricultural Research System (NARS) institutes generate the demand-led agricultural technologies (varieties and management practices) and information. The research will develop and refine technologies that will bridge yield gaps and promote diversification, sustainable natural resources management: rain water and river water harvesting for agricultural production, disease and pest management, development of varieties/species with post-harvest technology of high value agricultural commodities, mechanization, etc. It will also address climate change effects by breeding and introducing saline and drought tolerant, short duration varieties, introduction of high value commodities and low-cost, high-impact post-harvest technologies as well as research on packaging, harvesting, maturity index, food processing and market intelligence.

1.1.6 Value chain development under the 7th Five Year Plan (FY2016-FY2020)

Value chain development for identifying constraints to marketing supply channel is a new tool for rationalizing prices of agricultural produce between farm gate and consumer. MoA has been supporting value chain development of selected vegetables and fruits through its development projects. In the seventh five year plan the approach will be applied to other crops such as aromatic rice. The main effort will be to improve the efficiency of agricultural marketing to reduce market distortions and the cost of marketing, and to ensure that farmers get proper price for their produce and consumer gets quality products. For quality control and ensuring traceability**,** phytosanitary requirements, Department of Agricultural Marketing (DAM) will need to be involved and its capacity developed. The seventh plan will improve marketing services with a view to ensuring fair returns to the growers for their produces and adequate supply to the consumers at reasonable prices. In this regard, the establishment of HORTEX, a private board for value chain promotion for high value commodities, is an important institutional development. In addition, DAM will also be expected to play its role in value chain promotion and due emphasis on capacity building of government extension agencies for which necessary steps will be taken. A sustainable developed value chain will depend on active participation by all actors. So the role of the private sector in participating in the agriculture value chain is of critical importance. Strengthening the institutional capacity and reducing financial and regulatory constraints to address the complex production and marketing constraints including developing a viable private sector led value chain will be an important strategic issue to address. For value chain development augmentation of required technological support services should also be strengthened.

1.1.7 Introductory note on vegetable production and export Scenario in Bangladesh

Bangladesh, a country of tropical and subtropical climates, produces large volume of highly nutritious vegetables crops. Vegetables in Bangladesh cover an area of 1008 thousand acre with a total production of 4121 thousand metric ton (BBS, 2018[c]). The major vegetable growing areas of Bangladesh are Jessore, Bogra, Comilla, Chittagong, Khulna, Kushtia, Dhaka, Tangail, Rangpur, Rajshahi and Dinajpur and a major part of the vegetables produced in this area are transported to the capital or other cities as soon as possible through different marketing channels (Ahmed, 1992;

Hossain, 2000). Although root and tuber crops, namely, potato, sweet potato, aroids and yams are considered as vegetables in Bangladesh. Depending on growing season in Bangladesh vegetables are classified as winter and summer vegetables. Among the winter vegetables, brinjal, pumpkin, cabbage, cauliflower, tomato, bottle gourd, radish, country bean, palongshak, lalshak and indian spinach are important. Among summer vegetables, pumpkin, brinjal, teasel gourd, pointed gourd, lady's finger, ribbed gourd, snake gourd, bitter goud, yard long bean, cucumber, ash gourd, amaranths and Indian spinach are important. (BBS, 2018[c]).

Vegetables play a vital role in human nutrition, especially as sources of vitamins, minerals, dietary fibre, and antioxidants. Vegetables are highly valued in human diet mainly for vitamins and minerals. However, the present consumption of fruits and vegetables in Bangladesh is 256.3 g/day/capita (36.1 g leafy vegetables, 129.9 g non-leafy vegetables and 70.3 g Potato), which is far below the minimum average requirement of 400 g/day/capita (FAO/WHO 2003) which indicates a poor dietary status in Bangladesh. In this regard, the high levels of underweight (33%), stunting (36%) and wasting (14%) among children less than five years; anemia among infants, young children, adolescent girls and pregnant women; and poor diet diversification are of particular concerns (BDHS 2015; BCIP 2010).

The food and nutrition situation in Bangladesh is fragile due to inadequate and imbalanced diet intake. Consumption of a diversified diet to meet the needs of macro and micro nutrients needs to be promoted (Bhattacharjee et al., 2007; NFP 2008; BDHS 2009). A large proportion of Bangladeshi population is food insecure due to poor diet quality. The usual diet is heavily dependent on rice, and most of the energy in the diet is contributed by cereals. Out of the total 2210.40 kcal received per capita per day from all food items in 2016, 1421.70 kcal was contributed by cereals in which rice alone contributed 1272.30 kcal. The other major calorie contributing food group is vegetables (91.30 kcal). The average per capita per day intake of protein was 63.80 gram in 2016. The cereals group contributes the most in terms of protein intake and accounts for 30.62 gram (48 percent) of the total followed by vegetables 3.48 gram (5.45 percent of the total), among vegetables leafy vegetables amount is 1.12 g, and other vegetables 2.36 g in 2016 (HIES, 2016).

Bangladesh is endowed with a remarkably heterogeneous area, characterized by a great diversity of agro climatic zones, allowing for production of a variety of vegetables. Vegetable plays an important role in the economy of Bangladesh by increasing the income of the rural people. Vegetables cultivation in Bangladesh is labor intensive and as such it generates lot of employment opportunities for the rural women and rural youth. Thus, vegetables plays a vital role in the poverty elimination in our country and is directly linked with the food security, health and happiness of the people.

Now a days Vegetables are not only used for domestic consumption but also processed into various products like jam, jelly squash, pickles, sauces etc. A substantial quantities are exported in fresh and processed form, bringing much-needed foreign exchange for the country. Vegetables also provide plenty scope for achieving bio-diversity and diversification to maintain ecological balance and also to create sustainable agriculture and create an impact on the national economy in the years to come to achieve the Millennium Development Goal (MDG)/ Sustainable Development Goal (SDG) by the year 2030.

The need for great utilization of available wastelands against the background of dwindling water and energy resources has focused attention to dry land, to arid and semiarid tracts and to horticultural crops which have lesser demands of water and other inputs besides being 3 to 4 times more remunerative than field crops. It is estimated that Bangladesh has 8901 thousand acres of cultivable wasteland (BBS, 2018[c]), which is lying idle can be brought under vegetable crops without curtailing the area under food crops. The country has abundant sunshine throughout the year and widely varied agro-climatic conditions, which offers high potential for successful and profitable commercial vegetables.

Due to tropical and subtropical climates, a variety of fruits and vegetables are grown in Bangladesh. Bangladesh has achieved a significant growth in exporting vegetables. Bangladesh is the 3rd highest vegetable producing country in the world. The export volume of vegetables of Bangladesh was 2937929 kg in the FY 2017-18, whereas it was 2327242 kg in the FY 2016-17. The export of vegetables rose from 409742 thousand BDT in the FY 2016-17 to 609697 thousand BDT in the FY 2017-18 (BBS,

2018[c]). The country exports vegetables to more than 40 countries, though the expatriate Bangladeshis are the main consumers of our exported vegetables. Bangladesh exports vegetables to SAARC country to India rose from 1105788 thousand BDT in the FY 2013-14 to 2312969 thousand BDT in the FY 2017-18; to Pakistan rose from 657133 thousand BDT in the FY 2016-17 to 9136151 thousand BDT in the FY 2017-18 (BBS, 2018[a]). Bangladesh also exporting to other SAARC countries named Srilanka, Nepal, Maldives and Bhutan. This growing trend in export suggests that Bangladesh has significant potential to increase exports of vegetables to international markets. Provided necessary measures are taken to comply with the market specific quality standards for exporting vegetables and that certifications for health and food safety are genuine.

Analysis of the trends in exports of vegetables from Bangladesh in recent years reveals an encouraging sign of export potential for this sector. While Bangladesh exported vegetables worth US$44.67 million in the FY 2008-09, within 5 years it rose to US$ 147.54 million in the FY 2013-14. Different types of vegetables are exported from Bangladesh to more than 40 countries in the world with consumers basically being limited to expatriate Bangladeshi markets. In the FY 2013-14, our export market for fresh vegetables comprised Middle Eastern countries with about 46.3% (Saudi Arabia 22.08%, UAE 7.67%, Kuwait 6.84%, Qatar 6.80%, Bahrain 1.65%, Oman 1.26%), EU region 25.87% (UK 19.09%, Italy 4.83%, and others 1.95%), East and South-East Asian countries 15.07% (Malaysia 12.52%, Singapore 2.55%), South Asian countries (Sri Lanka) 3.67%, and others 9%6 (EPB, 2015)

Total export from Bangladesh during 2015-2016 amounted US Dollar 34257.18 million as against US$ 31208.94 million during 2014-2015 showing an increase of US dollar 3048.24 million i.e. (+) 9.77%. The principal commodities that registered increase in the export earnings during the year under review are Petroleum bi Products 282.99%, Headgear/Cap 130.69%, Wood & Wood Products 67.23%, Umbrella Waking Sticks 27.27%, Ships, boats & floating structures 24.94%, Printed Materials 20.00%, Rubber 16.60%, Other Footwear 15.69%, Building Materials 15.38%, Man Made Filaments & Staple Fibres 15.13%, Handicrafts 14.79%, Computer Services 14.55%, Engineering Products 14.10%, Paper & Paper Products 13.03%, Woven Garments 12.81%, Wigs & Human Hair 11.08%, Chemical Products

10.48%, Knitwear 7.47%, Jute & Jute goods 5.88%, Leather & Leather Products 2.69%, Agricultural Products 1.71%, Specialized Textiles 1.62%, Vegetables 1.07% and Pharmaceuticals 13.04%. (EPB, 2017).

Bangladesh is rich in producing agro-based goods, and has registered substantial agricultural growth in the last three decades through adoption of good agricultural practice (GAPs), modernisation in production and post-harvesting procedures, and use of improved and sustainable technology. Currently, the country is self-sufficient in the production in cereal foodstuff through simultaneous rise in productivity and farming area. Among the other agro products, vegetables play a very important role in supporting the domestic demand for food and ensuring food security. Bangladesh's climate (both tropical and sub-tropical) and soil are suitable for a wide range of vegetables cultivation. Vegetables contribute to 3.12% of the agricultural Gross Domestic Product and gross value added by vegetables was 49393 million BDT in Bangladesh in the FY 2017-18 (BBS, 2018[a]). Total production in vegetables reached 4121 thousand metric tons under vegetable cultivated area 1008 thousand acres in the FY 2017-18. Total cultivated area of Bitter Gourd, Teasel Gourd, Brinjal (Kharif) and Brinjal (Rabi) in Bangladesh are 26490, 12352, 45760 and 80618 acres respectively in the FY 2017-18. Total production of Bitter Gourd, Teasel Gourd, Brinjal (Kharif) and Brinjal (Rabi) in Bangladesh are 57908, 28648, 160145 and 355862 MT respectively in the FY 2017-18. Cultivated area of Bitter Gourd, Teasel Gourd, Brinjal (Kharif) and Brinjal (Rabi) are 446, 1839, 1038 and 1210 acres respectively in the FY 2017-18 in Narsingdi district. Total production of Bitter Gourd, Teasel Gourd, Brinjal (Kharif) and Brinjal (Rabi) are 931, 7581, 3116 and 9404 MT respectively in Narsingdi district in the FY 2017-18 (BBS, 2018[c]).

1.1.8 Introductory note on post-harvest practices in Bangladesh

Reducing post-harvest loses is the main focus of appropriate postharvest management practices. A global agenda under the United Nations Sustainable Development Goal (SDG) 12.3 which targets 50% reduction of per capita global food waste at the retail and consumer levels and food losses along production and supply chains, including post-harvest losses by 2030. SDG 12.3 recognizes that about one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons of food per year worth nearly USD one trillion. These losses account

for about one-fourth of water used in agriculture, total cropland area, and total fertilizer use, and produce about 3.3 billion tons of CO2 emissions yearly. (SDG, 2015)

Unfortunately, a considerable proportion of the harvested produce never reaches the consumers mainly because of postharvest losses. The estimated postharvest losses of fruits and vegetables lie in the range of 20-40% (Wills et al., 2004). Postharvest losses are extremely high in the fruit and vegetable production sectors and are estimated between 5% and 50 % in the tropics and sub-tropics (Salunkhe and Kadam, 1998). Poor handling and inadequate storage facilities as well as lack of appropriate packaging techniques have resulted in the loss of vast quantities and quality of food. Factors affecting postharvest losses of perishable food crop produce vary widely from place to place and are dependent on the systems of cultivation, harvesting, field handling, packaging or packing, transportation, as well as storage or refrigeration and marketing of the produce and there is the need for the farmer to give maximum attention to these processes (Mrema and Rolle, 2002). The adoption of good postharvest practices can extend the useful postharvest life of fruits and vegetables to the extent that the produce quality and condition at harvest permit. Proper postharvest practices ensure that the quality of the produce is preserved until it reaches the consumer and utilized (Olympo and Kumah, 2009).

Ali et al. (2013) revealed that postharvest losses from growers to consumers of Toamto, Brinjal, Cabbage and Cucumber were 31.09%, 32.03%, 24.94% and 24.28% respectively, where it is only 5-25% in developed countries (Kader, 1992). Post-harvest loss can be defined as a measurable quantitative and qualitative loss of a given product at any moment along the post-harvest chain (De lucia and Assemato, 1994). Both qualitative and quantitative losses occur in horticultural commodities between harvest and consumption, hence minimizing post-harvest losses of already produced food is more sustainable than increasing production (Kader et al., 2004). Post-harvest losses include the rotting of produce and damage during storage, packaging and transportation which leads to consumer rejection. Most losses and wastes occur in the latter part of the food chain through excessive processing, packaging and marketing (FAO, 2008).

In marketing aspect research in post-harvest activities specifically prevention of losses at different stakeholder level will provide valuable information and guideline for loss reducing activities, as a result it increases benefits by the increase of quality and prices. To maintain vegetable quality at different levels postharvest operations like harvesting, sorting, grading, packaging, loading, unloading, cooling and storage are hardly used in Bangladesh (Hassan, 2010).

Over the last two decades significant progress has also been made in the production of potato and vegetables. The major problem faced by potato and vegetable production is the volatility in prices and large post-harvest loss, occasionally over 30%. It will be difficult to sustain the growth of production of these high-value and labour-intensive crops unless investment is made in the post-harvest management (a 10% reduction of post-harvest loss would add 10% additional food for the nation), processing and storage to stagger marketing of the crops throughout the year to match the demand that remains stable across the season (GED, 2015).

Postharvest practice referred to best practices and simple, low-cost technologies and innovations to reduce losses, enhance quality and food safety, and increase profitability of producers or farm enterprise. In Bangladesh Hortex Foundation, Bangladesh Fruits, Vegetables & Allied Products Exporter's Association (BFVAPEA) are working with farmers, value chain actor to apply proper post-harvest practices to reduce losses and get quality produces for vegetable exporting. In this study, these practiced was considered as post-harvest practices in Bangladesh. It involves various steps such as harvesting, field handling, packinghouse operations, packaging, storage, transport, handling in markets and at home.

1.1.9 Introductory note on vegetable value chain in Bangladesh

Vegetable Value chain denotes from production to consumption, including varieties with appropriate postharvest practices such as harvesting, packinghouse operations, packaging, storage, transport, processing, handling in markets and at home, value addition. Vegetable value chain means chain of activities from input supply (seed, fertilizer, chemicals) through production, appropriate postharvest activities, marketing to end consumer through proper channel. The actors of the value chain of vegetables

and the incidence of post-harvest practices value chain plays an important role in export market value chain of vegetables.

Moreover, the extent to which solutions are adopted for the necessary harvesting and PHL procedures and application of technologies, varies greatly amongst and even within countries (Prusky, 2011). For a sustainable approach to PHL reduction, a specific approach has to be adopted within the context of the relevant value chain, which is dependent on the scale of operation, the intended market and the returns on investment in which each form of technology is implemented. The adoption of methods and technologies depend greatly on whether value chain actors can see a clear, direct or indirect, (financial) advantage (Hodges et al., 2011). Many development agencies therefore take a multi-sectorial and value chain approach when recommending strategies that affect scale-appropriate improved practices for reducing PHLs (Larsen et al., 2009).

Organic vegetables play a significant role in vegetables value chain. Organic products are products which are produced under requirements of the Organic Foods Production Act (Diver et al., 1999). According to the USDA (1994), organic production systems exclude the use of synthetic fertilizers, pesticides including those used in postharvest handling and growth regulators. Osei-Asare (2009), asserted that there are several motivating factors for organic production worldwide. There is high demand for organically produced agricultural produce on the international market, especially in Europe and the USA; Diver et al. (1999) reported that organically produced agricultural products attract high premium which is estimated 10% to 300%. Kavin et al. (2007) also reported that conventional agriculture has negative impact on the environment and human health as compared to organic production.

Minimizing yield gap is an important issue for Bangladesh to strengthen vegetables value chain. The difference between farm level yield and yield at research stations of crops has remained an issue of concern for many years. It is generally recognized that the actual yield of crops fall short of potential yield by about 30%. Farmers' acceptance of a technology does not necessarily depend on the objective attributes of a technology, but on a range of socioeconomic factors associated with adoption of a technology. Processing industry of horticulture crops including vegetable crops is a

very backbone of horticulture industry taking care of gluts and wastes. Processing can fetch an additional income to the growers and helps in stabilizing the prices with economic returns. The best indicator of the economic contribution of food processing to the food system is the value addition. Value addition is the indicator of the industry's contribution to GDP (Magray et al., 2017).

In Bangladesh, increasing private sector interest/investments in agriculture value chain is an important issue. The challenge is to sustain and further develop the capacity of agriculture to effectively respond to market signals - to ensure that what is grown can be sold at remunerative prices, both to maximize rural income generating opportunities and optimize the use of limited natural resources. The small and marginal farmers need to be supported in producing diversified crop suitable for both markets and household consumption to improve their nutritional status. They also need to be supported in selling their products at remunerative prices by developing linkages with domestic and international markets (GED, 2015).

1.2 Statement of the problem

Vegetables are highly perishable in nature and should be brought to the consuming as quickly as possible in order to satisfy the market demand. Even the retailers should sell the produce as soon as possible to avoid qualitative and quantitative losses of vegetables. Poor post-harvest practices and marketing systems cause huge post-harvest losses of vegetables during harvesting, storage, transport, wholesaling and retailing, particularly when the conditions remain unfavorable and at one stage produce becomes unfit for marketing or human consumption. Farmers are forced to dispose of all that they produce in return for uneconomical prices especially during periods of bumper harvest.

There are number of proven recommended simple post-harvest practices in vegetable production but not all of those are practiced by the farmers properly although they are intelligent and hard working. As a result a wide yield gap between actual achievement and achievable potential in the vegetable farming system still exists. Attainment of highest possible yields in vegetable and thereby maximum profit may be achieved only when farmers are well equipped with required technological knowledge on post-harvest practices and needed inputs and other relevant supports and most authentically

if knowledge and skills are applied correctly in the field. A systematic research is needed to find out the effects of using of post-harvest practices of the commercially important vegetables in Bangladesh for exporting. Identification of technological and knowledge gaps, adoption of proper post-harvest practices, value addition by the farmers and value chain actors in the entire value chain of vegetables is also a critical research question.

It is imperative to commission a longitudinal research study to internalize the dynamics of proper post-harvest practices and its effects on socio-economic patterns of farmers in order to strengthen vegetable export market.

In view of the above considerations, the present study would attempt to find out answers to the following research questions:

1. What are the selected personal, economical, social and professional characteristics of the farmers?
2. What are the extent of effects of using selected post-harvest practices to strengthen vegetable export market as perceived by the farmers?
3. What are the comparatively benefited items of effects as perceived by the farmers by using selected post-harvest practices to strengthen vegetable export market?
4. What are the comparatively highest use item among all of the use items of post-harvest practices to strengthen vegetable export market?
5. What are the problems faced by the farmers in vegetable value chain especially using post-harvest practices to strengthen vegetable export market?
6. What was the contribution of the selected characteristics of the farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market?
7. What was the effects of the selected characteristics of farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market?

1.3 Objectives of the study

The overall objective of the study is to internalize the effects of use of selected post-harvest practices to strengthen vegetable export market. However, to give a shape the research in a manageable and meaningful way, the following specific objectives were formulated by the researcher:

1. To describe some selected personal, economical, social and professional characteristics of the farmers
2. To determine and describe the extent of effects of using selected post-harvest practices to strengthen vegetable export market as perceived by the farmers
3. To compare the item wise effects of using selected post-harvest practices to strengthen vegetable export market
4. To compare the uses of selected post-harvest practices to strengthen vegetable export market
5. To compare the severity of the problems faced in vegetable value chain by the farmers to strengthen vegetable export market and to suggest for mitigating the problems
6. To explore the contribution of the selected characteristics of farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market
7. To explore the effects of the selected characteristics of farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market

1.4 Justification of the study

Post-harvest practices of vegetables is important factor in vegetable value chain for minimization of postharvest losses, nutritional improvement, food and financial security and employment generation. To meet the demand of consumers or exporters it is quite necessary to reduce the postharvest losses as much as possible through using proper post-harvest practices. Therefore, it is urgent to formulate national policy to reduce enormous postharvest losses, to produce safe and good quality vegetables, to develop value chain of vegetables, to increase income through vegetables export and to elevate the rate of per capita consumption of vegetables of the people of Bangladesh.

Reliable statistical data are meager to assess the effects of use of post-harvest practices to strengthen vegetable export market of Bangladesh. However, there are some anecdotal evidences and inadequate reports on effects of use of post-harvest practices to strengthen vegetable export market. Hence, a systematic research was needed to estimate the levels of postharvest losses, to measure the effects of use of post-harvest practices to strengthen vegetable export market those are commercially important vegetables in Bangladesh.

In the past, production-oriented research has received greater attention than post-harvest research to strengthen vegetable export market. There is enormous potential for vegetables for both the domestic and foreign investments if government of Bangladesh addresses critical requirements like international safety and quality standards for this industry. From the foregoing discussion, it is clear that emphasis should be given to formulate national policy to minimize postharvest losses of vegetable, and the government would take initiatives and allocate resources to improve the post-harvest practices, and thereby improve the socio-economic status of the farmers. In addition, reports with adequate details to measure the effects of use of post-harvest practices of at different levels of vegetable value chain in Bangladesh are also scarce.

Therefore, this study has been undertaken to assess the effects of use of post-harvest practices of vegetables in production, marketing and exporting, to identify the comparative use items of post-harvest practices those are responsible to reduce post-harvest losses, to identify problems in vegetable value chain and to suggest for mitigating the problems.

The present attempt to research entitled **"Effects of using selected post-harvest practices to strengthen vegetable export market"** is made to disseminate the outcomes of the research study along with some suitable post-harvest practices to the farmers in order to minimize post-harvest loss, to increase both domestic and global market value, maintain quality and safety of vegetables in vegetable value chain and increase income through export by using post-harvest practices.

1.5 Scope of the study

In this study extent of effects of using selected vegetables post-harvest practices were determined. The findings of the study will be specifically applicable for Belabo, Raipura and Shibpur upazila under Narsingdi district. However, the findings will also have implications for other areas of the country having relevance to the socio-cultural context of the study area.

This would also enable to identify the problems which effects the use of post-harvest practices in entire vegetable value chain. This important aspect would ultimately help the extension providers in formulating appropriate technologies of post-harvest practices and that would be helpful to strengthen vegetable value chain of export market as well as ensure food safety and security.

GO, Value Chain Actors, NGOs and private extension providers are working for development programmes. Some of them are working for sustainable development of agriculture by environment friendly post-harvest practices of vegetables. With the help of the findings of the research, the concerned authority could expect to select appropriate strategies for using the post-harvest activities to reduce postharvest losses of vegetables in Bangladesh.

This study will reveal the effects of using selected vegetables post-harvest practices among the farmers of selected sample area which also influences the socio-economic development that shows a scenario of vegetables value chain regarding export market. Thus, the findings of the study are expected to help the researchers, academicians, professionals, government policymakers, GO and NGO officials, value chain actors, development practitioners and other personnel who are directly or indirectly connected with value chain activities to point in more sophistication in effects of use of post-harvest practices towards return on investment, creating profit, globalization of supply and production, improved eco-friendly postharvest practices. The findings might be supplementing other empirical evidences to different aspects of post-harvest practices in order to build an adequate conceptualization of vegetable value chain.

1.6 Assumptions of the study

An assumption is the supposition that an apparent fact or principle is true in the light of the available evidence (Goode and Hatt, 1952). The researcher had the following assumptions in mind while undertaking this study.

1. The respondents selected for the study were competent enough to answer the queries made by the researcher.
2. The respondents included in the sample were capable of furnishing proper responses to the questions included in the interview schedule and check list.
3. The researcher who acts as interviewer feels comfortable with study areas social Environment.
4. The views and opinions provided by the farmers included in the sample were the representative views and opinions of all farmers of the study area.
5. Data collected by researcher and prejudices that were free from biasness conformity to the objectives of the study.
6. The items, questions and scales used for measuring the variables were reasonably adequate to reflect the respondents' real views and opinions.
7. The data for the study were valid and reliable.
8. The findings of the study were expected to be useful for planning and implementation of various extension programmes for improving ecological and sustainable agriculture of the country.
9. The views and opinions expressed by the respondents may have the same views and opinions of the population of the study areas.

1.7 Limitations of the study

The limitations of the study are stated below-

1. Since the findings were based on the ability of the respondents to recall and on the verbal opinions expressed by them, the objectivity of the study was confined to their ability to recall, and also their sincerity and honesty in providing the needed information.
2. This study was conducted in selected areas of Bangladesh, not the whole country.

3. Factors of the farmers were many and varied, but in the present study only some factors on personal, economic, social and psychological aspects were taken into consideration.
4. There were many and vast areas of effects of using post-harvest practices like cereal crops, cash crops, oil seed crops, spices, etc. But for this study, information related to selected aspects of using of post-harvest practices of vegetables were considered.
5. The focus of the study was made mostly on the extent of effects of use of selected post-harvest practices, its benefits and constraints faced by the farmers in value addition activities, but it was not possible to investigate other issues of the problem in depth.
6. Many of the factors of value chain actors and situations were excluded from the investigation due to the limitations of time, money and other resources.
7. The study has been confined to few areas of Narsingdi district of Bangladesh and data were collected from a small group of respondents.
8. The researcher had to depend on selected respondents and also selected service providers for his required information.
9. Characteristics of the respondents were many and varied, but for this study only few characteristics have been selected.

1.8 Definition of key terms

A concept is an abstract of observed thing, events or phenomenon or in other words, it is a short hand representation of variety of facts (Wilkinson and Bhandarkar, 1977). A researcher needs to clarify the meaning and contents of every term that he uses in his research study. It should clarify the issue as well as explain the fact to the investigator and readers. Certain terms used throughout the study are defined and interpreted below for clarity of understanding:

Age: Age referred to the period of time of a respondent from his birth to the time of interview.

Annual income from vegetable: Annual family income of a respondent generally refers to the total earning by him and other members of his family from different

sources during a year. Annual income from vegetable only includes the earning from vegetable by the respondent.

Annual family income: Annual income referred to the total annual earnings of all the family members of a respondent from agriculture, livestock and fisheries and other accessible sources (business, service, daily working etc.).

Assumption: An assumption is "The supposition that an apparent fact or principle is true in the light of the available evidence" (Goode and Hatt, 1952).

Credit received: Credit received of beneficiaries refers to the degree to which his credit requirement was fulfilled by the amount of credit actually received (whether it was received from institutional or non-institutional sources).

Education: Education referred to the development of desirable Knowledge, skill and attitude in the individual through reading, writing and other related activities. It was measured in terms of actual grades, years of schooling or class passed by a respondent from a formal institute.

Effects: Effects is something that is produced by an agency or cause; result; consequence. Effect may refer to a result or change of something.

Effects of using selected post-harvest practices: Effects of using selected post-harvest practices means the outcome of the extent of use selected post-harvest practices. The effectiveness of using selected post-harvest practices includes how frequently they are used and how effectively they are used in increasing production, income, exporting.

Experience in vegetable cultivation: Experience as a general concept comprises knowledge or skill of something or some event gained through involvement in or exposure to that thing or event. Experience refers to the nature of the events someone or something has undergone. Experience is what is happening to us all the time - as long we *exist*. However, in this study, it was considered as the year of starting from first vegetables cultivation till the year of data collection.

Experience in exportable vegetable cultivation: In this study, it was considered as the year of starting from first exportable vegetables cultivation till the year of data collection.

Exportable vegetable cultivation area: Exportable vegetable cultivation area referred to the area of land under his/her management only for vegetable cultivation. The area was estimated in terms of full benefit to farmers or his/her family.

Family agricultural labour: In this study family agricultural labor means family member engaged in various agricultural activities of exportable vegetable cultivation.

Farmers: The persons who were involved in farming activities are called farmers. They participated in different farm and community level activities like crops, livestock, fisheries, other farming activities etc. In this study, vegetable growers were treated as farmers.

Farming: Farming may be defined as an activity carried out by household or holding that represent managerial units organized for the economic production of crops, livestock and fishes.

GO Official: GO (Government Organization) official contact of a respondent referred to the extent of contact with 4 different GO officials, viz. Sub Assistant Agriculture Officers (SAAO), Agricultural Extension Officer (AEO), Upazila Agriculture Officer (UAO) and District or above level Agriculture Officers. In this study, Department of Agricultural Extension (DAE) has been used as the GO.

Group Communication: Group communication of a respondent referred to the extent of contact with 4 selected group communication media, viz. Focus group discussion, Farmer's field day, method demonstration meeting and result demonstration meeting

Hypothesis: Defined by Goode and Hatt (1952), a proposition this can be put to "a test to determine its validity". It may be true or false, it may seem contrary to or in accord with common sense. However, it leads to an empirical test.

Knowledge: Knowledge is those behaviour and test situations which emphasized the remembering either by recognition or recall of idea, material or phenomenon (Bloom, 1956). In this study postharvest practice knowledge indicated the extent of postharvest practice knowledge of a respondent at the time of interview as evident from his responses to a set of questions related to postharvest management logically scientifically prepared for this purpose. It referred to the amount of understood information possessed by the value chain actors on various aspects of appropriate post-harvest practices of vegetables.

Mass Media Contact: Mass contact of a respondent referred to the extent of contact with 7 selected mass communication media, viz. radio, television, daily newspapers, agricultural leaflet/folder, agricultural booklets/magazines, agricultural film show and agricultural fair.

Middlemen: It refers to the vegetables collector, Foreya, Arotdar, Bepari, Wholesaler, and Retailer in this study.

NGO & Foundation/Association Officials: NGO (Non-Government Organization) & Co-operative officals contact of a respondent referred to the extent of contact with 5 different NGO & Co-operative officials, viz. Unit level Agro based NGO officials, Upazila/ District Level Agro based NGO officials, Central Agro based NGO personnel, Unit level Agro based Co-Operative Society/ Association/ Foundation Officials and Central Agro based Co-Operative Society/ Association/Foundation Officials In this study, Any Agrobased NGO, Hortex Foundation, Bangladesh Fruits, Vegetables & Allied Products Exporter's Association (BFVAPEA) was considered.

Null hypothesis: The hypothesis which we pick for statistical test is null hypothesis (Ho). In this study the null hypothesis is stated that there is no relationship between the concerned variables.

Personal Communication Exposure: Personal contact of a respondent referred to the extent of contact with 6 different types of personal communication exposure, viz. With Neighbor farmers, With relatives engaged in agricultural production, Farmers' group leaders, Agricultural input dealers (seed, Fertilizer, Pesticides etc), Use of call

center to get agricultural related information, Use of mobile apps to get agricultural knowledge.

Post-harvest value chain: Postharvest activities are conducted starting at the farm (harvesting and field handling), packhouse or processing plant, and during transport and marketing. (Acedo et al., 2016).

Post-harvest practice: Post-harvest practices include harvesting, cooling, curing, sorting, grading, handling, storage, processing, wrapping, packaging, transport and the market phase. Post-harvest practice was concerned with maintaining quality from production in the paddock to the vegetables being placed on a plate for consumption.

Problem faced: Problem means any difficult situation which requires some actions to minimize the gap between "what ought to be" and "what is". The term problem faced referred to different problem faced by the value chain actors in vegetable production, harvesting and marketing.

Respondents: Randomly selected people considered to be representable of the population are known as respondents. They are the people from whom a social research worker usually gets most data required for his research. In this study the respondents were the value chain actors such as village level vegetable farmers, Middlemen and Exporter.

Selected post-harvest practices: In this study best practices determined by Hortex Foundation, Bangladesh Fruits, Vegetables and Allied Products Exporter's Association (BFVAPEA) for exporting vegetables from Bangladesh was considered as selected post-harvest practices.

Statistical test: A body of rules which help to take decision regarding accepting or rejection of the hypothesis is defined as test. In this study if a null hypothesis is rejected it is assumed that there is a relationship between the variables.

Training exposure on vegetable post-harvest practices: Training exposure of a respondent referred to the total number of days that the respondent had undertaken different types of training on post-harvest management in his entire life from different

organizations. The measurement of training included from the day of starting training on vegetable cultivation and till the day of data collection.

Vegetable Value chain: Vegetable value chain refers chain of activities from input supply (seed, fertilizer, chemicals) through vegetable production, postharvest activities, marketing and retail.

Value Chain: The concept of value chain was first developed in 1985 by Michael Porter. A value chain is a set of activities that a firm operating in a specific industry performs in order to deliver a valuable product (i.e., good and/or service) for the market.

Value Chain Actors:

- **Input Suppliers:** The initial actor in the value chain who supplies input materials such seeds and seedlings, fertilizer, pesticide to the farmer for vegetable production.Usually the sub-regional (district) and regional (divisional) level traders, district nursery associations, and relevant government departments provide the inputs.
- **Primary suppliers:** Collectors and Farmers are the primary suppliers of the local vegetable produces. Most of the vegetables are harvested by farmers, and collector collected vegetable produces from the farmers.
- **Pikers (Local Traders):** Pikers are the ones usually stationed in the big markets near the plant-growing or collecting areas who buy or take the supply from the collectors and growers.
- **Beparies (traders):** Beparies buy both from pikers and even directly from local collectors or growers through collecting agents or Phariahs. These Beparies are located in relatively important commercial hubs, i.e. in sub-regional (district) and regional (divisional) marketplaces.
- **Wholesalers:** Buy primary-processed vegetable produces from Beparies and also from middlemen (collecting agents). They are stationed at important regional trade hubs and supply to the exporters and processing house. Retailers and consumers also get produces from them.
- **Exporter:** Usually exports good quality vegetables to the foreign country. They procure vegetables from the wholesale market stationed at the regional

(divisional) level. At times they also buy vegetables from Beparies, Retailers and Farmers. Before exporting they give final shape of produces at their pack house according to importer demand.

- **Importer:** Import vegetables from other country from mostly exporter.
- **Consumers:** The final actor in the vegetable value chain, are mostly dependent on retailer to purchase fresh uncut vegetable.

Variable: A variable is something which varies. More specifically, Variables are those attributes of objects, events, things and beings which vary and can be measured. In other words, variables are the characteristics or conditions that can be observed, manipulated or controlled by the researcher (Ray and Mondal, 2011).

1.9 Organization of the study

The study is organized under the following seven chapters:

Chapter 1 - Introduction: Describes the importance of the topic, key issues, objectives, scope and limitations of the study.

Chapter 2 - Review of Literature: A brief review and definition of concepts, economic models and results of the related studies are done.

Chapter 3 - Materials and Methods: Explains the sampling design, method of data collection and tools of analysis used in the study.

Chapter 4 - Characteristics profile of farmers: A detailed discussion of the characteristics profile of the farmers of the study is made to draw specific inferences.

Chapter 5 - Effects of using selected post-harvest practices and related matters: A detailed discussion of effects of use of selected post-harvest practices and related matters of the study is made to draw specific inferences.

Chapter 6 - Contribution and Effects: A detailed discussion of the contributions and effects of selected characteristics of the farmers of the study are made to draw specific inferences.

Chapter 7 - Summary, Conclusions and Recommendations: A brief summary of work done, the salient findings and inferences drawn and their implications for policy are presented.

CHAPTER 2

REVIEW OF LITERATURE

An exertion was made in this Chapter to represent a brief review of related research information which gives a very clear direction to the researcher for selection research issue by identifying research gap. Review of literature forms a linkage between a past and present research works related to problem that helps a researcher to draw a satisfactory conclusion. The researcher made an elaborate search of available literatures to review the findings of past researches in this respect. However, no study was found systematic and directly related to the present study. Therefore, an attempt has been made to review and document closely related literatures in this Chapter available from books, journals, review papers, concept note, daily newspapers, magazines, etc. Relevant literatures have been reviewed and illustrated in different sections as stated below:

2.1 Review of studies relating post-harvest practices

2.1.1 Minimization of post-harvest losses by various technological adoptions

There are two approaches for reducing postharvest losses of vegetables. The first approach for loss reduction is to follow scientific postharvest management of vegetables. Another approach for loss reduction in processing into value added products. Postharvest technology of vegetable crops envisages development of appropriate techniques to reduce postharvest losses to prevent spoilage and help to utilize maximum crops in a nutritious and safe manner.

Magray et al. (2017) stated that varieties with better keeping and processing quality and lesser handling susceptibility should be bred and selected for different vegetables. Virtually all postharvest quality characteristics of horticultural crops are genetically programmed and will naturally vary by cultivar (Kitinoja and Gorny 2009). According to Robinson and Kolavalli (2010), varietal choice influences yields, although there are other conditions that may also influence yield. Clottey et al. (2009) also realized that farmers do not invest in using pure seed but rather re-use seed from

the previous crop, often resulting in lower yields and increasing disease persistence. They attributed this to the fact that there was no incentive in investing in good seed since the fruit prices are the same irrespective of the variety and seed quality.

2.1.2 Post-harvest management practices

Post-harvest losses can be reduced by adopting breeding technologies for longer shelf life, improvement of pre-harvest factors and harvesting techniques, proper methods of handling, marketing, packaging, transportation and storage, development of appropriate processing technology. Post-harvest starts at field level through harvesting. Review related to post-harvest practices stated below-

2.1.2.1 Harvesting

Magray et al. (2017) stated that harvesting should be done at proper stage where there is minimum damage and loss, as rapidly as possible and at minimum cost. Harvesting should be done at early morning or late evening hours (Sumi, 2014). A temperature of above 27^0C during harvesting should be avoided. The products that are to be send to distant markets are harvested in the evening and transported in the cool hours of night whereas commodities for local markets are harvested early morning. Harvesting should not be done immediately after rain or irrigation. Harvesting at optimum stage of maturity ensures maximum quality and yield. Care must be taken to avoid mechanical injury to product (Acedo et al., 2016)

2.1.2.2 Postharvest handling

According to Kitinoja and Gorny (2009), postharvest handling of fresh vegetables has a direct link with its shelf life. They reported that, handling starts right from harvesting and put estimates of losses in developing countries in the range of 20% to 50% tracing causes of losses to the field, during transport and marketing. As a remedy, Kitinoja and Gorny (2009) recommend that when handling fresh produce at its market destination, it is important to avoid rough handling, minimize the number of handling steps and strictly follow a temperature and relative humidity management. Stacking of non-uniform containers should also be done with care to prevent collapse of weaker packages and heavier cartons should always be placed at the bottom of a stack.

2.1.2.3 Cleaning

Magray et al. (2017) stated that the produce is cleaned/washed to remove adhering dirt, dust, insects, mould and spray residues and to improve appearance. Onion, garlic, okra and mushrooms are not washed after harvest. Clean produce has higher market appeal and price than dirty ones. Cleaning reduces microbial contamination, physical damage and transport cost. Produce can be cleaned by trimming fruit stem of tomato or eggplant, roots of leaf mustard, leaves and butt end of cauliflower, cabbage or Chinese kale; in cabbage, retain 3-4 wrapper leaves for protection. Trimming enhances visual quality, reduces deterioration of produce, facilitates handling packaging and transport. Wiping tomato, eggplant or cucumber with clean soft cloth. Washing using clean water to remove adhering soil and other debris. After washing, the produce should be air-dried before packing. While cleaning, sorting can be done. Avoid contact of produce with the soil which is a rich source of spoilage and human pathogens (Rahman et al., 2018; Acedo et al., 2016).

2.1.2.4 Sorting

Sorting of harvested vegetable produce is done to remove diseased, damaged, misshapen, over mature, insect attacked and rotten vegetable. Disease/insect attacked should also be discarded to avoid any spread of infection to normal and healthy vegetable/fruit produce (Magray et al., 2017). In Bangladesh, sorting is practiced for most of the fruits and vegetables to remove damaged, diseased and insect infested produce on the basis of visual observation (Hassan, 2010[a]). However, in the advanced countries different types of sorters are used. The commonly used sorting equipments are belt conveyor, push-bar conveyor and roller conveyor (Kitinoja and Kader 2003).

2.1.2.5 Grading

Grading is one of the important postharvest operations. In Bangladesh, grading is practiced in limited scale based on size. Sumi (2014) stated that grading of vegetables is poorly practiced in Bangladesh. Products are prepared for market without or minimum sorting and grading. Some growers and intermediaries were found to practice grading of their produce only based on visual judgment. There are no scientific methods of grading of grade standards of fruits and vegetables in Bangladesh (Sumi, 2014; Hassan, 2010[a]). In this regard, the introduction of EUREPGAP (common standards for agricultural farm management practices in the

European countries) in the 1990s in Europe would be worth mentioning. Therefore, emphasis must be given to develop GAP (Good Agricultural Practices) for the horticultural produce in Bangladesh not only for export but also for domestic market development in order to ensure quality and safety in the horticultural supply chain. Sizing rings are used based on the size and shape of commodity to manually grade horticultural produce (FAO 1989). Automatic grading of fruits is also a common practice in the developed countries. Automatic rotary cylinder sizer is used to grade fruits in the developed countries (Reyes 1988). Grading is done when the sorted defect-free produce is classified into grades or classes of specific weights or sizes (sizing) and maturity stage. It can be done after sorting or just before packing. Graders must be skillful and provided with adequate lighting and work breaks. Grading aids should be used such as grading tables and color pictures of quality grading and defects (Rahman et al., 2018).

2.1.2.6 Treatment before packing

Rahman et al. (2018) and Acedo et al. (2016) suggested some treatment before packing of vegetables, these are stated below-

- **Sanitizers**

  - Washing in 100-200 ppm chlorine (mixing 4-8 tablespoons of commercial bleach, which has 5.25% sodium hypochlorite or NaOCl, per gallon of water) for 1-3 minutes can reduce microbial load and decay in vegetables. The produce should be air-dried before packing.

  - Calcinated calcium from scallop powder applied as 0.01% solution (0.1 gram scallop powder per liter of water) as 3-5 minute dip enhanced food safety. It was developed as a non-chlorine sanitize because of health concern on chlorine which reacts with organic matter in the produce to form trihalomethanes, a highly carcinogenic compound.

- **Soft rot control**

  BacteriaI soft rot is the most serious problem in cabbages in the humid tropics. Applying 10% alum (10g alum/100 ml water), lime paste (mix lime powder and water at 1:1) or guava leaf extract (mix pure extract and water at 1:1) on the butt end of cabbage reduced trimming loss due to soft rot to 0-20% from 20-44% without treatment, resulting in net return of 0.09-0.16 USD/kg produce based on studies in Cambodia, Laos and Vietnam.

• **Chitosan**

Extracted from local shrimp waste in Cambodia, chitosan at 1% (10g/liter water) as 5-min dip delayed ripening and increased shelf life of tomato by 6 days more and reduced weight loss by 50% lower than that of untreated fruit, giving a net return of 0.20 USD/kg produce.

2.1.2.7 Curing

Magray et al. (2017) stated that Curing is a process of strengthening and wound periderm (skin) of root and tuber crops for a specified period under well-defined conditions of temperature and relative humidity which enhances shelf life of these crops by forming corky layer which protects against water loss and infections by decaying organisms. In bulb crops (onion &garlic).Curing is a drying process for toughening of outer skin and tightening of necks. Potato curing is most effective at about 200c and 80% relative humidity.

2.1.2.8 Waxing

Magray et al. (2017) stated that Waxing is done mainly to minimize water loss and reduce shriveling and wilting to enhance therefore storage life. Wax seals off the stem near the petiole and the pores on the surface of fruits which are the main routes of transpiration. Waxing on the surface of fruit or vegetable product which are the main routes of transpiration. Waxing also improves appearance of produce. Paraffin wax, Carnauba wax and various resins are common types of wax used for preparation of wax emulsion. Waxes are generally applied by foaming, spraying and brushing of which foaming is the best, since it leaves a very thin coating. Some of the common coating materials are semperfresh, prolong and waxol. Vegetables such as tomato, brinjal, sweet pepper, cucumber, muskmelon, carrot etc. are often waxed with a water emulsion by dipping or spraying to retard the moisture loss from the product and at the same time to improve their lustre. This practice of keeping the product sound and lustrous is generally not in vogue in our country.

2.1.2.9 Precooling

Magray et al. (2017) stated that Pre-cooling is the process of removing field heat from the harvested commodity, particularly when harvested during hot weather. Pre-cooling helps in decreasing rate of transpiration and respiration delayed ripening and

easing the load on the cooling system of transport or storage chambers. A precooling method to rapidly remove product heat before cold storage to slow metabolic processes and reduce heat load in the cool chamber.

There are two simple designs; knockdown hydrocooler and overhead hydrocooler. The knockdown hydrocooler uses iced water (5^{o}C) for 10-15 min dipping while the overhead hydrocooler applies the 5^{o}C water with water pump for 15-30 min to bring down product temperature to 10^{o}C. The produce is then drained of excess water before keeping in the storage chamber. Crushed ice is commonly used in packages to cool produce in transit to market. Direct contact of ice can injure the produce. The ice bottle technique is an innovative way to avoid direct contact of ice with the produce. The ice bottles (2 pieces per pack of 25 kg vegetable) are wrapped with newsprint and placed in the package. Temperatures are reduced to 20-25^{o}C from 35-40^{o}C in packs of produce sealed in the afternoon and transported the following morning (Rahman et al., 2018; Acedo et al., 2016).

2.1.2.10 Packaging

Magray et al. (2017) stated that Packaging is a fundamental and necessary for management of highly perishable products. The main role of packaging is to assemble the produce into convenient units for handling and safeguard the produce during distribution, storage and marketing. Packaging materials are selected according to plant characteristics. It improves storage life of produce and provides greater attraction to the produce. Although packaging of perishables is not quite satisfactory in Bangladesh but there are ample scopes to introduce and expand the use of improved packaging to reduce postharvest loss and maintain quality (Rahman et al., 2018; Hassan, 2010[a]). Improved packaging such as plastic crates (stackable and nestable), woven plastic sacks, plastic net bags, and corrugated fibre board cartons should be used instead of the conventional bamboo made packages, which cause substantial damage to the produce during handling. The use of plastic crates in increasing, especially for high value produce. Packages should be strong so as to withstand repeated postharvest handling. Packages should not be very large or voluminous. In Bangladesh, the ‘Bepari’ very often use large and extra-large packages (made of bamboo and jute sacks) with capacity varies from approximately 300-600 kg per package, and there is high risk of damage to the produce during

transportation and subsequent handling. The packages should not be overloaded and the produce should not be held too tightly or too loosely to minimize damage during transportation and handling (Rahman et al., 2018; Hassan, 2010[a]). Packages should have ventilation holes to allow aeration (5% of the surface area per side; Kitinoja and Kader 2003). Different types of packaging accessories like cups, wraps, foam nets, liners and cushioning (shredded papers, leaves, vines, etc.) should be used to protect the produce during transportation and handling (Rahman et al., 2018; Hassan, 2010[a]). The packages should have label with farm logo and other relevant information for value addition and enhanced marketing (Hassan, 2010[a]).

2.1.2.11 Storage

Magray et al. (2017) stated that Storage of vegetable produce an important for improving shelf life avoiding market glut and to ensure supply through the year and increase profit to the producers. The principle aim of storage is to reduce and control transpiration, respiration and disease infection at the same time maintaining life processes at the required level. The important method of storage of perishable horticultural produce include low temperature storage (Hassan et al., 1998; Kader, 2002) modified atmosphere (MA) storage (Hassan and Shipton 2006; Hassan and Shipton 2006[a]; Hassan et al., 2009[a]; Hassan et al., 2009[b]), controlled atmosphere (CA) storage (wills et al., 2004), use of heat treatments (wills et al., 1998; Ledger 2004; Hassan et al., 2004) use of ethylene scavenging chemicals (Jiang et al., 2000; Hofman et al., 2001; Reid 2002; wills et al., 2004) and use of application of recommended fungicides (Ogawa and Manji 1984; Ledger, 2004). Temperature management is the single most effective tool for maintaining postharvest quality by extending the shelf life of fresh horticultural produce. The optimum storage temperature for okra is 7-10^{o}C. Exposure of okra pods to undesirable temperatures will result in bleaching, surface burning, shriveling, excessive softening and desiccation (Cantwell and Trevor, 2002) Temperature also influences the effect of ethylene, reduces oxygen, and elevates carbon dioxide level; affect pathogen spore germination and growth rate. Low temperature reduces the adverse effects of pathogens on fresh produce. For instance, cooling commodities below 5^{o}C immediately after harvest reduces the incidence of Rhizopus rot (Brackett, 1993). The symptoms of chilling injury include surface and internal discoloration (browning), pitting, water soaked areas, off-flavor

development, and accelerated incidence of surface moulds and decay (Mitchel and Kader1992).

2.1.2.11.1 Coolbot cold storage

The Coolbot technology uses a device that overrides the air conditioner's temperature gauge to lower the temperature from 16^{o}C (lowest in an air conditioned room) to 4^{o}C, thereby converting an insulated room and air conditioner into a cool room, substantially reducing the cost of a cool storage environment. Temperatures are maintained at 11-13^{o}C for tropical vegetables and 5-7^{o}C for subtropical produce; shelf life markedly increased (Table 2.1). Do not mix these two types of vegetables because if tropical produce is stored at 5-7^{o}C, they will develop chilling injury while if subtropical produce is stored at 11-13^{o}C, they will have shortened shelf life. The Coolbot maintains lower RH than the recommended one often below 50%, rapidly desiccating vegetables. Providing wet cloth or pan of water, misting with water or keeping produce in MAP can maintain high RH. (Rahman et al., 2018; Acedo et al., 2016)

Table 2.1 Shelf life and weight loss of vegetables stored in the Coolbot storage

Vegetable	Weight loss, %		Shelf life, days	
	Coolbot	Ambient	Coolbot	Ambient
Tomato	5	10-12	18-24	9-12
Eggplant	2	7	14	4
Leaf mustard	5	13	6	0.5

Source- Results were from AVRDC projects in Horticulture Research Center, BARI, Bangladesh; Coolbot temperature was maintained at 12-13^{o}C while ambient temperature varied from 22-35^{o}C. Crop varieties were the commercial ones and samples were at commercial harvest maturity.

2.1.2.11.2 Evaporative cooling storage

Rahman et al. (2018) and Acedo et al. (2016) stated that Cooling by evaporation of water provided in the vicinity of produce. The decrease in temperature is small, usually 1-8^{o}C lower than ambient, but RH increases to more than 90%. It is effective in reducing weight loss. Simple evaporative cooler (EC) structures (also called zero-energy cool chamber as it does not use electricity). They reduced weight loss and improved shelf life of vegetables, resulting in high net returns (Table 2.2).

Table 2.2 Technical and economic benefits of storage of vegetables in evaporative coolers

Vegetable	Weight loss, %	Shelf life, days	Net return, USD/kg (partial budget)
Tomato	1-7 (5-23)	12-15 (7-9)	0.24-0.34
Chili	4-6 (12)	6-8 (3-4)	0.28-0.33
Eggplant	1 (6)	4 (2)	0.20
Leaf mustard	3-15 (15-28)	3 (1)	0.14-0.26
Cauliflower	18 (44)	9 (7)	0.50
Bitter gourd	2 (6)	5 (2)	0.25
Cabbage	6-11 (19-22)	14-22 (8-16)	0.19-0.24
Chinese kale	4 (23)	4 (2)	0.22
Cucumber	3 (10)	4 (2)	0.18
Long bean	4 (12)	3 (1)	0.30
Mustard, aromatic	7 (14)	3 (1)	0.52

Source- Results were from AVRDC projects in Horticulture Research Center (HRC), BARI, Bangladesh; Values in parentheses are responses of produce stored at ambient. The vegetables were commercial varieties at usual harvest maturity.

2.1.2.12 Post-harvest disease control

Magray et al. (2017) stated that Vegetables suffer significantly due to invasion of fungi and bacteria causing disease and resulting in huge postharvest losses. Succulence of vegetables makes them prone to infection by micro-organisms Mechanical injuries, contamination by diseases vegetables, heat and other environmental agencies pre-dispose products to diseases. Post-harvest diseases can be controlled by use fungicides as sprays or dips, incorporated in wax or impregnated in packaging materials.

2.1.2.13 Sprout inhibition

Magray et al. (2017) stated that Tuber and bulb crops (onion & potato) enter a dormant stage at maturity, sprouting starts at the end of dormancy or rest period. Sprouting is a growth resumption process. Sprouting causes huge loss due to respiratory utilization of substrates. Maleic hydrazide (MH-40), 3-Cholorisopropyly-N-Phynle Carbamate (CIPC), Methyl ester of a-napthaleneacetic acid (MENA) and 2,3,4,6 tetra nitro benzene (TCNB) are commonly used as sprout inhibitors. Gamma irradiation at 0.02- 0.15 kGy is widely accepted by many countries for successful sprout inhibition of onion and potato without affecting other quality attributes.

2.1.2.14 Transport

Magray et al. (2017) stated that Transport is an important linkage in postharvest handling, storage and distribution. Transport of horticultural produce from field to the distribution markets is done by rail, truck, airplane and ship. Serious losses take place due to improper handling, careless loading and unloading and use of improper containers. Transport of produce during cool hours of night, use of ventilated, insulated evaporative cooled or refrigerated vehicles ensures preservation of quality. Pallets are used in many developed countries for trading of horticultural produce. It is also important to introduce mechanical loading and unloading particularly with the use of fork lift trucks. In advanced countries refrigerated containers known as reefer containers produce. Sumi (2014) observed that Fruits and vegetables are transported from the growers field to the local assemble markets by van, rickshaw, and by others. Majority of the farmers are transported their products by van 65.9% and about 2.3% by pickup van. Transportation is an important postharvest operation immediately after harvest. The harvested produces are transported from the farm in two phases. Firstly, the produces are transported from the place of harvest to packaging house, where the produce are subjected to different postharvest operations like cleaning, sorting, grading and different postharvest treatments for shelf life extension. Then the produces are packaged. Secondly, the packaged produces are transported to different destinations like distribution center, wholesalers, supermarkets and the retailers. Refrigerated vehicle should be used for transportation of perishable horticultural produce to check transport damage during which recommended temperatures and relative humidity should be maintained. Modified atmosphere packaging should be employed to ensure safety of the commodities during transport. Initial wrapping of produce in perforated or non-perforated plastic bags depending on nature of produce prior to packaging would be used. During transporting vegetables some point needed to considered such as the transport vehicle should not be overloaded, strong and durable packages should be used, rough handling during loading and unloading should be avoided, containers should be aligned properly, vibration damage would be reduced by using plastic crates, liners and padding. Ventilation should be ensured to prevent heat generation during transportation. The packages should be loaded in uniform stacks and braced securely. Workers should not stand upon the produce during loading and unloading. The entire load should be covered with a silver or light-colored canvas (Rahman et al., 2018; Acedo et al., 2016; Hassan, 2010[a]).

2.1.2.15 Marketing system

The changing demand in domestic and international markets for high-value product creates challenges and opportunities. Majority of the horticultural commodities like fruits and vegetables are produced by small and marginal holders, but due to weak and fragmented value-chain, only a small percentage of the produce reaches the urban market (Minten et al., 2010). Appropriate marketing infrastructure is crucial for efficient marketing of fruits and vegetables. Adequate transportation and product handling are also important for the trade of agricultural products and important factors in assuring good prices and poverty alleviation (Khandaker et al., 2009). Investment is required for improved maintenance of road and port infrastructures. In addition to infrastructure development, modification of policies and management are also needed to improve appropriate and timely shipping of perishables (World Bank 2005). Vegetable market is often suffering from several constraints due to their high perishable nature, season market and bulky nature. Assembling and subsequent marketing of the produce is further blocked due to lack of proper storage facilities and quick transport systems. Very often the products are formed to dispose of their produce at a very nominal price where there arises seasonal gluts due to these bottle necks. Another major defect in vegetable marketing is the in involvement of several intermediaries which dominate the trade and get huge profit. Consequently producer's margin in the consumer price becomes very low. It is therefore essential that organized effort for establishing co-operative system of marketing should be enforced at village and district levels to control activity of intermediaries and to regulate the vegetable marketing smoothly and in a streamlined system. Moreover, close co-ordination among Agricultural Marketing Board, National Horticulture Board and state department of agriculture/Horticulture should be ensured to formulate an action plan for regulating marketing of vegetables in a smooth and streamlined way (Magray et al., 2017).

2.1.3 Effects of post-harvest practices

Post-harvest practices specifically reduce postharvest loss. So, proper use of postharvest practices can increase market share and competitiveness of smallholders, stimulate growth of agribusiness industries, such as input suppliers (e.g. packaging, processing ingredient) and logistics providers (e.g. transport, storage). There create an opportunity to generate more employment and income opportunities and stimulate the

rural economy. Promote gender equality as more women are involved in postharvest and marketing operations. Moreover, improve human nutrition and health. Reducing postharvest losses reduces poverty and food insecurity (Rahman et al., 2018; Acedo et al., 2016).

Losses of horticultural produce are a major problem in the post-harvest chain. They can be caused by a wide variety of factors, ranging from growing conditions to handling at retail level. Not only are losses clearly a waste of food, but they also represent a similar waste of human effort, farm inputs, livelihoods, investments and scarce resources such as water (World Resource Institute, 1998). Hassan et al. (2011) observed that post-harvest wastage of 13 selected fruits and vegetables in major growing areas annually costs the country about Tk. 3,442 crore on retail price. Findings also showed that the post-harvest loss ranges from 23.6 to 43.5 percent of the fruits and vegetables that include jackfruit, pineapple, papaya, mango, litchi, banana, orange, cucumber, cauliflower, tomato, okra, brinjal, and red amaranth. Reducing food loss and waste through use of post-harvest practices can save money for farmers, businesses, and households; can feed more people; and can alleviate pressure on climate, water, and land resources (Acedo et al., 2016).

Sumi (2014) revealed that 48.18% farmers sold their vegetables @7-25Tk./Kg.. It is observed that the farmers sold his product 9.09% to the direct market, 81.8% to the middle man and 9.09% sold to the whole sale market. The loss occurs due to unscientific pre-production and post-harvest management as well as lack of appropriate processing and marketing facilities that have adverse impacts on farmer income, consumer prices and nutritional quality of the produce. Sumi (2014) also stated that traders use full sacks and basket of produce as seats while transporting the produce to distant markets. In the wholesale markets of city/town, unloading, reloading and handling are made roughly that cause substantial post-harvest loss. Retail markets are unpaved, open to dust, rain and sun. Sometimes, produce are sprinkled with dirty water while on display.

Mutari et al. (2011) conducted a study on the effects of postharvest handling and storage temperature on the quality and shelf of tomato which revealed that rough handling of tomatoes can result in the destruction of the fruit cell wall leading to

softening and reduced marketability of the produce. Also, high storage temperature can result in increased respiration (3.8 ml CO_2/kg-h) and ethylene production (7.85 µl/kg/h) significantly as well as accelerate ripening (16.80) and weight loss (97.08%). Therefore these conditions (rough handling and high temperature) accelerate the metabolic rate of tomatoes and thereby reduce the shelf life of the produce.

Nasrin et al. (2008) conducted a study on shelf life and quality of tomato and confirmed that tomato treated with chlorine; packed in perforated (0.25%) polyethylene bag and kept at ambient temperature (20-25 °C) & relative humidity 70-90%) condition resulted in substantial reduction in decay and weight losses. The same treatment combination also considerably delayed compositional changes in TSS, total sugar, reducing sugar, vitamin-C, B-carotene, etc. Under this condition, shelf life of tomato extended upto 17days as compared to non-treated and kept in ambient condition without packaging or packed in gunny bag for 7 days only.

2.2 Review of studies relating value chain

2.2.1 Value chain concept

Value chain is a market-oriented approach that can be used to explain and find ways to overcome the trade barriers faced by the rural poor (Mitchell et al. 2009). A "value chain" is the collection of activities that a firm performs in order to design, create, build, and deliver a valuable product or service to the market (Porter, 1985). It describes the full range of value-adding activities that participants undertake to bring a product or service through the different stages of production (involving procurement of raw materials and other inputs, assembly, physical transformation, acquisition of required services such as transportation) to deliver the product to its final consumer (Kaplinsky & Morris,

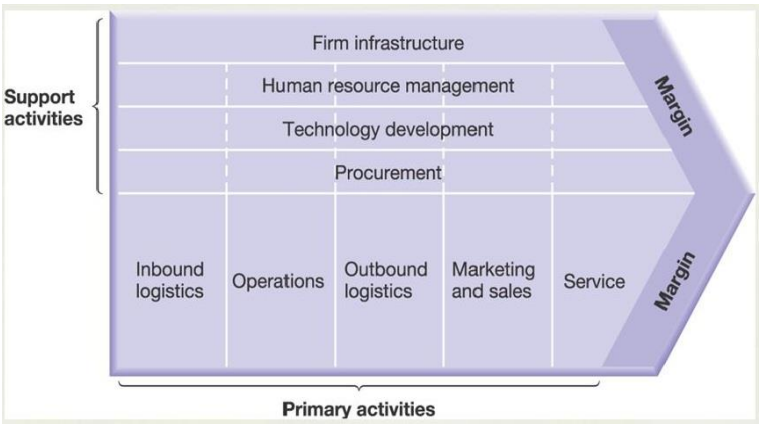

Figure 2. 1 Value chain concept; Porter (1985)

2001; Pietrobelli & Saliola, 2008). Porter (1985) indicated that value can be created by product differentiation through activities and services along every step of the value chain. These activities include production, marketing, distribution, and support to the final consumer (Cunningham, 2001). The product reaches the final consumer having passed through a number of intermediaries, each of whom is said to add value to the final product (Kaplinsky, 2000). Therefore, the total value delivered by the participants at the end is the total sum of the value builds up throughout the chain, and the end customer pays the total price for the final product including a certain amount of profit (Fredendall & Hill, 2001).

Figure 2.2 illustrates the difference between a supply chain and a value chain. The diagram shows the supply chain as a sequence of arrows moving from raw materials to the final customer, passing through different phases. Each phase states an individual firm adding value by performing own value chain activities. However, in this diagram only one firm demonstrates the core function for value addition in the overall supply chain. In the example, marketing, operations management and purchasing are shown as the added value to the chain. In general, each firm in the supply chain network has their own internal functions that add value to the product or service until the end of the supply chain (Fredendall & Hill, 2001).

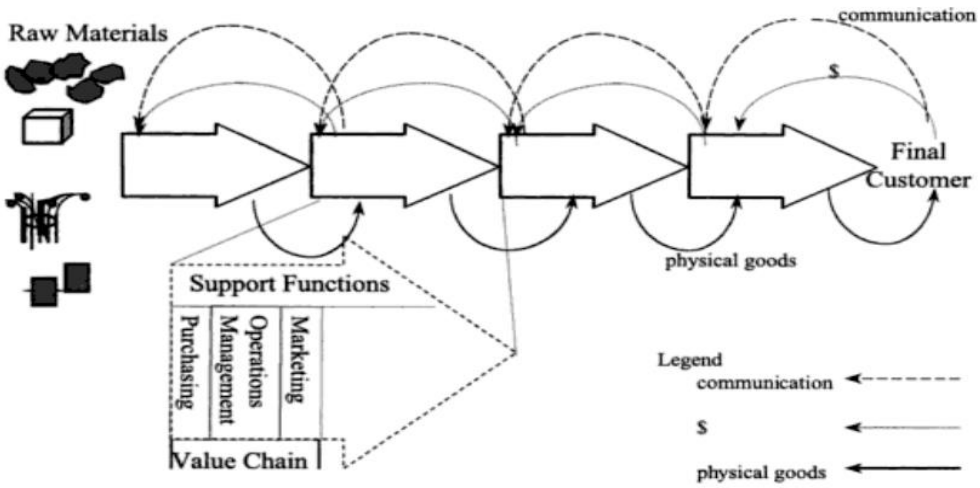

Figure 2. 2 Supply chain and value chain (Fredendall & Hill, 2001)

A successful value chain depends on the relationships between the members and the attitude of the participants; this leads to improvement in efficiencies and greater value creation (Ilyas et al., 2007). The communication from the final consumer is also

important for the successful flow of the physical goods throughout the chain (Fredendall & Hill, 2001). Bammann (2007) stated that there are three important levels of the value chain. These are a) Value chain participants - participants in the chain who deal directly with the product (i.e. producers, processors, traders, etc.). b). Value chain supporters- actors who do not deal directly with the product, but who provide services which add value to the product (i.e. input suppliers, industry associations, researchers). C) Value chain influencers- actors or services which have a big impact or influence on the product (i.e. the regulatory framework, policies, policy makers, and infrastructure).

2.2.2 Value chain study approaches

Value chain analysis (VCA) normally describes the weak linkages and identifies many potential upgrading strategies (Anandajayasekeram and Gebremedhin, 2009). Kaplinsky and Morris (2001) argue that there is no correct way to conduct a value chain analysis; rather, the approach taken fundamentally depends on the particular question. The approach suggested by Kaplinsky and Morris (2001); Van den Berg (2004); Herr and Muzira (2009), Thar (2016); Sarma et al. (2019) in analysing agricultural commodity has been adopted. This comprises four aspects of the value chain analysis. These area a) Value chain mapping- VC maps the actors participating in the value chain (production, distribution, processing, marketing and consumption). This helps to understand the characteristics of the chain participants and the relationships among them, including the flow of product through the chain to its destination of either the domestic or foreign markets. b) Identifying the distribution of benefits of actors in the chain- VCA defines the margins and profits within the chain to determine who benefits from participating in the chain and who requires support to improve performance. This is important in the context of developing countries and agriculture in particular given that the poor are vulnerable to the process of globalization. c) Examining the role of upgrading within the chain- VCA examines the role of upgrading within the chain by identifying the constraints and weaknesses. Upgrading involves improvement in quality, product design which enable the producers to gain higher value or through product differentiation. An analysis of the upgrading process includes an assessment of the constraints that are currently present for the chain actors. And d) Role of governance in the value chain - VCA also describes the governance role which supports participants in the value chain.

Governance in a value chain refers to the structure of relationships and coordination mechanism between actors in the value chain. This is important in improving capabilities and increase value addition in the sector and corrects distributional distortions.

2.2.3 Value chain actors

Craig (2000) divides the actors of the value chain into two categories: upstream and downstream members. An upstream member provides the raw materials or finished goods that are put into a business process. And the downstream members consume the output of the corporation or company business process.

Sarma et al. (2019) conducted a research on tomato value chain in Bangladesh to

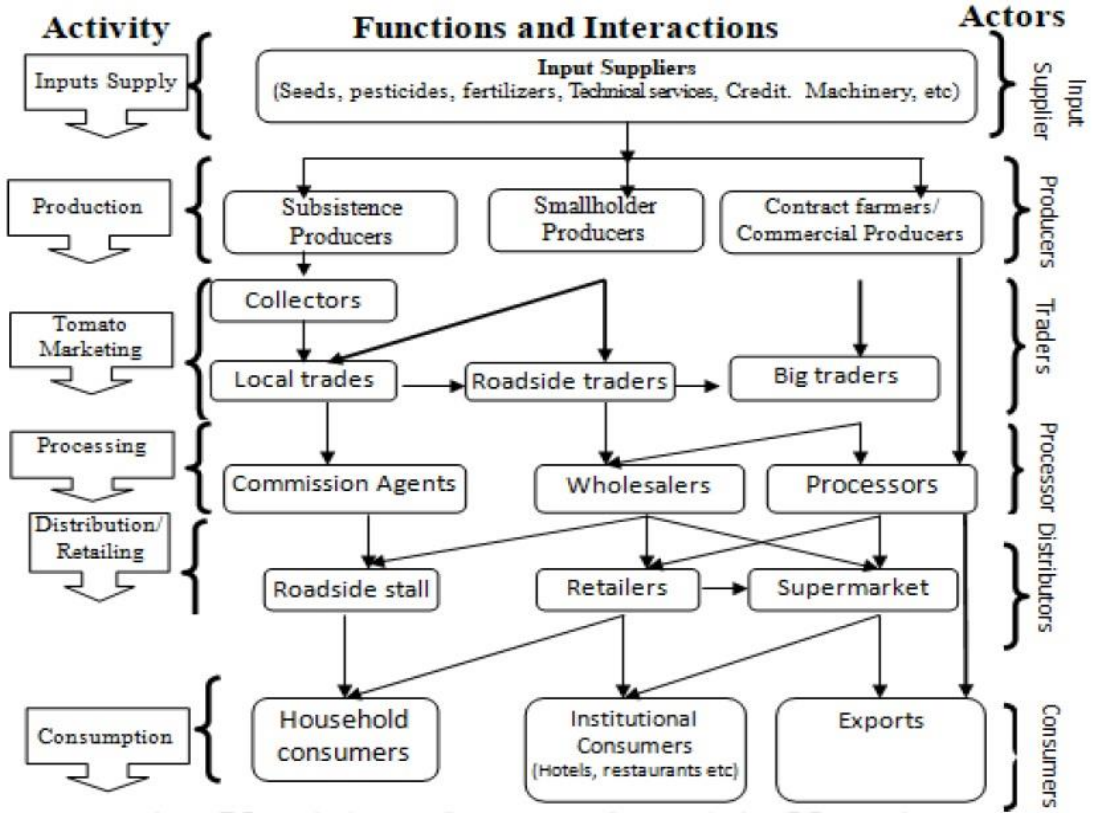

Figure 2. 3 Linkages and flow of tomato value chain in the study area

identify value chain actors such as input supplier, producers, traders, processors, distributors and consumers which was shown in figure 2.3.

Shahidullah (2007) in his study stated that, the upstream value chain members in the Bangladesh medicinal plant industry are comprised of an input supplier, primary producers and processors, brokers and traders, and wholesalers, while in the

downstream are the distributors, herbal doctors, herbal dispensaries and consumers. Manufacturers are in between, performing the core business process to transform materials into products.

2.2.4 Value addition

This value addition to a product is the firm's competitive advantage to establishing the goal to deliver the product with maximum value to the end user for the least possible total cost to the company, thereby maximizing profit (Porter, 1985). Porter (1985) distinguished two important value-adding activities of an organization: primary activities (inbound logistics, operations, outbound logistics, marketing, and sales), and support activities (strategic planning, human resource management, technology development, and procurement).

Value addition is one aspect of marketing that deals with practices that change or transform a primary product into goods that have an additional value. Values adding activities based on their simplicity and difficulties. The simplest are washing, cleaning, grading, bulking and storage; these activities are conducted by the control of farmers. And the complicated are ginning, roasting, refrigerating, milling, cutting, mixing, dehydration, cooking and packaging. These activities are generally undertaken by specialist market chain actors or service providers (Muluken, 2014).

2.2.5 Value chain upgrading

Upgrading of value added in products is related to (potential) demands in a market (Laufenberg et al., 2003). Pietrobelli and Saliola (2008) define the following upgrading options: entering higher unit value market niches, entering new sectors, undertaking new productive functions and in all cases enlarging the technological capabilities of the firms. Trienekens (2011) describes the upgrading of value added production is various forms; upgrading of products (and packaging), upgrading of processes, functional upgrading (insourcing production or distribution functions) and inter-sectorial upgrading (where chain actors introduce value adding processes from other sectors to offer new products or services: e.g. a farmer who enters into tourism activities).

2.2.6 Value chain approach for agricultural products

The concept of agricultural value chain includes the full range of activities and participants involved in moving agricultural products from input suppliers to farmers' fields linking to the next stakeholder and finally to the consumers in order to form a viable chain (Singh et al., 2013). Food value chains comprise all activities required to bring farm products to consumers, including agricultural production, processing, storage, marketing (including exports), distribution, and consumption (Gomez et al., 2011). Value addition results from a wide range of activities; for a typical agricultural value chain; this would involve production, transporting, processing, trading, retailing, and consumption (Anandajaysekeram & Gebremedhin, 2009). Value chains are also channels for which finance (credit, revenues, and capital) moves from consumers to producers; technologies, trainings and assistance are disseminated among producers, traders, processors and transporters; and information on consumer preference and demand are transmitted from consumers back to producers, processors and other service providers (Figure 2.4).

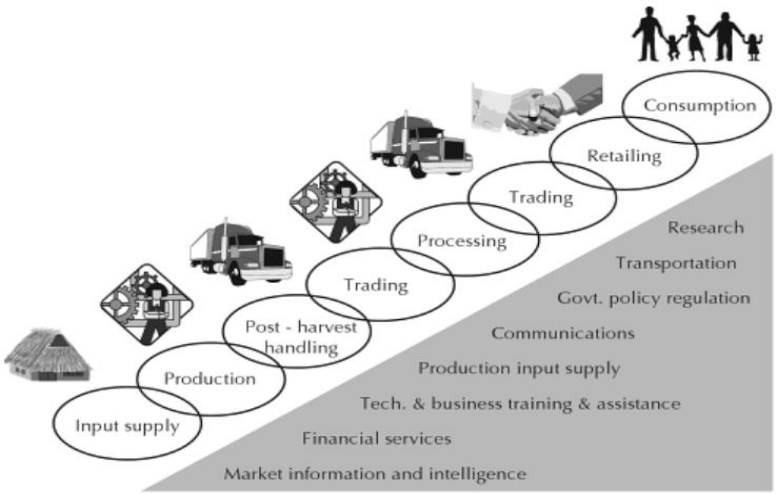

Figure 2. 4 Typical agricultural value chain and associated business development services (Anandjaysekeram & Gebremedhin, 2009)

It has been argued that linking of farmers to the markets through efficient value chains would reduce the use of intermediaries in the chain, and strengthen the value adding activities by better technology and inputs, upgraded infrastructure and processing and exports (Miller and Jones, 2010; Pabuayon et al., 2009). Farmers involved in the supply chain functions have less negotiating power and make little money having to incentive for improving their product and this creates a great deal of risk for the traders who buy only low-quality produce (Emana and Nigussie, 2011). However, Faida (2006) stated that if farmers can negotiate a deal with a trader who buys a

certain amount of high-quality product and the trader in turn has a contract with the end users/ consumers, this makes the chain to function smoothly and develops a sense of benefiting all actors from having a smooth supply of top quality products in a sustainable manner. This function through which each actor is prepared to invest and support other actors to maximize the benefit from the chain performance is known as a value chain.

2.3 Review of studies relating to measurement of effectiveness

Effectiveness of any activities in any aspect has a problem of conceptualization. The term may be variously perceived depending on one's orientation, purpose and field of investigation. Relevant literatures have been reviewed to clarify the concept effectiveness of agricultural development activities and the factors that are likely to influence it. Hence review of relevant literature from other functional fields of management may help develop better understanding about the concept of effectiveness and its determinants (Hasanullah, 1989).

Effectiveness of AICCs was measured using 4 - point rating scale while each aforesaid dimension, score of 3, 2, 1 and 0 were assigned to indicate the extent of effectiveness as 'highly effective', 'moderately effective', 'low effective', and 'not at all effective', respectively. A respondent's obtained scores of all five aspects were added to compute his/her total effectiveness score. A score of '0' indicated 'no effective' while '15' indicated 'highly effective'. Finally, the respondents were categorized into three categories according to their perceived effectiveness scores (Khan et al., 2017). The effectiveness of extension services received was measured on a 3-point Likert scale while each aforesaid dimension, score of 2, 1 and 0 were assigned to indicate the extent of effectiveness as 'very effective', 'effective' and 'not effective', respectively (Oluwasusi et al., 2014).

Khatun (2007) stated that effectiveness of agriculture related TV Programmes for dissemination of agricultural information was the dependent variable of her study. It was measured on the basis of perception of the farmers regarding the effectiveness of agriculture related TV Programmes for dissemination of agricultural information to the farmers. The extent of effectiveness of the programmes was measured by using a 4 point rating scale with four alternative responses of the respondents such as most

effective, effective, less effective and not at all effective. Scores were assigned to these alternative responses as 3 for ‘most effective’, 2 for ‘effective’, 1 for ‘less effective’ and 0 for ‘not at all effective’. By adding the assigned scores of 11 selected types of information of a respondent together, the effectiveness score was obtained. The dependent variable was the effectiveness of extension teaching methods. It was measured on a four point Likert scale: Very effective (3 points), Effective (2 points), fairly effective (1 point) and Not effective (0 point). The maximum score points was 48 while the minimum point was zero (Okunade, 2007)

Rahman (2007) stated that a total of 20 aspects of the effective use of extension teaching methods were identified for assessment. In preparing the scale, the items were written in such a way that the rating person did not face any difficulty in understanding the meaning of items and giving their rating on each item properly. The twenty items of the scale represented twenty major areas of extension teaching methods of the SAAOs. The extent of the effective use of extension teaching methods was measured by using a 4 point rating scale, such as very effective, effective, less effective and not effective and score was assigned to each of the scale 3, 2, 1, 0 respectively.

Effectiveness of mass media in adoption of rice production technologies was the dependent variable of the study. It was measured on the basis of opinion of the farmers how effective the different mass media namely radio, television, newspaper, poster, field day and opinion leader in adoption of rice production technologies considering five stages of innovation decision process like knowledge, persuasion, decision, implementation and confirmation stage. In doing so, farmers were asked to give their opinion according to stage wise extent of effectiveness of mass media. The extent of effectiveness of mass media was measured by using a 4 point rating scale, such as very effective, effective, less effective and not effective and score was assigned to each of the scale 3, 2, 1, 0 respectively (Roy, 2006).

Uddin (2006) stated that “effectiveness of the agricultural development activities of World Vision” was the dependent variable of this study. A total of sixteen selected items were constructed to measure the effectiveness of the agricultural development activities of World Vision as perceived by the World Vision beneficiaries. A five-

point Likert scale was used to measure the opinion about effectiveness of agricultural development activities of the respondent against each item with following responses namely- 'most effective, more effective, effective, less effective and not at all effective with corresponding scores of 4, 3, 2, 1 and 0. Effectiveness of the agricultural development activities of World Vision as perceived by a respondent was measured by summing up all the scores of all the sixteen items of that respondent. The score of effectiveness of the agricultural development activities of World Vision as perceived by the beneficiaries could range from 0 to 64, while 0 indicating no effectiveness and 64 indicates very high effectiveness.

2.4 Review of studies relating to effectiveness

Khan et al. (2017) determined that more than one-third (37%) of the farmers perceived that effectiveness of AICC in technology transfer was high while 38% of the farmers perceived as “moderately effective” and 25% perceived as “low effective”. Aderinto et al. (2017) conducted a study on Effectiveness of Extension Service Delivery and Productivity of Cassava Farmers in Southwestern Nigeria. Result showed that extension agencies were not effectively meeting the aspirations of cassava farmers. Majority (76.1%) of the respondents noted services being rendered to them to be on the low divide of effectiveness while 23.9% rated it to be high. Extension agencies should therefore be more accessible and provide cassava farmers with effective support services for improved productivity.

Rahman (2015) revealed that training programme on mushroom cultivation was medium effective among highest proportion (39.8%) of the trained mushroom farmers, while 32% and 28.2% were found low and high effective respectively. It was found that training programme on mushroom cultivation was effective to the trained farmers from medium to very high level. So, necessary steps need to be taken to enhance the existing activities of mushroom training programme that could improve the sustainable mushroom production as well as the livelihood of the mushroom farmers throughout the country. Afroz (2014) observed that result demonstration program had medium effectiveness (64.40 percent) among the farmers in the transfer of BRRI dhan-50.

Roy (2013) found that about four-fifth of the FFS farmers (91%) perceived FFS for soil and crop management as medium to high effective in Farmer Field School (FFS) for soil and crop management in the study area. Khatun (2007) stated that the score for effectiveness of agriculture related TV programmes in disseminating agricultural information as perceived by the farmers was ranged from 15 to 32 against the possible range of 0 to 27. The mean and standard deviation were 24.32 and 2.70 respectively. An overwhelming majority (85%) of the farmers perceived medium to low effectiveness and 15% perceived high effectiveness of the agriculture related TV programmes in disseminating agricultural information. Rahman (2007) revealed that highest proportion (56 percent) of the respondents had moderately effective use of extension teaching methods compared to 18 and 26 percent having less effective use and highly effective use of extension teaching methods respectively. Roy (2006), reported that 48.18 % respondents belonged to medium effective category while 37.27% highly effective category and 14.55% low effective category. Thus, about 85% respondents opined that mass media had medium to highly effective in adoption of rice production technology in this study area. Majydyan (1996) determined the effectiveness of 11 communication media by farmer's perception on four message characteristics adequateness, understandability, applicability, land persuasiveness etc. Tripathy and Pandey (1967) reported that indirect methods were most effective followed by personal contact, demonstration, group discussion and literature. Radio, film show and meeting were moderately effective. Tours, exhibits and fairs were less effective.

2.5 Review of studies relating to farmers characteristics

Socio-economic variables may influence the accessibility to agricultural information of the farmers (Rehman, 2010). Farmers' characteristics such as education, farm size, annual family income, organizational participation, extension contact, awareness on ICT facilities, access to ICT facilities, knowledge on ICT, and training received on ICT had significant positive relationship with their perceived effectiveness of AICC while age and household size had negative and insignificant relationship with effectiveness of AICC. The influential factors that affecting the effectiveness of AICC were education, annual family income and knowledge on ICT were confirmed by the multiple regression models. This model also explained that these three explanatory variables together explained 81.2% variation in perceived effectiveness of AICC

while knowledge on ICT explained 70% variation in perceived effectiveness of AICC. Lack of operational knowledge of computer, lack of training facilities on ICT, low awareness among rural farmers were identified as the major constraints of using AICC facilities. However, extension policy makers should take into consideration above findings and provides ICT training to the users, developing ICT infrastructure, adequate maintenance of the center facilities etc. that influence to make AICC effective and sustainable. (Khan et al., 2017)

Aderinto et al. (2017) in their study observed that most respondents were males (74.7%), married (97.1%) and members of farmers' association (71.0%) while 59.6% had no formal education. Mean age was 47.9±11.79 years, farm size 4.6±2.03/ ha, family size 6.5±0.46 persons and farming experience 24.7±12.55 years. Majority of the respondents had low access to extension (4.62±1.24), Service effectiveness rating was low for extension (13.3±5.16). Respondents considered irregular visits of extension agents (100.0%) as the most severe constraints to utilization of services. Majority (80.9%) recorded low productivity. Respondents' productivity was influenced by farming experience (β=-.193), family size (β=-0.111), farm size (β = -0.187), membership of association (β=0.112), and production capacity (β=0.096.) Rahman (2015) stated that the correlation analysis indicated that age, cosmopoliteness and extension media contact of the trained mushroom farmers had significant positive relationships with their effectiveness of training programme on mushroom cultivation. Fatalism and problems faced by the trained farmers in mushroom cultivation had significant negative relationships with their effectiveness of training programme on mushroom cultivation. Education, family size, annual family income, peer group influence, organizational participation, innovativeness had no significant relationships with their effectiveness of training programme on mushroom cultivation. Oluwasusi et al. (2014) conducted a study to determine the effectiveness of extension services among food crop farmers in Ekiti State, Nigeria. Results reveal that more than half of the farmers are female (56.6%) and have poor contact with extension services (54.5%). Significant relationship exists between age, sex, level of education, farming experience, farmer's attitude toward extension services, extension services received, and the effectiveness of extension services. Training and increased incentives for extension agents, as well as proper monitoring and evaluation of extension budgets, are pertinent to improving extension service delivery to farmers.

2.6 Research gap of the study

There are lots of researches on use of post-harvest practices on various issues. In the past, production-oriented research has received greater attention than post-harvest research to strengthen vegetable export market. Most of the research were taken to reduce post-harvest loss, knowledge on post-harvest practices. Previously no study was undertaken so far on effects of using selected post-harvest practices to strengthen vegetable export market. In addition, reports with adequate details to measure the effects of use of post-harvest practices of at different levels of vegetable value chain in Bangladesh are also scarce. To the best of the knowledge of the present Researcher, very little attempts were made to determine effects of using selected post-harvest practices to strengthen vegetable export market.

2.7 Conceptual framework of the study

In scientific research, selection and measurement of variables constitute an important task. The hypothesis of a research while constructed properly contains at least two important elements i.e. “a dependent variable” and “an independent variable”. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variables (Townsend, 1953). An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationships to an observed phenomenon. In view of the prime theme of the study, the researcher constructed a conceptual framework which is self-explanatory and is presented in Figure 2.5.

It is assumed that selected characteristics of the farmers (Independent variables) might have contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Dependent variable).

Government initiatives strengthening post-harvest value chain through Agricultural Extension Service Providers (GOs, NGOs and Private sectors). Agricultural Extension Service Providers are servicing the farmers to solve their problems; alternately farmer’s post-harvest activities might be effective to strengthen vegetable export market.

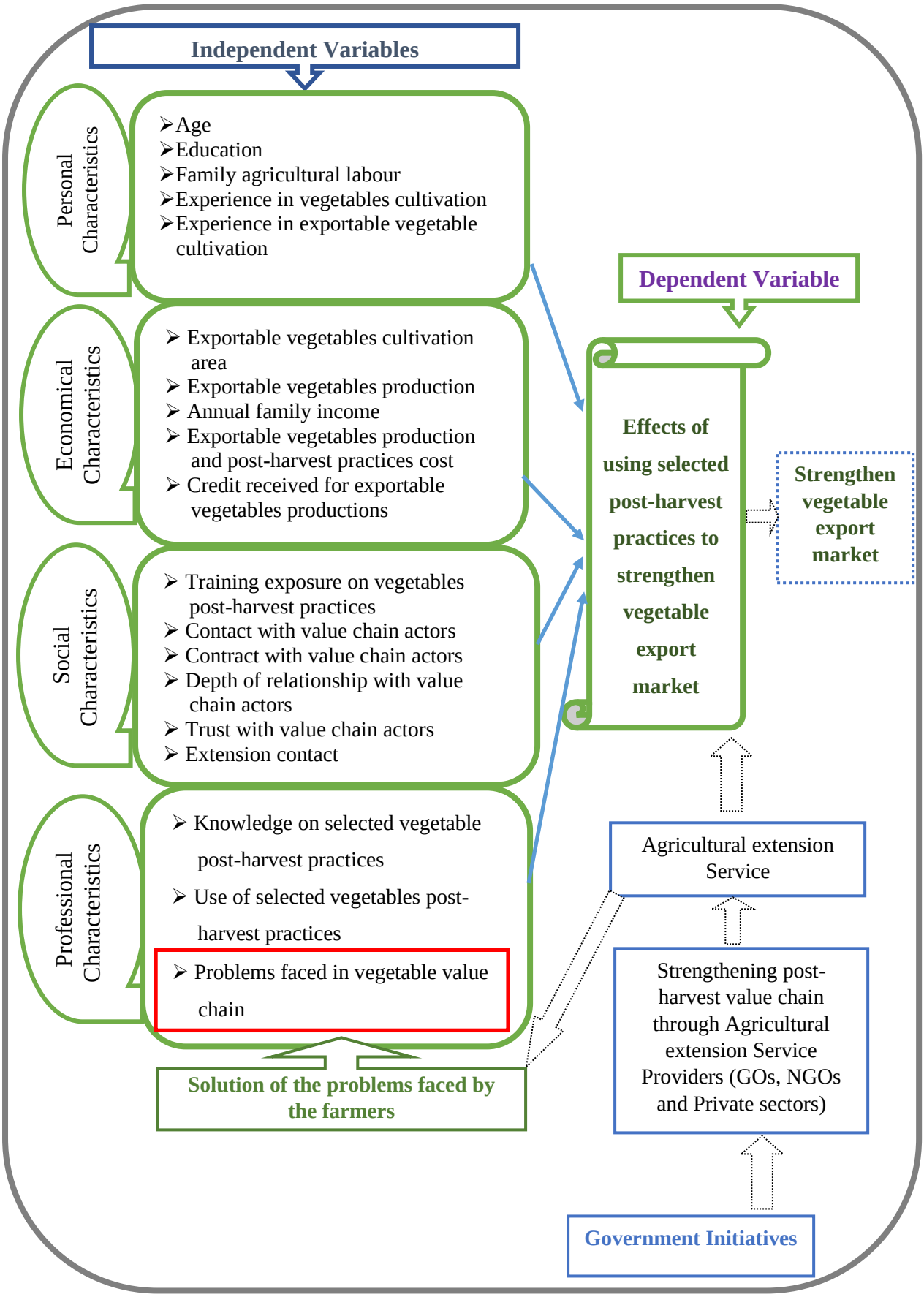

Figure 2. 5 Conceptual framework of the study

CHAPTER 3

MATERIALS AND METHODS

A researcher should work very carefully in formulating methods and procedures. Methodology gives clear direction to a researcher about his works and activities during the whole period of the study. Appropriate procedures for collecting data were taken by the researcher to collect valid and reliable information. Various methods, tools and techniques were used during different stages of this research work and compilation of data. The purpose of this chapter was to describe the setting, methods and procedures used in conducting this study.

3.1 Locale of the study

Four (4) criteria, such as (a) financing organizational activities through contract farming (b) program intensity of associations (c) use of selected post-harvest activities and (d) amount of export vegetables were considered to select Narsingdi district for the study. Bangladesh Fruits, Vegetables and Allied Products Exporter's Association (BFVAPEA) is in actively operating in this district. Three upazilas namely Belabo, Raipura and Shibpur of Narsingdi district were selected purposively based on the intensity of BFVAPEA activity. Farmers' group formed by BFVAPEA are actively producing vegetables like Bitter Gourd, Brinjal and Teasel Gourd and exporting from different villages of different unions of the three upazilas under Narsingdi district. On this consideration these three upazilas of Narsingdi district were selected as the local of the study.

Map of Narsingdi district and separate maps of Belabo, Raipura and Shibpur upazila showing BFVAPEA activity in the unions are presented in Figure 3.1, 3.2, 3.3 and 3.4 respectively.

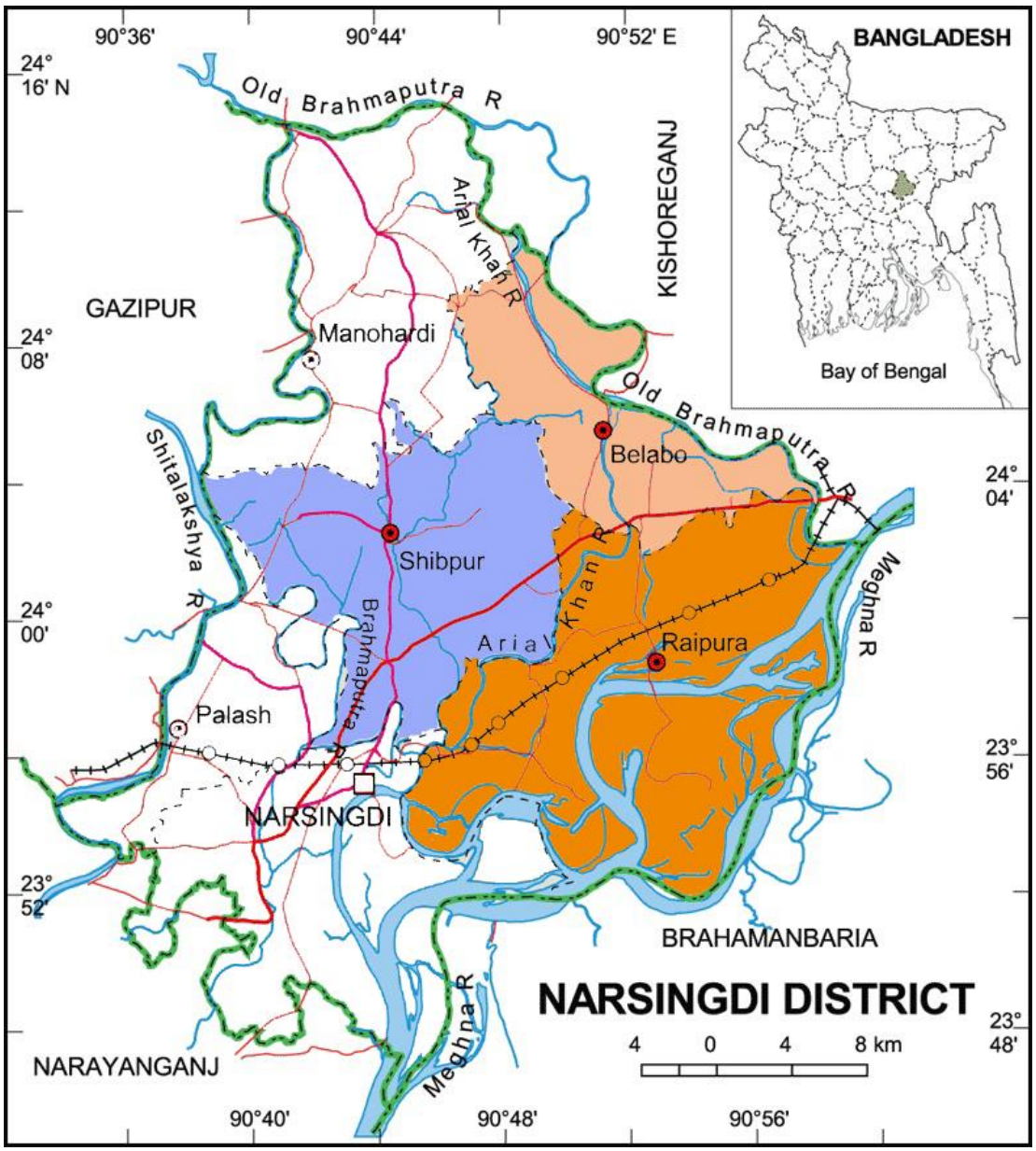

Figure 3. 1 Map of Narsingdi district showing the three selected upazilas

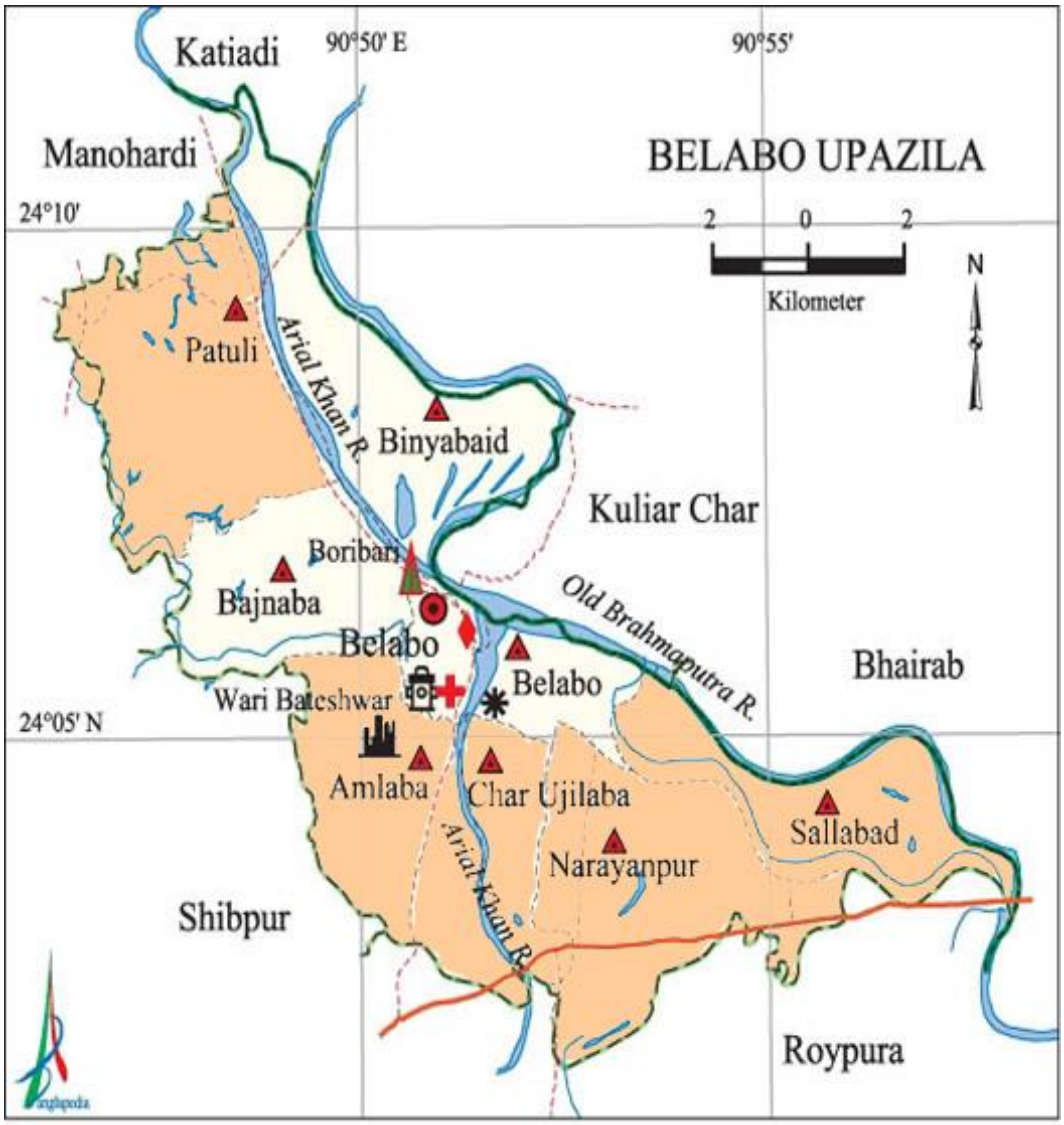

Figure 3. 2 Map of Belabo upazila showing the study unions

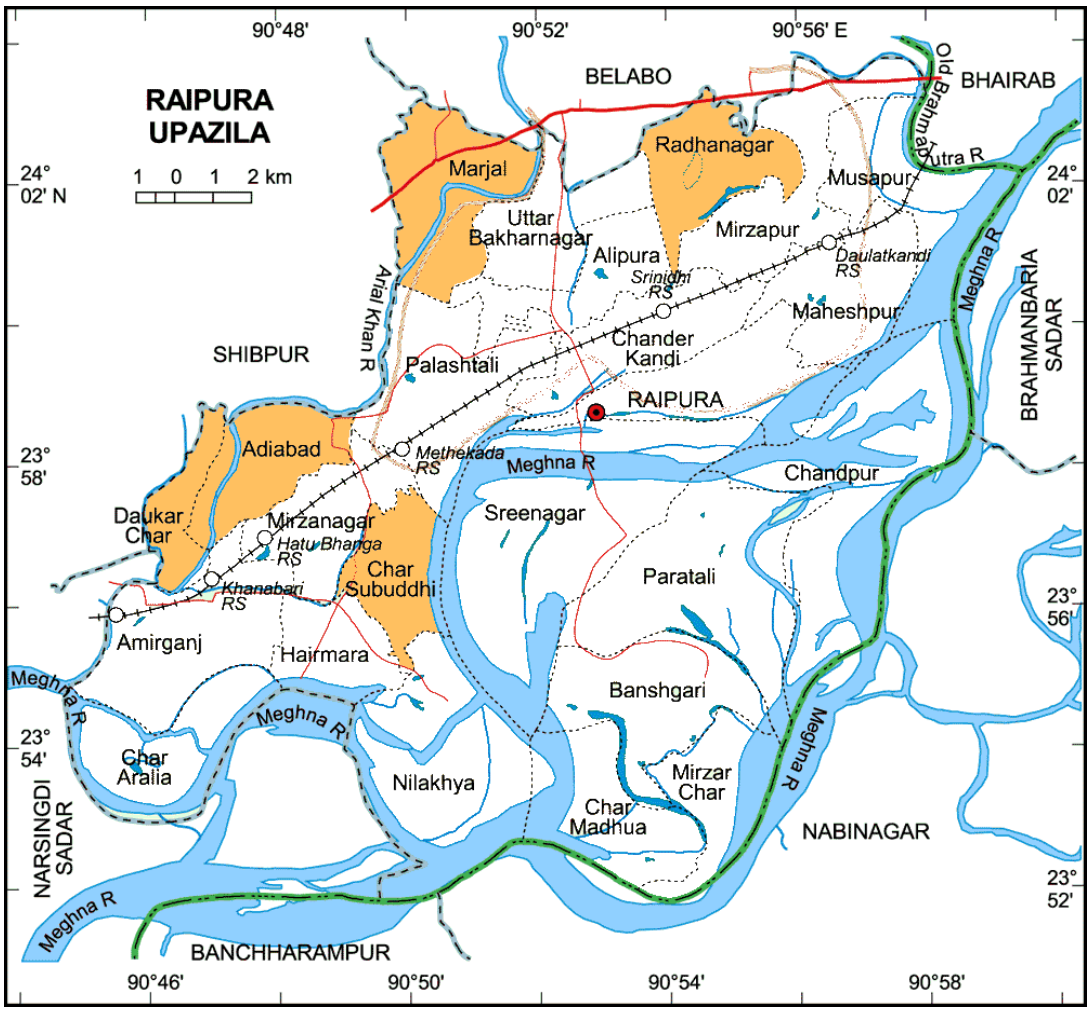

Figure 3. 3 Map of Raipura upazila showing the study unions

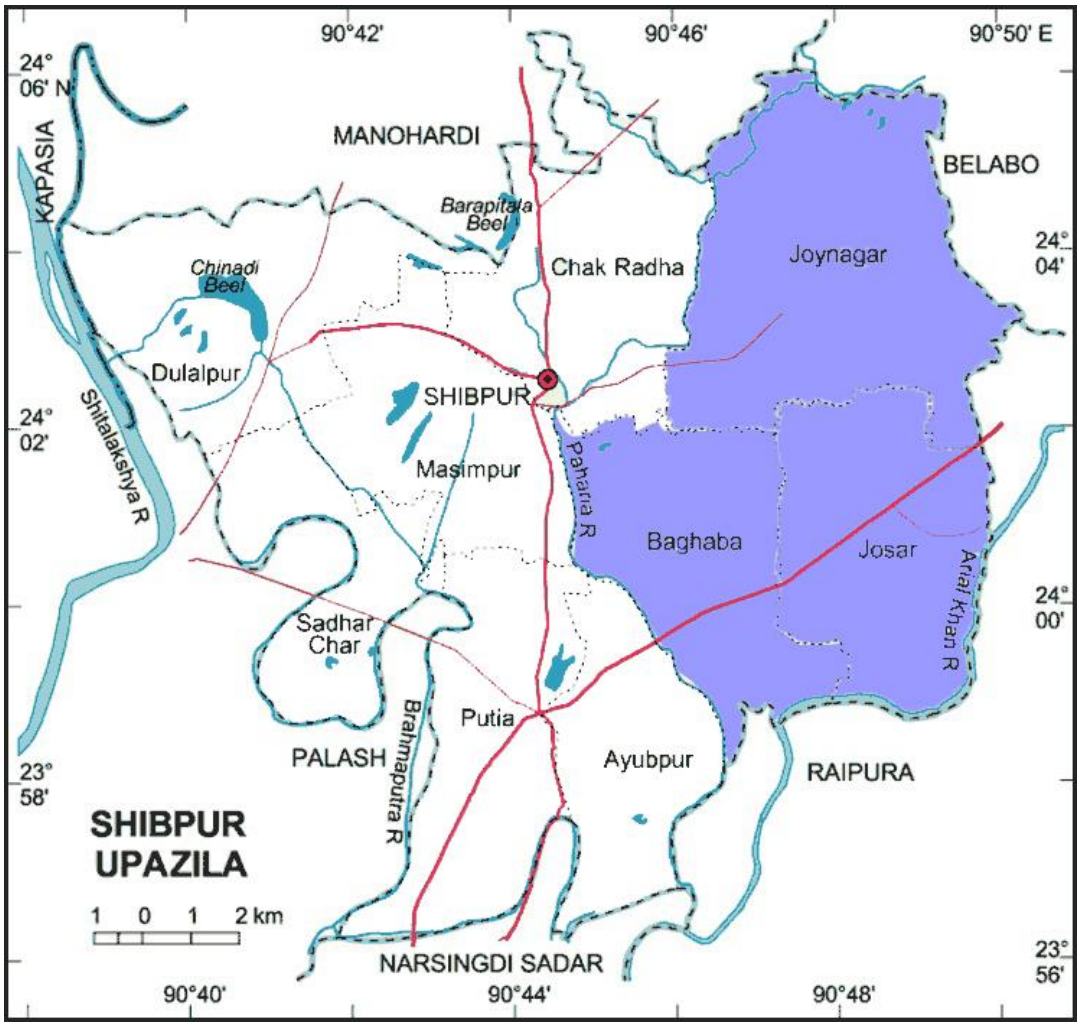

Figure 3. 4 Map of Shibpur upazila showing the study unions

3.2 Population of the study

A total of 717 farmers of the selected three upazilas of Narsingdi district are actively producing and exporting Bitter Gourd, Brinjal and Teasel Gourd with the help of BFVAPEA. These 717 farmers was considered as the population of the study.

3.3 Sample and sampling procedure of the study

The sample size was chosen with a number of factors including the purpose of the study, population size, the risk of selecting a bad sample and the allowable sampling error. There are several methods for determining the sample size but the following formula developed by Yamane (1967) was used to determine the sample size.

$$n = \frac{Z^2 P (1- P) N}{Z^2 P (1- P) + N (e)^2}$$

Where,

n = sample size

N = population size

e = the level of precision (5%)

z = the value of the standard normal variable given the chosen confidence level (e.g. z= 1.96 with a CL = 95%)

p = the proportion or degree of variability = 50%.

By putting the values in the above formula, the sample size was determined as follows:

$$n = \frac{0.25 (Z^2) N}{0.25 (Z^2) + N (e)^2}$$

$$= \frac{0.25x1.96x1.96x717}{0.25x1.96x1.96 + 717x0.05x0.05}$$

$$= \frac{688.6068}{.9604 + 1.7925}$$

$$= \frac{688.6068}{2.7529}$$

$$= 250.1386 \approx 250$$

Sample size calculator developed by Creative Research System (1984) was also used to determine the sample size. By putting a 5% Confidence level, 5 as Confidence interval and 717 as population, the sample size was obtained as 250.

Thus, 250 respondents constituted the sample of the study. Separate list of farmers for Bitter Gourd, Brinjal and Teasel Gourd producing and exporting vegetables of different villages, different unions of each of the three upazilas were collected from BFVAPEA office. Proportionate random sampling technique was used for selecting sample from farmers' group formed by BFVAPEA in different villages of different unions of three selected upazilas under Narsingdi district as shown in Table 3.1. Ten percent of the population was selected through proportionate random sampling procedure to include in the reserve list. A reserve list was maintained to fill in the gaps in case of any respondent in the original list was missing or absent in the time of interview. Finally 91, 75 and 84 farmers were included for Bitter Gourd, Brinjal and Teasel Gourd respectively in the sample.

Table 3.1 Number distribution of the population and sample of farmers and those included in the reserve list

Vegetables	Upazila	Union	Village	Population (Farmer)	Sample Size for study group	Reserve list
Bitter Gourd	Belabo	Sallabad	Sallabad	20	7	1
		Patuli	Vabla	20	7	1
		Char Ujilaba	Baricha	20	7	1
		Narayanpur	Rahimakandi	17	6	1
	Subtotal Belbo			**77**	**27**	**4**
	Raipura	Char Subuddhi	Charsubuddi	15	5	0
		Marjal	Char Marjal	12	4	0
			Marjal	20	7	1
		Daukar Char	Daukar Char	16	6	1
		Radhanagar	Paschim Radhanagar	10	3	0
		Adiabad	Adiabad	16	6	1
	Subtotal Raipura			**89**	**31**	**3**
	Shibpur	Josar	Chaitonya	18	6	1
		Joynagar	Joynagar	20	7	1
		Baghaba	Kharakmara	20	7	1
			Kundarpara	16	6	1
			Brahmondi	20	7	1
	Subtotal Shibpur			**94**	**33**	**5**
	Total Bitter Gourd farmer			**260**	**91**	**12**
Brinjal	Belabo	Sallabad	Sallabad	20	7	1
		Patuli	Vabla	20	7	1
		Char Ujilaba	Baricha	20	7	1
	Subtotal Belbo			**60**	**21**	**3**

Vegetables	Upazila	Union	Village	Population (Farmer)	Sample Size for study group	Reserve list
	Raipura	Char Subuddhi	Charsubuddhi	15	5	0
		Marjal	Char Marjal	12	4	0
			Marjal	20	7	1
		Daukar Char	Daukar Char	16	6	1
		Radhanagar	Paschim Radhanagar	10	3	0
	Subtotal Raipura			**73**	**25**	**2**
	Shibpur	Baghaba	Kundarpara	20	7	1
			Brahmondi	17	6	1
			Kharakmara	25	9	1
		Joynagar	Joynagar	20	7	1
	Subtotal Shibpur			**82**	**29**	**3**
	Total Brinjal farmer			**215**	**75**	**8**
Teasel Gourd	Belabo	Char Ujilaba	Baricha	20	7	1
		Narayanpur	Rahimakandi	17	6	1
			Baterchar	14	5	0
			Uttar Rahimakandi	12	4	0
			Jallabaj	20	7	1
			Botibandha	18	6	1
		Amlaba	Amlaba	20	7	1
	Subtotal Belbo			**121**	**42**	**5**
	Raipura	Adiabad	Adiabad	16	6	1
			Saherchar	10	3	0
	Subtotal Raipura			**26**	**9**	**1**
	Shibpur	Josar	Chaitonya	18	6	1
			Debalertek	20	7	1
		Baghaba	Kharakmara	17	6	1
			Kundarpara	20	7	1
			Brahmondi	20	7	1
	Subtotal Shibpur			**95**	**33**	**6**
	Total Teasel Gourd farmer			**242**	**84**	**12**
Grand Total				**717**	**250**	**32**

3.4 Data collecting instrument

A draft interview schedule was prepared keeping in mind the objectives of the study. Direct questions and different scales were kept in the questionnaire to get the desired information. The principal method employed was the face-to-face personal interview using the interview schedule for the study. The draft interview schedule was pretested with 36 farmers by taking 4 farmers for each of 3 vegetables from each of 3 upazilas. Final interview schedule was prepared after necessary addition, deletion, corrections and modification based on pre-test results. English version of the interview schedule is shown in Appendix-I.

3.5 Data collection procedure

Data were collected by the researcher himself through face to face interviewing of the selected sample farmers by using Bengali interview schedule. The data were collected during the period from August 01, 2019 to November 31, 2019. Researcher has visited every selected sample respondent with the help of the BFVAPEA personnel with prior appointment. In case of non-availability of the sample farmers, the researcher paid make-up visit to their convenient date and time. However, it was not possible to collect data from 8 farmers in the original sample due to their unavailability at the time of interview despite several attempts to contact them. Therefore, the researcher had to collect data from 8 farmers of the reserve list.

3.6 Variables of the study

The variable is a characteristic, which can assume varying, or different values in successive individual cases. Measurable characteristics of a population that may vary from element to element either in magnitude or in quality are called variables (Ahmed et al., 2004). Ezkiel and Fox (1959) defined a variable as any measurable characteristics which can assume varying or different values in successive individual cases. The success of a research to a considerable extent depends on the exact selection of the variables. The variables of the study had been selected after a thorough searching of literatures and discussions with the Advisory Committee Members, and relevant experts of both home and abroad. There are two types of variables in any relationship study, viz. independent variable and dependent variable. An independent variable is the presumed cause of the dependent variable, the presumed effect (Kerlinger, 1973). A causal (Independent) variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the causal variable (Townsend, 1953). The dependent variable is often called the criterion or predicted variables, whereas the independent variable is called the treatment, experimental and antecedent variable (Dalen, 1977).

In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literatures to widen this understanding about the natures and scopes of the variables relevant to this

research. At last the researcher had selected 19 Independent (Causal) variables and one dependent variable. The 19 selected characteristics of the farmers were considered as independent variables of the study and these were (a) personal characteristics - age, education, family agricultural labour, experience in vegetables cultivation, experience in exportable vegetables production, (b) economical characteristics - exportable vegetables cultivation area, exportable vegetables production, annual family income, exportable vegetables production and post-harvest practices cost, credit received for exportable vegetables produces, (c) social characteristics - training exposure on vegetables post-harvest practices, contact with value chain actors, contract with value chain actors, depth of relationship with value chain actors, trust with value chain actors, extension contact and (d) professional characteristics - knowledge on selected vegetables post-harvest practices, use of selected vegetables post-harvest practices and problems faced in vegetable value chain. Effects of using selected post-harvest practices to strengthen vegetable export market constituted the dependent variable of the study. The variables of the study were operationalized through direct questions, developing relevant scales by the researcher and scales developed by others as shown in Table 3.2.

Table 3.2 Summarized operationalization of the variables of the study with measuring unit

Variables	Measuring unit	Operationalization
Independent variables		
Personal characteristics		
1. Age	Actual years	Direct question
2. Education	Schooling years	Direct question
3. Family agricultural labour	Number of family member	Direct question
4. Experience in vegetables cultivation	Experience in year	Direct question
5. Experience in exportable vegetables production	Experience in year	Direct question
Economical characteristics		
1. Exportable vegetables cultivation area	Hectare	Direct question
2. Exportable vegetables production	Kg	Direct question
3. Annual family income	‘000’ BDT	Direct question
4. Exportable vegetables production and post-harvest practices cost	‘000’ BDT	Direct question
5. Credit received for exportable	‘000’ BDT	Direct question

Variables	Measuring unit	Operationalization
vegetables production		
Social characteristics		
1. Training exposure on vegetables post-harvest practices	Number of days	Direct question
2. Contact with value chain actors	Scores	Scale developed for this study
3. Contract with value chain actors	Scores	Scale developed for this study
4. Depth of relationship with value chain actors	Scores	Scale developed for this study
5. Trust with value chain actors	Scores	Scale developed for this study
6. Extension contact	Scores	Scale used by Ali (2008) and slightly modified for this study
Professional characteristics		
1. Knowledge on selected vegetable post-harvest practices	Scores	Scale developed by Coombs (1950), Bloom (1956), Perry and Michael (1951), Mehta (1958) and used by Singh (1981), Sagar (1983), Ray and Bora (1991), Choudhury (1998), Islam (2000) and Ali (2008)
2. Use of selected vegetables post-harvest practices	Scores	Scale developed for the study
3. Problems faced in vegetable value chain	Scores	Scale developed for this study
Dependent variable		
Effects of using selected post-harvest practices to strengthen vegetable export market	Scores	Scale developed with the help of Khan et al. (2017), Khatun (2007), Okunade (2007), Roy (2006) and Majydyan (1996) with slight modification

3.7 Measurement of independent variables

It was pertinent to follow a methodological procedure for measuring the selected variables in order to conduct the study in accordance with the objectives. The procedures for measuring the independent (causal) variables are described below:

3.7.1 Personal characteristics

3.7.1.1 Age

Age of a respondent was measured in terms of years from his/her birth to the time of interview. A score of one (1) was assigned for each year of age. Question regarding this variable appears in item no. 1 in the interview schedule (Appendix-I).

3.7.1.2 Education

Education was measured in terms of one's year of successful schooling. One (1) score was given for passing each year in an educational institution. Mazumder (2014), Ali (2008), Moin (2008) and Amin (2004) followed this procedure for measuring education score. For example, if the farmer passed the H.S.C. examination, his education score was given as 12; if farmer passed the final examination of class Eight (VIII), his education scores was given as 8. If the farmer did not know how to read and write, his education score was given as '0' (zero). A score of 0.5 (half) was given to that farmer who could sign his/her name only. A score of one (1) was assigned for those farmer who learnt only reading and writing on simple basis from the adult learning center (Ali, 2008). Question regarding this variable appears in the item no. 2 in the interview schedule (Appendix-I).

3.7.1.3 Family agricultural labour

Family agricultural labor means the number of family members engaged in various agricultural activities of exportable vegetable cultivation. Agricultural labour or worker means a person who is employed in agricultural work for wages on the basis of daily, monthly or yearly contract or on a contract of doing any specific work (Bangladesh labour Act, 2006: Act 42 Section 2, subsection 8a). Child means a person who has not completed his fourteenth (14) year of age (Bangladesh labour Act, 2006, Act 42, section 2, subsection 63), Adolescent means a person who has completed his fourteenth(14) year but has not completed his eighteenth (18) year of age (Bangladesh labour Act, 2006, Act 42 section 2 subsection 8), Adult means a person who has completed his eighteenth (18) year of age (Bangladesh labour Act, 2006, Act 42, section 2 subsection 36). A score of 1, 1/3 and 2/3 were assigned for adult, adolescent and child member who engaged in agricultural farming practices. The scores against the different age levels of his family members were added together to determine

family agricultural labour of the respondent. Questions regarding this variable appears in the item no. 3 in the interview schedule (Appendix-I).

3.7.1.4 Experience in vegetables cultivation

Vegetables cultivation experience of the respondent was measured by the number of years a respondent engaged in vegetable cultivation. The measurement included from the year of starting of first vegetables cultivation till the year of data collection. A score of one (1) was assigned for each year of experience. Islam (2006) used this type of measurement. Question regarding this variable appears in the item no. 4 in the interview schedule (Appendix-I).

3.7.1.5 Experience in exportable vegetables production

Experience in exportable vegetables production of the respondent was measured by the number of years a respondent engaged in exportable vegetable production. The measurement included from the year of starting of first exportable vegetables cultivation till the year of data collection. A score of one (1) was assigned for each year of experience. Question regarding this variable appears in the item no. 5 in the interview schedule (Appendix-I).

3.7.2 Economical characteristics

3.7.2.1 Exportable vegetables cultivation area

Exportable vegetables cultivation area was measured by the area of land on which the farmer cultivated exportable vegetables. It was measured in Hectare. Question regarding this variable appears in the item no. 6 in the interview schedule (Appendix-I).

3.7.2.2 Exportable vegetables production

Exportable vegetables production of a farmer was measured by the amount of vegetable production of the farmer from his/her exportable vegetables cultivated area. The unit of measurement was in ‘Kg’ Question regarding this variable appears in the item no. 7 in the interview schedule (Appendix-I).

3.7.2.3 Annual family income

Annual family income referred to the total earnings of a farmer and the members of his/her family from agricultural and non-agricultural sources (business, services, daily labour etc.) during the whole year. It was measured by the total earning of all the members of the family. Annual family income was expressed in '000' BDT i.e. One (1) score was given for BDT 1000 annual family income. For example, a score of forty five (45) was given to a farmer whose annual income was BDT 45,000. Questions regarding this variable appears in the item no. 8 in the interview schedule (Appendix-I).

3.7.2.4 Exportable vegetables production and post-harvest practice cost

Exportable vegetables production and post-harvest practice cost of a farmer was measured in '000' BDT. One (1) score was given for BDT 1000 cost for exportable vegetables production and post-harvest practice. This includes vegetables cultivation cost and post-harvest value chain cost at different level of post-harvest practices. For example, a score of forty (40) was given to a farmer whose exportable vegetables production and post-harvest practice cost BDT 40,000. Questions regarding this variable appears in the item no. 9 in the interview schedule (Appendix-I).

3.7.2.5 Credit received for exportable vegetable production

Credit received from different sources for exportable vegetables production of a farmer was measured in 'thousand' BDT on the basis of total credit received from different sources to produce exportable vegetables by the farmer. One (1) score was given for BDT 1000 credit received for exportable vegetable production. For example, a score of thirty five (35) was given to a respondent whose received credit for exportable vegetables production was BDT 35,000. Questions regarding this variable appears in the item no. 10 in the interview schedule (Appendix-I).

3.7.3 Social characteristics

3.7.3.1 Training exposure on vegetables post-harvest practices

Training exposure on vegetables post-harvest practices refers to the extent of farmers' participation in formal training programs offered by different organizations and agencies time-to-time on vegetables post-harvest practices. It was considered through the respondents' total number of days of participation in training program. A score of

one (1) was assigned for each day of training experience. A zero (0) score was assigned for no training exposure. Ali (2008) used this type of measurement. Questions regarding this variable appears in the item no. 11 in the interview schedule (Appendix-I).

3.7.3.2 Contact with value chain actors

Contact with value chain actors of a farmer was measured by asking his/her frequency of contact with eight (8) types of value chain actors. Question regarding this variable appears in the item no. 12 in the interview schedule (Appendix-I).

A farmer was asked to indicate his frequency of visit against each of the value chain actors along with 8-point continuum: "Always", "Once in a day", "Once in a week", "Once in a fortnight", "Once in a month", "Once in a quarter", "Once in a year" and "No contact" and weights assigned to these responses as 7, 6, 5, 4, 3, 2, 1 & 0 respectively. The total score of a respondent was determined by adding the weights for responses against all the items. Thus, the possible score of a farmer could range from 0 to 56, where 0 indicated no contact and 56 indicated highest level of contact.

3.7.3.3 Contract with value chain actors

Contract with value chain actors of a farmer was measured by asking what kind of contract he/she made with the value chain actors. Score was assigned as 3, 2, 1 and 0 for MoU/Deed, Written contract, Verbal contract and No contract respectively. Question regarding this variable appears in the item no. 13 in the interview schedule (Appendix-I).

A farmer was asked to indicate his kind of contract with value chain actors such as MOU/Deed, Written contract, Verbal contract and No contract. Weightages assigned to these responses were 3, 2, 1 and 0 respectively. The total score of a farmer was determined by adding the weights for responses against all the items. Thus, the possible contract with value chain actors' score of a farmer could range from 0 to 3, where 0 indicated no contract and 3 indicated formal MOU/Deed with value chain actors.

3.7.3.4 Depth of relationship with value chain actors

Depth of relationship with value chain actors of a farmer was measured by asking his/her nature of depth of relationship with eight (8) types of value chain actors. Question regarding this variable appears in the item no. 14 in the interview schedule (Appendix-I).

A farmer was asked to indicate his extent of depth of relationship against each of the items along with a 6-point rating scale: very high, high, substantial, little, very little and not at all. Weightages were assigned to these responses as 5, 4, 3, 2, 1 and 0 respectively. The weights of all responses with all value chain actors was summated together to obtain the extent of depth of relationship with value chain actors. Thus, the depth of relationship score of a farmer could range from 0 to 40 where 0 indicated the no relationship and 40 indicated the highest level of relationship with value chain actors.

3.7.3.5 Trust with value chain actors

Trust with value chain actors of a respondent was measured by asking his/her level of trust with eight (8) types of value chain actors by using 6 point rating scale. Question regarding this variable appears in the item no. 15 in the interview schedule (Appendix-I).

A farmer was asked to indicate his level of trust against eight (8) types of value chain actors by using 6 point continuum: very high, high, substantial, little, very little and no trust. Weightages were assigned to these responses as 5, 4, 3, 2, 1 and 0 respectively. The weights of all responses was summated together to obtain the level of trust with value chain actors. Thus, the level of trust score of a respondent could range from 0 to 40 where 0 indicated the no trust and 40 indicated the highest level of trust with value chain actors.

3.7.3.6 Extension contact

Extension contact of a respondent was measured by the extent of contact with 26 selected agricultural extension media. A scale was developed arranging the weights as 3, 2, 1 and 0 for the responses for regularly, occasionally, rare and not at all contact with these agricultural extension related media respectively. Scale developed by Ali

(2008) for measuring extension contact was used with slight modified by the present researcher for measuring extension contact of the farmers. Logical frequencies of contact was assigned for each type of responses for each item as mentioned in the item no. 16 of the interview schedule (Appendix-I).

Finally extension contact score of a farmer was computed by summing all the scores for contact with 26 types of selected extension media by that respondent. Thus, extension contact score of a farmer could range from 0 to 78 while '0' indicating no extension contact and '78' indicating highest extension contact.

3.7.4 Professional characteristics

3.7.4.1 Knowledge on selected vegetable post-harvest practices

Knowledge as defined in this study included 'those behaviour and test situations which emphasized the remembering either by recognition or recall of ideas, material or phenomenon' (Bloom, 1956). This variable indicated the extent of post-harvest practice knowledge of the respondents at the time of interview as evident from their responses to a set of questions logically and scientifically prepared for this purpose. The steps followed in developing the scale for knowledge test for this study are discussed below:

Collection of items: The content of knowledge test is composed of questions called items. Items for the test were collected from different sources, such as, literatures; agricultural scientists of Agronomy, horticulture, soil science, agricultural chemistry, entomology, plant pathology, agribusiness management, agri-economics, agro-forestry, environmental science, and agricultural extension education of home and abroad; extension personnel; NGO personnel; Bangladesh Fruits Vegetables & Allied Products Exporter's Association (BFVAPEA), Hortex Foundation, vegetables exporters, vegetable value chain actors, progressive farmers and researcher's own experience. The questions were designed to test the post-harvest practice knowledge of the farmers. The items were collected and prepared in relation to post-harvest practices of vegetable to strengthen value chain. Fifty Four (54) items were collected initially which appeared to be relevant.

The selection of items was done on the basis of Bloom's (1956) revised taxonomy as devised by Anderson and Krathwohl (2001). The items contained questions on each of remembering, understanding, applying, analyzing, evaluating and creating about post-harvest practices. Considering the above mentioned criteria, 36 questions by taking 6 from each of remembering, understanding, applying, analyzing, evaluating and creating about post-harvest practices were selected out of initially collected 54 items with the consultation with Advisory Committee Member for administering these items to the Judges for Judges' rating and 36 farmers for item analysis.

Judges' rating: The selected 36 items were sent to 30 experts (Judges) to rate the items of the scale of knowledge on selected vegetable post-harvest practices. The Judges were selected from different related disciplines including agricultural extension, agronomy, horticulture, plant pathology, entomology, soil science and environmental science of different agricultural universities, research institutes, extension organizations and non-government organizations. Letter to Judges from the Chairman of the Advisory Committee of this research appears on Appendix-II. For determining the appropriateness and relevancy of the items of "knowledge on selected vegetable post-harvest practices scale", the Judges were requested to mention their opinion in 9-point suitability continuum against each of the practice (1 for least appropriate and 9 for most appropriate). Out of 30 judges, 25 replied. Therefore, the responses of 25 Judges were retained for selection of items for the scale of knowledge on selected vegetable post-harvest practices for the study. Based on the ratings of 25 Judges, Average Appropriateness Score (AAS_k) of each of the item was measured with the following formula:

$$AAS_k = \frac{\Sigma S_{ik}}{n}$$

Where,

AAS_k = Average Appropriateness Score of the i^{th} item of knowledge scale

S_{ik} = Appropriateness score given by the Judges for i^{th} item of knowledge scale

n = Number of Judges = 25

After determining the AAS_k of each of all the items, it was found that the AAS_k of all items was more than 4.5 out of 09 i.e. more than half of the highest possible AAS_k of 9. Based on this criteria all the 36 items were selected for the scale of knowledge on

selected vegetable post-harvest practices for pre-test. Average Appropriateness Score (AAS_k) was shown in Appendix-III.

Item analysis: After Judges' rating, 36 items of knowledge were considered for item analysis. The item analysis of a knowledge test usually yields two kinds of information, that is, item difficulty and item discrimination. The index of item difficulty indicates how difficult an item is, whereas, the index of discrimination explores the extent to which an item discriminates the well informed farmers from poorly informed ones.

Similar to the procedure followed by Ali (2008), the items were analyzed on the basis of pre-test data obtained by administering to 36 farmers. The 36 farmers for administering the items were randomly selected by taking four (4) from each of three (3) vegetables from each of three (3) upazilas and were different from the sample farmers of the present study. Nevertheless these 36 farmers were representative of the total population on the basis of which the final study was conducted. Each of the 36 items had three alternative choices of answers including one right answer. Each one of the 36 respondents, to whom the test was administered, was given one (1) score for right answer and zero (0) score for 'wrong' or no answer with respect to each item. The total number of right answers given by the respondent out of 36 items was the knowledge score secured by him. The maximum score was obviously 36 which could be scored when all the 36 items were answered correctly.

Calculation of difficulty index: Sagar (1983), Choudhury (1998), Islam (2000) used the following formula to calculate difficulty index of an item:

$$P_i = \frac{n_i}{N_i} \text{ X } 100$$

Where,

P_i = Difficulty index in percentage of i^{th} item

n_i = Number of farmers given correct answer to i^{th} item

N_i = Total number of farmers to whom i^{th} item was administered, i.e. 36 in the present study.

Actually difficulty index of an item indicates how difficult an item is. But the above formula is fully opposite to the concept of difficulty index. Actually, the value of P_i obtained from the above formula indicates how easy an item is. Because it is measured by the percentage of number of farmers given correct answer to i^{th} item and total number of farmers to whom i^{th} item was administered. It might be termed as easiness index (Ali 2008).

Under the above circumstances the researcher of the present study determined difficulty (P_i) index by the following revised formula developed by Ali (2008).

$$P_i = \frac{n_i}{N_i} \text{ X } 100$$

Where,

P_i = Difficulty index in percentage of i^{th} item

n_i = Number of farmers given incorrect answer to i^{th} item

N_i = Total number of farmers to whom i^{th} item was administered, i.e. 36 in the present study

All parts of the above two formulae are same, only the meaning of n_i is different. However, in the modified formula developed by Ali (2008), the higher was the difficulty index of an item, the more difficult the item was. Therefore, the difficulty indices of all the 36 items were calculated by the formula developed by Ali (2008). It was ensured that very difficult and very easy items were eliminated. The underlying assumption in the statistics of item difficulty was that the difficulty was linearly related to the level of an individual's post-harvest practices knowledge. When a respondent gave correct answer to an item, it was assumed, as Coombs (1950) described, that the item was less difficult than his ability to cope with it. The difficulty indices have been presented in Appendix-IV.

Calculation of discrimination index: The discrimination index can be computed by calculating the phi-coefficient as formulated by Perry and Michael (1951). However, Mehta (1958) developed $E^{1/3}$ method to find out item discrimination emphasizing that this method was analogous to, and hence, a convenient substitute for phi-coefficient. The method developed by Mehta (1958) was used by Singh (1981), Sagar (1983), Ray and Bora (1991), Choudhury (1998), Islam (2000) and Ali (2008).

Like Mehta (1958), Singh (1981), Sagar (1983), Ray and Bora (1991), Choudhury (1998), Islam (2000) and Ali (2008), the present researcher computed the total scores against all the correct responses of each farmer. The farmers were then arranged in descending order of total scores obtained by them. Then those farmers were divided into 6 equal groups each having 6 farmers as the total number of farmers in the sample for item analysis was 36. These groups were as G_1, G_2, G_3, G_4, G_5 and G_6 respectively. For determination of discrimination index the middle two groups, i.e. G_3, and G_4 were eliminated and kept only extreme four groups with high (G_1 and G_2) and low (G_5 and G_6) scores. Then discrimination index of each item was determined by using the following formula:

$$E^{1/3} = \frac{(S_1 + S_2) - (S_5 + S_6)}{N/3}$$

Where, S_1, S_2, S_3, S_4, S_5 and S_6 were the frequencies of correct answer for each item in G_1, G_2, G_3, G_4, G_5 and G_6 groups respectively and N was the total number of farmers in the sample of item analysis. The discrimination indices of all the 36 items were calculated by the procedure mentioned above and are presented in Appendix-IV.

Example of computation of difficulty and discrimination index: An example of computation of difficulty index and discrimination index of an item in connection with post-harvest practice knowledge is presented in table 3.3.

Table 3.3 Example of computation of difficulty and discrimination index

Item no.	Frequencies of correct answer						Total frequencies		Difficulty Index (P_i)	Discrimination Index ($E^{1/3}$)
	S_1	S_2	S_3	S_4	S_5	S_6	Correct answer	Incorrect answer		
1.a	6	6	6	6	2	1	27	9	25.00	0.750

Substituting the values for the item number 1.a, the value of difficulty index and that of discrimination index are calculated as below:

Difficulty index:

$$Pi = \frac{n_i}{N_i} \times 100$$

$$= \frac{9}{36} \times 100$$

$$= 25.00$$

Discrimination index:

$$E^{1/3} = \frac{(S_1 + S_2) - (S_5 + S_6)}{N/3}$$

$$= \frac{(6+6) - (2 + 1)}{36/3}$$

$$= \frac{12-3}{8}$$

$$= \frac{9}{12}$$

$$= 0.750$$

Final selection of items: Two criteria namely, item difficulty index and item discrimination index were considered for the selection of items in the final format of the vegetable post-harvest practices knowledge test.

In the present study items with difficulty index value ranging from 16.67 to 83.33 (Ali, 2008) and discrimination index ranging from 0.125 to 0.875 (Ali, 2008) were included in the final format of vegetable post-harvest practice knowledge scale. In this way, 24 items by taking 4 from each of remembering, understanding, applying, analyzing, evaluating and creating which fulfilled both the criteria and these items were selected for the final scale of the vegetable post-harvest practice knowledge (Appendix-IV).

Scoring system: Each item had three (3) alternative responses including one (1) right answer. The respondents were asked to choose the right answer for each item. One (1) score was given for right answer and zero (0) for wrong or no answer against each item. Summation of such scores for all the responses of a farmer was the vegetable

post-harvest practice knowledge score of that farmer. Thus, the knowledge score on selected vegetable post-harvest practice could range from 0 to 24, where '0' indicated very low level of knowledge and 24 indicated very high level of knowledge. Question regarding this variable appears in the item no. 17 in the interview schedule (Appendix-I).

3.7.4.2 Use of selected vegetables post-harvest practices

Vegetables post-harvest practices meant the practices those were used by the farmers after harvesting of the vegetables. Measurement procedures of this variable have been done based on the following steps:

Items collection: After searching of relevant literatures primarily 20 items were selected for measuring the use of selected vegetable post-harvest practices which might have great impact on effects of selected post-harvest practices to strengthen vegetable export market. After consultation with Advisory Committee Members, a total of 15 items were selected due to similarity to send Judges for Judges rating.

Judges' rating: The selected 15 items were sent to 30 experts (Judges) to rate the items of the scale of use of selected vegetable post-harvest practices. The Judges were selected from different related disciplines including agricultural extension, agronomy, horticulture, plant pathology, entomology, soil science and environmental science of different agricultural universities, research institutes, extension organizations and non-government organizations. Letter to Judges from the Chairman of the Advisory Committee of this research appears on Appendix-II. For determining the appropriateness and relevancy of the items of "use of selected vegetable post-harvest practices scale", the Judges were requested to mention their opinion in 9-point suitability continuum against each of the practice (1 for least appropriate and 9 for most appropriate). Out of 30 judges, 25 replied. Therefore, the responses of 25 Judges were retained for selection of items for the scale of use of selected vegetable post-harvest practices for the study. Based on the ratings of 25 Judges, Average Appropriateness Score (AAS_u) of each of the item was measured with the following formula:

$$AAS_u = \frac{\Sigma S_{iu}}{n}$$

Where,

AAS_u = Average Appropriateness Score of the i^{th} item of use scale

S_{iu} = Appropriateness score given by the Judges for i^{th} item of use scale

n = Number of Judges = 25

After determining the AAS_u of each of all the items, it was found that the AAS_u of all items was more than 4.5 out of 09 i.e. more than half of the highest possible AAS_u of 9. Based on this criteria all the 15 items were selected for the final scale of use of selected vegetable post-harvest practices. Average Appropriateness Score (AAS_u) was shown in Appendix-V.

Scoring System: Use of selected vegetables post-harvest practices of respondent was measured by asking 15 selected items related to post harvest practices. A four point scale was used and the respondents were asked to choose one response among four alternative responses as regularly, occasionally, rarely and not at all use. Scores were assigned to the responses as 3. 2. 1 and 0 respectively.

The use of selected vegetable post-harvest practices was therefore, determined by adding the total scores against all the 15 selected vegetable post-harvest practices. Thus, the score of use of selected vegetable post-harvest practice scale could range from 0 to 45, where '0' indicated no use and 30 indicated highest use. Question regarding this variable appears in the item no. 18 in the interview schedule (Appendix-I).

Measurement of Use Index (UI): To compare the use of different post-harvest practices items, Use Index (UI) was computed. The UI for each item was calculated by using the following formula:

$$\mathbf{UI = U_{re}x3 + U_{oc}x2 + U_{ra}x1 + U_{n}x0}$$

Where,

UI = Use Indes of i^{th} item

$\mathbf{U_{re}}$ = Number of respondents use post-harvest practices regularly

$\mathbf{U_{oc}}$ = Number of respondents use post-harvest practices occasionally

$\mathbf{U_{ra}}$ = Number of respondents use post-harvest practices rarely

$\mathbf{U_{n}}$ = Number of respondents not all use post-harvest practices

Thus, UI of any use of post-harvest practice item could range from 0 to 750 where 0 indicated no use of post-harvest practices and 750 indicated highest use of post-harvest practices. This process was followed for each item of this variable and it was done in order to make comparison among the use of post-harvest practice items by the farmers in vegetable value chain. Rank order was made based on the descending order of the UI of the items to compare the extent of use of post-harvest practices.

3.7.4.3 Problems faced in vegetable value chain

For measuring problems faced in vegetable value chain, items containing social, technical, environmental, marketing and psychological problems were selected after thorough consultation with the Advisory Committee Members, extension experts, researchers and from other available sources. Measurement procedure of this variable have been done based on the following steps:

Collection of items: The content of problem faced is composed of questions called items. Items for the test were collected from different sources, such as, literatures; agricultural scientists of agronomy, horticulture, soil science, agricultural chemistry, entomology, plant pathology, agribusiness management, agri-economics, agro-forestry, environmental science, and agricultural extension education of home and abroad; extension personnel; NGO personnel; Bangladesh Fruits Vegetables & Allied Products Exporter's Association (BFVAPEA), Hortex Foundation, vegetables exporters, vegetable value chain actors, progressive farmers and researcher's own experience. The items were designed to find out problem faced by the farmers during the time from vegetable production to exporting i.e. the entire value chain. The items were collected and prepared in relation to post-harvest practices of vegetables to strengthen vegetable export market. Forty Four (44) items were collected initially which appeared to be relevant.

Judges' rating: The selected 44 items were sent to 30 experts (Judges) to rate the items for the scale of problem faced by the farmers in vegetable value chain. The Judges were selected from different related disciplines including agricultural extension, agronomy, horticulture, plant pathology, entomology, soil science and environmental science of different agricultural universities, research institutes, extension organizations and non-government organizations. Letter to Judges from the Chairman of the Advisory Committee of this research appears on Appendix-II. For determining the appropriateness and relevancy of the items of "problem faced in vegetable value chain scale", the Judges were requested to mention their opinion in 9-point suitability continuum against each of the practices (1 for least appropriate and 9 for most appropriate). Out of 30 judges, 25 replied. Therefore, the responses of 25 Judges were retained for selection of items of the scale of problem faced by the farmers in vegetable value chain. Based on the ratings of 25 Judges, Average Appropriateness Score (AAS_p) of each of the item of problem scale was measured with the following formula:

$$AAS_p = \frac{\Sigma S_{ip}}{n}$$

Where,

AAS_p = Average Appropriateness Score of i^{th} item of problem scale

S_{ip} = Appropriateness Score given by the Judges of against i^{th} item

n = Number of Judges = 25

After determining the AAS_p of each of all the items, it was found that the AAS_p of some items were less than 4.50 out of 09 i.e. less than half of the possible AAS_p of 9. . AAS_p less than 5 were eliminated and 26 item was finally selected from 44 items. Average Appropriateness Score (AAS_p) was shown in Appendix-VI.

Scoring System: Twenty six (26) items of problems were selected and arranged in the scale in order to have real feelings on problems faced in vegetable value chain. It was measured on the basis of opinion of the farmers regarding the problem faced by them during entire value chain. The nature of responses of the respondents to the items was 'severe problem, moderate problem, less problem and no problem and the

scores were assigned as 3, 2, 1, 0 respectively. Problems faced in vegetables value chain score of a respondent was determined by adding up all the scores for all the responses of the items of that respondent. The possible range of score of problems faced was 0-78, while 0 indicating no problem and 78 indicating highest problems faced in post-harvest practices. Question regarding this variable appears in the item no. 19 in the interview schedule (Appendix-I).

Comparing severity of problems among the items: For comparing severity of problems among the items of each item was measured by using the following formula:

$$\mathbf{PFI = P_s x3 + P_m x2 + P_l x1 + P_n x0}$$

Where,

PFI = Problem Faced Index of i^{th} item

P_s = Number of respondents faced severe problem

P_m = Number of respondents faced moderate problem

P_l = Number of respondents faced less problem

P_n = Number of respondents faced no problem

Thus, PFI of any problem item could range from 0 to 750 where 0 indicated no problem and 750 indicated highest problem. This process was followed for each item of this variable and it was done in order to make comparison among problem items faced by the farmers in vegetable value chain. Rank order was made based on the descending order of the PFI of the items to compare the severity of the problems.

3.8 Measurement of dependent variable

Effects of using selected post-harvest practices to strengthen vegetable export market was the dependent variable of the study. Vegetable post-harvest practices meant the practices those were used by the farmers after harvesting the vegetables. Measurement procedures of this variable have been done based on the following steps:

Items collection: After searching of relevant literatures initially 28 items were selected for measuring effects of post-harvest practices to strengthen vegetable export

market. After consultation with Advisory Committee Members, a total of 19 items were selected for Judges' rating due to similarity in the items.

Judges' rating: The selected 19 items were sent to 30 experts (Judges) to rate the items for the scale of effects of using selected post-harvest practices to strengthen vegetable export market. The Judges were selected from different related disciplines including agricultural extension, agronomy, horticulture, plant pathology, entomology, soil science and environmental science of different agricultural universities, research institutes, extension organizations and non-government organizations. Letter to Judges from the Chairman of the Advisory Committee of this research appears on Appendix-II. For determining the appropriateness and relevancy of the items of "effects of using selected post-harvest practices to strengthen vegetable export market scale", the Judges were requested to mention their opinion in 9-point suitability continuum against each of the items (1 for least appropriate and 9 for most appropriate). Out of 30 judges, 25 replied. Therefore, the responses of 25 Judges were retained for selection of items for the scale of effects of using selected post-harvest practices to strengthen vegetable export market for the study. Based on the ratings of 25 Judges, Average Appropriateness Score (AAS_e) of each of the item of effects scale was measured with the following formula:

$$AAS_e = \frac{\Sigma S_{ie}}{n}$$

Where,

AAS_e = Average Appropriateness Score of the i^{th} item of effects scale

S_{ie} = Appropriateness Score given by the Judges for i^{th} item of effects scale

n = Number of Judges = 25

After determining the AAS_e of each of the items, it was found that the AAS_e of all items except one (1) item was more than 4.50 out of 09 i.e. the more than half of the highest possible AAS_e of 9. AAS_e less than 4.5 were eliminated and 18 items were finally selected from 19 items. Average Appropriateness Score (AAS_e) was shown in Appendix-VII.

Scoring System: It was measured on the basis of perception of the farmers regarding the effects of using selected post-harvest practices to strengthen vegetable export market. After finalization of items, the farmers were asked to give their opinion on the extent of effects of using selected vegetable post-harvest practices against each finalized effects item. The extent of effects of using selected vegetable post-harvest practices were measured by using a four (4) point rating scale with four alternative responses of the farmer such as highly effective, moderately effective, less effective and not at all effective. Four (4) point rating scale was also used by Khan et al. (2017), Khatun (2007), Okunade, (2007), Roy (2006) and Majydyan (1996) to measure effectiveness. Scores were assigned to these alternative responses as 3 for 'highly effective', 2 for 'moderately effective', 1 for 'less effective' and '0' for 'not at all effective'. By adding the scores against all the 18 selected items of a farmers together, the effectiveness score of him/her was obtained. Thus, the score of effectiveness of using selected vegetables post-harvest practices could range from 0-54, where 0 indicates not at all effective and 54 indicates highly effective of using post-harvest practices to strengthen vegetable export market. Items and question regarding this variable appears in the item no. 20 in the interview schedule (Appendix-I).

Measurement of Effects Index (EI): To compare the effects of different items, Effects Index (EI) was computed. The EI for each item was calculated by using the following formula:

$$\mathbf{EI = 3xf_{he} + 2xf_{me} + 1xf_{le} + 0xf_{n}}$$

Where,

EI = Effects Index (EI) of the i^{th} item

f_{he} = No. of farmers perceived highly effective

f_{me} = No. of farmers perceived moderately effective

f_{le} = No. of farmers perceived less effective

f_{n} = No. of farmers perceived not at all effective.

Thus, the value of EI of the items could range from 0 to 750, where 0 indicates no effect and 750 indicates high effect. This process was followed for each item of this variable and it was done in order to make comparison among the effects items. Rank

order was made based on the descending order of the EI of the items to compare the extent of effects of using vegetable post-harvest practices.

3.9 Validity and reliability of scale

To give due attention to the validity and reliability of the scale used for collecting data is one of the important tasks of research work. A scale possesses validity when it actually measures what it claims to measure. A scale is reliable when it can consistently produces the same results repeatedly when applied to the same sample (Goode and Hatt, 1952). Enough care was taken to prepare the interview schedule in general and the scales in particular for this study. The validity of contents of the scales was judged by obtaining opinions from the experts of the concerned discipline. Based on the comments and suggestions of the experts, the scales were modified to make it an acceptable form.

For validity and reliability of the scales, pre-test was done before giving final shape to the interview schedule. After preparation of draft data collection instrument, pretest was conducted on 36 farmers from the population but excluded from the sample. Twelve (12) farmers from three vegetables (by taking 4 from each vegetable) from one upazila were selected for pre-test by random selection. Thus, 36 farmers were selected from three upazilas for pre-test. Necessary corrections, additions, alternations and rearrangements were made in the schedule on the basis of feedback from the pre-test procedure. After correction, the interview schedule was finalized for the data collection. However, validity and reliability of the scales used for measuring the knowledge on selected vegetables post-harvest practices, use of selected vegetables post-harvest practices, problems faced in vegetables value chain and effects of using selected vegetables post-harvest practices were examined. Validity and reliability of these scales were tested both from pre-test data and a portion of final data. However, validity and reliability of these important scales have been described below:

3.9.1 Validity of knowledge on selected vegetables post-harvest practices scale

In the final selection of items for knowledge on selected vegetables post-harvest practice scale, care was taken to include items covering the entire universe of relevant behavioural aspects of the farmers with respect to knowledge on selected vegetables post-harvest practices. Fifty four (54) items were collected through various sources

including related publications and specialists of different related disciplines of home and abroad. Thirty six (36) items were selected out of these 54 items for Judges' rating. All of the 36 items were found appropriate after Judges' rating. Thirty six (36) items were then pre-tested by administering to 36 farmers of the research population, but with the exclusion of the sample as Ali (2008). On the basis of difficulty index and discrimination index, 24 out of 36 items were selected for the final scale. Aforesaid discussion indicates that the content validity was built in the process of constructing the scale. Hence, it was assumed that the scores obtained by administering this test measured vegetables post-harvest knowledge of the respondents as intended.

Again, validity of knowledge on selected vegetables post-harvest scale was measured by the relationships between the scores of individual items of vegetables post-harvest knowledge and the composite vegetables post-harvest knowledge score of 45 (part of final data) farmers by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area. The coefficient of correlations between the scores of each of 24 items of vegetables post-harvest knowledge and the score of composite vegetables post-harvest knowledge were found to be 0.718^{**}, 0.638^{**}, 0.346^{*}, 0.776^{**}, 0.373^{*}, 0.400^{**}, 0.523^{**}, 0.511^{**}, 0.776^{**}, 0.403^{**}, 0.477^{**}, 0.323^{*}, 0.519^{**}, 0.307^{*}, 0.463^{**}, 0.624^{**}, 0.310^{*}, 0.478^{**}, 0.477^{**}, 0.423^{**}, 0.461^{**}, 0.701^{**}, 0.477^{**} and 0.295^{*} which were significant at 0.000 to 0.05 level with 43 degrees of freedom. On the basis of the procedure followed, it can be assumed that the knowledge on selected vegetables post-harvest practices scale had content validity. Therefore, the scale may be taken as valid instrument to measure the knowledge on selected vegetable post-harvest practices of the farmer.

3.9.2 Reliability of knowledge on selected vegetable post-harvest practices scale

The reliability of knowledge on selected vegetable post-harvest practices scale was measured by split-half method. For this process, final data on knowledge score of 45 farmers by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area were considered. All the 24 items of the knowledge on selected vegetable post-harvest practices scale were divided into 2 equal halves. These two sets of items, each having 12 items, one with odd numbered and the other with even numbered items were the major two components of the scale as used by Ali (2008). The coefficient of

correlation between the two sets of score was computed and the value (0.847^{***}) was found to be strongly significant at 0.000 level with 43 degrees of freedom. The reliability co-efficient, thus obtained indicated that the 'internal consistency' of the knowledge on selected vegetables post-harvest practices scale developed for the present study was quite high.

3.9.3 Validity of use of selected vegetables post-harvest practices scale

In collection and selection of items for use of selected vegetables post-harvest practices scale of this study, care was taken to include the items representing the universe of content of vegetables post-harvest practices. The content of the use of selected vegetables post-harvest practices scale was selected based on relevant literatures and opinions of experts and extension personnel as measures of checks. Fifteen (15) items were selected with consultation with Advisory Committee Members from initially collected twenty (20) items. On the basis of Judges' rating, all the fifteen (15) items were selected for the final scale. Fifteen (15) items were then pre-tested by administering to 36 farmers of the research population, but with the exclusion of the sample. After pre-test all of the fifteen (15) items were selected for the final scale. Aforesaid discussion indicates that the content validity was built in the process of constructing the scale. Hence, it was assumed that the scores obtained by administering this test measured use of selected vegetables post-harvest practices of the farmer as intended.

Again, validity of use of selected vegetables post-harvest practices scale was measured by the relationships between the scores of individual items of use of selected vegetables post-harvest practices and the composite use of selected vegetables post-harvest practices scale score of 45 farmers (part of final data) by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area. The coefficients of correlation between the scores of individual items and the composite use of selected vegetables post-harvest practices score were found to be 0.755^{**}, 0.399^{**}, 0.374^{*}, 0.480^{**}, 0.376^{*}, 0.313^{*}, 0.600^{**}, 0.611^{**}, 0.638^{**}, 0.318^{*}, 0.688^{**}, 0.652^{**}, 0.390^{**}, 0.633^{**} and 0.301^{*} which were significant at 0.000 to 0.05 level with 43 degrees of freedom. On the basis of the procedure followed, it could be said that the use of selected vegetables post-harvest practices scale had content validity.

3.9.4 Reliability of use of selected vegetables post-harvest practices scale

The reliability of use of selected vegetables post-harvest practices scale was measured by split-half method. On the basis of final data of 45 farmers by taking 15 (5 from each vegetable) from each of 3 upazilas, all the 15 items of selected vegetables post-harvest practices scale were divided into 2 equal halves. The scale had two sets of scores, one with eight (8) odd numbered items and the other with seven (7) even numbered items. The coefficient of correlation between the two sets of scores was computed and the value (0.542^{***}) was found to be significant at 0.000 level with the 43 degree of freedom. The reliability co-efficient, thus obtained indicated that the 'internal consistency' of use of selected vegetables post-harvest practices scale developed for the present study was high.

3.9.5 Validity of problems faced in vegetable value chain scale

In the final selection of items for problems faced in vegetable value chain scale, care was taken to include items covering the entire universe of relevant behavioural aspects of the farmers with respect to problems faced in vegetable value chain. Items were collected through various sources including related publications and specialists of different related disciplines of home and abroad. On the basis of Judges' rating, 26 out of 44 items were selected for the pre-test. Twenty six (26) items were then pre-tested by administering to 36 farmers of the research population, but with the exclusion of the sample. After pre-test all of the twenty six (26) items were selected for the final scale. Aforesaid discussion indicates that the content validity was built in the process of constructing the scale. Hence, it was assumed that the scores obtained by administering this test measured problems faced in vegetable value chain as intended.

Again, validity of problems faced in vegetable value chain scale was measured by the relationships between the scores of individual items of problems faced in vegetable value chain and the composite sore of problems faced in vegetable value chain of 45 farmers (part of final data) by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area. The coefficient of correlations between the scores of 26 individual items of problems faced by the farmer in vegetables value chain and the score of composite problems faced by the farmer in vegetables value chain were found to be 0.634^{**}, 0.417^{**}, 0.364^{*}, 0.386^{**}, 0.431^{**}, 0.334^{*}, 0.666^{**}, 0.545^{**},

0.401**, 0.494**, 0.424**, 0.600**, 0.678**, 0.478**, 0.737**, 0.712**, 0.527**, 0.480**, 0.438**, 0.697**, 0.581**, 0.306*, 0.295*, 0.622**, 0.626** and 0.405** which were significant at 0.000 to 0.05 level with 43 degrees of freedom. On the basis of the procedure followed, it can be assumed that the problems faced by the farmers in vegetables value chain scale had content validity. Therefore, the scale may be taken as valid instrument to measure the problems faced in vegetable value chain.

3.9.6 Reliability of problems faced in vegetable value chain scale

The reliability of problems faced in vegetable value chain scale was measured by split-half method. The scale was administered to 45 farmers (part of final data) by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area. All the 26 items of the problems faced in vegetables value chain scale were divided into 2 equal halves. These two sets of items, each having 13 items, one with odd numbered and the other with even numbered items, were the major two components of the scale as used by Ali (2008) .The coefficient of correlation between the two sets of scores was computed and the value (0.797***) was found to be strongly significant at 0.000 level with 43 degrees of freedom. The reliability co-efficient, thus obtained indicated that the 'internal consistency' of the problems faced in vegetables value chain scale developed for the present study was quite high.

3.9.7 Validity of effects of using selected vegetable post-harvest practice scale

In the final selection of items for effects of using selected vegetable post-harvest practice scale, care was taken to include items covering the entire universe of relevant behavioural aspects of the farmers with respect to effects of using selected vegetable post-harvest practices. Items were collected through various sources including related publications and specialists of different related disciplines of home and abroad. Nineteen (19) items were selected with consultation with Advisory Committee Members for Judges' rating. On the basis of Judges' rating, 18 out of 19 items were selected for the pre-test. Eighteen (18) items were then pre-tested by administering to 36 farmers of the research population, but with the exclusion of the sample as Ali (2008). After pre-test all of the eighteen (18) items were selected for the final scale. Aforesaid discussion indicates that the content validity was built in the process of constructing the scale. Hence, it was assumed that the scores obtained by

administering this test measured effects of using selected vegetable post-harvest practices of the farmers as intended.

Again, validity of effects of using selected vegetable post-harvest practice scale was measured by the relationships between the scores of individual items of effects of using selected vegetable post-harvest practice and the composite effects of using selected vegetable post-harvest practice score of 45 (part of final data) farmers by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area. The coefficient of correlation between the scores of 18 individual items of effects of using selected vegetable post-harvest practice and the score of composite effects of using selected vegetables post-harvest practice were found to be 0.694^{**}, 0.388^{**}, 0.298^{*}, 0.489^{**}, 0.331^{*}, 0.332^{*}, 0.628^{**}, 0.592^{**}, 0.642^{**}, 0.327^{*}, 0.644^{**}, 0.656^{**}, 0.472^{**}, 0.608^{**}, 0.384^{**}, 0.389^{**}, 0.394^{**} and 0.664^{**} which were significant at 0.000 to 0.05 level with 43 degrees of freedom. On the basis of the procedure followed, it can be assumed that the effects of using selected vegetable post-harvest practice scale had content validity. Therefore, the scale may be taken as valid instrument to measure the effects of using selected vegetable post-harvest practice of the farmers.

3.9.8 Reliability of effects of using selected vegetable post-harvest practice scale

The reliability of effects of using selected vegetables post-harvest practices scale was measured by split-half method. Final data of 45 farmers (part of final data) by taking 15 (5 from each vegetable) from each of 3 upazilas of the study area were considered for this procedure. All the 18 items of the effects of using selected vegetable post-harvest practice were divided into 2 equal halves. These two sets of items, each having 9 items, one with nine (9) odd numbered and the other with nine (9) even numbered items were the major two components of the scale as used Ali (2008). The coefficient of correlation between the two sets of scores was computed and the value (0.693^{***}) was found to be strongly significant at 0.000 level with 43 degrees of freedom. The reliability co-efficient, thus obtained indicated that the ‘internal consistency’ of the effects of using selected vegetable post-harvest practices scale developed for the present study was quite high.

3.10 Statement of hypothesis

As defined by Goode and Hatt (1952) “A hypothesis is a proposition which can be put to a test to determine its validity. It may seem contrary to, or in accord with common sense. It may prove to be correct or incorrect. In any event, however, it leads to an empirical test”. According to Kerlinger (1973), a hypothesis is a conjectural statement of the relation between 2 or more variables. Hypothesis are always in declarative sentence form and they relate either generally of specifically variables to sentence form and they relate either generally or specifically variables to variables. Hypothesis may be broadly divided into two categories, namely, research hypothesis and null hypothesis.

3.10.1 Research hypothesis

In the light of the objectives of the study and variables selected, the following research hypotheses were formulated to test them in. The research hypotheses was stated in positive form, the hypotheses was as follows:

“Each of the nineteen (19) selected characteristics of the respondents have significant contribution/effect on/to the effects of using of selected post-harvest practices to strengthen vegetable export market as perceived by them”.

3.10.2 Null hypothesis

The aforesaid research hypothesis was converted into null hypothesis for testing the conceptual model of the study. The major null hypothesis formulated for testing the conceptual model of the study is presented below:

“There is no significant contribution/effect of the selected nineteen (19) characteristics of the farmers to/on the effects of using selected post-harvest practices to strengthen vegetable export market as perceived by them”.

3.11 Data Processing

3.11.1 Editing

The collected raw data were examined thoroughly to detect errors and omissions. As a matter of fact the researcher made a careful scrutiny of the completed interview schedule to make sure that necessary data were entered as complete as possible and

well arranged to facilitate coding and tabulation. Very minor mistakes were detected by doing this, which were corrected promptly.

3.11.2 Coding and tabulation

Having consulted with the research Advisory Committee Members, the researcher prepared a detailed coding plan. In case of qualitative data, suitable scoring techniques were followed by putting proper weightage against each of the traits to transform the data into quantitative forms. These were then tabulated in accordance with the objective of the study

3.11.3 Categorization of data

Following coding operation, the collected raw data as well as the respondents were classified into various categories to facilitate the description of the independent and dependent variables. These categories were developed for each of the variables by considering the nature of distribution of the data and extensive literature review. The procedures for categorization have been discussed while describing the variables in Chapter 4.

3.12 Statistical analysis

IBM SPSS Statistics 24 was used for data analysis. Descriptive statistical measures including number & percentage distribution, range, rank order, mean, standard deviation and co-efficient of variance were used for describing both the independent and dependent variables. Rank order was made whenever necessary. Tables were also used in presenting data for clarity of understanding.

Initially, Pearson Product Moment correlation was run to determine the relationship of the selected characteristics of the vegetable farmers with the effects of using selected post-harvest practices to strengthen vegetable export market. Full model regression analysis was also done. Due to misleading results from multi-collinearity, stepwise multiple regression was used to find out the contribution of the independent variables to the dependent variable. Finally, path analysis was done to find out the direct and indirect effects of the independent variables separately on the dependent variable. Five percent (0.05) level of probability was used as the basis for rejection of any null hypothesis throughout the study. Co-efficient values significant at 0.05 level is

indicated by one asterisk (*), and that at 0.01 level by two asterisks (**) and at 0.001 level or above by three asterisks (***). For determining comparative effects of items, comparative use of post-harvest practices items and severity of the problems, rank order were made based on the descending order of the Effects Index (EI), Use Index (UI) and Problems Faced Index (PFI) respectively.

CHAPTER 4

CHARACTERISTICS PROFILE OF THE FARMERS

Certain attributes or characteristics form an integral part in the development of human behaviour. These include the individual's personal, economical, social and professional characteristics. It can be postulated that these characteristics influence decision making relating to an actual behaviour in the individual's life. Conceptualization and measurement of these characteristics help in understanding and predicting the human behaviour within certain limits of probability. Difference in farmers' characteristics might therefore have considerable influence on farmers' behavioral change that occurs to farmers using selected vegetables post-harvest practices. It may also be assumed that these characteristics play significant roles in the perception of an individual.

The purpose of this Chapter is to describe the 19 selected characteristics of the sample farmers as was indicated in the objectives of the study as independent variables. These characteristics of the farmers are described in the following four (4) sections of this chapter. Procedure followed in measuring the characteristics have been described in Chapter 3. For describing the characteristics of the farmers, they were classified into suitable categories according to each of the characteristics. Category wise number and percentage distribution have been used to describe the characteristics.

4.1 Personal characteristics

A person may possess many personal characteristics. Five personal characteristics of the respondent farmers namely age, education, family agricultural labour, experience in vegetables cultivation and experience in exportable vegetables production were selected for the present study. Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the five (5) selected personal characteristics of the farmers have been presented in Table 4.1. Five (5) selected personal characteristics have been discussed below in the sub-sections:

Table 4.1 Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the five (5) selected personal characteristics of the farmers

Characteristics	Measuring unit	Possible range	Observed range	Mean	SD	CV%
1. Age	Actual years	Unknown	22 - 62	40.91	7.69	18.80
2. Education	Schooling years	Unknown	0.50 - 16	7.88	3.89	49.37
3. Family agricultural labour	Number of family members	Unknown	2-8	4.33	1.13	26.10
4. Experience in vegetables cultivation	Experience in year	Unknown	1 - 22	11.22	3.35	29.86
5. Experience in exportable vegetables production	Experience in year	Unknown	1 - 12	6.94	2.45	35.30

4.1.1 Age

The observed age of the farmers ranged from 22 to 62 years, the mean being 40.91 with a standard deviation of 7.69 and co-efficient of variation of 18.80% (Table 4.1). The respondents were classified into following three categories based on their age:

Categories	Basis of categorization (Years)
Young aged	up to 35
Middle aged	>35-50
Old aged	>50

Distribution of the farmers according to their age is shown in Table 4.2.

Table 4.2 Distribution of the farmers according to their age

Categories	Farmers	
	Number	Percent
Young aged	63	25.20
Middle aged	162	64.80
Old aged	25	10
Total	**250**	**100**

Data contained in the Table 4.2 indicated the about two-third (64.80%) of the farmers were middle aged compared to 25.20 percent being young and 10 percent old. Co-efficient of Variation (18.80%) of age of the respondents indicated that the sample farmers were homogenous based on their age. Findings again revealed that overwhelming majority (90 percent) of the farmers were young or middle aged. It was very logical that BFVAPEA selected young and middle aged farmers as exportable vegetable producers to strengthen vegetable export market through use of selected vegetables post-harvest practices. The general notion found from the introduction of most new technologies both within agriculture and outside of it is that older generations are the last to adopt them, while the younger generations typically embrace them more quickly (Dhraief, 2018). However, age of the respondent farmers was not significantly related ($r = 0.123^{NS}$ at 0.05 level of probability) with their effects of using selected post-harvest practices to strengthen vegetable export market. The findings imply that the age of the farmers were not an important factor for exerting the effects of using selected post-harvest practices to strengthen vegetable export market.

4.1.2 Education

Schooling years of the farmers ranged from 0.50 to 16.0, the mean being 7.88 with the standard deviation of 3.89 and co-efficient of variation of 49.37% (Table 4.1). The sample farmers were classified into following five (5) categories based on their level of education:

Categories	**Basis of categorization (Schooling years)**
Can sign only	0.5
Primary education	1 to 5
Secondary education	6 to 10
Higher secondary education	11 to 12
Tertiary education	above 12

Distribution of the farmers according to their education is shown in Table 4.3.

Table 4.3 Distribution of the farmers according to their education

Categories	Farmers	
	Number	**Percent**
Can sign only	7	2.80
Primary education	83	33.20
Secondary education	93	37.20
Higher secondary education	51	20.40
Tertiary education	16	6.40
Total	**250**	**100**

Data presented in Table 4.3 indicated that the highest proportion (37.20%) of the farmers had secondary level of education, followed by 33.20 percent primary level, 20.40 percent higher secondary level of education, 6.40 percent graduate level of education and rest 2.80 percent respondents could sign his/her name only. These finding indicated that about cent percent (97.20%) of the respondents were literate with primary to tertiary level of education and it was higher level of education than the national average literacy rate of 72.8% (BBS, 2018[a]). The reason was that the sample farmers were selected for post-harvest practices for exportable vegetables on the basis of relatively educated (above primary level) persons, so as to understand the relatively complex training where some sort of writing, presenting skill were required.

Co-efficient of Variation of education of the sample farmers (49.37%) indicated that the sample farmers were homogenous based on their education. However, education of the sample farmers was not significantly related ($r = 0.\ 005^{NS}$ at 0.05 level of probability) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. The findings imply that the education of the farmers were not an important factor for the effects of using selected post-harvest practices to strengthen vegetable export market.

4.1.3 Family agricultural labour

The observed range of family agricultural labour of the sample farmers ranged from 2 to 8, the mean being 4.33 with the standard deviation of 1.13 and co-efficient of variation of 49.326.10% (Table 4.1). The sample farmers were classified into following three categories based on the family member engaged in farm activities:

Categories	Basis of categorization (Number of family members)
Small family agricultural labour	< Mean - 1SD i.e. < 3.2
Medium family agricultural labour	Mean ± 1SD i.e. 3.2 - 5.46
Large family agricultural labour	Mean + 1 SD i.e. > 5.46

Distribution of the farmers according to their family agricultural labour is shown in Table 4.4.

Table 4.4 Distribution of the sample farmers according to family agricultural labour

Categories	Farmers	
	Number	**Percent**
Small family agricultural labour	49	19.60
Medium family agricultural labour	169	67.60
Large family agricultural labour	32	12.80
Total	**250**	**100**

Data presented in Table 4.4 indicated that the two-third (67.60%) had medium number of family members engaged in agriculture farming, followed by 19.60 percent having small number of family members and 12.80 percent had large number of family members engaged in agriculture farming. Findings again revealed that overwhelming majority (88.20%) of the farmers had small to medium family members those are engaged in agricultural farming specially in vegetable post-harvest activities.

Co-efficient of Variation (26.10%) of family agricultural labour of the farmers indicated that the sample farmers were homogenous based on their number of family members engaged in agricultural firm activities. However, family agricultural labour of the sample farmers was not significantly related ($r = 0.073^{NS}$ at 0.05 level of probability) with their effects of using selected post-harvest practices to strengthen vegetable export market. The findings imply that the family agricultural labour of the

farmers were not an important factor for the effects of using selected post-harvest practices to strengthen vegetable export market.

4.1.4 Experience in vegetables cultivation

The observed range of experience in vegetables cultivation score of the farmers was 1 to 22, the mean being 11.22 with the standard deviation of 3.35 and co-efficient of variation of 29.86% (Table 4.1). The sample farmers were classified into following three categories based on the experience in vegetables cultivation:

Categories	**Basis of categorization (Experience in years)**
Short farming experience	(< Mean - 1SD i.e. < 7.87)
Medium farming experience	(Mean ± 1SD i.e. 7.87 - 14.57)
Long farming experience	(> Mean + 1 SD i.e. > 14.57)

Distribution of the farmers according to their experience in vegetables cultivation is shown in Table 4.5.

Table 4.5 Distribution of the farmers according to experience in vegetables cultivation

Categories	**Farmers**	
	Number	**Percent**
Short farming experience	18	7.20
Medium farming experience	193	77.20
Long farming experience	39	15.60
Total	**250**	**100**

Data presented in Table 4.5 indicated that the majority (77.20%) of the farmers had medium farming experience in vegetables cultivation, followed by 15.60 percent having long farming experience in vegetables cultivation and 7.20 percent had short farming experience in vegetables cultivation. Findings again revealed that overwhelming majority (84.40%) of the farmers had short to medium farming experience in vegetables cultivation.

Co-efficient of Variation (29.86%) of experience in vegetables cultivation of the farmers indicated that the sample farmers were homogenous based on their experience in vegetables cultivation. However, experience in vegetables cultivation of the sample farmers was not significantly related (r = 0. 044^{NS} at 0.05 level of probability) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. The findings imply that the experience in vegetables cultivation of the farmers were not an important factor for the effects of using selected post-harvest practices to strengthen vegetable export market.

4.1.5 Experience in exportable vegetables cultivation

The observed score of experience in exportable vegetables cultivation of the farmers ranged from 1 to 12, the mean being 6.94 with the standard deviation of 2.45 and co-efficient of variation of 35.30% (Table 4.1). The sample farmers were classified into following three categories based on their experience in exportable vegetables cultivation:

Categories	**Basis of categorization (Experience in years)**
Short experience in exportable vegetable cultivation	< Mean - 1SD i.e. < 4.49
Medium experience in exportable vegetable cultivation	Mean±1SD i.e.4.49 - 9.39
Long experience in exportable vegetable cultivation	> Mean + 1 SD i.e. > 9.39

Distribution of the farmers according to their experience in exportable vegetables cultivation is shown in Table 4.6.

Table 4.6 Distribution of the farmers according to experience in exportable vegetables cultivation

Categories	**Farmers**	
	Number	**Percent**
Short experience in exportable vegetable cultivation	41	16.40
Medium experience in exportable vegetable cultivation	170	68.00
Long experience in exportable vegetable cultivation	39	15.60
Total	**250**	**100**

Data presented in Table 4.6 indicated that two-third proportion (68.00%) had medium experience in exportable vegetables cultivation, followed by 16.40 percent having short experience in exportable vegetables cultivation and 15.60 percent had long experience in exportable vegetables cultivation. Findings again revealed that overwhelming majority (83.60%) of the farmers had medium to high experience in exportable vegetables cultivation.

Co-efficient of Variation (35.30%) of experience in exportable vegetables cultivation of the farmers indicated that the sample farmers were homogenous based on their experience in exportable vegetables cultivation. However, experience in exportable vegetables cultivation of the sample farmers was positively associated ($r = 0.255^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Generally, experience helps to cope up any problematic situation. Therefore, the higher experience might be increased the risk bearing ability of the farmers in vegetable cultivation as well as increase their knowledge on postharvest practices (Azad, 2013).

4.2 Economical characteristics

An individual farmer may have many economical characteristics. Five (5) economical characteristics of the farmers namely exportable vegetables cultivation area, exportable vegetables production, annual family income, exportable vegetables production and post-harvest practices cost, credit received for exportable vegetables production were selected for the present study. Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the five (5) selected economical characteristics of the farmers have been presented in Table 4.7. Categories, number and percent distribution of these five (5) selected economical characteristics have been discussed below in sub-sections:

Table 4.7 Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the five (5) selected economical characteristics of the farmers

Characteristics	Measuring unit	Possible range	Observed range	Mean	SD	CV%
1. Exportable vegetables cultivation area	Hectare	Unknown	.08-0.45	0.17	0.07	41.18
2. Exportable vegetables production	Kg	Unknown	1700 - 9400	3468.40	1353.24	39.02
3. Annual family income	'000' BDT	Unknown	80-350	166.43	50.21	30.17
4. Exportable vegetables production and post-harvest practices cost	'000' BDT	Unknown	23-111	45.58	17.27	37.89
5. Credit received for exportable vegetables production	'000' BDT	Unknown	11-60	23.68	10.51	44.38

4.2.1 Exportable vegetables cultivation area

The observed range of exportable vegetables cultivation area of the farmers was 0.08 to 0.45 hectares, the mean being 0.17 with the standard deviation of .07 and co-efficient of variation of 41.18% (Table 4.7). The sample farmers were classified into following three categories based on their exportable vegetables cultivation area:

Categories	Basis of categorization (Hectare)
Small area	< Mean - 1SD i.e. < 0.10
Medium area	Mean ± 1SD i.e. 0.10 - 0.24
Large area	> Mean + 1 SD i.e. > 0.24

Distribution of the farmers according to their exportable vegetables cultivation area is shown in Table 4.8.

Table 4.8 Distribution of the farmers according to exportable vegetables cultivation area

Categories	Farmers	
	Number	Percent
Small area	9	3.60
Medium area	205	82.00
Large area	36	14.40
Total	**250**	**100**

Data presented in Table 4.8 indicated that the highest proportion (82.00%) of the farmers had medium exportable vegetables cultivation area, followed by 14.40 percent having large exportable vegetables cultivation area and 3.60 percent had small exportable vegetables cultivation area. Findings again revealed that overwhelming majority (96.40%) of the farmers had medium to high exportable vegetables cultivation area.

Co-efficient of Variation (41.18%) of exportable vegetables cultivation area of the farmers indicated that the sample farmers were homogenous based on their exportable vegetables cultivation area. However, experience in exportable vegetables cultivation of the sample farmers was positively associated ($r = 0.205^{**}$, significant at 0.001 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it could be said that the choice of vegetable production regarding the farming practices in the study area are expected to be considerably influenced by the medium and large land area of the farmers. So, they need comparatively cheaper technologies and target oriented special extension service to use post-harvest practices for exportable vegetable production.

4.2.2 Exportable vegetables production

The observed range of exportable vegetables production of the sample farmers was 1700 to 9400 kg, the mean being 3468.40 with the standard deviation of 1353.24 and co-efficient of variation of 39.02% (Table 4.7). The sample farmers were classified into following three categories based on the exportable vegetables production:

Categories	Basis of categorization (Kg)
Small volume	< Mean - 1SD i.e. < 2115.16
Medium volume	Mean ± 1SD i.e. 2115.16 - 4821.64
Large volume	> Mean + 1 SD i.e. > 4821.64

Distribution of the farmers according to their exportable vegetables production is shown in Table 4.9.

Table 4.9 Distribution of the farmers according to exportable vegetables production

Categories	Farmers	
	Number	Percent
Small volume	32	12.80
Medium volume	174	69.60
Large volume	44	17.60
Total	**250**	**100**

Data presented in Table 4.9 indicated that the two-third (69.60%) of the farmers had medium volume of exportable vegetables production, followed by 17.60 percent having large volume of exportable vegetables production and 12.80 percent had small volume of exportable vegetables production. Findings again revealed that overwhelming majority (87.20%) of the farmers had medium to high volume of exportable vegetables production.

Co-efficient of Variation (39.02%) of exportable vegetables production of the farmers indicated that the sample farmers were homogenous based on their exportable vegetables production. However, exportable vegetables production of the farmers was positively associated ($r = 0.211^{**}$, significant at 0.001 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it could be said that the exportable vegetable production in the study area are expected to be considerably influenced by the farming practices as well as use of post-harvest practices. So, they need comparatively modern and cheaper technologies

of vegetables post-harvest practices and target oriented special extension service for good quality exportable vegetable production to increase export of vegetables.

4.2.3 Annual family income

The observed range of annual family income of the sample farmers was 80 to 350 thousand BDT, the mean being 166.43 with the standard deviation of 50.21 and co-efficient of variation 30.17% (Table 4.7). The sample farmers were classified into following three categories based on the annual family income:

Categories	**Basis of categorization ('000' BDT)**
Low income	< Mean - 1SD i.e. < 116.22
Medium income	Mean ± 1SD i.e. 116.22 - 216.64
High income	> Mean + 1 SD i.e. > 216.64

Distribution of the farmers according to their annual family income is shown in Table 4.10.

Table 4.10 Distribution of the farmers according to their annual family income

Categories	**Farmers**	
	Number	**Percent**
Low income	16	6.40
Medium income	193	77.20
High income	41	16.40
Total	**250**	**100**

Data presented in Table 4.10 indicated that the most (77.20%) of the farmers had medium income, followed by 16.40 percent having high income and 6.40 percent had low income. Findings again revealed that overwhelming majority (83.60%) of the farmers had low to medium income.

Co-efficient of Variation (30.17%) of annual family income of the farmers indicated that the sample farmers were homogenous based on their annual family income.

However, annual family income of the sample farmers was positively associated (r = 0.221**, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it could be said that the annual family income of a farmer is an important indicator of how much s/he can invest in his farming to produce exportable vegetables. Generally higher income encourages one's integrity to achieve better performance and to show his/her individual better status in the society. The higher income increases the risk bearing ability of the farmers' exportable vegetable production. Farmers with low income generally invest less in their farms. It is therefore, likely that a considerable portion of farmers may face difficulty in exportable vegetable production.

4.2.4 Exportable vegetables production and post-harvest practices cost

The observed range of exportable vegetables production and post-harvest practices cost of the farmers was 23 to 111 thousand BDT, the mean being 45.58 with the standard deviation of 17.27 and co-efficient of variation of 37.89% (Table 4.7). The sample farmers were classified into following three categories based on exportable vegetables production and post-harvest practices cost:

Categories	**Basis of categorization ('000' BDT)**
Low cost	< Mean - 1SD i.e. < 28.31
Medium cost	Mean ± 1SD i.e. 28.31 - 62.85
High cost	> Mean + 1 SD i.e. > 62.85

Distribution of the farmers according to their exportable vegetables production and post-harvest practices cost is shown in Table 4.11.

Table 4.11 Distribution of the farmers according to their exportable vegetables production and post-harvest practices cost

Categories	**Farmers**	
	Number	**Percent**
Low cost	41	16.40
Medium cost	167	66.80
High cost	42	16.80
Total	**250**	**100**

Data presented in Table 4.11 indicated that the two-third (66.80%) of the farmers had medium cost, followed by 16.80 percent having high cost and 16.40 percent had low cost. Findings again revealed that overwhelming majority (83.60%) of the farmers had medium to high cost for exportable vegetable production and post-harvest practices cost.

Co-efficient of Variation (37.89%) of exportable vegetables production and post-harvest practices cost of the farmers indicated that the sample farmers were homogenous based on their exportable vegetables production and post-harvest practices cost. However, exportable vegetables production and post-harvest practices cost of the sample farmers was positively associated ($r = 0.199^{**}$, significant at 0.002 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

4.2.5 Credit received for exportable vegetables production

The observed credit received for exportable vegetables produces of the farmers ranged from 11 to 60 thousand BDT, the mean being 23.68 with the standard deviation of 10.51 and co-efficient of variation of 44.38% (Table 4.7). The sample farmers were classified into following three categories based on credit received for exportable vegetables production:

Categories	**Basis of categorization ('000' BDT)**
Low credit received	< Mean - 1SD i.e. < 13.17
Medium credit received	Mean ± 1SD i.e. 13.17– 34.19
Large credit received	> Mean + 1 SD i.e. > 34.19

Distribution of the farmers according to their credit received for exportable vegetables production is shown in Table 4.12.

Table 4.12 Distribution of the farmers according to their credit received for exportable vegetables production

Categories	Farmers	
	Number	**Percent**
Low amount	23	9.20
Medium amount	187	74.80
Large amount	40	16.00
Total	**250**	**100**

Data presented in Table 4.12 indicated that about three-fourth (74.80%) of the farmers received medium credit, followed by 16.00 percent high credit and 9.20 percent low credit. Findings again revealed that overwhelming majority (90.80%) of the farmers received medium to high amount of credit for exportable vegetable production.

Co-efficient of Variation (44.38%) of credit received for exportable vegetables production of the farmers indicated that the sample farmers were homogenous based on their credit received for exportable vegetables production. However, credit received for exportable vegetables production of the farmers was not significantly related ($r = 0.115^{NS}$ at 0.05 level of probability) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. The findings imply that the credit received for exportable vegetables production of the farmers were not an important indicator for effects of using selected post-harvest practices to strengthen vegetable export market.

4.3 Social Characteristics

An individual farmer may have many social characteristics. Six (6) social characteristics of the farmers were selected for the present study. These includes - training exposure on vegetables post-harvest practices, contact with value chain actors, contract with value chain actors, depth of relationship with value chain actors, trust with value chain actors and extension contact. Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the six (6) selected social characteristics of the farmers have been presented in Table 4.13. Categories, number and percent distribution of these six (6) selected social characteristics have been discussed below in the subsections:

Table 4.13 Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the six (6) selected social characteristics of the farmers

Characteristics	Measuring unit	Possible range	Observed range	Mean	SD	CV%
1.Training exposure on vegetables post-harvest practices	Number of days	Unknown	1-12	3.62	2.03	56.08
2. Contact with value chain actors	Scores	0 -56	14-55	38.71	10.64	27.49
3. Contract with value chain actors	Scores	0 - 3	23	2.29	0.45	19.65
4. Depth of relationship with value chain actors	Scores	0 - 40	7-38	29.11	7.15	24.56
5. Trust with value chain actors	Scores	0 - 40	8-38	31.19	6.40	20.52
6. Extension contact	Scores	0 -78	9-70	41.18	15.23	36.98

4.3.1 Training exposure on vegetables post-harvest practices

The observed training exposure on vegetables post-harvest practices of the farmers ranged from 1 to 12 days, the mean being 3.62 with the standard deviation of 2.03 and co-efficient of variation of 56.08% (Table 4.13). The sample farmers were classified into following three categories based on their training exposure on vegetables post-harvest practices:

Categories	Basis of categorization (Number of days)
Low training exposure	< Mean - 1SD i.e. < 1.59
Medium training exposure	Mean ± 1SD i.e. 1.59 - 5.65
High training exposure	> Mean + 1 SD i.e. > 5.65

Distribution of the farmers according to their training exposure on vegetables post-harvest practices is shown in Table 4.14.

Table 4.14 Distribution of the farmers according to their training exposure on vegetables post-harvest practices

Categories	Farmers	
	Number	Percent
Low training exposure	31	12.40
Medium training exposure	172	68.80
High training exposure	47	18.80
Total	**250**	**100**

Data presented in Table 4.14 indicated that the two-third (68.80%) of the farmers had medium training exposure, followed by 18.80 percent having high training exposure and 12.40 percent had low training exposure on vegetable post-harvest practices. Findings again revealed that overwhelming majority (87.60%) of the farmers had medium to high training exposure on vegetable post-harvest practices.

Co-efficient of Variation (56.08%) of training exposure on vegetables post-harvest practices of the farmers indicated that the sample farmers were heterogeneous based on their training exposure on vegetable post-harvest practices. However, training on vegetables post-harvest practices of the sample farmers was positively associated ($r = 0.322^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. It is logical that there is always a relationship between training exposure and knowledge on post-harvest practices. Because training received develops the farmers' knowledge, skill, and attitude in positive manner. The findings suggested that training exposure might be an important factor for the respondents to change their knowledge on post-harvest practices of vegetables.

4.3.2 Contact with value chain actors

The observed score of contact with value chain actors of the farmers ranged from 14 to 55 against the possible range of 0-56, the mean being 38.71 with the standard

deviation of 10.64 and co-efficient of variation 27.49% (Table 4.13). The sample farmers were classified into following three categories based on contact with value chain actors:

Categories	**Basis of categorization (Scores)**
Low contact	< Mean - 1SD i.e. < 28.07
Medium contact	Mean ± 1SD i.e. 28.07 - 49.35
High contact	> Mean + 1 SD i.e. > 49.35

Distribution of the farmers according to their contact with value chain actors is shown in Table 4.15.

Table 4.15 Distribution of the farmers according to their contact with value chain actors

Categories	**Farmers**	
	Number	**Percent**
Low contact	32	12.80
Medium contact	168	67.20
High contact	50	20.00
Total	**250**	**100**

Data presented in Table 4.15 indicated that the two-third (67.20%) of the farmers had medium contact, followed by 20.00 percent having high contact and 12.80 percent had low contact with the value chain actor. Findings again revealed that overwhelming majority (87.20%) of the farmers had medium to high contact with value chain actors.

Co-efficient of Variation (27.49%) of contact with value chain actors of the farmers indicated that the sample farmers were homogenous based on their contact with value chain actors. However, contact with value chain actors of the sample farmers was positively associated ($r = 0.275^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

4.3.3 Contract with value chain actors

The observed score of contract with value chain actors of the farmers ranged from 2 to 3 against the possible range of 0-3, the mean being 2.29 with standard deviation of 0.45 and co-efficient of variation of 19.65% (Table 4.13). The farmers were classified into following two categories based on contract with value chain actors:

Categories	Basis of categorization (Scores)
Written contract	2
MOU/ Deed	3

Distribution of the farmers according to their contract with value chain actors is shown in Table 4.16.

Table 4.16 Distribution of the sample farmers according to their contract with value chain actors

Categories	Farmers	
	Number	Percent
Written contract	178	71.20
MOU/ Deed	72	28.80
Total	**250**	**100**

Data presented in Table 4.16 indicated that most (71.20%) of the farmers had written contract and 28.80 having Memorandum of Understanding (MOU) or formal Deed with the value chain actors. It means that all the farmers were contracted with the value chain actors either by written or by MOU or Deed. Co-efficient of Variation (19.65%) of contract with value chain actors of the farmers indicated that the farmers were homogenous based on their contract with value chain actors. However, contract with value chain actors of the farmers was not significantly related ($r = 0.034^{NS}$ at 0.05 level of probability) with their perceived effectiveness of farmer to use of selected post-harvest practices. The findings imply that the contract with value chain actors of the farmers were not an important factor for effects of using selected post-harvest practices to strengthen vegetable export market.

4.3.4 Depth of relationship with value chain actors

The observed score of depth of relationship with value chain actors of the farmers ranged from 7 to 38 against the possible range of 0-40, the mean being 29.11with the standard deviation of 7.15 and co-efficient of variation 24.56% (Table 4.13). The farmers were classified into following three categories based on their depth of relationship with value chain actors:

Categories	Basis of categorization (Scores)
Low relationship	< Mean - 1SD i.e. < 21.96
Medium relationship	Mean ± 1SD i.e. 21.96 – 36.26
High relationship	> Mean + 1 SD i.e. > 36.26

Distribution of the farmers according to their depth of relationship with value chain actors is shown in Table 4.17.

Table 4.17 Distribution of the farmers according to their depth of relationship with value chain actors

Categories	Farmers	
	Number	Percent
Low relationship	31	12.40
Medium relationship	178	71.20
High relationship	41	16.40
Total	**250**	**100**

Data presented in Table 4.17 indicated that majority (71.20%) of the farmers had medium relationship, followed by 16.40 percent having high relationship and 12.40 percent had low relationship with value chain actor. Findings again revealed that overwhelming majority (87.60%) of the farmers had medium to high relationship with value chain actors.

Co-efficient of Variation (24.56%) of depth of relationship with value chain actors of the farmers (24.56%) indicated that the farmers were homogenous based on their depth of relationship with value chain actors. However, depth of relationship with

value chain actors of the sample farmers was positively associated (r = 0.321**, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

4.3.5 Trust with value chain actors

The observed score of trust with value chain actors of the farmers ranged from 8 to 38 against the possible range of 0-40, the mean being 31.19 with the standard deviation of 6.40 and co-efficient of variation of 20.52% (Table 4.13). The farmers were classified into following three categories based on trust with value chain actors:

Categories	**Basis of categorization (Scores)**
Low trust	< Mean - 1SD i.e. < 24.79
Medium trust	Mean ± 1SD i.e. 24.79 - 37.59
High trust	> Mean + 1 SD i.e. > 37.59

Distribution of the farmers according to their trust with value chain actors is shown in Table 4.18.

Table 4.18 Distribution of the farmers according to their trust with value chain actors

Categories	**Farmers**	
	Number	**Percent**
Low trust	33	13.20
Medium trust	200	80.00
High trust	17	06.80
Total	**250**	**100**

Data presented in Table 4.18 indicated that the most (80.00%) of the farmers had medium trust, followed by 13.20 percent having low trust and 6.80 percent had high trust with value chain actors. Findings again revealed that overwhelming majority (86.80%) of the farmers had medium to high trust with value chain actor.

Co-efficient of Variation (20.52%) of trust with value chain actors of the farmers indicated that the farmers were homogenous based on their trust with value chain actors. However, trust with value chain actors of the sample farmers was positively associated ($r = 0.420^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

4.3.6 Extension contact

The observed score of extension contact of the sample farmers ranged from 9 to 70 against the possible range of 0-78, the mean being 41.18 with the standard deviation of 15.23 and co-efficient of variation of 36.98% (Table 4.13). The sample farmers were classified into following three categories based on extension contact:

Categories	**Basis of categorization (Scores)**
Low extension contact	< Mean - 1SD i.e. < 25.95
Medium extension contact	Mean ± 1SD i.e. 25.95 - 56.41
High extension contact	> Mean + 1 SD i.e. > 56.41

Distribution of the farmers according to their extension contact is shown in Table 4.19.

Table 4.19 Distribution of the farmers according to their extension contact

Categories	**Farmers**	
	Number	**Percent**
Low extension contact	79	31.60
Medium extension contact	138	55.20
High extension contact	33	13.20
Total	**250**	**100**

Data presented in Table 4.19 indicated that the majority (55.20%) of the farmers had medium extension contact, followed by 31.60 percent having low extension contact and 13.20 percent had high extension contact. Findings again revealed that two-third (68.40%) of the farmers had medium to high extension contact.

Co-efficient of Variation (36.98%) of extension contact of the farmers indicated that the farmers were homogenous based on their extension contact. However, extension contact of the farmers was positively associated (r = 0.387**, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

4.4 Professional characteristics

An individual farmer may possess many professional characteristics. A good professional seeks to continue learning while practicing the profession by doing the necessary research to handle new situations and problems as they arise. Three professional characteristics of the sample farmers namely knowledge on selected vegetable post-harvest practices, use of selected vegetables post-harvest practices and problems faced in vegetable value chain were selected for the present study. Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the three (3) selected professional characteristics of the farmers have been presented in Table 4.20. Categories, number and percent distribution of these three selected professional characteristics have been discussed below in subsections:

Table 4.20 Salient features including measuring unit, possible and observed range, Mean, Standard Deviation (SD) and Co-efficient of variance (CV) of the three (3) selected professional characteristics of the farmers

Characteristics	Measuring unit	Possible range	Observed range	Mean	SD	CV%
1. Knowledge on selected vegetable post-harvest practices	Scores	0 - 24	13-23	20.52	1.46	7.11
2. Use of selected vegetables post-harvest practices	Scores	0 - 45	15-42	34.11	6.79	19.91
3. Problems faced in vegetable value chain	Scores	0 - 78	18-71	37.61	15.13	40.22

4.4.1 Knowledge on selected vegetable post-harvest practices

The observed score of knowledge on selected vegetable post-harvest practices of the farmers ranged from 13 to 23 against the possible range of 0-24, the mean being 20.52 with the standard deviation of 1.46 and co-efficient of variation of 7.11% (Table 4.20). The farmers were classified into following three categories based on their knowledge on selected vegetable post-harvest practices:

Categories	**Basis of categorization (Scores)**
Low knowledge	< Mean - 1SD i.e. < 19.06
Medium knowledge	Mean ± 1SD i.e. 19.06 - 21.98
High knowledge	> Mean + 1 SD i.e. > 21.98

Distribution of the farmers according to their knowledge on selected vegetables post-harvest practices is shown in Table 4.21.

Table 4.21 Distribution of the farmers according to their knowledge on selected vegetable post-harvest practices

Categories	**Farmers**	
	Number	**Percent**
Low knowledge	37	14.80
Medium knowledge	198	79.20
High knowledge	15	6.00
Total	**250**	**100**

Data presented in Table 4.21 indicated that majority (79.20%) of the farmers had medium knowledge, followed by 14.80 percent having low knowledge and 6.00 percent had high knowledge on selected vegetable post-harvest practices. Findings again revealed that overwhelming majority (85.20%) of the farmers had medium to high knowledge on selected vegetable post-harvest practices.

Co-efficient of Variation (7.11%) of knowledge on selected vegetable post-harvest practices of the farmers indicated that the farmers were homogenous based on their knowledge on selected vegetable post-harvest practices. However, knowledge on

selected vegetables post-harvest practices of the sample farmers was positively associated ($r = 0.398^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Ali (2008) also found a positive relationship between ecological agricultural knowledge and adoption of ecological agricultural practices.

4.4.2 Use of selected vegetables post-harvest practices

The observed score of use of selected vegetables post-harvest practices of the farmers ranged from 15 to 42 against the possible range of 0-45, the mean being 34.11 with the standard deviation of 6.79 and co-efficient of variation of 19.91% (Table 4.20). The farmers were classified into following three categories based on their use of selected vegetables post-harvest practices:

Categories	**Basis of categorization (Scores)**
Low use	< Mean - 1SD i.e. < 27.32
Medium use	Mean ± 1SD i.e. 27.32 - 40.90
High use	> Mean + 1 SD i.e. > 40.90

Distribution of the farmers according to their use of selected vegetables post-harvest practices is shown in Table 4.22.

Table 4.22 Distribution of the farmers according to their use of selected vegetables post-harvest practices

Categories	**Farmers**	
	Number	**Percent**
Low use	49	19.60
Medium use	161	64.40
High use	40	16.00
Total	**250**	**100**

Data presented in Table 4.22 indicated that nearly two-third (64.40%) of the farmers had medium use, followed by 19.60 percent having low use and 16.00 percent had

high use of selected vegetables post-harvest practices. Findings again revealed that overwhelming majority (80.40%) of the farmers had medium to high use.

Co-efficient of Variation (19.91%) of use of selected vegetables post-harvest practices of the farmers indicated that the farmers were homogenous based on their use of selected vegetables post-harvest practices. However, use of selected vegetables post-harvest practices of the sample farmers was positively associated ($r = 0.464^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Item-wise use of selected post-harvest practices of vegetables are described in the Chapter 5 to compare among the use items.

4.4.3 Problems faced in vegetable value chain

The observed problem faced in vegetable value chain score of the farmers ranged from 18 to 71 against the possible ranged 0-78, the mean being 37.61 with the standard deviation of 15.13 and co-efficient of variation of 40.22% (Table 4.20). Based on their problem faced in vegetable value chain, the farmers were classified into following three categories-

Categories	**Basis of categorization**
Low problem	< Mean - 1SD i.e. < 22.48
Medium problem	Mean ± 1SD i.e. 22.48 - 52.74
High problem	> Mean + 1 SD i.e. > 52.74

Distribution of the farmers according to problem faced in vegetable value chain is shown in Table 4.23.

Table 4.23 Distribution of the farmers according to problem faced in vegetable value chain

Categories	Farmers	
	Number	**Percent**
Low problem	14	5.60
Medium problem	210	84.00
High problem	26	10.40
Total	**250**	**100**

Data contained in the Table 4.23 revealed that the above two-thirds (84.00%) of the farmers had medium problem on post-harvest practices in vegetable value chain compared to 10.40% and 5.60% having high and low problem on post-harvest practices in vegetable value chain respectively. Since, nearly 6 percent of the farmers had still low problem, there is yet to be done some activities in this regard to find out the solution to resolve the problem faced by the farmers.

Data again revealed that majority (89.60%) of the farmers had low to medium problems faced in post-harvest practices in vegetable value chain. Co-efficient of Variation (40.22%) of problems faced in vegetable value chain of the farmers indicated that the farmers were homogenous based on their problems faced in vegetable value chain. However, problems faced in vegetable value chain had a negative relationship ($r = -0.463^{**}$, significant at 0.000 level) with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Ali (2008) also found problem faced in ecological agriculture had a negative relationship with adoption of ecological agricultural practices of the farmers. It means that majority of the farmers were able to mitigate their problems in post-harvest practices. It is assumed that the farmers having more capacity to mitigate their problems might have more capacity to determine their effectiveness of using selected vegetables post-harvest practices.

Item-wise problems faced in vegetable value chain of the farmers are described in the Chapter 5 to compare among the problem items.

CHAPTER 5

EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET AND RELATED MATTERS

5.1 Effects of using selected post-harvest practices to strengthen vegetable export market

Effects of using selected post-harvest practices to strengthen vegetable export market was the main focus i.e. the dependent variable of the study. Exportable vegetables is being producing by the farmers through post-harvest value chain at the primary stage of value chain activities. Effects of using selected post-harvest practices to strengthen vegetable export market was measured on the basis of the perception of the farmers on eighteen (18) items. Measurement procedure of effects of using selected post-harvest practices was described in Chapter 3 of this dissertation. Measuring unit, possible and observed range, mean, standard deviation (SD) and co-efficient of variance (CV) of the effects of using selected post-harvest practices as perceived by the farmers' are shown in Table 5.1.

Table 5.1 Measuring unit, possible and observed range, mean, standard deviation (SD) and co-efficient of variance (CV) of the effects of using selected post-harvest practices as perceived by the farmers

Dependent Variable	Measuring unit	Possible range	Observed range	Mean	SD	CV %
Effects of using selected post-harvest practices to strengthen vegetable export market	Scores	0 -54	29-52	44.67	5.50	12.31

The observed effects of using selected vegetable post-harvest practices score of the farmers ranged from 29 to 52 against the possible range of 0-54. The mean score was

44.67 with the standard deviation 5.50 and Co-efficient variance of 12.31%. Based on their effects' scores, the farmers were classified into following three categories:

Categories	Basis of categorization
Low effects	< Mean - 1SD i.e. < (44.67-5.5) or < 39.17
Medium effects	Mean ± 1SD i.e. (44.67-5.5) - (44.67+5.5) or 39.17 - 50.17
High effects	> Mean + 1 SD i.e. (44.67+5.5) > 50.17

Distribution of the farmers according to their perceived effects of using selected post-harvest practices to strengthen vegetable export market is shown in Table 5.2.

Table 5.2 Distribution of the farmers according to their perceived effects of using selected post-harvest practices to strengthen vegetable export market

Categories	Farmers	
	Number	Percent
Low effects	41	16.40
Medium effects	178	71.20
High effects	31	12.40
Total	**250**	**100**

Data contained in the Table 5.2 revealed that the above most (71.2%) of the farmers had medium perception on the effects of using selected vegetable post-harvest practices compared to 12.40% and 16.40% had high and low perception on effects of using selected post-harvest practices respectively to strengthen vegetable export market. Since, nearly 16 percent of the farmers had still perceived low effects, there is yet to be done much activities in this regard to make the use of selected post-harvest practices to strengthen vegetable export market more effectively.

However, majority (83.60%) of the farmers perceived that the use of selected post-harvest practices was medium to high effective to strengthen vegetable export market. It clearly indicates that adopted post-harvest practices aided to produce good quality vegetables for exporting. It might be due to various activities done by farmers in the study area on post-harvest practices such as fresh produce handling practices include

harvesting with an intact calyx, using scissors/knifes to cut the fruit from the vine, harvesting at the appropriate stage, careful handling of produce after harvest, using soft leaves or old newspapers to cover baskets/plastic carets before loading, gentle loading for transporting or into appropriate containers, storage of harvested produce in cool rooms or in the shade, sorting and grading by color and size and packaging with suitable materials. Concerned GOs, NGOs and Associations also played an important role to use selected vegetables post-harvest practices by the farmers through various training on post-harvest practices. Weinberger et al. (2009) stated that more farmers have adopted fresh produce handling technologies. Farmers who adopted practices for fresh produce handling usually have changed a range of practices between harvesting and selling.

5.2 Item wise comparative effects of using post-harvest practices

To compare the item wise effects of using post-harvest practices, Effect Index (EI) was computed as described in Chapter 3 of this dissertation. The observed Effect Index (EI) of the items ranged from 506 to 712 against the possible range of 0-750. EI of the each items with rank order of EI is presented in Table 5.3.

Table 5.3 Effects Index (EI) of using post-harvest practices scores of each items with rank order

Item no.	Item of effects	Number of farmers perceived					EI	Rank Order
		Highly effective (3)	Moderately effective (2)	Low effective (1)	Not at all effective (0)	Total		
1	Reduce wastage of vegetables	222	15	5	8	250	**701**	**2**
2	Value addition of vegetables at different level of post-harvest practices	213	19	13	5	250	**690**	**3**
3	Quality vegetable produces	208	26	8	8	250	**684**	**4**
4	Increase market accessibility	203	28	7	12	250	**672**	**5**

Item no.	Item of effects	Number of farmers perceived					EI	Rank Order
		Highly effective (3)	Moderately effective (2)	Low effective (1)	Not at all effective (0)	Total		
5	Increase vegetable export	174	56	7	13	250	**641**	**8**
6	Increase selling price of produced vegetable	185	46	11	8	250	**658**	**7**
7	Increase net income	228	10	8	4	250	**712**	**1**
8	Free from contamination of any hazardous objects	196	28	17	9	250	**661**	**6**
9	Increase shelf life of produces	170	29	32	19	250	**600**	**13**
10	Increase exporter's demand for foreign market	161	55	25	9	250	**618**	**12**
11	Strengthening good relationship with value chain actors	176	32	31	11	250	**623**	**10**
12	Increase buyer satisfaction	182	25	25	18	250	**621**	**11**
13	Facilitate good access to credit support	127	40	45	38	250	**506**	**18**
14	Employment generation for selected post-harvest practices	170	55	15	10	250	**635**	**9**
15	Rapport building with government and other stakeholders	121	40	73	16	250	**516**	**17**
16	Awareness buildup	170	18	38	24	250	**584**	**14**

Item no.	Item of effects	Number of farmers perceived					EI	Rank Order
		Highly effective (3)	Moderately effective (2)	Low effective (1)	Not at all effective (0)	Total		
	towards good agricultural practices							
17	Considerable amount of water used in washing & cleaning, which flow untreated into adjacent water bodies has minimal environmental effects	120	48	69	13	250	**525**	**15**
18	Elimination of adulteration & harmful chemical during post-harvest practices	116	55	62	17	250	**520**	**16**

Table 5.3 revealed that on the basis of descending order of EI, it was observed that "Increase net income" ranked first followed by "Reduce wastage of vegetables", "Value addition of vegetables at different level of Post-harvest practices", "Quality vegetable produces", "Increase market accessibility", "Free from contamination of any hazardous objects", "Increase selling price of produced vegetable", "Increase vegetable export", "Employment generation for selected post-harvest practices", "Strengthening good relationship with value chain actors", "Increase buyer satisfaction", "Increase exporter's demand for foreign market", "Increase shelf life of produces", "Awareness buildup towards good agricultural practices", "Considerable amount of water used in washing & cleaning which flow untreated into adjacent water bodies has minimal environmental effects", "Elimination of adulteration & harmful chemical during post-harvest practices", "Rapport building with government and other stakeholders" and "Facilitate good access to credit support". Based on descending rank order of EI, the effect items are described below:

Increase net income: Data in the Table 5.3 revealed that "Increase net income" had the highest EI (712) based on the descending order of EI of the items. Weinberger et al. (2009) found the similar result. He stated that profit is the main concerned of a farm. He again reported that 71 percent of the adopters perceived that their farm profits increased because of higher prices, price differentiation for products of different grades, and farmers being able to sell higher quantities. Farmers were able to obtain a 25 percent higher price for tomatoes due to a change in harvesting practices. Some farmers also commented on a more stable farm income over the year because a contract arrangement was achieved. On the other hand, farmers are getting various types of agricultural training on vegetable post-harvest practices from different Agricultural Extension Service Providers. This also might be the reason for the highest level of effect of using vegetable post-harvest practices as perceived by the farmers of the present study.

Reduce wastage of vegetables: "Reduce wastage of vegetables" had the second highest EI based on descending order of EI of the items. Harvesting techniques are important for decreasing the losses of vegetables. Harvesting should usually be done during the cooler time of the early morning to minimize the initial temperature of the plucked produce and reduce the costs of cooling (Web 1). Weinberger et al. (2009) stated in his study that two-third (67%) of the farmers reported that post-harvest practices reduce post-harvest losses of vegetable. Ali et al. (2013) conducted a study on improvement of postharvest practices. He reported that same postharvest treatments and packaging techniques were found to be effective for minimizing postharvest losses. In most cases, plastic crate lining with newspaper was selected as good package for minimizing physical damage during transportation. Chlorine wash (tomato, brinjal, and papaya) and/or hot water treatment (mango, papaya) was found beneficial for reducing diseases or decay and physiological loss in weight during storage. Wrapping with newspaper was identified as effective practice both for transportation and storage of papaya. Keeping wrapper leaves surrounded by 'Head' was observed as acceptable practice for transporting cabbage for minimizing physical damage and weight losses. Applying alum or lime paste on stem butt end of cabbage was found beneficial for minimizing 'Head blemish' and disease infestation. Similarly, in this study, it was found that "reduce wastage of vegetable" had the 2nd

highest effect of using selected post-harvest practice to strengthen vegetable export market.

Value addition of vegetables at different level of post-harvest practices: "Value addition of vegetables at different level of post-harvest practices" had the third highest EI score based on descending order of EI of the items. Porter defined the "value chain" as a representation of a firm's value-adding activities, based on its pricing strategy and cost structure and highlighting the interdependencies and linkages between vertically-arrayed actors in the creation of value for a firm and also identified (1) primary activities, which directly contribute to add value to the production of goods and services and (2) support activities, which have an indirect effect on the final value of the product (Van Den Berg et al., 2009). It involves a chain of activities that are associated with adding value to a product through the production and distribution processes of each activity (Schmitz, 2005). Primary activities at farm level by the farmers, practicing various selected post-harvest activities may added vegetables value. Post-harvest value chain is a high-level model of how businesses receive raw materials as input, add value to the raw materials through various processes and sell finished products to customers. In post-harvest value chain operation activities, value adding and costs are integrated phenomenon. At each stage in the value chain, the product changes hand through chain actors, transaction cost are incurred, and generally, some form of value added. Value addition results from diverse activities including bulking, cleaning, grading and packaging, transporting, storing and processing (Anandajayasekeram and Gebremedhin, 2009). The various actors who are involved in the tomato value chain also indicate value addition by the farmer (43.72%), collectors (9.80%), small traders (3.15%), big traders (18.56%), wholesaler (3.01%), retailers (6.40%) and consumers (15.36%). The highest value was added by farmer followed by big traders, consumers, collectors, retailors, small traders and wholesalers (Sarma, 2019). A post-harvest value chain, therefore, incorporates productive transformation and value addition at each stage of post-harvest practices.

Quality vegetable produces: "Quality vegetable produces" had the fourth highest EI based on descending order of EI of the items. Post-harvest practices enhanced product quality. Quality of vegetables may be improved by the use of techniques of post-

harvest practices from training. Weinberger et al. (2009) stated that two-third (67%) of the farmers reported that post-harvest practices improved fresh and good quality vegetables. Ultimately, by proper sorting and grading, the producers can be benefited. Better post-harvest handling can increase food quality by minimize the loss of nutrients. Produces are heat up during transport and decay, water loss and shrink are increased (Web 3). As a result, quality and freshness are lost, which can be improved by using proper packaging techniques. Liners or cushioning made of paper and foam can be useful to protect fruit or vegetable from vibration damage during transport (Web 2).The maximum physical damage (20%) was recorded in Brinjal transported in open condition (without washing and without packaging) while it was minimum (1.53%) in both treated and untreated Brinjal but carrying into plastic crates. It was calculated that the physical damage could be minimized (18.47%) through carrying of brinjal with plastic crate compared to open condition (Ali et al., 2013). Reducing of physical damage, improves the quality of vegetables.

Increase market accessibility: "Increase market accessibility" had the fifth highest EI based on descending rank order of EI of the items. By proper sorting and grading, the producers can get high price of the produces, as the exporters and consumers are attracted by high graded produces. On the other hand, high graded produces can be degraded by contamination of lower graded produces which are infected by diseases, insects or any other means. Washing is done to remove dirt, latex and microbial infection. Washed commodity commands a better price than dirty commodity and attracts the consumers' mind. Fruits and vegetables growers and traders can be benefited from washing prior to packing and cold storage. Banana and mangoes are washed to remove latex and minimize staining. Tomatoes, cucumbers and leafy greens can be washed with chlorinated water before packing and cooling (Web 1). The postharvest techniques are economically efficient. Producer's market share shows that producers obtain the largest share when they sell out directly to roadside traders which is about 85.32%. Tomato value chains are creating shared value to enhance marketing success (Sarma et al., 2019). Small and large scale commercial farmers sell most of their products to various market intermediaries. The producers generally deal with traders and wholesalers. In most cases, farmers depend on village level traders for price information but over the last few years, the situation has slightly changed due to producing good quality vegetables by using best post-harvest practices, easy

access to communication technology and the big farmers generally have access to market information to some extent.

Free from contamination of any hazardous objects: "Free from contamination of any hazardous objects" had the sixth highest EI based on descending rank order of EI among the items. Specially, washing by using clean water removes adhering soil and other debris. After washing the produce should be air-dried before packing. Use of sorting table or groundcover/tripal on floor to avoid contact of produce with the soil which is a rich source of spoilage and human pathogens. Sanitary washing (chlorine wash), wiping vegetables with soft cloth, these various post-harvest practices are done to make the produces free from contamination of any hazardous objects (Acedo et al. 2016).

Increase selling price of produced vegetable: "Increase selling price of produced vegetable" had the seventh highest EI based on descending rank order of EI among the items. Farmers are contracted with guaranteed price. Depending on the crop, the harvested produce is sorted and packed on farm and brought to the collection center (pack house) for quality checking, sorting, treatment, packing, pre-cooling, and cold storage. Clean produce has higher market appeal and price than dirty ones (Acedo et al., 2016). In some rural assemble markets, Bepari collectively show artificial reluctance to buy produce for a while to create panic, which ultimately force the farmers to sell produce at lower prices. Grower's organizations and cooperatives should be encouraged. Often growers do not receive reasonable price of their produce due to high production, less price and wastage. Various value added products like flakes, chips, fries, etc. could be produced for domestic market and export (Bhuiyan, 2015). Therefore, efficient vegetable value chain is of paramount importance to reduce postharvest loss and the risk and uncertainty in timely delivery of quality and safe produce at reasonable prices to the market or exporter.

Increase vegetable export: "Increase vegetable export" had the eighth highest EI based on descending rank order of EI among the items. Export chains of vegetables vary with degree of vertical coordination. Vertically-integrated exporters are exporters who grow produce on their own farms, arrange shipping to overseas destinations and even distribute the goods to supermarkets and wholesalers in foreign markets. Other

groups of exporters are those who consolidate produce from contract growers directly and those who consolidate produce procured by brokers who in turn consolidate produce from farmers in spot market transactions or through farmer groups (Acedo et al., 2016). Farmers are growing exportable quality vegetables through contract farming by using selected post-harvest practices for long time, therefore their perception is effective.

Employment generation for selected post-harvest practices: "Employment generation for selected post-harvest practices" had the ninth highest EI based on descending rank order of EI among the items. Weinberger et al. (2009) stated observed that substantial improvements in income were observed for those who adopted the improved postharvest technologies, ranging from 25 to 30 percent. Other beneficial impacts at the community level were also reported, and the most remarkable among these was employment generation. Many local people are involved in post-harvest value chain that create employment. Post-harvest activities also provide employment to family members. Promote gender equality as more women are involved in postharvest and marketing operations.

Strengthening good relationship with value chain actors: "Strengthening good relationship with value chain actors" had the tenth highest effect of using selected post-harvest practices to strengthen vegetable export market based on descending rank order of EI among the items. Weinberger et al. (2009) stated that the majority of the respondents reported an improvement in their buyer-seller relationship. Buyers now frequently visit farmers' houses to buy more vegetables. Contracted buyer give training support on post-harvest practices, sometimes give credit facilities for cultivation, look after their post-harvest activities as well as cultivation. These co-operations made a strong and trustworthy relationship between farmers-buyers. Besides this, Government Agricultural Extension Service providing organizations like Department of Agricultural Extension (DAE), Hortex Foundation, BFVAPEA also providing agricultural advices related to post-harvest practices for producing exportable good quality produces as well as vegetables cultivation.

Increase buyer satisfaction: "Increase buyer satisfaction" had the eleventh highest EI based on descending rank order of EI among the items. Farmers were able to find a

larger number of buyers, many farmers reported their buyers are satisfied, and crops can now be easily sold due to producing good quality and exportable vegetables. Sorting and grading makes the buyers attracted to buy their products and continuing contract to produce exportable vegetables.

Increase exporters demand for foreign market: "Increase exporters demand for foreign market" had the twelfth highest EI based on descending rank order of EI among the items. Improved post-harvest practices by the farmers lead to greater demand for their produce from a larger number of buyers. The majority of the intermediaries and exporters had an explicitly positive attitude towards the post-harvest technology used by the farmers.

Increase shelf life of produces: "Increase shelf life of produces" had the thirteenth highest EI based on descending rank order of EI among the items. Shelf life of vegetables can be prolonged by proper post-harvest technology. Brinjal washed with chlorine (200 ppm NaoCl) and packed in perforated polyethylene bag (0.5%) had the maximum shelf life (14 days) while the minimum shelf life (4days) was recorded in without washed and packaging condition (Ali et al. 2013).

Awareness buildup towards good agricultural practices: "Awareness buildup towards good agricultural practices" had the fourteenth highest EI based on descending rank order of EI among the items. Personnel associated with growing and harvesting might be applied Good Agricultural Practices (GAPs) and protect harvested produce from contamination. Sanitary procedures in production, harvesting, packing and shipping to prevent or minimize contamination with human pathogens. Awareness may be build up through training on organic vegetable production and post-harvest practices.

Considerable amount of water used in washing & cleaning, which flow untreated into adjacent water bodies has minimal environmental effects: "Considerable amount of water used in washing & cleaning, which flow untreated into adjacent water bodies has minimal environmental effects" had the fifteenth highest EI based on descending rank order of EI among the items. The challenge is to find measures that not only help farmers adapt and maintain agricultural productivity and profitability,

but also reduce the emissions associated with production. Even if drastic actions were taken today to reduce Greenhouse gas (GHG) emissions dramatically, little could be done to address some of the anticipated effects. The consequences of climate change are long-lasting, increasing the importance of taking forceful action to reduce emissions (mitigation) that incorporates adaptation measures (Vergara, 2004). Practices to prevent and control hazards associated to vegetable postharvest chain, ensuring a safe and wholesome product, while minimizing the negative impact of those practices on the environment and on workers' health. Farmers used clean water which flow untreated into adjacent water bodies has minimal environmental effects and human health.

Elimination of adulteration & harmful chemical during post-harvest practices: "Elimination of adulteration & harmful chemical during post-harvest practices" had the sixteenth highest EI based on descending rank order of EI among the items. In order to minimize postharvest losses, packaging requirements for fruits and vegetables, and improvement of packaging methods were reported by Wills et al. (1982). These authors also reviewed the major postharvest diseases of fruits and vegetables and described the chemical treatments that are being used as postharvest treatments to minimize the losses. Acedo et al. (2016) stated that insect pests of vegetables are usually most destructive at the larva stage. Among them, fruit fly is the most important pest in export trade. Other insect pests include bean pod borer and moths (e.g. diamond back moth of cabbages). Postharvest management of insect pests should involve the use of safe or non-chemical treatments such as heat treatment (hot water dip, vapour heat .treatment), cold sterilization, high carbon dioxide exposure or irradiation. Chemical control using insecticides might be avoided and if not, might be used at levels non-toxic to non-target organisms particularly humans.

Rapport building with government and other stakeholders: "Rapport building with government and other stakeholders" had the seventeenth highest EI based on descending rank order of EI among the items. Farmers' ability to maintain productivity in a changing environment is of course linked to government policies and programs. Along with general policies to promote agricultural development, policies that specifically focus on improving agricultural productivity and promoting relevant research and technology adoption are most likely to be effective (Nelson et al., 2009).

Facilitate good access to credit support: "Facilitate good access to credit support" had the eighteenth highest EI based on descending rank order of EI among the items. Credit support of Banks are much more complicated. Credit support from NGOs and others sources is though available but interest rate is so high. So credit facilities is not available for the farmers. For this reason farmers perception is lower against it facilitate good access to credit support.

5.3 Item wise use of selected post-harvest practices of vegetables

To compare the use of selected post-harvest practices of vegetables items, Use Index (UI) was computed. The UI for each item calculation procedure was described in Chapter 3. The observed UI scores of the items ranged from 387 to 719 against the possible range of 0-750. UI scores of the each items and rank order is shown in Table 5.4.

Table 5.4 Use Index (UI) scores of the each items with rank order

Sl no.	Item of selected post-harvest practices	Number of Farmer					UI score	Rank Order
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)	Total		
1	Harvesting of vegetable according to appropriate harvesting maturity	211	16	21	2	250	**686**	**2**
2	Harvesting vegetables at appropriate harvesting time	171	34	31	14	250	**612**	**7**
3	Harvesting of vegetable with proper care to minimize mechanical injury/ damage	173	36	29	12	250	**620**	**6**
4	Sterilized knife or instrument for harvesting vegetables	177	45	19	9	250	**640**	**5**
5	Use hand	88	37	49	76	250	**387**	**15**

Sl no.	Item of selected post-harvest practices	Number of Farmer					UI score	Rank Order
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)	Total		
	gloves at harvesting time							
6	Keeping harvested vegetables in a shady place or pre-cooling	197	31	16	6	250	**669**	**3**
7	Proper washing of vegetables	128	43	8	71	250	**478**	**12**
8	Wiping or air drying of washed vegetables at shady place	118	39	9	84	250	**441**	**13**
9	Sorting of vegetables	228	13	9	0	250	**719**	**1**
10	Grading of vegetable according to size, shape and maturity or graders during field handling	185	43	12	10	250	**653**	**4**
11	Proper packing of vegetables	156	30	39	25	250	**567**	**8**
12	Plastic crate with covering wet & sanitized cloth	152	37	36	25	250	**566**	**9**
13	Line material for recommended vegetable	149	25	40	36	250	**537**	**10**
14	Safe transportation on time	136	51	11	52	250	**521**	**11**
15	Cold chain for vegetable storage	116	31	21	82	250	**431**	**14**
Total								

On the basis of descending order of UI (Table 5.4) of the each item of the use of selected post-harvest practices of vegetables, it was observed that, “Sorting of vegetables” ranked first followed by “Harvesting of vegetable according to appropriate harvesting maturity”, “Keeping harvested vegetables in a shady place or pre-cooling”, “Grading of vegetable according to size, shape and maturity or graders during field handling”, “Sterilized knife or instrument for harvesting vegetables”, “Harvesting of vegetable with proper care to minimize mechanical injury/ damage”, “Harvesting vegetables at appropriate harvesting time”, “Proper packing of vegetables”, “Plastic crate with covering wet & sanitized cloth”, “Line material for recommended vegetable”, “Safe transportation on time”, “Proper washing of vegetables”, “Wiping or air drying of washed vegetables at shady place”, “Cold chain for vegetable storage” and “Use hand gloves at harvesting time”. Based on descending rank order of EI, the effect items are described below:

Sorting of vegetables: Data in the Table 5.4 revealed that “Sorting of vegetables” had the highest UI (719) based on the descending order of UI of the items. Acedo et al. (2016) stated that sorting can add 40-60% more value to the produce. Sorting is done to remove damaged or diseased produce or those not meeting quality requirements. It is usually the main post-harvest activities of the farmers to produce good quality and safe vegetables to attract the buyers or exporters. Sorting aids should be used such as sorting tables, triple or ground cover. Sorting can reduce postharvest losses by preventing disease contamination of sound produce which otherwise occurs when sound and diseased produce is mixed.

Harvesting of vegetable according to appropriate harvesting maturity: Data in the Table 5.4 revealed that “Harvesting of vegetable according to appropriate harvesting maturity” had the second highest UI based on the descending order of UI of the items. Quality of vegetables cannot be improved after harvest. Therefore it very important to harvest vegetables at optimum maturity (Bachmann and Earles, 2000). Bitter Gourd, Brinjal and Teasel Gourd need to be harvest at immature stage but of full size (high yield) or size desired by markets before seeds begin to enlarge and harden. Firmness and glossiness are also maturity indicators and can be combined with the number of days elapsed from flowering (10-40 days depending on variety). Over mature fruit are pithy, bitter, hard and may show yellowing.

Keeping harvested vegetables in a shady place or pre-cooling: Data in the Table 5.4 revealed that "Keeping harvested vegetables in a shady place or pre-cooling" had the third highest UI based on the descending order of UI of the items. Field heat is usually high and undesirable at harvesting stage of many fruits and vegetables and should be removed as quickly as possible before any postharvest handling activity (Bachmann and Earles, 2000). Excessive field heat gives rise to an undesirable increase in metabolic activity and immediate cooling after harvest is therefore important (Akbudak et al., 2012). Harvesting vegetables when the sun is up is practiced since the produce is less brittle and more resistant to damage during subsequent handling. Therefore, harvested vegetables should be kept under shady place to reduce heat load and water loss. The vegetables should also be allowed to pre-cooling before packing and storage in cold storage. High product temperature accelerates quality deterioration due to increased water loss and respiration. Precooling minimizes the effect of microbial activity, metabolic activity, respiration rate, and ethylene production (Shahi et al., 2012), whilst reducing the ripening rate, water loss, and decay, thereby preserving quality and extending shelf life of harvested vegetables (Ferreira et al., 1994)

Grading of vegetable according to size, shape and maturity or graders: Data in the Table 5.4 revealed that "Grading of vegetable according to size, shape and maturity or graders during field handling" had the fourth highest UI based on the descending order of UI of the items. Grading is the process of categorizing fruits and vegetables on the basis of colour, size, stage of maturity, or degree of ripening. Grading can add 40-60% more value to the produce (Acedo et al., 2016). Grading facilitates production, packhouse operations and marketing when the quality grades used are recognized in a value chain or entire industry. Quality grades (or grade standards) serve as a universal language of trade and driver of technology adoption. Markets can place orders based on quality grades which will then be used to guide operations in the pack house and farms. Grading is done when the sorted defect-free produce is classified into grades or classes of specific weights or sizes (sizing) and maturity stage. It can be done after sorting or just before packing.

Sterilized knife or instrument for harvesting vegetables: Data in the Table 5.4 revealed that "Sterilized knife or instrument for harvesting vegetables" had the fifth highest UI based on the descending order of UI of the items. Vegetables should be cut with knife/scissor rather than snapped or twisted to avoid damage. Sterilized knife should be sharpened to reduce effort and lessen picker's fatigue.

Harvesting of vegetable with proper care to minimize mechanical injury/ damage: Data in the Table 5.4 revealed that "Harvesting of vegetable with proper care to minimize mechanical injury/ damage" had the sixth highest UI based on the descending order of UI of the items. Carefully harvest of vegetables needed to minimize physical injury and damage of plants and preserve quality of vegetables. Avoid pulling fruit to prevent removal of stem end and damage of plant and fruit for subsequent harvest. Pulling fruit from the plant may remove the pedicel, exposing the stem-end which is the cause for water loss and respiratory gases.

Harvesting vegetables at appropriate harvesting time: Data in the Table 5.4 revealed that "Harvesting vegetables at appropriate harvesting time" had the seventh highest UI based on the descending order of UI of the items. Harvesting of fruits should be done in either early or late hours of the day to avoid excessive field heat generation. Harvesting at cooler times of the day minimizes product heat load and increases work efficiency of pickers. Harvesting during or just after rain is not recommended as wet condition (rain water on the leaves or fruit) favors microbial growth and enhance tissue breakdown. If harvesting cannot be avoided during rainy days, the produce must be washed and dried properly before packaging.

Proper packing of vegetables: Data in the Table 5.4 revealed that "Proper packing of vegetables" had the eighth highest UI based on the descending order of UI of the items. Packaging should be designed to prevent physical damage to produce, and be easy to handle. Poor packaging is a one of major cause of post-harvest losses. It is enclosing food produce or product to protect it from mechanical injuries, tampering, and contamination from physical, chemical, and biological sources (Prasad and Kochhar, 2014). Package selection depends on the type of produce, distance and mode of transport, and market. Some common packaging materials used in most developing countries include wooden crates, cardboard boxes, woven palmbaskets,

plastic crates, nylon sacks, jute sacks, and polythene bags (Idah et al., 2007). Most of the abovementioned packaging materials do not give all the protection needed by the commodity. Whilst the majority of these packaging materials like the nylon sacks do not allow good aeration within the packaged commodity causing a build-up of heat due to respiration, others like the woven basket have rough surfaces and edges which cause mechanical injuries to the produce. Vegetable containers such as bamboo and plastic baskets, plastic crates, wooden crates are more advisable. Package should be done according to its' capacity. Farmers need to conscious on do not underpack (more vibration damage) or overpack (more compression damage). Modified Atmosphere Packaging (MAP) is the sealing of produce in plastic bags to establish an atmosphere of low oxygen and high carbon dioxide, and humid condition that slow metabolic processes and water loss. 25 micron-thick (with market label as 001 film) low-density polyethylene (LDPE), high-density PE (HDPE) or polypropylene (PP) films. Thicker films (002-004) are not advisable due to increased water condensation inside the bag that favors rotting. Benefits of MAP are high (Acedo et al., 2016)

Plastic crate with covering wet & sanitized cloth: Data in the Table 5.4 revealed that "Plastic crate with covering wet & sanitized cloth" had the ninth highest UI based on the descending order of UI of the items. Refrigerated van is not available during transporting, in this case farmers may use plastic crate with covering wet & sanitized cloth to protect the vegetables from direct sun heat. Fresh produce must be properly protected during transportation in order to minimize mechanical damage, temperature abuse, taint and contamination by food-borne pathogens.

Line material for recommended vegetable: Data in the Table 5.4 revealed that "Line material for recommended vegetable" had the tenth highest UI based on the descending order of UI of the items. Bamboo basket, woven basket have rough surfaces and edges which cause mechanical injuries to the vegetables. Ali et al. (2013) found that plastic crate lining with newspaper was selected as good package for minimizing physical damage during transportation.

Safe transportation on time: Data in the Table 5.4 revealed that "Safe transportation on time" had the eleventh highest UI based on the descending order of UI of the items. Transporting harvested vegetables to the market on such bad road network and

the lack of proper transportation like refrigerated vans become a big challenge for both producers and distributors (Abimbola, 2014). This challenge therefore causes unnecessary delays in getting the produce to the market. Meanwhile, any delay between harvest and consumption of vegetables can result in losses (Kader, 1986. Losses of up to about 20% are incurred by producers due to transportation delays (Babatola et al., 2008). Farmers, therefore make use of any available means of transport for their produce without considering its appropriateness in order to avoid delays. Some modes of transportation include human labour, public transport, rented trucks, busses, pick-up vans and rickshaw etc. Ali et al. (2013) found that the maximum physical damage (20%) was recorded in brinjal transported in open condition (without washing and without packaging) while it was minimum (1.53%) in both treated and untreated brinjal but carrying into plastic crates. It was calculated that the physical damage could be minimized (18.47%) through carrying of Brinjal with plastic crate compared to open condition. Lack of hygiene in transport can adversely affect quality of vegetables. To prevent contamination by foodborne pathogens, transport systems should follow good sanitation practices, ensure proper temperature and RH management, and minimize potential damage to the produce.

Proper washing of vegetables: Data in the Table 5.4 revealed that "Proper washing of vegetables" had the twelfth highest UI based on the descending order of UI of the items. Washing using clean water to remove adhering soil and other debris. After washing, the produce should be air-dried before packing. Ali et al. (2013) reported that washing in 100-200 ppm chlorine (mixing 4-8 tablespoons of commercial bleach, which has 5.25% sodium hypochlorite or NaOCl, per gallon of water) for 1-3 minutes can reduce microbial load and decay in Brinjal. The produce should be air-dried before packing.

Wiping or air drying of washed vegetables at shady place: Data in the Table 5.4 revealed that "Wiping or air drying of washed vegetables at shady place" had the thirteenth highest UI based on the descending order of UI of the items. Vegetables can be cleaned by wiping tomato, eggplant or cucumber with clean soft cloth under shady place. After washing vegetables, it is needed to air-dry under shady place before packing.

Cold chain for vegetable storage: Data in the Table 5.4 revealed that "Cold chain for vegetable storage" had the fourteenth highest UI based on the descending order of UI of the items. There is lack of cold-storage at farmer's field. On the other hand vegetables are perishable sensitive. To keep vegetables in cold storage is also expensive as well as there is no crop insurance. Therefore maximum farmers sold their product to avoid risk and loss.

Use hand gloves at harvesting time: Data in the Table 5.4 revealed that "Use hand gloves at harvesting time" had the fifteenth highest UI based on the descending order of UI of the items. Protective clothing, hand gloves should also be worn for pickers 'protection from plant hairs or trichomes (tomato, eggplant, cucumber, okra) or sap (chili) that may cause skin burning or allergy. Lack of awareness most of the farmers don't interested to wore protective cloth or hand gloves.

5.4 Item wise Comparative severity of the problems faced by the farmers in vegetable value chain

A problem is a situation preventing something from being achieved. The word comes from a Greek word meaning an "obstacle" (something that is in your way). Someone who has a problem must find a way of solving it. The means of solving a problem is called a "solution". Problem defined by Goode (1945) is any significant perplexing and challenging situation, real and artificial, the solution of which requires reflective "thinking". Problem faced, therefore, refers to the extent to which individual faces difficult situations about which something needs to be done. Farmers producing exportable vegetables often faced problem in vegetable value chain. There are various problem that faced by the farmers during post-harvest practices, among them only twenty six (26) problems were considered in this study. Item selection and measurement procedure of problem faced scale was described in Chapter 3 of this dissertation.

To compare the problem faced of different selected items, Problem Faced Index (PFI) was computed. The PFI for each item calculation procedure was described in Chapter 3. The observed PFI scores of the items ranged from 114 to 684 against the possible range of 0-750. PFI scores of the each items and rank order is shown in Table 5.5.

Table 5.5 Problem Faced Index (PFI) scores of the each items with rank order

Items of problem	Extent of problem faced					PFI scores	Rank order
	Severe Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)	Total		
A. Social problems							
1. Absence of exportable vegetable farmers association and support	19	24	28	179	250	**133**	**24**
2. Inadequate extension service to support exportable vegetable production	15	17	40	178	250	**119**	**25**
3. Absence of group based farming practice	21	25	51	153	250	**164**	**22**
4. Difficult to make communication with vegetable exporter	23	31	44	152	250	**175**	**21**
B. Technical problems							
5. Unavailability of appropriate inputs for exportable vegetable production	151	37	30	32	250	**557**	**6**
6. Lack of sufficient space for washing and drying vegetables	126	39	49	36	250	**505**	**8**
7. Difficult to sorting & grading according to exporters requirement	154	45	18	33	250	**570**	**5**
8. Absence of cool chain management	112	47	46	45	250	**476**	**9**
9. Insufficient packaging materials to meet up exporters wish	96	51	11	92	250	**401**	**11**
10. Absence of sufficient laboratory for quality test both inputs and exportable vegetables	88	39	9	114	250	**351**	**13**
C. Environmental problem							
11. Lack of weather information, early message of weather forecasting	45	39	48	118	250	**261**	**17**

Items of problem	Extent of problem faced					PFI scores	Rank order
	Severe Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)	Total		
12. Increase Insect & Disease attack during postharvest activities due to natural hazards	136	35	45	34	250	**523**	**7**
D. Marketing problems							
13. Lack of market information to the farmers such as prices, flow of the product	205	16	23	6	250	**670**	**2**
14. Lack of knowledge about the demand in the market	25	33	45	147	250	**186**	**20**
15. Poor linkage in the marketing channel from farmgate to exporters	78	32	18	122	250	**316**	**14**
16. Lack of linkage between farmer and agro-processing entrepreneurs	35	36	55	124	250	**232**	**18**
17. Lack of fair competition in the market price	217	11	11	11	250	**684**	**1**
18. Poor and inadequate roads for transportation for marketing	21	22	38	169	250	**145**	**23**
19. Lack of proper transport vehicle to maintain cool chain	92	43	8	107	250	**370**	**12**
20. Lack of storage facilities	109	25	50	66	250	**427**	**10**
21. No formal contract with value chain actors	19	12	33	186	250	**114**	**26**
22. Uncertainty of transportation strike	28	34	55	133	250	**207**	**19**
23. Undesirable involvement of middlemen	61	36	50	103	250	**305**	**15**
E. Psychological problems							
24. Pressure on time delivery to exporters	54	34	45	117	250	**275**	**16**
25. Pressure from Middleman to sell	159	43	32	16	250	**595**	**4**

Items of problem	Extent of problem faced					PFI scores	Rank order
	Severe Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)	Total		
produces at lower price							
26. Depression on sale of lower graded vegetables	183	36	20	11	250	**641**	**3**

On the basis of descending order of PFI, it was observed that, "Lack of fair competition in the market price" ranked first followed by "Lack of market information to the farmers such as prices, flow of the product, "Depression on sale of lower graded vegetables", "Pressure from Middlemen to sell produces at lower price", "Difficult to sorting & grading according to exporters requirement", "Unavailability of appropriate inputs for exportable vegetable production", "Increase Insect & Disease attack during postharvest activities due to natural hazards", "Lack of sufficient space for washing and drying vegetables", "Absence of cool chain management", "Lack of storage facilities, "Insufficient packaging materials to meet up exporters wish", "Lack of proper transport vehicle to maintain cool chain", "Absence of sufficient laboratory for quality test both inputs and exportable vegetables", "Poor linkage in the marketing channel from farmgate to exporters", "Undesirable involvement of middlemen", "Pressure for on-time delivery to exporters", "Lack of weather information, early message of weather forecasting", "Lack of linkage between farmer and agro-processing entrepreneurs", "Uncertainty of transportation strike", "Lack of knowledge about the demand in the market", "Difficult to make communication with vegetable exporter", "Absence of group based farming practice", "Poor and inadequate roads for transportation for marketing", "Absence of exportable vegetable farmers association and support", "Inadequate extension service to support exportable vegetable production, and "No formal contract with value chain actors".

5.5 Suggestions for solving problems faced by the farmers in vegetable value chain

To solve the problems of the farmers, they were asked to make three important suggestions against each problem. Based on the highest citation numbers, three suggestions of each problem are mentioned in Table 5.6

Table 5.6 Suggestions to mitigate the problems faced by the farmers

Sl. no.	Items of problem	Suggestions to mitigate the problem
A. Social problems		
1	Absence of exportable vegetable farmers association and support	1. Arranging motivational campaign for the Farmers' group leaders so that they can able to help other group farmers to produce good quality vegetables
		2. Arrangement of result demonstration and method demonstration for farmers regarding post-harvest practices - learning by seeing
		3. Arranging focus group discussion with Farmers' group leaders so that they can make them able to share learning and knowledge of post-harvest practices with others farmer
2	Inadequate extension service to support exportable vegetable production	1. Increase monitoring and evaluation of government and non-government extension service providing organizations
		2. Arranging more skill based training and motivations programmes for the individual extension service providers specially on exportable vegetable production
		3. Involvement of sufficient extension service providing individual in each organizations to help farmers to produce good quality and exportable vegetables
3	Absence of group based farming practice	1. Taking motivational initiatives by the Extension service providers towards the farmers that the group farming help them to reduce cost of production as well as increase income
		2. Creating farmers group leaders from who have small and medium land for producing exportable vegetables
		3. Providing training, credit facilities, free technical

Sl. no.	Items of problem	Suggestions to mitigate the problem
		support, market information, machineries support with low cost for group based farming by the Government agencies as well as private sectors
4	Difficult to make communication with vegetable exporter	1. Creating e-commerce platform to make communication with buyers/ exporters
		2. Making database of exportable vegetables producing farmers to give internet facilities with low cost with the help of concerned authority.
		3. Establishing B2B relationship between farmers and buyers/exporters
B. Technical problems		
5	Unavailability of appropriate inputs for exportable vegetable production	1. Establishing of farmers' co-operatives for distributing agricultural inputs to the farmers for producing exportable vegetables
		2. Strongly monitoring of the agricultural inputs quality timely by the relevant government agency
		3. Providing sufficient credit to the farmers for buying agricultural inputs
6	Lack of sufficient space for washing and drying vegetables	1. Establish collection point/center at near farm through farmers' co-operatives
		2. Government initiatives to give land lease to farmers co-operatives who are producing exportable vegetables
		3. Encourage private sector to establish collection point at nearby exportable vegetables producers farm/land
7	Difficult to sorting & grading according to exporters requirement	1. Capacity building of farmers through training on sorting and grading
		2. Providing sorting table or ground cover
		3. Use of rating scales (e.g. visual quality rating, color index, and defects rating) with quality and

Sl. no.	Items of problem	Suggestions to mitigate the problem
		color charts; colorimeter or chromameter (quantitative color); gloss meter; weighing scale; caliper(for size)
8	Absence of cool chain management	1. Establishment of shade at farm level with minimum cost
		2. The ice bottles are wrapped with newsprint paper and placed in the package to cool vegetables in transit to market
		3. Use of Knockdown/overhead hydro cooler (precooling) method at low cost to rapidly remove product heat before load in the cool chamber at cold storage.
9	Insufficient packaging materials to meet up exporters wish	1. Government can tie up with the packaging materials providing company
		2. Packing unit can be set up by the farmers' co-operative societies which will provide employment opportunities to the local people
		3. Reduce cost of packing materials
10	Absence of sufficient laboratory for quality test both inputs and exportable vegetables	1. Government initiatives to establish quarantine laboratory for quality test of inputs if possible at district level
		2.Government initiatives to establish quarantine laboratory for quality test of exportable vegetables if possible at division level
		3. Establishing laboratory for quality test through Public Private Partnership (PPP)
C. Environmental problem		
11	Lack of weather information, early message of weather forecasting	1. Developing weather forecasting through own satellite by government
		2. Delivering free early message to farmers on weather forecasting
		3. Offering internet package at minimum cost to the farmers

Sl. no.	Items of problem	Suggestions to mitigate the problem
12	Increase Insect & Disease attack during postharvest activities due to natural hazards	1. Develop disease forecasting facilities to proper control of pest during post-harvest activities
		2. Provide immediate suggestions and technical support for pest and disease control while post-harvest activities going on
		3. In case of severe attack during post-harvest activities, chemicals should be used at levels non-toxic to non-target organisms particularly humans
D. Marketing problems		
13	Lack of market information to the farmers such as prices, flow of the product	1. Planning vegetables wise group based farming to overcome access supply in the market
		2. Government portal can be developed showing the daily prices of vegetables
		3. Strengthening vegetables value chain to provide information on production, demand and supply of vegetables
14	Lack of knowledge about the demand in the market	1. Exhibitions and technical fair can be conducted for global market demand of vegetables
		2. Support of research institute, Export Promotion Bureau to provide global demand of vegetables
		3. Creating knowledge hub on global export import information at least union level
15	Poor linkage in the marketing channel from farmgate to exporters	1. Professional Networking buildup between the farmers and others value chain actors
		2. Strong monitoring system in vegetables value chain by government at each stage.
		3. Establishing semi processing unit through Public Private Partnership (PPP) near production area
16	Lack of linkage between farmer and	1. Emphasize on contract farming between the farmers and private food processing company the

Sl. no.	Items of problem	Suggestions to mitigate the problem
	agro-processing entrepreneurs	2. Outsourcing of vegetables can be done by the processing units
		3. NGOs can play a vital role as an intermediary between farmers and agri-entrepreneurs
17	Lack of fair competition in the market price	1. Strong monitoring for ensuring fair price of exportable vegetables
		2. Strengthening value chain to get fair price
		3. Facilitating mini cold storage for vegetables nearby market
18	Poor and inadequate roads for transportation for marketing	1. Construction of new roads, bridges etc.
		2. Rebuild the damage roads, bridges etc.
		3. Providing more budgets for increasing transportation facilities
19	Lack of proper transport vehicle to maintain cool chain	1. Provide refrigerated refer van for exportable vegetables transport in rural areas by Public Private Partnership (PPP)
		2. In non-refrigerated transport, evaporative cooling and Modified Atmosphere (MA) techniques can be applied
		3. Fuel cost need to decrease for transportation of exportable vegetable products
20	Lack of storage facilities	1. Construct storage facilities by private sector or co-operative societies for agricultural products specially for vegetables
		2. Motivational campaign by GO and private sector for using storage facilities for getting benefits
		3. Need to provide GOs subsidy for establishing low cost storing facilities at local level
21	No formal contract with value chain actors	1. Trust build up among the value chain actors
		2. Facilitate credit support and crop insurance for producing exportable vegetables
		3. Make win-win situation for the exportable

Sl. no.	Items of problem	Suggestions to mitigate the problem
		vegetable growers
22	Uncertainty of transportation strike	1. Giving flexibility in case of transporting exportable vegetables by Transport Federation during uncertain transport strike
		2. Immediate actions to resolve the strike by government in case of uncertain transport strike
		3. Developing and establishing crop insurance for exportable vegetables for uncertain transport strike by government
23	Undesirable involvement of middlemen	1. Government initiative to decrease the number of middle men for buying of agricultural inputs and selling of vegetables products
		2. Providing job facilities for the Middlemen in both public and private sector
		3. Development of vegetable value chain activities for the middlemen
E. Psychological problems		
24	Pressure for on- time delivery to exporters	1. Make business plan of vegetable exporting
		2. Maintain crop calendar and seasonality
		3. Provide technical support and rapport building with the farmers for on time cultivation
25	Pressure from Middleman to sell produces at lower price	1. Develop digital communication platform
		2. Develop market monitoring system
		3. Increase group selling by the farmers through motivational activities
26	Depression on sale of lower graded vegetables	1. Make skilled farmers through training on sorting and grading
		2. Ensure selling product in the local market with fair price
		3. Implementation of Good Agricultural Practices (GAP) to produce good quality vegetables to reduce lower grade

CHAPTER 6

CONTRIBUTION AND EFFECT OF SELECTED CHARACTERISTICS OF THE FARMERS TO/ON THEIR PERCEIVED EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET

The purpose of this Chapter is to examine the contribution and effect of selected characteristics of the farmers to/on their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Effects of using selected vegetables post-harvest practices is a multivariate phenomenon involving interaction of many factors. Past studies on effects of using selected vegetables post-harvest practices have brought to light a good number of characteristics of an individual that affect the perception behaviour. For this study nineteen (19) characteristics of the farmers were selected as the independent variables.

Effects of using selected post-harvest practices to strengthen vegetable export market (Y) was the dependent variable of this study. The procedure followed in measuring the dependent and independent variables have already been discussed in Chapter 3. Research and null hypotheses have been stated for testing the contribution/effect of the selected characteristics of the farmers to/on their perceived effects of using selected post-harvest practices to strengthen vegetable export market in Chapter 3. Pearson product moment correlation test was initially run to test the relationships between each of the selected characteristics of the farmers and their perceived effects of using selected post-harvest practices to strengthen vegetable export market. The result of correlation matrix containing inter-correlation among the variables is shown in Appendix-IX. However, the results of correlation co-efficient of each of the selected characteristics of the respondent farmers with their perceived effects of using selected post-harvest practices to strengthen vegetable export market are shown in Table 6.1.

Table 6.1 Results of correlation co-efficient of each of the selected characteristics of the respondent farmer with their perceived effects of using selected post-harvest practices to strengthen vegetable export market

Focus variable	Sample farmers characteristics	Value of Co-efficient of correlation (r)
Effects of using selected post-harvest practices to strengthen vegetable export market (Y)	Age (X_1)	0.123^{NS}
	Education(X_2)	0.005^{NS}
	Family agricultural labour (X_3)	0.073^{NS}
	Experience in vegetables cultivation (X_4)	0.044^{NS}
	Experience in exportable vegetables production (X_5)	0.244^{**}
	Exportable vegetables cultivation area (X_6)	0.205^{**}
	Exportable vegetables production (X_7)	0.211^{**}
	Annual family income (X_8)	0.221^{**}
	Exportable vegetables production and post-harvest practices cost (X_9)	0.199^{**}
	Credit received for exportable vegetables production (X_{10})	0.115^{NS}
	Training exposure on vegetables post-harvest practices (X_{11})	0.322^{**}
	Contact with value chain actors (X_{12})	0.275^{**}
	Contract with value chain actors (X_{13})	0.034^{NS}
	Depth of relationship with value chain actors (X_{14})	0.321^{**}
	Trust with value chain actors (X_{15})	0.420^{**}
	Extension contact (X_{16})	0.387^{**}
	Knowledge on selected vegetable post-harvest practices (X_{17})	0.398^{**}
	Use of selected vegetables post-harvest practices (X_{18})	0.464^{**}
	Problems faced in vegetable value chain (X_{19})	-0.463^{**}

^{NS}Not significant, *Significant at 0.05 Level, **Significant at 0.01 Level

Correlation analysis showed that out of nineteen (19) characteristics of the farmers, thirteen (13) had significant relationship with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. The characteristics of the farmers, Experience in exportable vegetables production (X_5), Exportable vegetables cultivation area (X_6), Exportable vegetables production (X_7), Annual family income (X_8), Exportable vegetables production and post-harvest practices cost (X_9), Training exposure on vegetables post-harvest practices (X_{11}), Contact with value chain actors (X_{12}), Depth of relationship with value chain actors (X_{14}), Trust with

value chain actors (X_{15}), Extension contact (X_{16}) Knowledge on selected vegetable post-harvest practices (X_{17}) and Use of selected vegetable post-harvest practices (X_{18}) of the sample farmers had significant positive relationship with their perceived effects of using selected post-harvest practices to strengthen vegetable export market. But Problems faced in vegetable value chain (X_{19}) of the farmers had significant negative relationship with their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

6.1 Contribution of the selected characteristics of the farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market

The independent variables in isolation would not give a comprehensive picture of the contribution of independent variables to their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Y). The different characteristics of the respondents may interact together to make a combined contribution to the effects of using selected post-harvest practices to strengthen vegetable export market. Keeping this fact in view linear multiple regression analysis was used to assess the contribution of the independent variables to the effects of using selected post-harvest practices to strengthen vegetable export market. Full model multiple regression analyses was initially run by involving all the independent variables with the effects of using selected post-harvest practices to strengthen vegetable export market.

It was observed that the full model regression results were misleading due to the existence of interrelationships among the independent variables. It was evident from correlation matrix showing the interrelationships among the independent variables and existence of contradiction in the sign of correlation co-efficient and regression co-efficient.

Droper and Smith (1981) suggested running stepwise multiple regression analysis to insert variables in turn until the regression equation is satisfactory. Therefore, in order to avoid the misleading results due to the problem of multi-collinearity and to determine the best explanatory variables, the method of step-wise multiple regression was employed by involving the following seven (7) sets of independent variables with

the effects of using selected post-harvest practices to strengthen vegetable export market. The objective of the step wise multiple regression models were to find out the contribution of the variables, which were significant only. Results of these seven (7) sets of step wise multiple regression analysis in the form of table or equation have been discussed below:

Set-I

All the selected nineteen (19) independent variables of this study were fitted together in this set of step wise multiple regression with the effects of using selected post-harvest practices to strengthen vegetable export market (Y) as the dependent variable. Table 6.2 revealed the summarized results of step-wise multiple regression analysis showing the contribution of all the nineteen (19) selected characteristics of the farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. It was observed that out of nineteen (19) independent variables only six (6) variables namely, Use of selected vegetables post-harvest practices (X_{18}), Problems faced in vegetable value chain (X_{19}), Knowledge on selected vegetable post-harvest practices (X_{17}), Exportable vegetables production (X_7), Experience in exportable vegetables production (X_5) and Extension contact (X_{16}) were entered into regression equation.

Table 6.2 Summary of stepwise multiple regression analysis showing the contribution of all the 19 independent variables to the effects of using selected post-harvest practices to strengthen vegetable export market

Variables entered	Standardized partial 'b' coefficient	Value of 't' (with probability level)	Adjusted R^2	Increase in R^2	Variation explained in percent
Use of selected vegetables post-harvest practices (X_{18})	0.233	3.824 (0.000)	0.213	0.213	21.3
Problems faced in vegetable value chain (X_{19})	-0.164	-2.002 (0.046)	0.301	0.088	8.80
Knowledge on selected vegetable post-harvest practices (X_{17})	0.150	2.534 (0.012)	0.320	0.019	1.90
Exportable vegetables production (X_7)	0.161	3.094 (0.002)	.336	0.016	1.60
Experience in exportable vegetables production (X_5)	0.152	2.845 (0.005)	0.351	0.015	1.50
Extension contact (X_{16})	0.153	1.979 (0.0449)	0.359	0.008	0.80
Total				**0.359**	**35.9**

Multiple R = 0.612
R-square = 0.374
Adjusted R - square = 0.359
F-ratio = 24.242 at 0.000 level of significance

The remaining variables i.e. Age (X_1), Education (X_2), Family agricultural labour (X_3), Experience in vegetables cultivation (X_4), Exportable vegetables cultivation area (X_6), Annual family income (X_8), Exportable vegetables production and post-harvest practices cost (X_9), Credit received for exportable vegetables production (X_{10}), Training exposure on vegetables post-harvest practices (X_{11}), Contact with value chain actors (X_{12}), Contract with value chain actors (X_{13}), Depth of relationship with value chain actors (X_{14}) and Trust with value chain actors (X_{15}) were not entered into the regression equation.

Data presented in Table 6.2 indicated that the multiple R, R^2 and adjusted R^2 in the step-wise multiple regression analysis were 0.612, 0.374 and 0.359 respectively, and the corresponding F-ratio of 24.242 was significant at 0.000 level. The regression equation so obtained is presented below:

$Y = 21.876 + 0.233(X_{18}) - 0.164(X_{19}) + 0.150\ (X_{17}) +$ $0.161\ (X_7) + 0.152\ (X_5) + 0.153\ (X_{16})$	Adjusted $R^2 = 0.359$ F-ratio = 24.242 Constant = 21.876

This indicated that the whole model of nineteen (19) variables explained 35.9 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta weight) of six (6) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these six (6) variables.

Set-II

Thirteen (13) independent variables (significant in Pearson product moment correlation) were fitted together in this set of step-wise multiple regression with effects of using selected post-harvest practices to strengthen vegetable export market (Y) as the dependent variable. It was observed that out of thirteen (13) independent variables only six (6) variables namely, Use of selected vegetables post-harvest practices (X_{18}), Problems faced in vegetable value chain (X_{19}), Knowledge on selected vegetable post-harvest practices (X_{17}), Exportable vegetables production (X_7), Experience in exportable vegetables production (X_5) and Extension contact (X_{16}) were entered into regression equation. This produce same result as Set-I.

The regression equation also found same as Set-I is presented below:

$Y = 21.876 + 0.233(X_{18}) - 0.164(X_{19}) + 0.150\ (X_{17}) +$ $0.161\ (X_7) + 0.152\ (X_5) + 0.153\ (X_{16})$	Adjusted $R^2 = 0.359$ F-ratio = 24.242 Constant = 21.876

This indicated that the whole model of thirteen (13) variables explained 35.9 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta

weight) of six (6) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these six (6) variables.

Set-III

Only selected five (5) personal variables i.e. Age (X_1), Education (X_2), Family agricultural labour (X_3), Experience in vegetables cultivation (X_4), Experience in exportable vegetables production (X_5) under this set were fitted together into step-wise multiple regression as the independent variables with the effects of using selected post-harvest practices to strengthen vegetable export market (Y) as the dependent variable. It was observed that out of 5 independent variables only two (2) variables namely, Experience in exportable vegetables production (X_5) and Experience in vegetables cultivation (X_4) were entered into the regression equation. The regression equation so obtained is presented below:

$Y = 42.728 + 0.436 (X_5) - 0.268 (X_4)$	Adjusted $R^2 = 0.087$ F-ratio = 12.871 Constant = 42.728

This indicated that the whole model of five (5) variables explained 8.7 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta weight) of two (2) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these 2 variables.

Set-IV

Only selected five (5) economical variables i.e. Exportable vegetables cultivation area (X_6), Exportable vegetables production (X_7), Annual family income (X_8), Exportable vegetables production and post-harvest practices cost (X_9), Credit received for exportable vegetables production (X_{10}) were fitted together as the independent variables in this Set-IV of step-wise multiple regression with the effects of using selected post-harvest practices to strengthen vegetable export market (Y) as the dependent variable. It was observed that out of five(5) independent variables only 4 variables namely, Annual family income (X_8), Credit received for exportable vegetables production (X_{10}), Exportable vegetables production (X_7) and Exportable

vegetables production and post-harvest practices cost (X_9) were entered into the regression equation. The regression equation so obtained is presented below:

$Y = 35.145 + 0.612 (X_8) - 0.764 (X_{10}) + 0.203 (X_7) + 0.342 (X_9)$	Adjusted $R^2 = 0.145$ F-ratio = 11.526 Constant = 35.145

This indicated that the whole model of five (5) variables explained 14.5 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta weight) of four (4) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these four (4) variables.

Set-V

Only selected 6 social variables i.e. Training exposure on vegetables post-harvest practices (X_{11}), Contact with value chain actors (X_{12}), Contract with value chain actors (X_{13}), Depth of relationship with value chain actors (X_{14}), Trust with value chain actors (X_{15}) and Extension contact (X_{16}) were fitted together as the independent variables in this Set-V of step-wise multiple regression with the effects of using selected post-harvest practices to strengthen vegetable export market (Y) as the dependent variable. It was observed that out of six (6) independent variables only three (3) variables namely, Trust with value chain actors (X_{15}), Extension contact (X_{16}) and Depth of relationship with value chain actors (X_{14}) were entered into the regression equation. The regression equation so obtained is presented below:

$Y = 32.073 + 0.661 (X_{15}) + 0.309 (X_{16}) - 0.434 (X_{14})$	Adjusted $R^2 = 0.249$ F-ratio = 28.517 Constant = 32.073

This indicated that the whole model of 6 variables explained 24.9 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta weight) of three (3) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these three (3) variables.

Set-VI

Only selected three (3) professional variables i.e. Knowledge on selected vegetable post-harvest practices (X_{17}), Use of selected vegetables post-harvest practices (X_{18}) and Problems faced in vegetable value chain (X_{19}) were fitted together as the independent variables in this Set-VI of step-wise multiple regression with the effects of using selected post-harvest practices to strengthen vegetable export market (Y) as the dependent variable. It was observed that out of three (3) independent variables all three (3) variables namely, Use of selected vegetables post-harvest practices (X_{18}), Problems faced in vegetable value chain (X_{19}) and Knowledge on selected vegetable post-harvest practices (X_{17}) were entered into the regression equation. The regression equation so obtained is presented below:

$Y = 28.154 + 0.269 (X_{18}) - 0.293 (X_{19}) + 0.169 (X_{17})$	Adjusted $R^2 = 0.320$ F-ratio = 40.069 Constant = 28.154

This indicated that the whole model of three (3) variables explained 32 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta weight) of three (3) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these three (3) variables.

Set-VII (Final model)

After running above six sets of stepwise multiple regression analysis, it was found that twelve (12) individual variables namely, Experience in vegetables cultivation (X_4), Experience in exportable vegetables production (X_5), Exportable vegetables production (X_7), Annual family income (X_8), Exportable vegetables production and post-harvest practices cost (X_9), Credit received for exportable vegetables production (X_{10}), Depth of relationship with value chain actors (X_{14}), Trust with value chain actors (X_{15}), Extension contact (X_{16}), Knowledge on selected vegetable post-harvest practices (X_{17}), Use of selected vegetables post-harvest practices (X_{18}) and Problems faced in vegetable value chain (X_{19}) were significant in either one or more sets. Attempt has been made to run stepwise multiple regression analysis by these twelve (12) independent variables with the effects of using selected post-harvest practices to

strengthen vegetable export market (Y) as the dependent variable. Table 6.3 revealed the summarized results of step-wise multiple regression analysis showing the contribution of all the twelve (12) independent variables to the effects of using selected post-harvest practices to strengthen vegetable export market. It was observed that out of twelve (12) independent variables only six (6) variables namely, Use of selected vegetables post-harvest practices (X_{18}) Problems faced in vegetable value chain (X_{19}), Knowledge on selected vegetable post-harvest practices (X_{17}), Exportable vegetables production (X_7), Experience in exportable vegetables production (X_5) and Extension contact (X_{16}) were entered into regression equation. It was also found that result of this set of stepwise multiple regression analysis was exactly same as the result of set-I and set-II. The results of this model is again shown in Table 6.3 and treated as the final model. The result of full model of stepwise regression is shown in Appendix-VIII.

Table 6.3 Summary of stepwise multiple regression analysis showing the contribution of all the twelve (12) independent variables to the effects of using selected post-harvest practices to strengthen vegetable export market

Variables entered	Standardized partial 'b' coefficient	Value of 't' (with probability level)	Adjusted R^2	Increase in R^2	Variation explained in percent
Use of selected vegetables post-harvest practices (X_{18})	0.233	3.824 (0.000)	0.213	0.213	21.3
Problems faced in vegetable value chain (X_{19})	-0.164	-2.002 (0.046)	0.301	0.088	8.80
Knowledge on selected vegetable post-harvest practices (X_{17})	0.150	2.534 (0.012)	0.320	0.019	1.90
Exportable vegetables production (X_7)	0.161	3.094 (0.002)	.336	0.016	1.60
Experience in exportable vegetables production (X_5)	0.152	2.845 (0.005)	0.351	0.015	1.50
Extension contact (X_{16})	0.153	1.979 (0.049)	0.359	0.008	0.80
Total				**0.359**	**35.9**

Variables entered	Standardized partial 'b' coefficient	Value of 't' (with probability level)	Adjusted R^2	Increase in R^2	Variation explained in percent
Multiple R = 0.612					
R-square = 0.374					
Adjusted R - square = 0.359					
F-ratio = 24.242 at 0.000 level of significance					
The remaining variables i.e. Experience in vegetables cultivation (X_4), Annual family income (X_8), Exportable vegetables production and post-harvest practices cost (X_9), Credit received for exportable vegetables production (X_{10}), Depth of relationship with value chain actors (X_{14}) and Trust with value chain actors (X_{15}) were not entered into the regression equation of set-VII. Another seven variables namely, Age (X_1), Education (X_2), Family agricultural labour (X_3), Exportable vegetables cultivation area (X_6), Training exposure on vegetables post-harvest practices (X_{11}), Contact with value chain actors (X_{12}) and Contract with value chain actors (X_{13}) were not entered into regression equation of set-I and set-II.					

Data presented in Table 6.3 indicated that the multiple R, R^2 and adjusted R^2 in the step-wise multiple regression analysis were 0.612, 0.374 and 0.359 respectively, and the corresponding F-ratio of 24.242 was significant at 0.000 level. The regression equation so obtained is presented below:

$Y = 21.876 + 0.233(X_{18}) - 0.164(X_{19}) + 0.150 (X_{17}) + 0.161 (X_7) + 0.152 (X_5) + 0.153 (X_{16})$	Adjusted $R^2 = 0.359$ F-ratio = 24.242 Constant = 21.876

This indicated that the whole model of nineteen (19) variables explained 35.9 percent of the total variation in effects of using selected post-harvest practices to strengthen vegetable export market. But since the standardized regression coefficients (Beta weight) of six (6) variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these six (6) variables.

Results of stepwise multiple regression analysis of this set again indicated that the Use of selected vegetables post-harvest practices (X_{18}) of the sample farmers was by far the most important characteristic which strongly and positively influenced their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Knowledge on selected vegetable post-harvest practices (X_{17}), Exportable vegetables production (X_7) and Experience in exportable vegetables production (X_5) also had remarkable positive influence on effects of using selected post-harvest practices to strengthen vegetable export market. Extension contact (X_{16}) had somewhat positive influence on the effects of using selected post-harvest practices to strengthen vegetable export market. Problems faced in vegetable value chain (X_{19}) had negative influence on the effects of using selected post-harvest practices to strengthen vegetable export market. Since the rest thirteen (13) variables or characteristics of the farmers did not enter into the regression model, it was inferred that these thirteen (13) characteristics either had multi-collinearity problem or had minimum contribution to the total explained variation of 35.9 percent.

Analysis of data presented in different Tables (Table 6.2 and Table 6.3) and regression equations indicated that in different combinations, standardized partial regression co-efficient of six (6) independent variables were significant out of nineteen (19) independent variables with the effects of using selected post-harvest practices to strengthen vegetable export market. It was observed that regression co-efficient between some of these six (6) independent variables and effects of using selected post-harvest practices to strengthen vegetable export market as dependent variable had different probability levels (0.000 to 0.049) in different sets. It could logically happen due to the existence of interrelationship among the different independent variables. Similar observations were experienced by different researchers like Supe and Singh (1972), Pathak and Mazumdar (1978), Pathak (1981), Hossain (1987), Karim et al. (1992) and Ali (2008). Result of set-I, set-II and Set-VII was exactly same and the result of set-VII was treated as the final model which may otherwise be considered as the best explanatory model.

On the basis of set-VII of stepwise regression analysis, contributions of significant six (6) independent variables to effects of using selected post-harvest practices to

strengthen vegetable export market as the dependent variable are presented below in order of importance.

Use of selected vegetables post-harvest practices (X_{18}): The co-efficient of correlation showed significant positive relationship between the use of selected vegetables post-harvest practices (X_{18}) of the farmers and their effects of using selected post-harvest practices to strengthen vegetable export market (Appendix-IX).

Step-wise multiple regression analysis indicated that use of selected vegetables post-harvest practices (X_{18}) of the farmers had strong significant and positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Use of selected vegetables post-harvest practices (X_{18}) was by far found to be the most important positive contributor to the effects of using selected post-harvest practices to strengthen vegetable export market. Use of selected vegetables post-harvest practices (X_{18}) of the farmers increases their positive perception on the effects of using selected post-harvest practices to strengthen vegetable export market. From the stepwise multiple regressions, it was concluded that use of selected vegetables post-harvest practices (X_{18})of the farmers had first highest positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. This implies that with the increase of use of selected vegetables post-harvest practices (X_{18}) of the farmers will increase their positive perception on the effects of using selected post-harvest practices to strengthen vegetable export market.

Problems faced in vegetable value chain (X_{19}): Pearson product moment correlation co-efficient revealed that Problems faced in vegetable value chain (X_{19}) by the farmers had significant but negative correlation with their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Appendix-IX).

Step-wise multiple regression analysis indicated that Problems faced in vegetable value chain (X_{19}) of the sample farmers was an important contributor and had significant but negative contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market

Some farmers thought that there were some problems in vegetables post-harvest value chain in Bangladesh. It is quite logical that the farmers who faced more problems in vegetables post-harvest value chain were not satisfied on producing and exporting vegetables in Bangladesh in a larger scale. This might be the reason for problems faced in vegetable value chain (X_{19}) having the negative contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Knowledge on selected vegetable post-harvest practices (X_{17}): The co-efficient of correlation also showed significant positive relationship between knowledge on selected vegetables post-harvest practices (X_{17}) of the farmers and their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Appendix-IX).

Step-wise multiple regression analysis indicated that knowledge on selected vegetable post-harvest practices (X_{17}) of the farmers had significant and positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Knowledgeable person could understand the merits and demerits of anything easily in a short time. By the motivational programme and training of BFVAPEA, GOs and NGOs, the farmers could improve their knowledge on selected vegetable post-harvest practices. Therefore, farmers having high knowledge on selected vegetable post-harvest practices perceived high effects of using selected post-harvest practices to strengthen vegetable export market. This was supported by the studies of Masram (1999), Asaduzzaman (2002), Islam (2003), Rabbany (2003), Hamidi (2004) and Ali (2008).

Exportable vegetables production (X_7): Pearson product moment correlation co-efficient revealed that exportable vegetables production (X_7) of the farmers had positive relationship with their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Appendix-IX).

Step-wise multiple regression analysis indicated that exportable vegetables production (X_7) of the farmers was an important significant positive contributor to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Exportable vegetables production (X7) increases the income of sample farmers to sell good quality exportable vegetables to the buyers. Different agricultural advisory service providing organizations of Bangladesh are providing various types of training on good agricultural practices and suitable vegetable post-harvest practices in the present study area including other areas of Bangladesh to their target people. As a result, the farmers of Bangladesh are now capable to produce more export quality vegetables by using selected post-harvest practices. This might be the reason for exportable vegetables production (X_7) of the farmers had positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Experience in exportable vegetables production (X_5): Pearson product moment correlation co-efficient revealed that experience in exportable vegetables production (X_5) of the farmers had positive significant relationship with their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Appendix-IX).

Step-wise multiple regression analysis indicated that experience in exportable vegetables production (X_5) of the farmers had strong significant and positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Experienced person could understand the production process of vegetables production easily in a short time. By the production of exportable vegetables using selected post-harvest practices could improve their agricultural activities. Therefore, farmers having high experience in exportable vegetables production could easily produce good quality vegetables to attract and satisfy the buyers. This might be the reason for experience in exportable vegetables production (X_5) of the farmers had the positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Extension contact (X_{16}): Pearson product moment correlation co-efficient revealed that extension contact (X_{16}) of the farmers had significant positive correlation with their perceived effects of using selected post-harvest practices to strengthen vegetable export market (Appendix-IX).

Step-wise multiple regression analysis indicated that extension contact (X_{16}) of the farmers was an important contributor and had significant but positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

Actually mass farmers of the study area as well as Bangladesh were satisfied on agricultural service providers including GOs and NGOs in Bangladesh. Different agricultural extension service providing organizations, mass media and individuals are working for dissemination of agricultural information like vegetables post-harvest practices to the farmers. Local farmer group leaders, neighboring farmers and input dealers are also providing necessary information to the farmers. Therefore, it may be said that the farmers having greater extension contact with the local individual sources, mass media, concerned GOs officials, NGOs and Associations officials obviously had higher perceived effects of using selected post-harvest practices to strengthen vegetable export market. This might be the reason for extension contact (X_{16}) of the farmers had the positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Hamidi (2004) found a significant relationship between the communication exposure of the farmers and their adoption of IPM practices in rice cultivation. Ali (2008) found a significant relationship between the NGO contact of the farmers and their adoption of ecological agricultural practices.

6.2 Direct and Indirect effects of the selected characteristics of the farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market

In the present study Pearson product moment correlation test, full model linear multiple regression and stepwise multiple regression were conducted. It is not possible to find out the direct effects and indirect effects separately by these tests. But, in path analysis, it is possible to get direct effects and indirect effects separately.

Path coefficient is simply a standardized partial regression coefficient and as such measures the direct influence of one variable upon another and permits the separation of the correlation coefficient into components of direct and indirect effects (Dewey and Lu, 1959). This allows the reflection of direct effect of an independent variable and its indirect effect through other variables on the dependent variable (Sasmal and Chakrabarty, 1978).

Direct effect of an independent variable on the dependent variable is the standardized beta co-efficient (value of 'b' of regression analysis) of the respective independent variable. Whereas indirect effect of an independent variable through a channeled variable is measured by the following formula:

$e = \Sigma\ b \times r$

Where,

e = Total indirect effect of an independent variable

b = Direct effect of the Variable through which indirect effect is channeled

r = Correlation co-efficient between respective independent variable and variable through which indirect effect is channeled.

Path coefficient analysis was employed in order to obtain clear understanding of the direct and indirect effects of selected independent variables. Path analysis was done involving the significant variables of step-wise multiple regression analysis. Path coefficients showing the direct and indirect effects of significant 6 independent variables of step-wise multiple regression analysis on the farmers' perception on the effects of using selected post-harvest practices to strengthen vegetable export market have been presented in Table 6.4.

Analysis of data furnished in Table 6.3 indicated that among the independent variables, Use of selected vegetables post-harvest practices (X_{18}) of the farmers had the highest direct effect (0.233) in the positive direction effect on their perception on the effects of using selected post-harvest practices to strengthen vegetable export market. Exportable vegetables production (X_7), Extension contact (X_{16}) and Experience in exportable vegetables production (X_5) had appreciable positive direct effect in the positive direction on farmers' perception on the effects of using selected

post-harvest practices to strengthen vegetable export market and their direct effect were 0.161, 0.153 and 0.152 respectively. Knowledge on selected vegetables post-harvest practices (X_{17}) of the farmers had the lowest direct positive effect (0.150) to their perception on the effects of using selected post-harvest practices to strengthen vegetable export market. Problems faced in vegetable value chain (X_{19}) had direct negative effect (-0.164) on farmers' perception on the effects of using selected post-harvest practices to strengthen vegetable export market.

Here, it may be mentioned that without path co-efficient analysis it is not possible to know the indirect effects of an independent variable through other variables on the dependent variable. Therefore, emphasis has been given on the indirect effects which have been obtained from path co-efficient analysis (Table 6.4).

knowledge on selected vegetable post-harvest practices (X_{17}) had the highest (0.248) total indirect effect followed by extension contact (X_{16}), use of selected vegetables post-harvest practices (X_{18}), experience in exportable vegetables production (X_5) and exportable vegetables production (X_7) had appreciable total indirect effect while the problems faced in vegetable value chain (X_{19}) by the farmers had the negative total indirect effect (-0.299) to their perception on the effects of using selected post-harvest practices to strengthen vegetable export market.

Table 6.4 Path coefficients showing the direct and indirect effects of 6 significant independent variables of stepwise multiple regression analysis on the farmers' effects of using selected post-harvest practices to strengthen vegetable export market

Independent variables	Variables through which indirect effects are channeled	Indirect effects	Total indirect effect	Direct effect
Knowledge on selected vegetables post-harvest practices (X_{17})	Use of selected vegetables post-harvest practices (X_{18})	0.106	0.248	0.150
	Problems faced in vegetables post-harvest value chain (X_{19})	0.060		
	Extension contact (X_{16})	0.045		
	Experience in exportable vegetables production (X_5)	0.035		
	Exportable vegetables production (X_7)	0.002		

Independent variables	Variables through which indirect effects are channeled	Indirect effects	Total indirect effect	Direct effect
Extension contact (X_{16})	Problems faced in vegetables post-harvest value chain (X_{19})	0.123	0.234	0.153
	Use of selected vegetables post-harvest practices (X_{18})	0.058		
	Knowledge on selected vegetables post-harvest practices (X_{17})	0.044		
	Exportable vegetables production (X_7)	0.007		
	Experience in exportable vegetables production (X_5)	0.002		
Use of selected vegetables post-harvest practices (X_{18})	Knowledge on selected vegetables post-harvest practices (X_{17})	0.068	0.231	0.233
	Problems faced in vegetables post-harvest value chain (X_{19})	0.066		
	Extension contact (X_{16})	0.038		
	Experience in exportable vegetables production (X_5)	0.033		
	Exportable vegetables pro	0.025		
Experience in exportable vegetables production (X_5)	Use of selected vegetables post-harvest practices (X_{18})	0.051	0.091	0.152
	Knowledge on selected vegetables post-harvest practices (X_{17})	0.035		
	Problems faced in vegetables post-harvest value chain (X_{19})	0.019		
	Extension contact (X_{16})	0.002		
	Exportable vegetables production (X_7)	-0.016		
Exportable vegetables production (X_7)	Use of selected vegetables post-harvest practices (X_{18})	0.036	0.049	0.161
	Problems faced in vegetables post-harvest value chain (X_{19})	0.019		
	Extension contact (X_{16})	0.007		
	Knowledge on selected vegetables post-harvest practices (X_{17})	0.002		
	Experience in exportable vegetables production (X_5)	-0.015		
Problems faced in vegetables post-harvest value chain (X_{19})	Experience in exportable vegetables production (X_5)	-0.018	-0.299	-0.164
	Exportable vegetables production (X_7)	-0.019		
	Knowledge on selected vegetables post-harvest practices (X_{17})	-0.055		
	Use of selected vegetables post-harvest practices (X_{18})	-0.094		
	Extension contact (X_{16})	-0.114		

On the basis of path analysis, the independent variables having indirect effects on effects of using selected post-harvest practices to strengthen vegetable export market have been presented below in descending order.

Knowledge on selected vegetable post-harvest practices (X_{17}): Path analysis (Table 6.4) showed that knowledge on selected vegetable post-harvest practices (X_{17}) of the sample farmers had the highest total indirect effect (0.248) and a positive direct effect of 0.150 on their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

The indirect effect was mostly channeled positively through use of selected vegetables post-harvest practices (X_{18}). The indirect effect of knowledge on selected vegetables post-harvest practices (X_{17}) was somewhat positively channeled through problems faced in vegetables post-harvest value chain (X_{19}), extension contact (X_{16}) and experience in exportable vegetables production (X_5). There was negligible indirect effect of knowledge on selected vegetables post-harvest practices (X_{17}) of the farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market through exportable vegetables production (X_7).
It may be inferred that other variables remaining constant, knowledge on selected vegetables post-harvest practices (X_{17}) had an influence on the effects of using selected post-harvest practices to strengthen vegetable export market and was a determinant of the effects of using selected post-harvest practices to strengthen vegetable export market.

Extension contact (X_{16}): Path analysis (Table 6.4) showed that extension contact (X_{16}) of the sample farmers had the 2nd highest total indirect effect (0.234) and a positive direct effect of 0.153 on their perceived effects of using selected post-harvest practices to strengthen vegetable export market

The indirect effect was mostly channeled positively through problems faced in vegetable value chain (X_{19}). The indirect effect of extension contact (X_{16}) was somewhat positively channeled through use of selected vegetables post-harvest practices (X_{18}) and knowledge on selected vegetables post-harvest practices (X_{17}). There was negligible indirect effect of extension contact (X_{16}) of the farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable

export market through exportable vegetables production (X_7) and experience in exportable vegetables production (X_5).

It may be inferred that other variables remaining constant, extension contact (X_{16}) had an influence on the effects of using selected post-harvest practices to strengthen vegetable export market and was a determinant of the effects of using selected post-harvest practices to strengthen vegetable export market.

Use of selected vegetables post-harvest practices (X_{18}): Path analysis (Table 6.4) showed that use of selected vegetables post-harvest practices (X_{18}) of the sample farmers had the 3rd highest total indirect effect (0.231) and a positive direct effect of 0.233 on their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

The indirect effect was mostly channeled positively through knowledge on selected vegetable post-harvest practices (X_{17}) and problems faced in vegetable value chain (X_{19}).
The indirect effect of use of selected vegetables post-harvest practices (X_{18}) of the farmers on their effects of using selected post-harvest practices to strengthen vegetable export market was somewhat positively channeled through extension contact (X_{16}), experience in exportable vegetables production (X_5) and exportable vegetables production (X_7).

It may be inferred that other variables remaining constant, use of selected vegetables post-harvest practices (X_{18}) had an influence on the effects of using selected post-harvest practices to strengthen vegetable export market and was a determinant of the effects of using selected post-harvest practices to strengthen vegetable export market.

Experience in exportable vegetables production (X_5): Path analysis (Table 6.4) showed that experience in exportable vegetables production (X_5) of the sample farmers had the 4th total indirect effect (0.091) and a positive direct effect of 0.152 on their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

The indirect effect was mostly channeled positively through use of selected vegetables post-harvest practices (X_{18}). The indirect effect of experience in exportable vegetables production (X_5) was somewhat positively channeled through knowledge on selected vegetable post-harvest practices (X_{17}) and problems faced in vegetable value chain (X_{19}). There was negligible indirect effect of experience in exportable vegetables production (X_5) of the farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market through extension contact (X_{16}) and exportable vegetables production (X_7).

It may be inferred that other variables remaining constant, experience in exportable vegetables production (X_5) had an influence on the effects of using selected post-harvest practices to strengthen vegetable export market and was a determinant of the effects of using selected post-harvest practices to strengthen vegetable export market.

Exportable vegetables production (X_7): Path analysis (Table 6.4) showed that experience in exportable vegetables production (X_5) of the sample farmers had the 5th total indirect effect (0.049) and a positive direct effect of 0.161 on their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

The indirect effect was mostly channeled positively through use of selected vegetables post-harvest practices (X_{18}). The indirect effect of exportable vegetables production (X_7) was somewhat positively channeled through problems faced in vegetable value chain (X_{19}). There was negligible indirect effect of exportable vegetables production (X_7) of the farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market through extension contact (X_{16}), knowledge on selected vegetable post-harvest practices (X_{17}) and experience in exportable vegetables production (X_5).

It may be inferred that other variables remaining constant, exportable vegetables production (X_7) had an influence on the effects of using selected post-harvest practices to strengthen vegetable export market and was a determinant of the effects of using selected post-harvest practices to strengthen vegetable export market.

Problems faced in vegetable value chain (X_{19}): Path analysis (Table 6.4) showed that problems faced in vegetable value chain (X_{19}) of the sample farmers had a total negative indirect effect (-0.299) and a negative direct effect of -0.164 on their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

There were negligible indirect negative effect of problems faced in vegetable value chain (X_{19}) of the farmers on their effects of using selected post-harvest practices to strengthen vegetable export market through experience in exportable vegetables production (X_5), exportable vegetables production (X_7), knowledge on selected vegetable post-harvest practices (X_{17}), use of selected vegetables post-harvest practices (X_{18}) and extension contact (X_{16}).

It may be inferred that other variables remaining constant, problems faced in vegetable value chain (X_{19}) had an influence on the effects of using selected post-harvest practices to strengthen vegetable export market and was a determinant of the effects of using selected post-harvest practices to strengthen vegetable export market.

CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

7.1.1 Introduction

Postharvest practices referred to best practices and simple, low-cost technologies and innovations to reduce losses, enhance quality and food safety, and increase profitability of producers or farm enterprise. In Bangladesh Hortex Foundation, Bangladesh Fruits, Vegetables & Allied Products Exporter's Association (BFVAPEA) are working with farmers, value chain actor to apply proper post-harvest practices to reduce losses and get quality produces. In this study, these practiced was considered as post-harvest practices of vegetables. It involves various steps such as harvesting, field handling, packinghouse operations (such as pre-cooling, washing, cleaning, wiping, drying, sorting, grading, treatment), packaging, storage, transport, handling in markets and at home.

Reduction of post-harvest losses can increase food availability to the growing world population, decrease the area needed for production, and conserve natural resources. Strategies for loss prevention include: (1) use of genotypes that have longer post-harvest-life; (2) use of integrated crop management systems and Good Agricultural Practices that result in good keeping quality of the commodity; and (3) use of proper post-harvest handling practices in order to maintain the quality and safety of fresh produce.

Bangladesh has achieved a significant growth in exporting vegetables. Bangladesh is the 3rd highest vegetable producing country in the world. The export volume of vegetables of Bangladesh was 2,937.92 MT in the FY 2017-18 and earned 609.69 million BDT in FY 2017-18 (BBS, 2018[c]).The country exports vegetables to more than 40 countries, though the expatriate Bangladeshis are the main consumers of our

exported vegetables. The growing trend in export suggests that Bangladesh has significant potential to increase exports of vegetables to international markets.

7.1.2 Objectives of the study

The following specific objectives were formulated by the researcher for this study:

1. To describe some selected personal, economical, social and professional characteristics of the farmers
2. To determine and describe the extent of effects of using selected post-harvest practices to strengthen vegetable export market as perceived by the farmers
3. To compare the item wise effects of using selected post-harvest practices to strengthen vegetable export market
4. To compare the uses of selected post-harvest practices to strengthen vegetable export market
5. To compare the severity of the problems faced by farmers for using selected post-harvest practices to strengthen vegetable export market entire vegetable value chain and to suggest for mitigating the problems
6. To explore the contribution of the selected characteristics of farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market
7. To explore the effects of the selected characteristics of farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market

7.1.3 Methodology

Three upazilas namely Belabo, Raipura and Shibpur of Narsingdi district were selected purposively based on the intensity of BFVAPEA activity. A total of 717 farmers of the selected three upazilas of Narsingdi district are actively producing and exporting Bitter Gourd, Brinjal and Teasel Gourd with the help of BFVAPEA. These 717 farmers was considered as the population of the study.

By using sample size calculation formula and sample size calculator, 250 respondents founded the sample of the study. Proportionate random sampling technique was used for selecting sample from farmers' group formed by BFVAPEA in different villages

of different unions of three selected upazilas under Narsingdi district. Ten percent of the population was selected through proportionate random sampling procedure to include in the reserve list. Finally 250 farmers were included in the sample by taking 91, 75 and 84 farmers for Bitter Gourd, Brinjal and Teasel Gourd respectively. Data were collected by the researcher himself through face to face interviewing of the selected farmers by using Bengali interview schedule. The data were collected during the period from August 01, 2019 to November 31, 2019.

The 19 selected characteristics of the farmers were considered as independent variables of the study and these were (a) personal characteristics - age, education, family agricultural labour, experience in vegetables cultivation, experience in exportable vegetables production, (b) economical characteristics - exportable vegetables cultivation area, exportable vegetables production, annual family income, exportable vegetables production and post-harvest practices cost, credit received for exportable vegetables produces, (c) social characteristics - training exposure on vegetables post-harvest practices, contact with value chain actors, contract with value chain actors, depth of relationship with value chain actors, trust with value chain actors, extension contact and (d) professional characteristics - knowledge on selected vegetables post-harvest practices, use of selected vegetables post-harvest practices and problems faced in vegetable value chain. Effects of using selected post-harvest practices to strengthen vegetable export market constituted the dependent variable of the study.

IBM SPSS Statistics 24 was used for data analysis. Descriptive statistical measures including number & percentage distribution, range, mean, standard deviation and co-efficient of variance were used for describing both the independent and dependent variables. Rank order was made whenever necessary. Tables were also used in presenting data for clarity of understanding. Initially, Pearson Product Moment correlation and Full model regression analysis was also done. Due to misleading results from multi-collinearity, stepwise multiple regression was used to find out the contribution of the independent variables to the dependent variable. Finally, path analysis was done to find out the direct and indirect effects of the independent variables separately on the dependent variable. Five percent (0.05) level of probability was used as the basis for rejection of any null hypothesis throughout the study. Co-

efficient values significant at 0.05 level is indicated by one asterisk (*), and that at 0.01 level by two asterisks (**) and at 0.001 level or above by three asterisks (***). For determining comparative effects of items, comparative use of post-harvest practices items and severity of the problems, rank order were made based on the descending order of the Effects Index (EI), Use Index (UI) and Problems Faced Index (PFI) respectively.

7.1.4 Statement of hypotheses

The following null hypothesis formulated for testing the conceptual model of the study was:

"There is no significant contribution/effect of the selected nineteen (19) characteristics of the farmers to/on their perceived effects of using selected post-harvest practices to strengthen vegetable export market".

7.1.5 Characteristics profile of the farmers

Personal characteristics

Age: About two-third (64.80%) of the farmers were middle aged compared to 25.20 percent being young and 10 percent old.

Education: Highest proportion (37.20%) of the farmers had secondary level of education, followed by 33.20 percent primary level, 20.40 percent higher secondary level of education, 6.40 percent graduate level of education and rest 2.80 percent respondents could sign his/her name only. These finding indicated that about cent percent (97.20%) of the respondents were literate with primary to tertiary level of education.

Family agricultural labour: Two-thirds (67.60%) had medium number of family members engaged in agriculture farming, followed by 19.60 percent having small number of family members and 12.80 percent had large number of family members engaged in agriculture farming.

Experience in vegetables cultivation: Majority (77.20%) of the farmers had medium farming experience in vegetables cultivation, followed by 15.60 percent having long farming experience in vegetables cultivation and 7.20 percent had short farming experience in vegetables cultivation. Findings again revealed that overwhelming

majority (84.40%) of the farmers had short to medium farming experience in vegetables cultivation.

Experience in exportable vegetables cultivation: Two-thirds proportion (68.00%) had medium experience in exportable vegetables cultivation, followed by 16.40 percent having short experience in exportable vegetables cultivation and 15.60 percent had long experience in exportable vegetables cultivation. Findings again revealed that overwhelming majority (83.60%) of the farmers had medium to high experience in exportable vegetables cultivation.

Economical characteristics

Exportable vegetables cultivation area: Highest proportion (82.00%) of the farmers had medium exportable vegetables cultivation area, followed by 14.40 percent having large exportable vegetables cultivation area and 3.60 percent had small exportable vegetables cultivation area. Findings again revealed that overwhelming majority (96.40 percent) of the farmers had medium to high exportable vegetables cultivation area.

Exportable vegetables production Two-third (69.60%) of the farmers had medium volume of exportable vegetables production, followed by 17.60 percent having large volume of exportable vegetables production and 12.80 percent had small volume of exportable vegetables production. Findings again revealed that overwhelming majority (87.20%) of the farmers had medium to high volume of exportable vegetables production.

Annual family income: The most (77.20%) of the farmers had medium income, followed by 16.40 percent having high income and 6.40 percent had low income. Findings again revealed that overwhelming majority (83.60%) of the farmers had low to medium income.

Exportable vegetables production and post-harvest practices cost: Two-third (66.80%) of the farmers had medium cost, followed by 16.80 percent having high cost and 16.40 percent had low cost. Findings again revealed that overwhelming majority (83.60 percent) of the farmers had medium to high cost for exportable vegetable production and post-harvest practices cost.

Credit received for exportable vegetables production: About three-fourth (74.80%) of the farmers received medium credit, followed by 16.00 percent high credit and 9.20 percent low credit. Findings again revealed that overwhelming majority (90.80%) of the farmers received medium to high amount of credit for exportable vegetable production.

Social Characteristics

Training exposure on vegetables post-harvest practices: Two-third (68.80%) of the farmers had medium training exposure, followed by 18.80 percent having high training exposure and 12.40 percent had low training exposure on vegetable post-harvest practices. Findings again revealed that overwhelming majority (87.60%) of the farmers had medium to high training exposure on vegetable post-harvest practices.

Contact with value chain actors: Two-third (67.20%) of the farmers had medium contact, followed by 20.00 percent having high contact and 12.80 percent had low contact with the value chain actor. Findings again revealed that overwhelming majority (87.20%) of the farmers had medium to high contact with value chain actors.

Contract with value chain actors: Most (71.20%) of the farmers had written contract and 28.80 having Memorandum of Understanding (MOU) or formal Deed with the value chain actors. It means that all the farmers were contracted with the value chain actors either by written or by MOU or Deed.

Depth of relationship with value chain actors: Majority (71.20%) of the farmers had medium relationship, followed by 16.40 percent having high relationship and 12.40 percent had low relationship with value chain actor. Findings again revealed that overwhelming majority (87.60%) of the farmers had medium to high relationship with value chain actors.

Trust with value chain actors: Most (80.00%) of the farmers had medium trust, followed by 13.20 percent having low trust and 6.80 percent had high trust with value chain actors. Findings again revealed that overwhelming majority (86.80%) of the farmers had medium to high trust with value chain actor.

Extension contact: Majority (55.20%) of the farmers had medium extension contact, followed by 31.60 percent having low extension contact and 13.20 percent had high

extension contact. Findings again revealed that two-third (68.40%) of the farmers had medium to high extension contact.

Professional characteristics

Knowledge on selected vegetable post-harvest practices: Majority (79.20%) of the farmers had medium knowledge, followed by 14.80 percent having low knowledge and 6.00 percent had high knowledge on selected vegetable post-harvest practices. Findings again revealed that overwhelming majority (85.20%) of the farmers had medium to high knowledge on selected vegetable post-harvest practices.

Use of selected vegetables post-harvest practices: Nearly two-thirds (64.40%) of the farmers had medium use, followed by 19.60 percent having low use and 16.00 percent had high use of selected vegetables post-harvest practices. Findings again revealed that overwhelming majority (80.40 percent) of the farmers had medium to high use.

Problems faced in vegetable value chain: Majority (84.00%) of the farmers had medium problem on post-harvest practices in vegetable value chain compared to 10.40% and 5.60% having high and low problem on post-harvest practices in vegetable value chain respectively. Data again revealed that majority (89.60%) of the farmers had low to medium problems faced in post-harvest practices in vegetable value chain.

7.1.6 Effects of using selected post-harvest practices to strengthen vegetable export market

Extent of effects of using selected post-harvest practices: Overwhelming majority (83.60%) of the farmers perceived that the use of selected post-harvest practices was medium to high effective to strengthen vegetable export market. It clearly indicates that adopted post-harvest practices aided to produce good quality vegetables for exporting. It might be due to various post-harvest activities done by farmers in the study area. Concerned GOs, NGOs and Associations also played an important role by providing training to the farmers on vegetables post-harvest practices for producing export quality vegetable.

Item wise comparative effects of using post-harvest practices: on the basis of descending order of EI, it was observed that "Increase net income" ranked first and "Facilitate good access to credit support" ranked lowest.

7.1.7 Item wise use of selected post-harvest practices of vegetables:

On the basis of descending order of UI, it was observed that "Sorting of vegetables" ranked first and "Use hand gloves at harvesting time" ranked lowest.

7.1.8 Item wise comparative severity of the problem faced by the farmers in vegetable value chain

On the basis of descending order of PFI, it was observed that, "Lack of fair competition in the market price" ranked first and "No formal contract with value chain actors" ranked lowest.

7.1.9 Contribution of the selected characteristics of the farmers to their perceived effects of using selected post-harvest practices to strengthen vegetable export market

Stepwise multiple regression showed that 6 independent variables combinedly explained 35.9 percent of the total variation. Use of selected vegetables post-harvest practices (X_{18}) of the sample farmers was by far the most important characteristic which strongly and positively influenced their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Knowledge on selected vegetable post-harvest practices (X_{17}), Exportable vegetables production (X_7) and Experience in exportable vegetables production (X_5) also had remarkable positive influence on effects. Extension contact (X_{16}) had somewhat positive influence on the effects. Problems faced in vegetable value chain (X_{19}) had negative influence on the effects of using selected post-harvest practices to strengthen vegetable export market. Since the rest thirteen (13) variables or characteristics of the farmers did not enter into the regression model, it was inferred that these thirteen (13) characteristics either had multi-collinearity problem or had minimum contribution to the total explained variation of 35.9 percent.

7.1.10 Direct and Indirect effects of the selected characteristics of the farmers on their perceived effects of using selected post-harvest practices to strengthen vegetable export market

Path coefficients showed the direct and indirect effects of significant variables on their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Path analysis showed that knowledge on selected vegetable post-harvest practices (X_{17}) of the sample farmers had the highest total indirect effect (0.248) on their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Extension contact (X_{16}) of the sample farmers had the 2nd highest total indirect effect (0.234). Use of selected vegetables post-harvest practices (X_{18}) of the sample farmers had the 3rd highest total indirect effect (0.231) and a positive direct effect of 0.233 on their perceived effects. Experience in exportable vegetables production (X_5) of the sample farmers had the 4th total indirect effect (0.091) on their perceived effects. Experience in exportable vegetables production (X_5) of the sample farmers had the 5th total indirect effect (0.049) on their perceived effects. Problems faced in vegetable value chain (X_{19}) of the sample farmers had a total negative indirect effect (-0.299) on their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

7.2 Conclusions

Conclusion is the final decision or judgment, which is placed through contention at the end or termination of a research work. On the basis of the findings, discussion and logical interpretation, the following conclusions were drawn:

i. Overwhelming majority (83.60%) of the farmers perceived that the use of selected post-harvest practices was medium to high effective to strengthen vegetable export market. It clearly indicates that adopted post-harvest practices aided to produce good quality vegetables for exporting. Various activities is being done by the farmers in the study area on post-harvest practices to strengthen vegetable export market. It is therefore, concluded that there is scope to work for those who perceived lower effects of using selected post-harvest practices to strengthen vegetable export market.

ii. The large majority (80.40%) of the farmers had medium to high use of vegetables post-harvest practices. Findings indicated that use of selected

vegetables post-harvest practices of the farmers had strong significant and positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. It is therefore, concluded that with the increased use of post-harvest practices, the farmers could increase their positive perception on the effects of using selected post-harvest practices to strengthen vegetable export market.

iii. Overwhelming majority (85.20%) of the farmers had medium to high knowledge on selected vegetable post-harvest practices. Findings indicated that knowledge on selected vegetable post-harvest practices of the farmers had significant and positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it may be concluded that farmers having higher knowledge on selected vegetable post-harvest practices perceived higher effects of using selected post-harvest practices to strengthen vegetable export market.

iv. Overwhelming majority (87.20%) of the farmers had medium to high volume of exportable vegetables production. Findings indicated that exportable vegetables production of the farmers was an important significant positive contributor to their perceived effects of using selected post-harvest practices in strengthening vegetable export market. So, it may be concluded that, the farmers of Bangladesh are now capable to produce more export quality vegetables by using selected post-harvest practices. Increase of volume of export quality vegetables may increase their positive perception on the effects of using selected post-harvest practices to strengthen vegetable export market.

v. Overwhelming majority (83.60%) of the farmers had medium to high experience in exportable vegetables production. There existed a positive significant contribution of the farmers experience in exportable vegetable production and their perceived effects of using selected post-harvest practices to produce quality vegetables. Therefore, it may be concluded that the perceived effects of using selected post-harvest practices to strengthen vegetable export market was higher to the farmers who are experienced in exportable vegetable production.

vi. Two-thirds (68.40%) of the farmers had medium to high extension contact. Findings indicated that extension contact of the farmers had significant positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. So, it may be concluded that if the farmers come in more contact with extension service providers, mass media, they could be more aware to the use selected post-harvest practices to produce export quality vegetables.

vii. Overwhelming majority (89.60%) of the farmers faced low to medium problems in post-harvest practices in vegetable value chain. Problems faced in vegetable value chain by the farmers had negative contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. It is therefore, logically concluded that mitigation of problems of farmers can increase their perceived effects of using selected post-harvest practices to strengthen vegetable export market.

7.3 Recommendations

7.3.1 Recommendations for policy implication

i. Overwhelming majority (83.60%) of the farmers perceived that the use of selected post-harvest practices was medium to high effective to strengthen vegetable export market. Since, nearly 16 percent of the farmers had still perceived low effects, there is yet to be done much activities in this regard to make the use of selected post-harvest practices to strengthen vegetable export market more effectively. It may be therefore, recommended that concerned GOs and extension service providers should take initiatives for extension activities related to post-harvest practices, market linkage among value chain actors especially exporters with farmers, so that farmers could increase export quality vegetables and increase their income by exporting vegetables. It could be done through use of post-harvest practices in producing export quality vegetables.

ii. Use of post-harvest practices of the farmers had positive significant contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it may be recommended that the extension service providers should take initiative to

promote the use of modern tools for vegetable harvest, determine appropriate harvesting time and maturity stage of vegetables to reduce post-harvest losses during transportation, introduce low cost post-harvest treatment to reduce losses and ensure better quality of vegetables, create awareness regarding sorting, proper grading and packing of vegetables. Provide refer van during transporting vegetables at low cost or through forming farmers group. To meet up demand for good quality vegetables in both domestic and export markets, concerned GOs need to develop crop specific cold chains for vegetables.

iii. Knowledge on selected post-harvest practices of the farmers had significant positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Knowledgeable person could understand the benefits of using selected post-harvest practices easily in a short time and by the training programme. Therefore, it may be recommended that the concerned authorities (extension service providers) should arrange training programme on post-harvest technology for their target people so that they could improve their knowledge on post-harvest practices to strengthen vegetable export market.

iv. There existed a positive significant contribution of the farmers' exportable vegetable production to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Production volume of vegetables is increased when reduce of wastage of vegetables is possible. To reduce postharvest loss and to maintain quality and safety of fruits and vegetables both for domestic and export purposes, a comprehensive policy for postharvest practices of vegetables is urgently needed. So it is recommended that that concerned GOs need to develop low cost cold chain management, facilitate infrastructure development such as established pack house or shady place near farmers field to do post-harvest activities by the farmers easily.

v. Experience in exportable vegetables production of the farmers had significant contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. that So, it is

strongly recommended adequate technical support, motivational campaign and training facilities should be extended to the young and low experienced farmers so that they could perform better farming activities by using proper post-harvest practice to produce export quality vegetables.

vi. Extension contact of the farmers had significant positive contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it may be recommended that national and local motivational campaign including training and technical support should be provided by the concerned extension service providers like Department of Agricultural Extension (DAE), concerned GOs, NGOs and private extension providers to strengthen their extension delivery mechanism in connection with vegetable post-harvest practices in a larger scale.

viii. Farmers are have been facing various problems in using post-harvest practices in vegetable value chain. It has negative contribution to their perceived effects of using selected post-harvest practices to strengthen vegetable export market. Therefore, it may be recommended that, necessary steps should be taken by extension service providers to mitigate these problems so that farmers can improve post-harvest activities which in turn make their perceived effects of using selected post-harvest practices for production of export quality vegetables.

7.3.2 Recommendations for future study

On the basis of scope and limitations of the present study and the observations made by the researcher, the following recommendations have been made for further study:

i. This study was conducted in selected three upazilas namely Belabo, Raipura and Shibpur of Narsingdi districts of Bangladesh, It is recommended that such studies should be conducted in other areas of Bangladesh.

ii. Factors of the farmers were many and varied, but in the present study only 19 factors on personal, economical, social and professional aspects were taken into consideration. Obviously, there are other variables which cause variations in the effects of using selected post-harvest practices to

strengthen vegetable export market. Further research should be conducted involving other variables.

iii. There were many and vast subject-matter areas of post-harvest but in the present study, post-harvest practices related to only vegetables was considered. Further research is needed in connection with effects of using selected post-harvest practices related to fruits, flower, spices etc.

iv. There were many effects of using selected post-harvest practices to strengthen vegetable export market, but only 18 effects items were considered for this study. Further research is needed to determine the effects of using selected post-harvest practices to strengthen vegetable export market of other effects items.

v. This study identified the social, economical, psychological, technical and marketing problems of vegetable value chain. Further research is needed to identify other problems of vegetable value chain.

vi. This study identified the problems of selected post-harvest practices only. Further research is needed to identify and solve other problems of post-harvest practices by promoting GOs, NGOs and private extension providers separately.

7.4 Message from the study

Use of selected post-harvest practices was effective to strengthen vegetable export market. To make it more effective, training should be provided to the farmers related to post-harvest practices. Vegetable-specific guidelines or training manual should be prepared for production export quality vegetables. Vegetable-specific cool chain should be developed or established for exporting vegetables. Shady place or pack house need to establish through concerned GOs or Public Private Partnership near to farmers' field to do post-harvest activities by the farmers. This can be effective to reduce post-harvest loss as well as produce good quality and safe vegetable to strengthen vegetable export market.

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APPENDICES

Appendix- I

Department of Agricultural Extension & Information System

Sher-e-Bangla Agricultural University, Dhaka – 1207

Interview schedule for **farmer** to conduct research on

"EFFECTS OF USING SELECTED POST-HARVEST PRACTICES TO STRENGTHEN VEGETABLE EXPORT MARKET"

Sample No.

Name of farmer: Mobile phone #

Address:

Village……Union……

Thana……District……..

(Please provide following information. Your information will be kept confidential and will be used for research purpose only)

A. Personal characteristics

1. Age

How old are you? …… years.

2. Education

Please put tick mark (√) in the appropriate parenthesis or mention your level of education.

i) Can't read and write ( )
ii) Can't read and write but can sign only ( )
iii) I learnt reading and writing from adult learning center ( )
iv) I read upto class ……

3. Family agricultural labor

Please mention the number of your family members engaged in vegetables production as agricultural labor.

Sl. no.	Age range of the family member	Number of family member
1	Child (Below 14)	
2	Adolescent (14 to 18)\	
3	Adult (Above 18)	
Total family member		

4. Experience in vegetables cultivation

How many years you are producing vegetables? ……..... (Years)

5. Experience in exportable vegetables production

How many years you are producing exportable vegetables? ..... (Years)

B. Economical characteristics

6. Exportable vegetables cultivation area

Please furnish the following information about your vegetables cultivation area in this year.

Sl. no.	Name of vegetables	Cultivation area	
		Local unit	Hectare
1	Brinjal		
2	Bitter Gourd		
3	Teasle Gourd		
Total			

7. Exportable vegetables production

Please furnish the following information about your exportable vegetables production in this year.

Sl. no.	Name of vegetables	Total production (Kg)
1	Brinjal	
2	Bitter Gourd	
3	Teasle Gourd	
Total		

8. Annual family income

Please mention your annual family income from vegetables production and others.

Sl. no.	Sources of income	Amount (BDT)
1	Brinjal	
2	Bitter Gourd	
3	Teasle Gourd	
4	Income from other agricultural sources	
5	Income from non-agricultural sources	
Total income		

9. Exportable vegetables production and post-harvest practices cost

Please give the following information about your vegetables produces cost in this year.

Sl. no.	Name of the Items of cost		Brinjal (BDT)	Bitter Gourd (BDT)	Teasle Gourd (BDT)
a) Vegetable cultivation cost					
1.	Land lease				
2.	Seed and Seedling				
3.	Land preparation				
4.	Planting/Transplanting				
5.	Fertilizers	Cow dung			
		Compost/ Vermi Compost			
		Khoil			
		USP			
		TSP			
		MP			
		Gypsum			
		Zink			
		Boron			

Sl. no.	Name of the Items of cost	Brinjal (BDT)	Bitter Gourd (BDT)	Teasle Gourd (BDT)
6.	Pheromones, Spraying pesticide			
7.	Irrigation			
8.	Intercultural operation			
9.	Miscellaneous cost			
a) Sub-total of vegetable cultivation cost				
b) Post-harvest value chain cost				
10.	Harvesting			
11.	Washing			
12.	Drying & pre-cooling			
13.	Sorting			
14.	Grading			
15.	Processing/Treatment			
16.	Packaging			
17.	Transportation			
18.	Quality compliances cost			
b) Sub-total of post-harvest value chain cost				
Total vegetable produces cost =(a+b)				

10. Credit received for exportable vegetables production

Please mention your financial source(s) from where you received credit for vegetables production from different sources this year.

Sl. no.	Source of finance	Amount of BDT ('000' BDT)
1	Own	
2	Relatives	
3	Dadon/Mohajon(s)	
5	Cooperative(s)	
6	NGO(s)	
7	Middlemen (Faria, Aratdar,Paiker etc)	
8	Exporter(s)	
9	Bank(s)	
10	Others	
Total		

C. Social characteristics

11. Training on vegetables post-harvest practices

Did you receive any kind of agricultural training related to vegetable post-harvest practices? Please put tick mark (√) in the appropriate parenthesis.

Yes ( ) No ( ).

If yes please furnish the following information -

Sl. no.	Name of training course	Duration (days)	Conducting organization and place
1			
2			
3			
4			
5			
Total			

12. Contact with value chain actors

Please mention your extent of contact with the following value chain actors.

Sl. no.	Value chain actors	Extent of contact							
		Always (7)	Once in a day (6)	Once in a week (5)	Once in a fortnight (4)	Once in a month (3)	Once in a quarter (2)	Once in a year (1)	No contact (0)
1	Agricultural inputs dealer								
2	Faria								
3	Paiker/ Bepari								
4	Aratdar								
5	Wholesaler								
6	Retailer								
7	Superstore								
8	Exporter								

13. Contact with value chain actors

Please mention your contract with value chain actors by putting tick (√) in the appropriate row.

Sl. no.	Kinds of contract	Answer
1	MOU/Deed	
2	Written contract	
3	Verbal contract	
4	No contract	
Total		

14. Depth of relationship with value chain actors

Please mention your depth of relationship with the following value chain actors.

Sl. no.	Value chain actors	Depth of relationship					
		Very high (5)	High (4)	Substantial (3)	Little (2)	Very little (1)	No (0)
1	Agricultural inputs dealer						
2	Faria						
3	Paiker/ Bepari						
4	Aratdar						
5	Wholesaler						
6	Retailer						
7	Superstore						
8	Exporter						

15. Trust with value chain actors

Please mention your level of trust with the following value chain actors.

Sl. no.	Value chain actors	Level of trust					
		Very high (5)	High (4)	Substantial (3)	Little (2)	Very little (1)	No (0)
1	Agricultural inputs dealer						
2	Faria						
3	Paiker/ Bepari						
4	Aratdar						
5	Wholesaler						
6	Retailer						
7	Superstore						
8	Exporter						

16. Extension contact

Please give the information about the extent of contact with the following different communication media.

Sl. no.	Different communication media	Extent of extension contact			
		Regularly (3)	Occasionally (2)	Rare (1)	Not at all (0)
Personal communication exposure					
1	With Neighbor farmers	>4 times /month	3-4 times /month	1-2 times /month	No contact
2	With relatives engaged in agricultural production	>4 times /month	3-4 times /month	1-2 times /month	No contact
3	Farmers' group leaders	>4 times /month	3-4 times /month	1-2 times /month	No contact
4	Agricultural input dealers (seed, Fertilizer, Pesticides etc)	>4 times /quarter	3-4 times /quarter	1-2 times /quarter	No contact
5	Use of call center to get agricultural related information	>4 times /month	3-4 times /month	1-2 times /month	No contact
6	Use of mobile apps to get agricultural knowledge	>4 times /month	3-4 times /month	1-2 times /month	No contact
Extension GO officials					
7	Sub Assistant Agriculture Officer (SAAO)	>4 times /quarter	3-4 times /quarter	1-2 times /quarter	No contact
8	Agricultural Extension Officer (AEO)	>4 times /month	3-4 times /month	1-2 times /month	No contact
9	Upazilla Agriculture Officers (UAO)	>4 times /six months	3-4 times /six months	1-2 times /six months	No contact
10	District or above Level Agricultural Officers	>4 times /year	3-4 times /year	1-2 times /year	No contact
NGO/ Co-Operative Society/Association/Foundation officials					
11	Unit level Agro based NGO officials	>4 times /quarter	3-4 times /quarter	1-2 times /quarter	No contact
12	Upazila/ District Level Agro based NGO officials	>4 times /six months	3-4 times /six months	1-2 times /six months	No contact

Sl. no.	Different communication media	Extent of extension contact			
		Regularly (3)	Occasionally (2)	Rare (1)	Not at all (0)
13	Central Agro based NGO personnel	>4 times /year	3-4 times /year	1-2 times /year	No contact
14	Unit level Agro based Co-Operative Society/ Association/ Foundation Officials	>4 times /quarter	3-4 times /quarter	1-2 times /quarter	No contact
15	Central Agro based Co-Operative Society/ Association/Foundation Officials	>4 times /six months	3-4 times /six months	1-2 times /six months	No contact
Group Communication					
16	Focus group discussion regarding agricultural issues	>4 times /year	3-4 times /year	1-2 times /year	No contact
17	Farmer's field day	>4 times /life	3-4 times /life	1-2 times /life	No contact
18	Method demonstration of agriculture	>4 times /life	3-4 times /life	1-2 times /life	No contact
19	Result demonstration of agriculture	>4 times /life	3-4 times /life	1-2 times /life	No contact
Mass Media					
20	Hearing agricultural program on Radio	>4 times /week	3-4 times /week	1-2 times /week	No contact
21	Watching agricultural program on Television	5-6 times /week	3-4 times /week	1-2 times /week	No contact
22	Agricultural features in Daily newspapers / web based news paper	>4 times /week	3-4 times /week	1-2 times /week	No contact
23	Agricultural issues based Leaflet/folder	>4 times /year	3-4 times /year	1-2 times /year	No contact
24	Agricultural magazines	>4 times /year	3-4 times /year	1-2 times /year	No contact
25	Agricultural Film show	>4 times /life	3-4 times /life	1-2 times /life	No contact
26	Agricultural fair	>4 times /life	3-4 times /life	1-2 times /life	No contact

D. Professional characteristics

17. Knowledge on selected vegetables post-harvest practices

Please answer the following questions by putting tick (√) mark.

Item no.	Items of post-harvest knowledge test
Remembering	
1	Which is the best time of harvesting? □At Morning □ At Noon □ At Midnight
2	Which is the better stage to harvest Brinjal, Bitter Gourd and Teasle Gourd? □ At younger and tender □ at yellowing □both of none
3	Which is the best stage of vegetable harvesting? □ Optimum Maturity □ Over Maturity □ Both of None
4	Where you keep your harvested vegetable

Item no.	Items of post-harvest knowledge test
	□ At shady place □ Open , sunny place □ Both of None
Understanding	
5	Why you don't harvest Brinjal, Bitter Gourd and Teasle Gourd at over mature stage? □ Over mature fruit are pithy, hard and may show yellowing. □ Over mature fruit are soft, and never show yellowing □ Both of two
6	Why do you harvest vegetable carefully? □ To minimize physical injury □ To preserve quality □ Both of two
7	Which activities will add value of your produces? □ Proper use of post-harvest practices □ Post-harvest practices don't need □ Both of none
8	What will you do to produce safe food? □ Don't spray pesticide. Insecticide day before harvesting □ Spray pesticide, insecticide just before harvesting □ Spray pesticide, insecticide day before harvesting
Applying	
9	How do you harvest Brinjal, Bitter Gourd and Teasle Gourd? □ By using sanitized clipper, shear or knife □ Don't use sanitized clipper, shear or knife □ Both of the above two
10	How do you remove infected, pest attacked, diseased and damage vegetables? □ By sorting □ By Transporting □ By marketing
11	How do you grade your vegetables? □ According to size, shape & color □ According to graders □ Both of the two
12	Which packaging is good while transporting? □ Bamboo basket □ Plastic/wooden crates with inner cardboard □ Both of above two
Analyzing	
13	Why farmers don't show interest to use selected post-harvest practices? □ Most of them have no pack house for doing post-harvest activities □ Need extra time, money, labour □ Both of above two
14	Why washing is needed to get quality produces? □ To remove adhering soil and other debris by washing □ Washing increases damaged vegetable produces □ Washing add insect pest
15	Why farmers don't get better price? □ Farmers don't do sorting and grading practices properly □ Farmers do sorting and grading practices properly □ Both of above two
16	How underpack or over pack effects on quality produces while transporting your vegetables? □ Under pack causes more vibration damage □Over pack more compression damage □ Both of above two
Evaluating	
17	What is the disadvantages of harvested vegetables keeping in sun or rain □ Quality improve □ Quality Deteriorate □ Both of none
18	What is the merit of use of lining material for Brinjal and Bitter Gourd? □ Post-harvest loss will be minimize □ Post-harvest Loss will be increase □ Decrease market price
19	What is the disadvantaged if there is no pack house near field? □ cleaning, pre-cooling, sorting, grading, pre-treatments, packing, storage and dispatch to market activities is difficult to do □ Unsafe food □ Both of two
20	What is the benefit of use of selected post-harvest practices properly? □ Lower market price □ Unsafe food □ Add value in entire value chain
Creating	
21	How you can sanitize Brinjal vegetable □ No washing □ Washing in 100-200 ppm chlorine for 1-3 minutes □ Washing more than 200 ppm chlorine for more than 3 minutes

Item no.	Items of post-harvest knowledge test
22	In case of non-refrigerated transport what will you do? □ Use evaporative cooling system □ Use Modified Atmosphere packing □ Any of them
23	How you will avoid soil contact in packing house/ Under shade? □ Use ground cover □ Use raised table □ Use any one of them
24	For better market price what will you do? □ Modern packing □ No Packing □ No post- harvest activities

18. Use of selected vegetables post-harvest practices

Please mention your extent of use of selected post-harvest practices.

Sl. no.	Item of selected post-harvest practices	Extent of use			
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1	Harvesting of vegetable according to appropriate harvesting maturity				
2	Harvesting vegetables at appropriate harvesting time				
3	Harvesting of vegetable with proper care to minimize mechanical injury/ damage				
4	Sterilized knife or instrument for harvesting vegetables				
5	Use hand gloves at harvesting time				
6	Keeping harvested vegetables in a shady place or pre-cooling				
7	Proper washing of vegetables				
8	Wiping or air drying of washed vegetables at shady place				
9	Sorting of vegetables				
10	Grading of vegetable according to size, shape and maturity or graders during field handling				
11	Proper packing of vegetables				
12	Plastic crate with covering wet & sanitized cloth				
13	Line material for recommended vegetable				
14	Safe transportation on time				
15	Cold chain for vegetable storage				
Total					

19. Problems faced in vegetable value chain

Please indicate the extent of problems faced by you in vegetable value chain and give your suggestions to mitigate this problem.

Sl. no.	Items of problem	Extent of problem faced				Suggestions to mitigate the problem
		Severe Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)	
A. Social problems						
1	Absence of exportable vegetable farmers association and support					
2	Inadequate extension service to support exportable vegetable production					

Sl. no.	Items of problem	Extent of problem faced				Suggestions to mitigate the problem
		Severe Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)	
3	Absence of group based farming practice					
4	Difficult to make communication with vegetable exporter					
B. Technical problems						
5	Unavailability of appropriate inputs for exportable vegetable production					
6	Lack of sufficient space for washing and drying vegetables					
7	Difficult to sorting & grading according to exporters requirement					
8	Absence of cool chain management					
9	Insufficient packaging materials to meet up exporters wish					
10	Absence of sufficient laboratory for quality test both inputs and exportable vegetables					
C. Environmental problem						
11	Lack of weather information, early message of weather forecasting					
12	Increase Insect & Disease attack during postharvest activities due to natural hazards					
D. Marketing problems						
13	Lack of market information to the farmers such as prices, flow of the product					
14	Lack of knowledge about the demand in the market					
15	Poor linkage in the marketing channel from farmgate to exporters					
16	Lack of linkage between farmer and agro-processing entrepreneurs					
17	Lack of fair competition in the market price					
18	Poor and inadequate roads for transportation for marketing					
19	Lack of proper transport vehicle to maintain cool chain					
20	Lack of storage facilities					
21	No formal contract with value chain actors					
22	Uncertainty of transportation strike					
23	Undesirable involvement of middlemen					
E. Psychological problems						
24	Pressure on time delivery to exporters					
25	Pressure from Middleman to sell produces at lower price					
26	Depression on sale of lower graded vegetables					

20. Effects of using of selected post-harvest practices to strengthen vegetable export market

Please mention the degree of effects of using selected vegetable post-harvest practices to strengthen value chain of export market as perceived by you.

Sl. no.	Items of effects	Extent of effects			
		Highly effective (3)	**Moderately effective (2)**	**Low effective (1)**	**Not at all effective (0)**
1	Reduce wastage of vegetables				
2	Value addition of vegetables at different level of Post-harvest practices				
3	Quality vegetable produces				
4	Increase market accessibility				
5	Increase vegetable export quantity				
6	Increase selling price of produced vegetable				
7	Increase net income				
8	Free from contamination of any hazardous objects				
9	Increase shelf life of produces				
10	Increase exporter's demand for export market				
11	Strengthening good relationship with value chain actors				
12	Increase buyer satisfaction				
13	Facilitate access to credit support from Bank, NGO				
14	Create employment for using selected post-harvest practices				
15	Rapport building with GO officials, NGO personnel, Association personnel				
16	Capacity buildup towards good agricultural practices (GAP)				
17	Optimum water used in washing & cleaning, which flow untreated into adjacent water bodies is environment friendly post-harvest practices				
18	Elimination of adulteration & harmful chemical during post-harvest practices				
Total					

Thank you for your cooperation.

……..
Signature of the Interviewer with date

Appendix- II

Letter to Judges for Judges' Rating from Chairman, Advisory Committee of the concerned PhD student

Department of Agricultural Extension & Information System
Sher-e-Bangla Agricultural University, Dhaka -1207
Tel. +88 02 -44814039

Ref: SAU/AEIS-19/114 Date: 24 March 2019

To
…….....
……

Subject: Determining appropriateness of selected items of four (4) variables

Sir

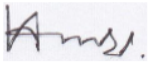
This is in connection with the study of one of my PhD student, Md. Julfiker Moin, Reg. No- 00993. He has under taken a research study on "Effects of Using Selected Post-harvest Practices to Strengthen Vegetable Export Market."

This study requires suggestions from Judges for selection of items for measuring the following variables of the interview schedule:

i) Effects of using of selected post-harvest practices to strengthen vegetable export market
ii) Knowledge on selected vegetables post-harvest practices
iii) Use of selected vegetables post-harvest practices
iv) Problems faced in vegetable value chain

I have the pleasure to inform you that you have been selected as one of the Judges for selecting and rating appropriateness of the items of the above mentioned scales. You are requested to rate the appropriateness of the items of the above mentioned scales ranging from **'1 to 9' where '1' indicated 'Less Appropriate' and '9' indicated 'Most Appropriate'**.
Please return these materials back at your earliest convenience after completing the work.

With personals regards
Sincerely yours,



(DR. MD. SEKENDER ALI)

Chairman, Advisory Committee of the concerned student
& Professor, Dept. of Agricultural Extension & Information System
Sher-e-Bangla Agricultural University, Dhaka-1207
Phone- +8801711230183, Email- msa_sau@yahoo.com

Enclosed: Items of selected scales

Instructions for Judges' Rating for following four (4) variables

The questions will be used for collecting data from the farmers. The Judges are requested to just **rate the items on the last column** by mentioning '1 to 9' where '1' indicated 'Less Appropriate' and '9' indicated 'Most Appropriate'.

i). Effects of using of selected post-harvest practices to strengthen vegetable export market

Please mention the extent of effects as perceived by you for using of selected post-harvest practices to strengthen vegetable export market.

Sl. no.	**Items of effects**	Extent of effects				**Judges' Rating (1 to 9)**
		Highly effective (3)	Moderately effective (2)	Low effective (1)	Not at all effective (0)	
1	Reduce wastage of vegetables					
2	Increase vegetable produces					
3	Value addition of vegetables at different level of Post-harvest practices					
4	Quality vegetable produces					
5	Increase market accessibility					
6	Increase vegetable export					
7	Increase selling price of produced vegetable					
8	Increase net income					
9	Free from contamination of any hazardous objects					
10	Increase shelf life of produces					
11	Increase exporter's demand for foreign market					
12	Strengthening good relationship with value chain actors					
13	Increase buyer satisfaction					
14	Facilitate good access to credit support					
15	Employment generation for selected post-harvest practices					
16	Rapport building with government and other stakeholders					
17	Awareness buildup towards good agricultural practices					
18	Considerable amount of water used in washing & cleaning, which flow untreated into adjacent water bodies has minimal environmental effects					
19	Elimination of adulteration & harmful chemical during post-harvest practices					
Total						

ii). Knowledge on selected vegetables post-harvest practices

Please answer the following questions by putting tick (√) mark.

Item No.	Items of post-harvest knowledge test	Judges' Rating (1 to 9)
Remembering		
1.a	Which is the best time for harvesting? □At Morning □ At Noon □ At Midnight	
1.b	Which is better stage for harvesting Brinjal, Bitter Gourd? □ At younger and tender □ at yellowing □both of none	
1.c	Which is the best stage of vegetable harvesting? □ Optimum Maturity □ Over Maturity □ Both of None	
1.d	When do you harvest Brinjal & Bitter Gourd? □ Within 10-14 days after flowering □ Before 10 days after flowering □ Both of None	
1.e	Which is the optimum Temperature & RH of Brinjal storage? □15°C & 90-95% RH □ 25°C & 70-80% RH □ -4°C 70-80 % RH	
1.f	Where do you keep your harvested vegetable? □ At shady place □ Open , sunny place □ Both of None	
Understanding		
2.a	What are the cause(s) of post-harvest losses? □ Properly done post-harvest practices □ Not properly done post-harvest practices □ Both of the above	
2.b	Why you don't harvest Brinjal and bittergourd at over mature stage? □ Over mature fruit are pithy, hard and may show yellowing. □ Over mature fruit are soft, and never show yellowing □ Both of two	
2.c	Why do you harvest vegetable carefully? □ To minimize physical injury □ To preserve quality □ Both of two	
2.d	How can you minimize damages of plant at harvesting time □ Handpicking fruits with scissors □ Hand picking with knife □ Both of above two	
2.e	Which activities will add vegetable production value? □ Proper use of post-harvest practices □ Post-harvest practices don't need □ Both of none	
2.f	What will you do to produce vegetable as safe food? □ Don't spray pesticide. Insecticide day before harvesting □ Spray pesticide, insecticide just before harvesting □ Spray pesticide, insecticide day before harvesting	
Applying		
3.a	How do you harvest Brinjal and bitter gourd? □ By using sanitized clipper, shear or knife □ Don't use sanitized clipper, shear or knife □ Both of the above two	
3.b	What you do to protect yourself from hairs or trichomes that may cause skin burning or allergy? □ Protective clothing should also be worn □ Don't need to wore protective cloths □ Both of the above two	
3.c	How do you remove infected, pest attacked, diseased and damage vegetables? □ By sorting □ By Transporting □ By marketing	
3.d	How do you graded your vegetables? □ According to size, shape & color □ According to graders □ Both of the two	
3.e	Which activities will add your vegetable value? □ Proper use of post-harvest practices □ Post-harvest practices don't need □ Both of none	
3.f	Which packaging is good while transporting? □ Bamboo basket □ Plastic/wooden crates with inner cardboard □ Both of above two	

Item No.	Items of post-harvest knowledge test	Judges' Rating (1 to 9)
Analyzing		
4.a	Why farmers don't show interest to use selected post-harvest practices? □ Most of them have no pack house for doing post-harvest activities □ Need extra time, money, labour □ Both of above two	
4.b	Why washing is needed to get quality produces? □ To remove adhering soil and other debris by washing □ Washing increases damaged vegetable produces □ Washing add insect pest	
4.c	Why farmers don't get better price? □ Farmers don't do sorting and grading practices properly □ Farmers do sorting and grading practices properly □ Both of above two	
4.d	How does underpack or over pack effects on quality produces while transporting your vegetables? □ Under pack causes more vibration damage □Over pack more compression damage □ Both of above two	
4.e	Why does transport is better two or more vegetables togetherly? □ Minimize transporting cost □ Increase of transport cost □ Increase good quality food	
4.f	How will you minimize losses during transport? □ Use canopied truck with cover □Wooden separators between layers of containers □ Both of above two	
Evaluating		
5.a	What is the merit of avoid pulling of fruits from plant? □ To prevent removal of stem □ To prevent damage of plant □ Both of above two	
5.b	What is the disadvantages of harvested vegetables keeping in sun or rain? □ Quality improve □ Quality Deteriorate □ Both of none	
5.c	What is the benefit of sorting & grading □ Better price □ Lower price □ Both of none	
5.d	What is the merit of use of lining material for Brinjal and Bitter Gourd? □Post-harvest loss will be minimize □ Post-harvest Loss will be increase □ Decrease market price	
5.e	What is the disadvantaged if there is no pack house near field? □ cleaning, pre-cooling, sorting, grading, pre-treatments, packing, storage and dispatch to market activities is difficult to do □ Unsafe food □ Both of two	
5.f	What is the benefit of use of selected post-harvest practices properly? □ Lower market price □ Unsafe food □ Add value in entire value chain	
Creating		
6.a	How you can sanitize Brinjal vegetable □ No washing □ Washing in 100-200 ppm chlorine for 1-3 minutes □ Washing more than 200 ppm chlorine for more than 3 minutes	
6.b	In case of non-refrigerated transport what will you do? □ Use evaporative cooling system □ Use Modified Atmosphere packing □ Any of them	
6.c	How will you avoid soil contact in packing house/ Under shade? □ Use ground cover □ Use raised table □ Use any one of them	
6.d	What will you do for better market price? □ Modern packing □ No Packing□ No post- harvest activities	
6.e	How do you reduce weight losses and increase shelf life of vegetables □ Modified atmosphere packing (MAP) □ Normal packing □None of them	
6.f	How you satisfy or attract your buyer? □ By using selected post-harvest practices properly □ No post- harvest activities □ Any of them	

iii). Use of selected vegetables post-harvest practices

Please mention your extent of use selected post-harvest practices of vegetables.

Sl. no.	Item of selected post-harvest practices	Extent of use				Judges' Rating (1 to 9)
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)	
1	Harvesting of vegetable according to appropriate harvesting maturity					
2	Harvesting vegetables at appropriate harvesting time of the day					
3	Harvesting of vegetable with proper care to minimize mechanical injury/ damage					
4	Sterilized knife or instrument for harvesting vegetables					
5	Use hand gloves at harvesting time					
6	Keeping harvested vegetables in a shady place or pre-cooling					
7	Proper washing of vegetables					
8	Wiping or air drying of washed vegetables at shady place					
9	Sorting of vegetables					
10	Grading of vegetable according to size, shape and maturity or graders during field handling					
11	Proper packing of vegetables					
12	Plastic crate with covering wet & sanitized cloth					
13	Line material for recommended vegetable					
14	Safe transportation on time					
15	Cold chain for vegetable storage					
Total						

iv). Problems faced in vegetable value chain

Please indicate the extent of problems faced by you in vegetable value chain process and give your suggestion to mitigate this problem

Sl. No	Items of problem	Extent of problem faced				Suggestion for mitigate this problem	Judges' Rating (1 to 9)
		Large Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)		
A. Social problems							
1	Difficult to form a farmers group on exportable vegetable produces						
2	Absence of exportable vegetable farmers association and support						
3	Inadequate extension service to support exportable vegetable production						
4	Absence of group based farming practice						
5	Difficult to make communication with vegetable exporter						
6	lack of backward-forward integration from farmer to consumer						
7	Lack of linkage between industry, Government and Institution						
B. Technical problems							
8	Unavailability of appropriate inputs for exportable vegetable production						
9	High price of Inputs						
10	Difficult to apply proper harvesting method to minimize physical damage of vegetable plant and fruit						
11	Lack of sufficient space for washing and drying vegetables						
12	Difficult to sorting & grading according to exporters requirement						
13	Absence of cool chain management						
14	Insufficient packaging materials to meet up exporters wish						
15	Absence of quality standard book, materials, handouts etc.						
16	Need additional time and labour for post-harvest practices						
17	Absence of laboratory for quality test both inputs and exportable vegetables						
18	Absence of standard quality certification agency						
C. Environmental problem							
19	Lack of weather information, early message of weather forecasting						
20	Unexpected post-harvest losses due to sudden weather fluctuation						
21	Decrease of quality vegetable production due to natural calamity						

Sl. No	Items of problem	Extent of problem faced				Suggestion for mitigate this problem	Judges' Rating (1 to 9)
		Large Problem (3)	Moderate problem (2)	Less problem (1)	No problem (0)		
	at harvesting period						
22	Insect & Disease attack during postharvest activities						
D. Marketing problems							
23	Poor market system in agriculture						
24	Lack of market information to the farmers such as prices, flow of the product, food processing unit etc.						
25	Lack of knowledge about the demand in the market						
26	Lack of timely information						
27	Lack of knowledge about the intermediaries						
28	Poor linkage in the marketing channel from farmgate to exporters because of small land sizing farmers						
29	Lack of linkage between farmer and processing unit because of unavailability of processing unit						
30	Absence of market standard						
31	Loosely connected with value chain actors						
32	Poor and inadequate roads for transportation for marketing						
33	Lack of proper transport vehicle to maintain cool chain						
34	Undesirable involvement of middlemen/politician/police						
35	Lack of storage facilities						
36	No formal contract with value chain actors						
37	Lack of fair competition in the market price						
38	Transportation Strike						
E. Psychological problems							
39	Pressure on time delivery to exporters						
40	Criticism from relatives and neighboring farmers to using selected post-harvest practices						
41	Harass from input dealers to get input timely						
42	Pressure from Middleman to sell produces at lower price						
43	Exporter blame regarding quality issues though they produced quality vegetable						
44	Depression on sale of lower graded vegetables						

Appendix- III

Average Appropriateness Score (AAS_k) of the i^{th} item of knowledge scale

Sl. No. of Items	Total Score given by Judges' (N=25)	AAS_k of the i^{th} item
1.a	191	7.64*
1.b	173	6.92*
1.c	176	7.04*
1.d	126	5.04*
1.e	127	5.08*
1.f	182	7.28*
2.a	128	5.12*
2.b	164	6.56*
2.c	172	6.88*
2.d	127	5.08*
2.e	174	6.96*
2.f	197	7.88*
3.a	176	7.04*
3.b	128	5.12*
3.c	173	6.92*
3.d	183	7.32*
3.e	130	5.20*
3.f	190	7.60*
4.a	198	7.92*
4.b	183	7.32*
4.c	177	7.08*
4.d	192	7.68*
4.e	131	5.24*
4.f	126	5.04*
5.a	129	5.16*
5.b	172	6.88*
5.c	129	5.16*
5.d	166	6.64*
5.e	179	7.16*
5.f	176	7.04*
6.a	184	7.36*
6.b	189	7.56*
6.c	178	7.12*
6.d	155	6.20*
6.e	127	5.08*
6.f	129	5.16*

*** Items selected for the Difficulty Indices and Discrimination Indices**

Appendix - IV

Difficulty Indices and Discrimination Indices of the 36 Items of Post-harvest Knowledge Test

Sl. No. of Items	Frequencies of correct answers given by each group of farmers (each group containing 6 farmers)						Total frequencies of (N=36)		Difficulty index (P)	Discrimination Index ($E^{1/3}$)
	G1	G2	G3	G4	G5	G6	correct answers	Wrong answer		
1.a	6	6	6	6	2	1	27	9	25.00*	0.750*
1.b	4	4	6	6	2	0	22	14	38.89*	0.500*
1.c	2	2	2	2	1	0	9	27	75.00*	0.250
1.d	0	1	1	0	1	0	3	33	91.67	0.000
1.e	6	6	6	6	4	3	31	5	13.89	0.417
1.f	4	4	4	3	3	3	21	15	41.67*	0.167*
2.a	2	1	1	0	0	0	4	32	88.89	0.250
2.b	6	6	4	2	4	3	25	11	30.56*	0.417*
2.c	4	4	5	3	1	1	18	18	50.00*	0.500*
2.d	0	1	0	0	0	0	1	35	97.22	0.083
2.e	3	2	0	0	1	0	6	30	83.33*	0.333*
2.f	4	3	4	6	2	2	21	15	41.67*	0.250*
3.a	4	4	1	1	0	0	10	26	72.22*	0.667*
3.b	3	3	1	2	3	3	15	21	58.33	0.000
3.c	2	1	3	3	1	0	10	26	72.22*	0.167*
3.d	6	5	6	6	4	3	30	6	16.67*	0.333*
3.e	6	6	6	6	6	4	34	2	5.56	0.167
3.f	2	2	4	3	1	0	12	24	66.67*	0.250*
4.a	6	6	4	5	3	4	28	8	22.22*	0.417*
4.b	4	4	2	2	0	0	12	24	66.67*	0.667*
4.c	5	3	4	2	2	0	16	20	55.56*	0.500*
4.d	6	6	4	4	3	2	25	11	30.56*	0.583*
4.e	3	3	3	3	3	3	18	18	50.00	0.000
4.f	6	6	6	4	6	6	34	2	5.56	0.000
5.a	6	6	6	6	4	3	31	5	13.89	0.417
5.b	5	4	0	0	0	0	9	27	75.00*	0.750*
5.c	3	1	0	0	0	0	4	32	88.89	0.333
5.d	4	3	3	3	3	2	18	18	50.00*	0.167*
5.e	4	4	4	4	2	1	19	17	47.22*	0.417*
5.f	6	6	4	5	5	4	30	6	16.67*	0.250*
6.a	6	6	3	3	4	5	27	9	25.00*	0.250*
6.b	5	5	1	2	0	0	13	23	63.89*	0.833*
6.c	5	4	4	4	2	2	21	15	41.67*	0.417*
6.d	4	2	3	3	1	0	13	23	63.89*	0.417*
6.e	6	6	6	6	4	3	31	5	13.89	0.417
6.f	0	1	1	0	1	0	3	33	91.67	0.000
Total	148	137	118	111	79	58				

* **Items selected for the study**

Appendix - V

Average Appropriateness Score (AAS_u) of the i^{th} item of use scale

Sl No.	Item of selected post-harvest practices	Total Score given by Judges' (N=25)	AAS_u of the i^{th} item
1	Harvesting of vegetable according to appropriate harvesting maturity	213	8.52*
2	Harvesting vegetables at appropriate harvesting time of the day	190	7.60*
3	Harvesting of vegetable with proper care to minimize mechanical injury/ damage	185	7.40*
4	Sterilized knife or instrument for harvesting vegetables	174	6.96*
5	Use hand gloves at harvesting time	168	6.72*
6	Keeping harvested vegetables in a shady place or pre-cooling	183	7.32*
7	Proper washing of vegetables	186	7.44*
8	Wiping or air drying of washed vegetables at shady place	171	6.84*
9	Sorting of vegetables	211	8.44*
10	Grading of vegetable according to size, shape and maturity or graders during field handling	209	8.36*
11	Proper packing of vegetables	198	7.92*
12	Plastic crate with covering wet & sanitized cloth	200	8.00*
13	Line material for recommended vegetable	178	7.12*
14	Safe transportation on time	196	7.84*
15	Cold chain for vegetable storage	192	7.68*

*** Items selected for the study**

Appendix – VI

Average Appropriateness Score (AAS_p) of i^{th} item of problem scale

Sl. no.	Items of problem faced in vegetable value chain	Total Score given by Judges' (N=25)	AAS_p of the i^{th} item
Social Problem			
1	Difficult to form a farmers group on exportable vegetable produces	109	4.36
2	Absence of exportable vegetable farmers association and support	175	7.00*
3	Inadequate extension service to support exportable vegetable production	179	7.16*
4	Absence of group based farming practice	233	9.32*
5	Difficult to make communication with vegetable exporter	158	6.32*
6	lack of backward-forward integration from farmer to consumer	106	4.24
7	Lack of linkage between industry, Government and Institution	110	4.40
Technical problems			
8	Unavailability of appropriate inputs for exportable vegetable production	183	7.32*
9	High price of Inputs	107	4.28
10	Difficult to apply proper harvesting method to minimize physical damage of vegetable plant and fruit	108	4.32
11	Lack of sufficient space for washing and drying vegetables	174	6.96*
12	Difficult to sorting & grading according to exporters requirement	179	7.16*
13	Absence of cool chain management	194	7.76*
14	Insufficient packaging materials to meet up exporters wish	183	7.32*
15	Absence of quality standard book, materials, handouts etc.	106	4.24
16	Need additional time and labour for post-harvest practices	102	4.08
17	Absence of laboratory for quality test both inputs and exportable vegetables	175	7.00*
18	Absence of standard quality certification agency	105	4.20
Environmental problem			
19	Lack of weather information, early message of weather forecasting	185	7.40*
20	Unexpected post-harvest losses due to sudden weather fluctuation	98	3.92
21	Decrease of quality vegetable production due to natural calamity at harvesting period	91	3.64

Sl. no.	Items of problem faced in vegetable value chain	Total Score given by Judges' (N=25)	AAS_p of the i^{th} item
22	Insect & Disease attack during postharvest activities due to natural hazards	175	7.00*
Marketing problems			
23	Poor market system in agriculture	108	4.32
24	Lack of market information to the farmers such as prices, flow of the product	188	7.52*
25	Lack of knowledge about the demand in the market	172	6.88*
26	Lack of timely information	107	4.28
27	Lack of knowledge about the intermediaries	103	4.12
28	Poor linkage in the marketing channel from farmgate to exporters	189	7.56*
29	Lack of linkage between farmer and agro-processing entrepreneurs	173	6.92*
30	Absence of market standard	104	4.16
31	Loosely connected with value chain actors	102	4.08
32	Poor and inadequate roads for transportation for marketing	191	7.64*
33	Lack of proper transport vehicle to maintain cool chain	197	7.88*
34	Undesirable involvement of middlemen/politician/police	153	6.12*
35	Lack of storage facilities	207	8.28*
36	No formal contract with value chain actors	174	6.96*
37	Lack of fair competition in the market price	165	6.60*
38	Uncertainty of transportation strike	139	5.56*
Psychological problems			
39	Pressure on time delivery to exporters	164	6.56*
40	Criticism from relatives and neighboring farmers to using selected post-harvest practices	109	4.36
41	Harass from input dealers to get input timely	108	4.32
42	Pressure from Middleman to sell produces at lower price	152	6.08*
43	Exporter blame regarding quality issues though they produced quality vegetable	105	4.20
44	Depression on sale of lower graded vegetables	165	6.60*

*** Items selected for the study**

Appendix – VII

Average Appropriateness Score (AAS_e) of the i^{th} item of effects scale

Sl. no.	Items of effects	Total Score given by Judges' (N=25)	AAS_e of the i^{th} item
1	Reduce wastage of vegetables	198	7.92*
2	Increase vegetable produces	94	3.76
3	Value addition of vegetables at different level of Post-harvest practices	205	8.20*
4	Quality vegetable produces	175	7.00*
5	Increase market accessibility	189	7.56*
6	Increase vegetable export	155	6.20*
7	Increase selling price of produced vegetable	161	6.44*
8	Increase net income	162	6.48*
9	Free from contamination of any hazardous objects	174	6.96*
10	Increase shelf life of produces	197	7.88*
11	Increase exporter's demand for foreign market	173	6.92*
12	Strengthening good relationship with value chain actors	154	6.16*
13	Increase buyer satisfaction	159	6.36*
14	Facilitate good access to credit support	146	5.84*
15	Employment generation for selected post-harvest practices	160	6.40*
16	Rapport building with government and other stakeholders	152	6.08*
17	Awareness buildup towards good agricultural practices	158	6.32*
18	Considerable amount of water used in washing & cleaning, which flow untreated into adjacent water bodies has minimal environmental effects	156	6.24*
19	Elimination of adulteration & harmful chemical during post-harvest practices	183	7.32*

*** Items selected for the study**

Appendix – VIII

Result of Stepwise Regression

Variables Entered/Removed[a]			
Model	**Variables Entered**	**Variables Removed**	**Method**
1	Use of selected vegetables post-harvest practices	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Problems faced in vegetable value chain	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Knowledge on selected vegetable post-harvest practices	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Exportable vegetables production	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	Experience in exportable vegetables production	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
6	Extension contact	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
a. Dependent Variable: Effects of using selected post-harvest practices to strengthen vegetable export market			

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.464[a]	0.216	0.213	4.881
2	0.554[b]	0.307	0.301	4.598
3	0.573[c]	0.328	0.320	4.536
4	0.589[d]	0.346	0.336	4.483
5	0.604[e]	0.364	0.351	4.43
6	0.612[f]	0.374	0.359	4.404
a. Predictors: (Constant), Use of selected vegetables post-harvest practices				
b. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain				
c. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices				
d. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production				
e. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production, Experience in exportable vegetables production				
f. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production, Experience in exportable vegetables production, Extension contact				

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1624.806	1	1624.806	68.197	.000[b]
	Residual	5908.638	248	23.825		
	Total	7533.444	249			
2	Regression	2310.826	2	1155.413	54.644	.000[c]
	Residual	5222.618	247	21.144		
	Total	7533.444	249			
3	Regression	2472.831	3	824.277	40.069	.000[d]
	Residual	5060.613	246	20.572		
	Total	7533.444	249			
4	Regression	2609.681	4	652.42	32.464	.000[e]
	Residual	4923.763	245	20.097		
	Total	7533.444	249			
5	Regression	2744.842	5	548.968	27.972	.000[f]
	Residual	4788.602	244	19.625		
	Total	7533.444	249			
6	Regression	2820.787	6	470.131	24.242	.000[g]
	Residual	4712.657	243	19.394		
	Total	7533.444	249			

a. Dependent Variable: Effects of using selected post-harvest practices to strengthen vegetable export market

b. Predictors: (Constant), Use of selected vegetables post-harvest practices

c. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain

d. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices

e. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production

f. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production, Experience in exportable vegetables production

g. Predictors: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production, Experience in exportable vegetables production, Extension contact

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	31.833	1.585		20.089	0.000
	Use of selected vegetables post-harvest practices	0.376	0.046	0.464	8.258	0.000
2	(Constant)	40.017	2.072		19.314	0.000
	Use of selected vegetables post-harvest practices	0.268	0.047	0.331	5.724	0.000
	Problems faced in vegetable value chain	-0.120	0.021	-0.330	-5.696	0.000
3	(Constant)	28.154	4.695		5.996	0.000
	Use of selected vegetables post-harvest practices	0.218	0.050	0.269	4.394	0.000
	Problems faced in vegetable value chain	-0.107	0.021	-0.293	-5.009	0.000
	Knowledge on selected vegetable post-harvest practices	0.638	0.227	0.169	2.806	0.005
4	(Constant)	25.735	4.733		5.438	0.000
	Use of selected vegetables post-harvest practices	0.200	0.050	0.247	4.033	0.000
	Problems faced in vegetable value chain	-0.103	0.021	-0.282	-4.862	0.000
	Knowledge on selected vegetable post-harvest practices	0.684	0.225	0.181	3.037	0.003
	Exportable vegetables production	0.001	0.000	0.137	2.610	0.010
5	(Constant)	25.590	4.677		5.471	0.000
	Use of selected vegetables post-harvest practices	0.181	0.049	0.223	3.659	0.000
	Problems faced in vegetable value chain	-0.102	0.021	-0.281	-4.903	0.000
	Knowledge on selected vegetable post-harvest practices	0.602	0.225	0.159	2.677	0.008
	Exportable vegetables production	0.001	0.000	0.155	2.957	0.003
	Experience in exportable vegetables production	0.318	0.121	0.140	2.624	0.009
6	(Constant)	21.876	5.014		4.363	0.000
	Use of selected vegetables post-harvest practices	0.189	0.049	0.233	3.824	0.000
	Problems faced in vegetable value chain	-0.060	0.030	-0.164	-2.002	0.046
	Knowledge on selected vegetable post-harvest practices	0.568	0.224	0.150	2.534	0.012
	Exportable vegetables production	0.001	0.000	0.161	3.094	0.002
	Experience in exportable vegetables production	0.345	0.121	0.152	2.845	0.005
	Extension contact	0.055	0.028	0.153	1.979	0.049
a. Dependent Variable: Effects of using selected post-harvest practices to strengthen vegetable export market						

Excluded Variables[a]						
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
6	Age	.002[g]	0.024	0.981	0.002	0.627
	Education	.017[g]	0.319	0.750	0.021	0.894
	Family agricultural labour	.028[g]	0.522	0.602	0.034	0.878
	Experience in vegetables cultivation	-.083[g]	-1.106	0.270	-0.071	0.453
	Exportable vegetables cultivation area	-.045[g]	-0.736	0.463	-0.047	0.702
	Annual family income	-.060[g]	-0.983	0.326	-0.063	0.696
	Exportable vegetables production and post-harvest practices cost	-.038[g]	-0.624	0.533	-0.040	0.704
	Credit received for exportable vegetables production	-.082[g]	-1.428	0.155	-0.091	0.770
	Training exposure on vegetables post-harvest practices	.046[g]	0.706	0.481	0.045	0.613
	Contact with value chain actors	-.068[g]	-1.028	0.305	-0.066	0.590
	Contract with value chain actors	-.080[g]	-1.487	0.138	-0.095	0.875
	Depth of relationship with value chain actors	-.083[g]	-1.133	0.258	-0.073	0.483
	Trust with value chain actors	.091[g]	1.337	0.183	0.086	0.551

a. Dependent Variable: Effects of using selected post-harvest practices to strengthen vegetable export market

b. Predictors in the Model: (Constant), Use of selected vegetables post-harvest practices

c. Predictors in the Model: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain

d. Predictors in the Model: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices

e. Predictors in the Model: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production

f. Predictors in the Model: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production, Experience in exportable vegetables production

g. Predictors in the Model: (Constant), Use of selected vegetables post-harvest practices, Problems faced in vegetable value chain, Knowledge on selected vegetable post-harvest practices, Exportable vegetables production, Experience in exportable vegetables production, Extension contact

Appendix – IX

Inter Correlation Matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	Y
X1	1	-.709**	.762**	.761**	.603**	-0.002	-0.061	-0.008	-0.035	-0.077	0.044	0.069	0.098	0.088	0.101	-0.073	0.110	0.117	-0.046	0.123
X2	-.709**	1	-.566**	-.565**	-.293**	-0.040	0.018	-0.021	0.002	0.005	-0.022	-0.060	-0.088	-0.005	-0.010	0.046	0.041	0.040	-0.056	0.005
X3	.762**	-.566**	1	.492**	.339**	-0.021	-0.070	-0.041	-0.047	-0.092	-0.005	0.022	.220**	0.110	0.110	-0.027	0.005	0.040	-0.009	0.073
X4	.761**	-.565**	.492**	1	.716**	0.033	-.147*	0.002	0.015	-0.022	0.037	0.008	0.039	-0.021	-0.044	-0.070	0.013	0.029	0.009	0.044
X5	.603**	-.293**	.339**	.716**	1	0.012	-0.098	0.058	0.051	-0.006	0.067	0.090	-0.069	0.097	0.118	0.015	.232**	.219**	-0.116	.244**
X6	-0.002	-0.040	-0.021	0.033	0.012	1	0.089	.940**	.867**	.896**	.799**	.631**	.254**	.510**	.421**	.533**	.179**	.152*	-.467**	.205**
X7	-0.061	0.018	-0.070	-.147*	-0.098	0.089	1	0.082	0.020	0.065	0.070	0.095	0.035	0.086	.155*	0.044	0.014	.156*	-0.115	.211**
X8	-0.008	-0.021	-0.041	0.002	0.058	.940**	0.082	1	.864**	.920**	.757**	.674**	.265**	.559**	.472**	.520**	.269**	.177**	-.485**	.221**
X9	-0.035	0.002	-0.047	0.015	0.051	.867**	0.020	.864**	1	.885**	.823**	.713**	.139*	.568**	.450**	.503**	.177**	0.121	-.503**	.199**
X10	-0.077	0.005	-0.092	-0.022	-0.006	.896**	0.065	.920**	.885**	1	.687**	.610**	.149*	.437**	.327**	.462**	.134*	0.057	-.395**	0.115
X11	0.044	-0.022	-0.005	0.037	0.067	.799**	0.070	.757**	.823**	.687**	1	.683**	.203**	.632**	.543**	.549**	.211**	.249**	-.604**	.322**
X12	0.069	-0.060	0.022	0.008	0.090	.631**	0.095	.674**	.713**	.610**	.683**	1	.171**	.776**	.736**	.514**	.321**	.243**	-.626**	.275**
X13	0.098	-0.088	.220**	0.039	-0.069	.254**	0.035	.265**	.139*	.149*	.203**	.171**	1	.272**	.205**	.320**	.133*	0.052	-.169**	0.034
X14	0.088	-0.005	0.110	-0.021	0.097	.510**	0.086	.559**	.568**	.437**	.632**	.776**	.272**	1	.891**	.538**	.406**	.319**	-.700**	.321**
X15	0.101	-0.010	0.110	-0.044	0.118	.421**	.155*	.472**	.450**	.327**	.543**	.736**	.205**	.891**	1	.471**	.448**	.370**	-.618**	.420**
X16	-0.073	0.046	-0.027	-0.070	0.015	.533**	0.044	.520**	.503**	.462**	.549**	.514**	.320**	.538**	.471**	1	.291**	.250**	-.747**	.387**
X17	0.110	0.041	0.005	0.013	.232**	.179**	0.014	.269**	.177**	.134*	.211**	.321**	.133*	.406**	.448**	.291**	1	.455**	-.364**	.398**
X18	0.117	0.040	0.040	0.029	.219**	.152*	.156*	.177**	0.121	0.057	.249**	.243**	0.052	.319**	.370**	.250**	.455**	1	-.403**	.464**
X19	-0.046	-0.056	-0.009	0.009	-0.116	-.467**	-0.115	-.485**	-.503**	-.395**	-.604**	-.626**	-.169**	-.700**	-.618**	-.747**	-.364**	-.403**	1	-.463**
Y	0.123	0.005	0.073	0.044	.244**	.205**	.211**	.221**	.199**	0.115	.322**	.275**	0.034	.321**	.420**	.387**	.398**	.464**	-.463**	1

** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed).

X1 = Age	X11 = Training on vegetables post-harvest practices
X2 = Education	X12 = Contact with value chain actors
X3 = Family agricultural labour	X13 = Contract with value chain actors
X4 = Experience in vegetables cultivation	X14 = Depth of relationship with value chain actors
X5 = Experience in exportable vegetables production	X15 = Trust with value chain actors
X6 = Exportable vegetables cultivation area	X16 = Extension contact
X7 = Exportable vegetables production	X17 = Knowledge on selected vegetables post-harvest practices
X8 = Annual family income	X18= Use of selected vegetables post-harvest practices
X9 = Exportable vegetables production and post-harvest practices cost	X19= Problems faced in vegetable value chain
X10 = Credit received for exportable vegetables production	Y = Effects of using selected post-harvest practices to strengthen vegetable export market