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PROMOTING NATURAL COLD STORAGE IN COASTAL AREA

A Feasibility Research and Business Analysis



MARGEN

Feasibility Study Report on Promoting Natural Cold Storage in Coastal Area

PROMOTING NATURAL COLD STORAGE IN COASTAL AREA

A Feasibility research and Business Analysis for Polder 29

SUBMITTED TO

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ACRONYM

AEZ – Agro Ecological Zone

ALO – Assistance for the Livelihood of the Origin

AVRDC – Asian Vegetable Research and Development Center (The World Vegetable Center)

BADC – Bangladesh Agricultural Development Corporation

BMD – Bangladesh Meteorological Department

BDT – Bangladeshi Taka

BWDB – Bangladesh Water Development Board

BG – Blue Gold

BBS – Bangladesh Bureau of Statistics

BCR – Cost Benefit Ratio

CDMP – Comprehensive Disaster Management Program

CIP – International Potato Center

CSS – Christian Services Society

DAE – Department of Agriculture Extension

DAM – Department of Agricultural marketing

FGD – Focus Group Discussion

Ha – Hectar

KII – Key Informants Interview

MT – Metric Ton

MJF – Manusher Jonno Foundation

RH – Relative Humidity

Sq – Square

SRDI – Soil Resources Development Institute

USAID - United States Agency for International Development

WMG – Water Management Group

EXECUTIVE SUMMARY

Bangladesh is predominantly an agrarian country. Agriculture sector contributes about 17 percent to the country's Gross Domestic Product (GDP) and employs more than 45 percent of total labour force and in 2014-15, Bangladesh produces around 12983 and 4677 thousand metric tons of vegetables (including potato) and fruits, respectively (Year book of Agricultural Statistics, 2015).

The coastal region has significant contribution in higher value addition in the crop and horticulture sector. But, salinity, inadequate water management, lack of availability of quality surface water for irrigation, lack of market linkage, lack of processing technology and storage system are the main challenges for the increased productivity in coastal agriculture. Despite many challenges, the region has considerable potential for crop, horticulture, fishery, livestock and value chain enhancement. The region is largely dominated by medium high land which is suitable for different agricultural practices around the year.

The study was conducted only Polder no. 29 out a total of 139 polders, which covers 4 Union of Dumuria and one union of Batiaghata sub-district under Khulna district. During the study, primary information were collected from 98 vegetable farmers, 22 vegetable traders, 3 input sellers, 42 WMG Members (Producers also) and 12 key informants through individual interview and focus group discussion by using questionnaires and checklist.

The 13,560 households living in the Polder no. 29 area have a total population of 55,304. The main cultivated crop of this area is rice but farmers also cultivate vegetables in lands which are adjacent to farmer's household and dyke in gher areas. The average size of land for vegetable cultivation is 55 decimals. The study is revealed that in the area under Polder no 29, major cultivated vegetables are Tomato, Cucumber, Bittergourd, Brinjal, Bttle gourd and Okra but not limited. After production farmers consume about 2-3% of produce and 1-2 % of total produce they distribute among the neighbor. Almost 95% of total produced vegetables are sold by the farmers. The research found that about 56% farmer sale their produced products from field just immediate after harvest. Almost all the vegetables consumed and trading in the area are produced locally except potato and some other off-seasoned and exotic varieties like capsicum; taro etc. are imported from outside of this area. The produced vegetables also imported from out-side of the areas after each crops season. In Polder no. 29, surplus vegetables go to the Khulna arot distribute in Khulna regional markets and during the season, national buyers also procure vegetables from this area to supply other districts of different regions of Bangladesh including Dhaka market..

There is no cold storage in Polder no. 29 area even in the Dumuria. There are 5 private owned/private cold-stores in Khulna, among those three cold stores are shut it down. All the cold stores are only use for potato having present capacity of about 6500 MT of potato. So, due to lack of proper post-harvest management and storage facility, the post-harvest loss of produced vegetables is very high and farmers are bound to sale their products immediatly which sometimes restrict farmers to get better price.

On the other hand, modern storage of vegetables and fruits and is virtually absent in Bangladesh. Cold storage facility is only available for potato. However, from the last couple of years many research organization, development projects, government line departments are trying to replicate low cost farmers' friendly natural cold storage which operates without energy or in some cases renewable energy like solar. During the study, the team reviewed different organization's initiatives for natural cold storage for vegetables like one storage established at Atmul village under Shibgonj upazila of Bogra distric with capacity of 240 metric tons in 2015, another one is Baniachong sub-district of Habigonj district which capacity is 200 kg of vegetables by using vaporization technology. Farmers can store their vegetables in these natural cold-storage for 10 to 15 days. Prof Dr Monzur Hossain from Rajshahi University has also established an environment-friendly cold storage with 300 metric-tons capacity in Rajshahi city in December, 2014 at a cost of around Taka 14 lakh where agricultural produce can store through the process of vaporization.

Considering the local context, environmental status of the Khuna region, produced agricultural products and market scenario, the study team recommend that Blue-gold project can take initiative to develop the natural cold storage by using vaporization technology with local materials as a pilot where farmers can store their produced products for at least two weeks to avoid seasonal glad as well as to create bulk amount for selling in distanced markets. The WMG Members under Blue-gold project can lead to maintenance the natural storage and community farmers can store their products with providing certain amount of fee. The study team believe that this initiative will lead to increase the vegetable farmers' income in the Polder no. 29 area.

SECTION ONE: INTRODUCTION

1.1. Background

The contribution of horticulture remains extremely important for ensuring food and nutritional security in Bangladesh. Presently, Bangladesh produces around 10923 and 4525 thousand metric tons of vegetables (including potato) and fruits per year, respectively (BBS 2010). The desired level of development in horticulture has not yet been achieved due to absence of proper postharvest management. Recently, Hassan (2010) reported that postharvest loss of fruits and vegetables in Bangladesh ranged from 23.6 to 43.5%, which accounts for an annual loss of 3442 crore taka.

Coastal region has significant contribution in higher value addition in the crop and horticulture sector. In 1995-96 the value of the crop and horticulture had been BDT 3357 million and in 1999-2000, generated BDT 3790 million taka (CDMP report).

Salinity level of water, inadequate water management infrastructures, lack of processing technology and storage system are the main challenges for the increased productivity in coastal agriculture. Due to low-lying land in coastal area of Bangladesh floods is a common phenomenon in this area and without controlling the flood maximum agriculture production is not possible. There are 145 polders in the coastal area developed mostly in the 1960 and 1970s and cover presently 70% of the coastal area. The polders provide a great potential for the primary productive sectors linked to land: crops, livestock, trees, and fish are the main components.



The Blue Gold an integrated sustainable economic development program by improving the water and productive sector in selected polder concentrate in three districts in the Southwest of Bangladesh: Patuakhali, Khulna and Satkhira. The Program covers 160,000 ha (gross) where an estimated 150,000 household will have direct benefits from the Program. The overall objective of the Blue Gold Program is “To reduce poverty for 150,000 households living on 160,000 ha of selected coastal polders by creating a healthy living environment and a sustainable socio-economic development. The program has four main components are community Mobilization and Institutional Strengthening, Water Resources Management, Food Security and Agricultural Production and Business Development and Private Sector Involvement.

The Program promotes innovations relevant for the beneficiaries. Blue Gold facilitates the innovations to identify and test the relevance and effectiveness. MarGEn conducted the feasibility study to explore the potentials for establishing the Improved Natural Storage and business analysis into the Blue Gold working area under the innovation fund.

Low cost natural storage is a solution that provides increased shelf life to the product decreases the wastage rate and provide opportunities for the farmers to sell their produces when demand of that product is high in the market. This improved natural storage technology has already been replicated in Bandarban and Khagrachori district. The project was implemented by Assistance for the livelihood of the origin (ALO) at Khagrachori and ECO Development Bandarban at Bandarban district with technical support from MarGEn and funded by Manusher Jonno Foundation (MJF). Japan Embassy has also established another two stores at Sherpur in Bogra district.

1.2 Objective of the Study

The overall objective of the study is a) to assess and analyze the feasibility for Natural Cold Storage Construction and b) to identify the Business Model of the Natural Cold Storage into the polders area Blue Gold is working. And the specific objectives are:

- To know environmental context (soil, water, humidity, temperature etc).
- To assess the production, productivity and cost-benefit (BCR) of vegetable
- To analyze the local value chain of agricultural goods and figure out profit margin at different level of market actors.
- To assess the problem/benefit faced by the small farmers in marketing.
- To know the post harvest management practice and storage system of mostly cultivated agro products of the area
- To identify probable business model to best fit in for the polder community

1.3 Methodology

1.3.1 Study Area

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The feasibility study area was 29 Polder where Blue Gold works with 56 Water Management Groups in the 5 Union under two upazilla. The study team has covered 4 Union from Dumuria and 1 union from Batiaghata sub-district of the 29 polder in. 16 villages were randomly selected from the 56 WMG list by the study team to collect data. The following locations were covered by the study team. Besides the village the study team collected market information from the following local market (Hat) in during the study

Table 1: Study area covered under the Polder 29

Village	Union	Goe-Code	No. of WMG	Sub-district	Polder
Baniakhali	Sarappur	88	15	Dumuria	Polder 29, Dumuria Sub-district
BrittiBhulbaria					
Khukhia	Sahas	81	16		
Gojendrapur					
Gajendrapur Daxin					
Dumuria Dakkin	Dumuria	27	2		
Dumuria Uttar					
Ghona	Bhandarpara	13	18		
Ghona Uttarpara					
Taltola					
Banda					
Lohaidanga					
Ula Charail					
Sundarmahal	Surkhe				
Shomvunagar					
Kodla					

Table 2: Local Market covered under the polder 29

Local Market	Union	Sub-District	Polder
Sarappur Bazar	Sarappur	Dumuria	Polder 29
Baniakhali			
Sahas Bazar	Sahas		
Bagdari Bazar			
Bhandarpara	Dumuria		



Hat			
Bhand arpara	Bhand arpara		
Ula Bazar			
Boroauria Hat	Surkhali		

1.3.2 Study tools/ Type of respondents covered

During the study the following study tools were used according to the respondents.

Table 3: Sample type and study methodology

Study Methodology	Participants	Study Tool(s)
Individual Interview	<ul style="list-style-type: none"> - Producer - Trader - WMG member - Input seller 	Structured Questionnaire(s)
Focus Group Discussion	<ul style="list-style-type: none"> - Water Management Group (WMG) 	Checklist
Key Informants Interview	<ul style="list-style-type: none"> - Lead farmer - Large Trader - DAE Khulna - Water Development Board, Khulna - Soil Resources Development Institute, Khulna - Bangladesh Metrological Department, Khulna - Input seller - WMG Leader - Blue Gold Official 	Semi- structured Questionnaire(s)
Field Observation	Informal discussion with the community peoples, visit crop fields, visiting market place etc.	

1.3.3 Sample Covered/ No of respondents

The study was covered total 176 numbers of respondents through the different interview method. About 10% of the respondents were women and 90% percent were men.

Table 4: Number of Sample covered in the study

Types of Respondents	No of Respondents	Method of Interview
Vegetable Producers	98	Individual Interview
Vegetable Traders	22	Individual Interview/KII
Input Retailer	3	Individual Interview/ KII
WMG Members (Producers also)	42	Focus Group Discussion
Local Resources Person	12	Key Informants Interview

1.3.4 Study Approach

This feasibility study was conducted by following mixed method approaches based on empirical evidences. Both qualitative and quantitative data collection approach were used to get a holistic insight about the existing situation of crop cultivation in the polder 29 of Dumuria sub-district in Khulna.

1.3.5 Tools Development

The tools (questionnaires) for the feasibility study were designed around research question and key expected outcomes of the study. The aim was to develop questionnaires those were simple to answer and record responses. The questionnaires were prepared keeping in mind of the local context and the livelihood patterns of the respondents. The previous experience of the study team in relevant to value chain analysis in agriculture sector helped. Additional response options were added as required.

1.3.6 Orientation

Before collecting data, an orientation to the study team was conducted on 26 January at the CSS Ava Center aiming to orient program of Blue Gold, study objectives, questionnaires updating, managing the data, etc. Total 9ight members of the study team participated in the orientation facilitated by MarGEn professionals.

1.3.7 Data Collection and Validation

Using the above tools, information wa *Orientation of the study Team*
WMG groups, individual farmers, traders key informants etc. After completing the day study team reviewed the field findings and shared the lesson learnt among the team members. This was the primary stage of data validation. Finally, during the process of data input and report writing, experts validated the data and presented into this report.

1.3.8 Data Entry, Analysis and Reporting

The collected data were analysed based on their nature. The quantitative information was gathered in SPSS (Statistical Package for Social Science) and qualitative information was composed, analysed and reported by the experts to understand vegetable Market at present.



Limitations:

- The study was carry out only in Polder 29 areas due to limited time and resources. It would not cover the whole working areas of Blue Gold project or even representative sample of the project areas.
- The sample size of the study was very low and only considered to cover the respective categories of the stakeholders which had the direct influence on primary data.
- Local materials are usually used to construct the natural storage and evaporation technology is used so, temperature and humidity is controlled naturally. No mechanical control mechanism is used in the storage. So, sudden fluctuation of outside temperature and humidity may influence the inside environment accordingly.
- The construction cost was estimated based on the cost those are already established. The study team not be able to collect the cost of raw materials from the recommended areas due to limited time and resources.

SECTION TWO: OVERVIEW OF THE STUDY AREA

2.1 Local Context Analysis

Dumuria sub-district, 23 sq km, located in between 22°39' and 22°56' north latitudes and in between 89°15' and 89°32' east longitudes. It is bounded by Manirampur, Abhaynagar and Phultala sub-districts on the north and Batiaghata and Paikgacha sub-districts are on the south side of the Dumuria in the Khulna district.

There are 16 Union in the Dumuria. 29 no. Polder works with 4 Union of Dumuria and one union of Batiaghata. Polder 29 covers a small portion of Dumuria union, more than half of Sahas union and the entire Bhandar para union as well as Sarappur union. The polder was constructed in 1966-71 by the Bangladesh Water Development Board (BWDB) and was one of the two polders selected as pilot project implementation under the Delta Development Project in 1988. The polder was recently rehabilitated under the IPSWAM project from 2003 – 2011.

Dumuria is under the AEZ no. 12.-“Low Ganges River Floodplain.’ The greater part of this region has smooth relief. River banks generally stand about a meter or less above the

level of adjoining basins. The region is characterized by a close network of interconnected tidal rivers and creeks. Ground water is saline in near surface aquifers throughout most of this region. Sweet water occurs in aquifers at around 300 meters. Net cropped area of Dumuria sub-district is 63013 acre (According to BBS, 2010-11). The study found that net 4620 acre of land used in the polder 29 for vegetable cultivation. Cropping intensity of Dumuria is 120 in 2011 but in case of Khulna cropping intensity is 147 in 2014-15 according to agriculture census. According to Blue Gold Research cropping intensity of this polder is 166.

2.2 Climate of the study area

Data on different meteorological parameters such as rainfall, temperature and humidity are collected for assessing the existing climate which is directly related to the vegetable cultivation and post harvest management. The nearest station of Bangladesh Meteorological Department (BMD) based at Khulna. Khulna is humid during summer and pleasant in winter. Khulna has an annual average temperature of 26.3 °C (79.3 °F) and monthly means varying between 12.4 °C (54.3 °F) in January and 34.3 °C (93.7 °F) in May.

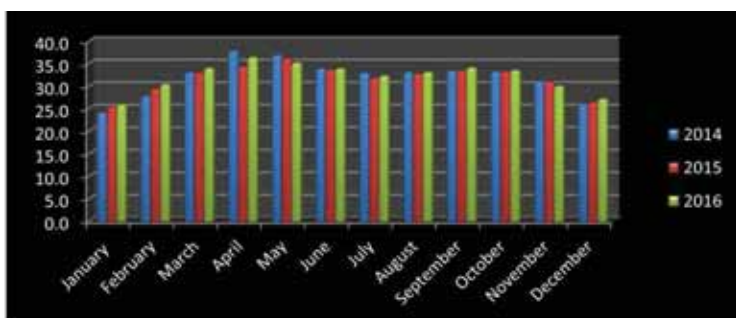


Fig 1: Month wise maximum temperature of Khulna District

Month wise maximum temperature

Form the last three years temperature data of 2014 to 2016 it is found that highest temperature exist in the region during April and May which is 36° C. Average highest temperature of Khulna district is 31° C.

Month wise minimum temperature of khulna district

Lowest temperature exists at the region in the month of December and January. The average lowest annual temperature of Khulna is 22° C. Monthly lowest temperature is 13° C exist in the month of January and 15° C observed exist in the month of December. Temperature gradually increase from the month of February and fall after the month of September.

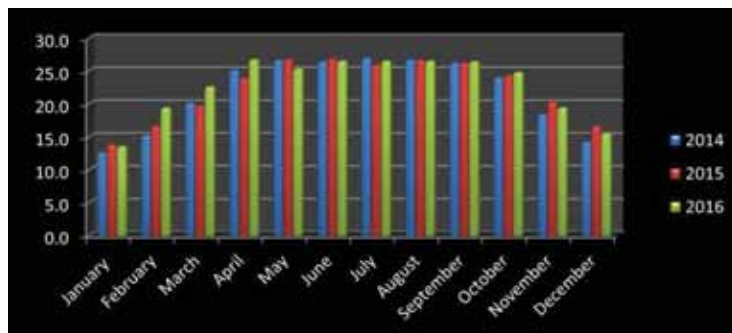


Fig 2: Month wise minimum temperature of Khulna district

Permanently wet basin peat and muck, part with alluvial topsoil. The land topography of the study area is medium low land and low land. According to Khulna Soil Resources Development Institute (SRDI) soil type of this area is clay soil and for this reason vegetable are not grown well in this area. Water logged here for long time. In dry season soil become very hard. Soil salinity is high. It is higher in winter season. It is another reason for low vegetable cultivation said the

Table 5: Monthly Rainfall and Relative Humidity of Khulna District

Months	2014		2015		2016	
	Rainfall (mm)	RH	Rainfall (mm)	RH	Rainfall (mm)	RH
January	0	0.8	41.0	81.0	0.0	80.0
February	24	75.0	35.0	76.0	97.0	78.0
March	5	69.0	28.0	70.0	5.0	75.0
April	0	65.0	107.0	77.0	54.0	75.0
May	118	74.0	128.0	77.0	350.0	78.0
June	447	84.0	318.0	84.0	353.0	
July	394	86.0	924.0	91.0	413.0	
August	258	86.0	371.0	87.0	646.0	
September	205	85.0	293.0	86.0	147.0	
October	10	80.0	83.0	82.0	81.0	
November	0	78.0	3.0	81.0	75.0	
December	0	82.0	6.0	85.0	0.0	

Source: District Weather Office, Khulna

Khulna District Average Rainfall and Relative Humidity: Annual average rainfall of Khulna is 1,809.4 millimetres (71.24 in). Approximately 87% of the annual average rainfall occurs between May and October

2.3 Demographic Characteristics of the Study area

The 13,560 households living in the 29 polder area have a total population of 55,304. According to the report female population of the area is higher than the male population. The average density of population is 1023 persons per sq. km which is higher than national density of 1,015 persons per sq. km.

Table 6: Population of the Union under Polder 29

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Sub-district	Polder	Union	No. of WMG	HH	Population
Dumuria	29	Sarappur	15	3908	15266
		Sahas	16	4654	19295
		Dumuria	2	451	1986
		Bhandarpara	18	3861	15860
Batiaghata		Surkhali	5	1445	5990

Source: EIA on Rehabilitation of Polder 29

Population of 15 to 64 years category is considered as labor force whereas, populations below 14 years and above 65 years are considered as dependent. Thus the team did not consider any dependent respondent during the study. Total 140 farmers responded in the study with an average age of 43 years old. The farmers have average 22 years of experience in agriculture as well as vegetable cultivation.

Table 7: Age Distribution of the Respondents

Age Distribution	No. of Respondent	Average Age
18-29 years	24	17%
30-45 year	60	43%
46-70 year	56	40%

Source: Field data

2.4 Land holdings of the study area

The Census of Agriculture, 2008 by BBS classified land holdings into two broad categories- one is farm-holdings and another is non-farm holdings. A farm holding is defined as being an agricultural production unit having cultivated land equal to or more than 0.05 acre. Farm holdings are classified into following three broad groups; a) **small** farm holdings having minimum cultivated land 0.05 acre but operated land more than this minimum but upto 2.49 acres b) **medium** farm holdings having operated land in between 2.50 to 7.49 acres and c) **large** farm holdings having operated land 7.50 acres and above. According to classification respondents farmers are categorized and the of the study.

Table 8: Category of the respondents according to farm holding

Category	Land size	Number
Small Farm Holding	0-249	108
Medium Farm Holding	250-749	29
Large Farm Holding	>750	2

Average land cultivated for vegetable is 55 decimal of land. During the study the team selected the farmers who have own land for vegetable cultivation. The following categorized vegetable farmers are interviewed during the study.

Table 9: Vegetable farm size of the respondents

Category of vegetable farmers	Land owned	Number
Marginal	5 to 24	57
Small	25 to 50	37
Medium	51 to 100	30
Large	More than 100	15

2.5 Vegetable cultivation Practice in the study area

Most of the villagers cultivate all year round. Cropping pattern of this village varies depending on different season. The main crop cultivate in this area is aman and boro paddy. But most of the farmers also produce different type of vegetable in different seasons like different type of gourds like ash gourd, bitter gourd, pumpkin, cucumber, kusi, Okra, YLB etc. in Kharif season and Bottle gourd, radish, tomato, brinjal, cabbage, cowpea, various beans etc. in rabi season They practices mixed cultivation technique in both agricultural and fish production part. Majority of the farmers cultivate fish and vegetables jointly. Farmers use bank of gher for vegetables cultivation. This area is abundant with fish both in river and pond. After harvesting paddy, fish cultivation starts to this same land. In the paddy field, farmer usually cultivate aman paddy at the middle of the field and around the field (generally lower portion) they cultivate fishes. Water logging problem is one of the vital problems of this village mainly in Rainy season. On the other hand, farmers suffer in extreme



Huge vegetable cultivate in dyke cropping method

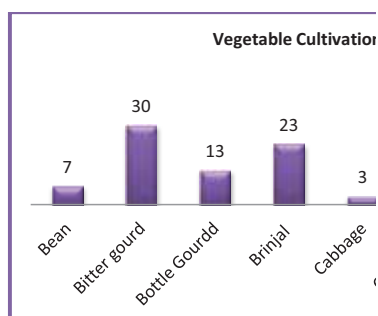


Fig 3: Varieties of vegetable cultivated in the area polder 29

irrigation problem mainly in Rabi season. Farmers adjacent of the Vadra river collect water for irrigation but sometimes it also remain dry. As per Sub Assistant Agriculture officer of the area, total vegetable cultivated land in the polder 29 is about 880 ha and total production is about 11000 MT. According to DAE data in Dumuria Sub-districts Tomato is cultivated in highest 877 acre of land followed by cauliflower 813 acre and Bean 667 acre of land. However, Bottle gourd, Brinjal cultivated mostly in Kharip-2. In the polder 29. (Table 10)

There are other crops cultivated in kharip-2 like Bitter gourd, cucumber, sweet gourd in Dumuria. In the polder 29 area, the study team found that almost half (44 number) of respondents (farmers) cultivate tomato in Rabi, 35 number of farmers out of 97 respond cucumber in Kharip season. About 31% farmers said that they cultivate Bitter gourd followed by Brinjal 24% number of farmers. Therefore, from the study it is revealed that in the area Polder 29, major vegetables are **Tomato, Cucumber, Bittergourd, Brinjal, Bttle gourd and Okra but not limited.**

Table 10 : Major Vegetable Production in the Dumuria Sub-district

Vegetable	Cultivated Land(Acre)	Production (MT)
-----------	------------------------	-----------------

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Bean	667	1970
Tomato	877	8165
Raddish	321	3640
Cabbage	422	6840
Cauliflower	813	10528
Brinjal	482	4680
Bottle Gourd	383	4650

Source: DAE, Dumuria Upazilla, 2015

Furthermore, it is found that major vegetables cultivated in Rabi and Kharip-2 season. Thus tomato only cultivates in Rabi season, brinjal cultivates both rabi and kharip. Most of the farmers cultivate cucumber in Kharip-2 season where as almost all are cultivated bottle gourd in the the Khari-1 season.



Fig 4: Seasonal Production of different vegetables

2.6 Local Storage System

There is no cold storage in the area 29 polder even in the Dumuria. There are 5 private owned cold stores in Khulna among those five three cold stores shut it down. All the cold stores are only use for potato having present capacity of about 6500 MT of potato. There are no other stores in Khulna area where farmers can store or preserve their produces.

Table 11: Cold storage number and capacity in Khulna

Name of Cold Storage	Capacity (MT)	Products	Remarks
Doulotpur Ice and Cold Storage	5000	Potato	
Mahmud Food Processing and Cold Storage	1680	Potato	
A B Industries Ltd	1000	Potato	Closed
Himagar Ltd	1500	Potato	Closed
Khulna Ice and Cold Storage	1600	Potato	Closed

Source: Department of Agriculture Marketing

According to the key informants and farmers of the area, salinity intrusion and drainage of flooding or heavy rain water are the most important problem of the polder 29. Drainage, the most important problem that creates barrier to cultivate high value crops in commercial scale in the Polder 29. During monsoon and post-monsoon periods, most of the khals can not able to drain out the water due to occurrences. Due to the reduced drainage capacity of khals, rainwater often inundates the adjacent agricultural fields for a period of 4~5 days, and affects the crop production. Similarly in the polder area, salinity intrusion, especially in the dry period hinder to cultivate crops and vegetables. Such salinity intrusion caused severe scarcity of drinking water sources.



SECTION THREE: LOCAL VEGETABLE BUSINESS ANALYSIS

The study team concentrated on vegetables cultivation of the polder area, however it was necessary to understand about the local cropping pattern. The vegetable based cropping pattern depends on the land topography. In the polder area most of vegetables cultivated as dyke cropping but some of high land where vegetables are cultivated. According to the key informant's, most prominent cropping pattern of the polder area is "Fallow – Aman – Boro". But Vegetable- Vegetable – Vegetable cropping pattern is practiced in the dyke of low land where fish rice culture is mostly accepted.

3.1 Business Analysis of Farmers

After production farmers consume about 2-3% of produce and 1-2 % of total produce they distribute among the neighbor. Almost 95% of total produced vegetables are sold by the farmers. Selling behavior depends on the price and volume products. In addition, distance of market and transport cost also considered during the sales of the products.

The research found that about 56% farmers sell their produce from field. Sometimes they sell vegetables to small traders called “Faria” and sometimes to large traders when they have to harvest large amount of product at a time. Very few percent of farmers (8%) used to sell at distant market.

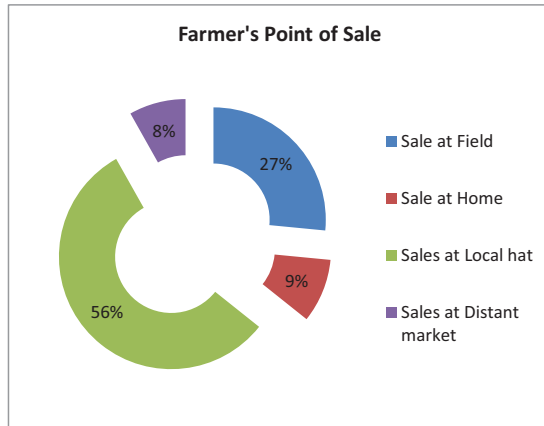


Fig:5 Selling point of farmers' produces

About half of the farmers (46 number of farmers) reported that they sell their product to the “Bepari”, large traders who usually purchase from farmers at large volume. The farmers who sell their products at the market sell it through the Arottdar. About 20% of the total respondent farmers said that they sell vegetables to Arottdar. Small farmers said that they sell products at the local market directly to the consumers. 52 farmers replied they know about the high price market information when they were asked however, 46 respondents don't know about the high price market.

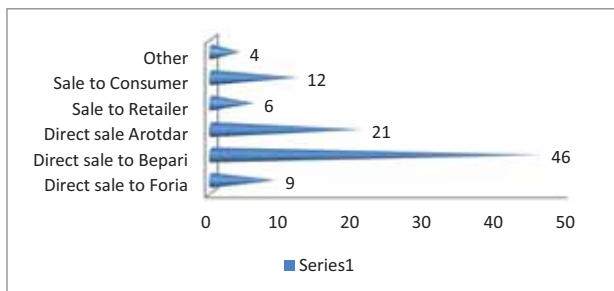


Fig 6: Farmers' produce sold to different market actor

From the research it is observed that most of the vegetables are cultivated on an average 15 decimal of land per farmer. Only tomato is cultivated in more land i.e. average

30 decimal of land. However, farmers earn more profit from cucumber 3250 tk per decimal of land followed by brinjal 1740 tk per decimal and 1150 tk per decimal.

Table 12: BCR of different vegetables

Vegetable	Avg. Land(Decimal)	Avg. Cost/decimal)	Avg. Revenue/decimal	Profit/Decimal
Tomato	30	250	1400	1150
Brinjal	15	340	2080	1740
Bean	15	220	1200	980
Cauliflower	16	260	900	640
Bottle Gourd	15	252	650	398
Cucumber	17	250	3500	3250

Source: Field Data

3.2 Business Analysis of the Traders

Almost all the vegetables consumed and trading in the area are produced locally except potato and some other off-seasoned and exotic varieties like capsicum; taro etc are imported from outside of this area. In the area polder 29 surplus vegetables goes to the Khulna market and sometimes national buyers procure vegetables here to supply other districts. During the research the team got information on local vegetables business and regular buying selling pattern from the 22 vegetables traders who all are local business persons. Among them 41% traders (9 persons) have business with the adjacent market. 5 traders said that often they supply product to the Dhaka market and rest of the them (8 persons) only do their business locally

62% transaction of local vegetables happens in cash. But sometimes traders are not able to pay the full amount when farmers harvest large volume of vegetables. From the research it is revealed that about 38% transactions happen in credit.

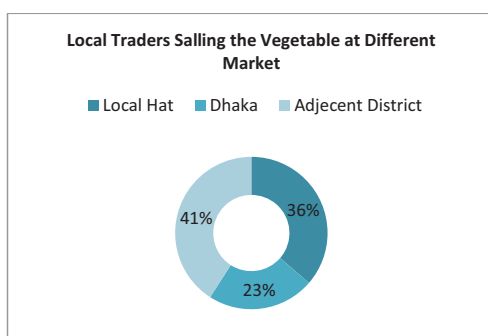


Fig 7: Supply of vegetables at different market

The study team found that average bulk purchase price of vegetables 13-14 tk per kg and whole sale price is 16 – 17 tk per kg from traders to traders. There are some associated costs for each of the buying and selling at every actor level and it varies from 0.1 tk to 1.0 per kg. Due to the seasonality the team found that highest market price exists for Okra and Brinjal. Price varies from product to product in relation with production and demand with season to season.

Table 13: Different vegetable buying, selling and associated cost

Products	Purchase Price (BDT/kg)	Selling Price(BDT/kg)	Associated Cost (tk/kg)
Brinjal	17	23	1.0
Cucumber	13	15	0.1
Tomato	12	15	0.5
Bean	13	15	0.1
Bottle Gourd	10	14	0.5
Okra	19	21	0.1
Cauliflower	9	12	0.2
Bitter Gourd	16	19	0.3

Source : Field Data



SECTION FOUR. POST HARVEST MANAGEMENT OF VEGETABLE

The postharvest qualities of vegetables are largely determined by pre-harvest factors such as production location, soil type, irrigation, rootstock, shading and nutrition. Monselise and Goren (1987) divided the pre-harvest factors into primary and secondary. The primary factors include climate, nutrition and plant growth regulators, and the secondary factors include soil quality and management, rootstock, irrigation, pruning and crop load manipulation.

Relative humidity plays an important role in determining fruit quality. Higher relative humidity around the fruit reduces water and Ca movement into the fruit. It has been observed in tomato fruit, where higher relative humidity around the plant increases fruit Ca, and decreases shelf life due to Ca toxicity (Adams and Holder 1992; De Kreij et al. 1992). The stage of maturity at harvest affects fruit quality. Generally, the fruits harvested at the advanced stage of maturity have increased fruit size and eating qualities (taste and aroma) but decreased shelf life.

The temperature should be 2-5 degrees celsius for optimal produce storage. Before storing vegetables it needs to separate the ethylene sensitive items from ethylene producing items for longer shelf life.

Table 14: Ethylene sensitiveness of Different vegetable

	Does not produce ethylene and not sensitive to ethylene	Okra, Raddish, Chili, Carrote, Potato, Ginger, Garlic
	Does not produce ethylene but is sensitive to ethylene	Bean, Cucumber, Brinjal, Cabbage, Cauliflower
	Produce ethylene and is sensitive to ethylene	Tomato

Once harvested, fruits and vegetables must be stored under proper conditions. These can be classified into four groups

Table 15: Temperature and RH sensitiveness of different vegetable

Category of Sensitivity on Temp. and RH	Vegetables
Vegetables that require cool, moist conditions	Bean, Cucumber, Brinjal, Tomato
Vegetables that require cool, dry conditions	Gerlic, Onion
Vegetables that require warm, dry conditions	Pumpkin
vegetables that require cold, moist conditions	Cabbage, Cauliflower, Carrots, Raddish, Potato

Temperature influences vital physiological processes, namely respiration and ethylene production. Sommer (1985) mentioned that low temperature not only slowed down fungal development but also maximized postharvest life

Table 16: Storage condition of different vegetable

Product	Temperature (oC)	Relative humidity (%)	Approximate Storage Life
Cauliflower	0	95-98	20-28 days
Cucumber	10-13	95	10-15 days
Brinjal	12	90-95	8-10 days
Tomato	8-9	80-85	14-20 days
Okra	7-10	85-90	10-15 days
Bean	0-5	85-90	15-28 days
Bottle Gourd	10- 12	70-75	60-150 days

Source: Department of Agriculture Marketing

Nature of damage of vegetables and post harvest constraint at different actors level

Different types of damage of horticultural produce are observed in the entire marketing channel. The major damages include bruises, cuts and rots for most horticultural

produce, and latex injury for mango, banana and papaya. The important damages of fruits and vegetables in the supply chain are briefly discussed in this chapter.

Table 17 Nature of Damage and Problem associate with different vegetable

Vegetables	Damages	Level of Actor	Constraint
Tomato	Cuts and bruises are the predominant types of spoilage.	At Farmer level	Viral diseases especially the tomato mosaic virus
		At Bepari level	Lack of storage and inadequate transportation
Cauliflower	Cuts and over maturity of the curds are the major problems	At Farmer levels,	To insect damage and over maturity or discoloration of the curd. Over maturity, curd discoloration (red rot due to boron deficiency), and lack of storage
	The discoloration of the curds is observed to be the most serious problem in cauliflower transportation	At Bepari level	
		At Retailer level	
Brinjal	Detachment of fruit from the stalk is found to be the major cause of postharvest damage	At Retailer level	Fruit separation from the stalk is the major problem
Cucumber	In the case of cucumber, the maximum damage occurs due to cuts.	At Bepari level	The growers' problems are related to insect pests, diseases and lack of other inputs
		At Retailer level	Lack of knowledge on storage and transportation, quality deterioration due to water loss and subsequent shrinkage
Okra	The maximum damage occurs to okra pod due to bruises.	At Farmers level	Insect pests and diseases are observed to be the major problems. Apart from pests and diseases, other problems are related to seeds
		At Retailer level	Over maturity of the pods is an important problem of the okra
		At Bepari level	Quality deterioration of okra pods by rots and discoloration due to absence of proper storage facility

Source: Report on Post Harvest Handling of Fruits and Vegetables.

Moreover, in Bangladesh about 30% loss occurred at post harvest. The following table shows that farmers incurred highest level loss for okra where traders are facing highest level loss for cauliflower, cucumber followed by tomato.

Table 18: Postharvest losses at different levels of supply chain (%)

Postharvest loss at different actor level				
Commodity	Grower	Bepari	Wholesaler	Retailer
Tomato	6.9	9.1	8	8.9
Cauliflower	4.2	9.2	10.3	10.7
Okra	9.4	9.8	4.9	8.3
Brinjal	6.9	7.4	8.4	6.6
Cucumber	7.2	4.5	10.7	4.7

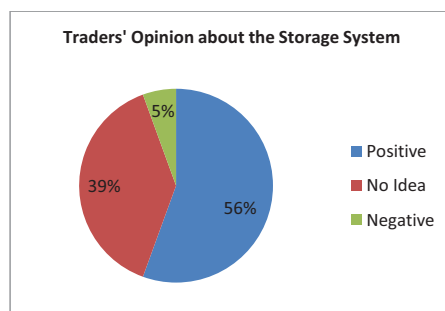
Source: Report on Post Harvest Handling of Fruits and Vegetables.

Regarding the necessity of vegetables storage, research found that 56% traders showed their positive interest about the vegetables storage and expressed the opinion that it will help them to minimize the loss and sale the product at distant market. 5% traders said that they have no idea about the vegetable storage where as 39% replied that no need to store vegetables because their business volume is low and limited capacity to invest to stock product for long interval.

Proper method and care about vegetable harvesting

When harvesting produce for storage or buying it locally in season, there are some precautions to assure maximum quality and minimize spoilage

- Harvest vegetable at peak maturity or as near as possible.
- Use only product that is free from all visible evidence of disease
- Do not pick any vegetable that has severe insect damage
- Handle food carefully after harvest so that it is not cut or bruised
- Leave an inch or more of stem on most vegetable to reduce water loss and prevent infection
- Use late maturing varieties better suited to storage
- Need separation of the varieties releases ethylene, which speeds the ripening process of other vegetables.
- All produce must be kept in a dark, aerated environment
- While most vegetables like moist conditions, standing water must be avoided, as it will quickly lead to rot
- One of the best ways to store small quantities of vegetable requiring cool, moist storage is in an extra or old refrigerator
- For best storage, produce should be washed free of soil and placed in plastic bags with 2" - 4 1/4" holes for ventilation.



Harvesting tips for some major vegetable before storage

Okra

- Desirable size of the pods attained
- The tips of the pods can easily be snapped
- The tender young fruits of 7-10 cm long should be harvested every alternate day
- The pods of okra become ready for harvest from the 6th day of flowering. Pods harvested on or after the 8th day of flowering become fibrous (Hazarika *et al.* 1997).

Brinjal

- Desirable size and color attained
- The fruits should be tender at harvest. Over mature fruits have dull color and hard seeds
- The surface of the fruit should not lose its bright and glossy appearance
- At harvest, the calyx and the peduncle should remain attached with the fruit (Som and Maity 2002).

Tomato

- Tomatoes should be harvested at mature-green stage (fully-grown fruit with light green colour at the blossom end and seeds are surrounded by jelly-like substances; Tiwari *et al.* 2002).
- Tomatoes can also be harvested at turning pink (1/4th of the surface at the blossom end shown pink; Wills *et al.* 2004).

Cauliflower

- Desirable size attained
- Cauliflower should be harvested at the stage when the curd is compact
- Over-mature curd becomes loosened with elongated flower clusters.

SECTION FIVE: LOW COST NATURAL COLD STORAGE FOR VEGETABLE PRESERVATION

Modern storage of fruits and vegetables is virtually absent in Bangladesh. Cold storage facility is only available for potato. However, there are a very few multi-chambered and privately-owned low temperature storage facilities in Badamtali, Dhaka (Plate 11.1) where the wholesalers keep high-value fruits, particularly the imported apples, orange, dates, pears and grapes which required large investment. However, from last couple of years many research organization, development projects, govt. line departments are trying to replicate low cost farmers' friendly natural cold storage which operates without energy or in some cases renewable energy like solar. Here the team reviewed different organization's initiatives for natural cold storage for vegetables. Some of them are given below

Fig 9: Improve natural storage system using the evaporation technology



An environment-friendly cold storage with 240 metric tonnes capacity was opened at Atmul village under Shibgonj upazila of the district 2015 for betterment of poor and marginal farmers across the area. The natural storage will preserve the agricultural produce through the process of vaporization. To help the farmers preserve perishable items such as potato, tomato, onion, and ginger at cheaper rates, the natural cold storage which uses green technology has been set up.



Last 4 February, 2017 the Director General of Department of Agricultural Marketing (DAM) visited a natural cold storage using no energy technology of evapo-transpiration. The store is in the Baniachong sub-district of Habigonj district. The structure was made by local materials bricks, sand, bamboo and straw etc. The store is about 5.5 X 3.75 sq feet having capacity 200 kg of vegetables. Farmers can store their vegetables here for 10 to 15 days.

Fig 10: Natural store developed by Department of Agricultural Marketing



An environment-friendly cold storage with 300 metric tonnes capacity was opened in Rajshahi city in December 2014 at a cost of around Taka 14 lakh. Prof Dr Monzur Hossain said the cold storage has been designed to facilitate the grassroots level farmers in Bangladesh. No electricity is required to run this cold storage. Instead the natural storage will preserve the agricultural produce through the process of vaporization.

Fig 11: Natural store of 300 MT capacities using the technology of evaporation

The cold storage was built three years back in Jhumjhampur for the preservation of fruits, flowers, vegetables, meat and fish at the Horticulture Development Centre of BADC (Bangladesh Agricultural Development Corporation). Tk 50 million was spent on building the storage, which charges 15 paisa per hour and Tk 3.60 per day for storing one kilogram of vegetables. Therefore the weekly and monthly costs for storing vegetables stand at Tk 25.20 and Tk 108 respectively. Such rates are not favorable for business, claimed farmers



Fig 12: BADC developed the natural store for vegetable and fruits



The USAID Horticulture Project with CIP and AVRDC is working with communities in Jessore and Barisal to find the best options of storage in partnership with BRAC. The ambient type stores are used to store 6-8 Tons of table potato for 3-4 months and farmers can get an increase (about 50%) in price of potato compared to the price during harvest.

Fig 13: Bamboo made natural storage system for potato preservation

The USAID Horticulture Project with CIP and AVRDC built 12 CoolBot storage units, all power-generated with individual capacities of seven to eight tons, to assist farmers with seed potato storage in different project areas. The Project will also conduct experiments with other horticultural crops and carry out a complete economic analysis of various stores.



Fig 14: CoolBot storage system



SECTION SIX: SUMMARY AND RECOMMENDATION

According to Department of Agricultural Extension (DAE) about 8.05 lakh hector of land targeted to produce vegetables in 2015-16 year. According to them more than 150 types of vegetables are being cultivated in the country. Recently Bangladesh has ranked third in vegetables production but still 30 to 35 % of post harvest loss is happening in vegetable sector. Every actor from farmers to consumers is paying for this loss and still Bangladeshi intakes 30% less vegetable than an individual needs (220gm) to take. Each of the intermediaries in vegetable trading is facing more than 8% of loss during the transportation and marketing of the products where as about 7-10% loss occurred at the farmers end. Absence of storage facilities, cold chain in the vegetable marketing and undefined market price are the main factors of postharvest loss of vegetables. Besides, proper harvesting techniques, packaging, proper grading and sorting also plays vital role to reduce the post harvest loss.

Approximate Demand- Supply Estimation of the Polder 29

- Total Net cropped area of Polder 29 is 5466 ha
- Summer vegetable cultivates 650 ha and winter vegetable cultivates 219 ha of land
- Total vegetable production (summer and winter) is more than 11000 MT (source, Blue Gold Report)
- **Avg. net vegetable production is 10000 MT** (Westage 10% at farmers end)
- Total population of polder 29 is about 60000 (58397, as per Blue Gold Report)
- According to WHO, individual vegetable intake 220 gm per day but Bangladeshi intake only 70%
- **Annual demand of vegetable in the area is 3000-3500 MT** (60000 population, 150gm consumption/day, 365 days)

Surplus production in the polder 29 area i.e about 6500 to 7000 MT of vegetable

In Khulna, there is only two cold storage having capacity of about 6500 MT only use for potato preservation. But there is no cold storage even for potato in the Dumuria sub-district. Natural storage of potato preservation at domestic level is well accepted and popular technology in potato growing area of Bangladesh where farmers can store their table potato for 3 to 4 months. Bangladesh Tuber Crop Research Center, International Potato Center and many development projects have introduced low cost natural storage system for potato but none of them work on vegetables preservation. However, recently Department of Agricultural Marketing has introduced small scale vegetable storage system using the evapo-transpiration technology. This technology provides 10 to 15^o C less temperature than outside of the store and relative humidity also remains higher.

Recommendations

Analyzing the information collected from the field and from the relevant documents the study team's recommendations are given in below:

- Establishing natural storage as pilot basis will be feasible for Polder no. 29 areas because around 11000 MT vegetable are produced in this area and farmers will be benefited by establishing natural storage in two aspects one is, it minimizes the burden of farmers from immediate selling of their products after harvest which also

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increase their bargaining power and another one is it create an opportunity to sell their products at Khulna arot in large volume.

- The owner of the storage house will be WMG and they will operate the business. The executive committee or a separate committee under the executive committee of WMG will manage and looks after the day to day business of natural storage. After reaching break- even point the storage generate profit for WMG and create a job opportunity for WMG group members.

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- Among the unions under the polder no 29, Bhandarpara and Sahas unions have highest area of vegetable cultivation land. Average 60 decimal of land/HH is being cultivated for vegetable in both Sahas and Bhandarpara union. So, this two union is more suitable to establish natural cold storage.

- The natural cold store at Birgonj, Dinajpur keeps the temperature 10 to 15 degree less than that of outside temperature. Relative Humidity remains 80 to 90%. So, A small scale Natural Storage using evaporation technology having capacity of 30 to 40MT of vegetables would be best option to minimize the post-harvest loss and to maximize the profitability.

- Many more varieties of vegetables are cultivating in the Polder 29 area but based on the volume of production most prominent vegetables are Tomato, Bean and Brinjal in Rabi season on the other hand Cucumber, Bottle Gourd, Bitter Gourd and Okra are in Kharif season. But based on the profitability, Cucumber, Brinjal, Tomato, Bean and Bottle gourd are the most significant vegetable in this area. Those vegetables are also required cool and moist condition. Cucumber, Brinjal and Bottle gourd required 10 - 13° C of temperature and relative humidity required more than 90% for the storage duration 10 to 20 days. Bottle gourd can store 60 to 150 days. Tomato and Okra required temperature 7- 10° C and relative humidity is 80 to 90% for the storing 10 to 20 days. So, Tomato, Bean and Brinjal in Rabi season and Cucumber, Bottle Gourd, Bitter Gourd and Okra in Kharif season are more suitable for storing in natural cold storage considering the volume and profitability of the crops.

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SECTION SEVEN: BUSINESS PLAN OF NATURAL COLD STORAGE

1. Summary of the Business

The Improve Natural Storage unit is a brick walled, thatched roof building constructed over an open water reservoir using the concept of evaporative cooling to greatly reduce the temperature within the facility. Farmers and traders can easily store surplus or unsold vegetables at any time by paying minimum amount for two weeks to avoid seasonal clearing as well as to create

bulk amount for selling in distanced markets. The large farmers or traders or any entrepreneur of the area can take initiative to establish this type of storage to store own produce or to sale the storage facilities. Natural storages at Dinajpur, Rangpur are established by individual entrepreneur on the other hand natural storages at Bandarban and Bogra are established by community people at group approach.

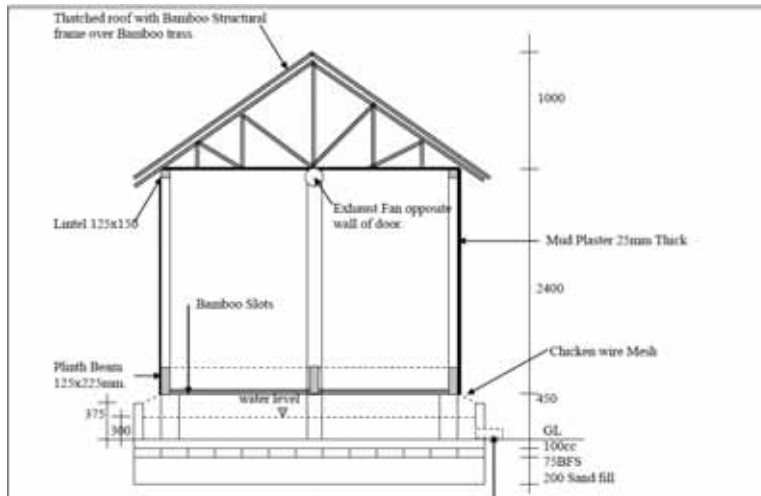


Fig15: Sectional Lay out the natural sort

- Proposed size of the store: 50 feet X 20 feet
- Proposed capacity: 20 to 30 Metric Ton
- Life span of the store: 20 Years
- Annual revenue of the store BDT 280000 by selling the store facilities
- In the area polder 29 Brinjal, Okra, Cucumber, Bottle Gourd, Tomato are the products to store at natural storage
- Store facilities will be rented for 15 days slot
- Rent of the store facilities is 1tk/kg vegetable/15 days
- Profit will be redistributed among the WMG's members
- Break Even point : 1147 MT
- No. employment generate: 1 number
- Potential area of the store establishment: Bhandarpara union or Sahas Union of polder 29.
- Spot of the store establishment: exact spot will be confirmed in consultation with WMGs of the Unions.

Farmers Benefit

- Usually farmers harvest their vegetables and sell immediately to traders from their farm gate or in local hat. Sometimes they get low price due to seasonal heap and need to immediate sells even in credit due to lack of storage facility. So, If there has a storage facilities, farmers can store their harvested products up to 10-15 days and sell it when the price raise within this time period.

- On the other hand, due to small quantity it is not feasible for them to carry their produced products in Khulna arot though the price usually varies from farm gate to Khulna arot is 2-3 Tk/Kg. During the study period, the study team found that on 28-01-2017 the price of Cauliflower was 800 Tk. per mound at village level whereas on the same day the price was 900-920 Tk per mound at Khulna arot. So, if they store their produced 3 to 4 times harvested products then it will helpful to create large volume and getting more profit by bring and selling this in Khulna market
- Moreover, farmers can minimize the postharvest loss from 5 to 7%.
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- ~~Moreover, farmers can minimize the postharvest loss from 5 to 7%.~~

2. Business Model

Since, all the farmers and local traders living in the polder 29 belongs the water management group (WMG) therefore, the natural storage will be established by the WMG. As owner of the storage house WMG will also operate the business. The executive committee or a separate committee under the executive committee of WMG will manage and looks after the day to day business. The farmers of the adjacent area and traders of the adjacent market are the major customers of this store house will get similar services from the storage. Both farmers and traders will have to pay the fixed price for per kg of vegetable for every 15 days. Due to limited space members of the respective WMG will get first priority to store the product during the time of high demand. Profit from this business will be distributed among the members of the WMG.

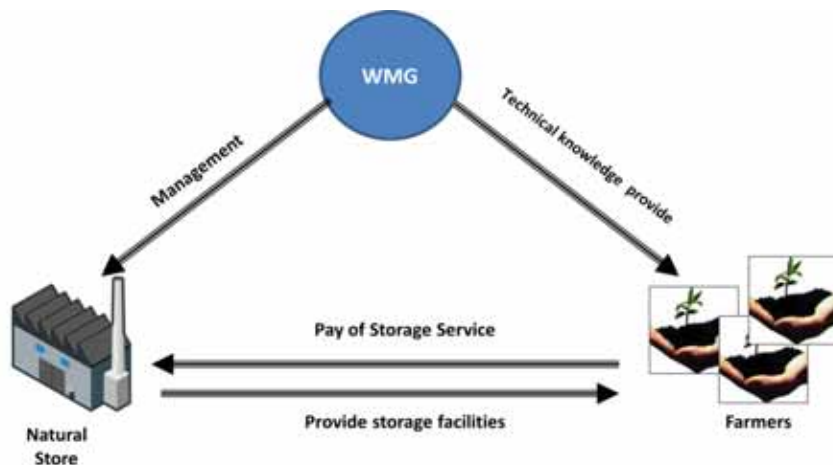


Fig:16 : Business Model for Storage Facilities

3. Marketing Strategy

The store will be used 7 to 8 months in a year for vegetable preservation in the area. Farmers will bring their vegetables and store into the storage house. Brinjal, Cucumber, Okra, Tomato, Bottle Gourd are the major vegetables of the area to store. Annual target of this natural store is 280 to 300 MT of vegetable storing.

Moreover, large traders who import potato from other districts can effectively use the store house for potato preservation because during the time from March to June there is less production of vegetable.

Cold store determines unit price on the basis of space and time. Similarly, the natural store will charge BDT 1.00 for 1kg vegetables for 15 days. Farmers can bring back his/her products any of the days within 15 days slot by paying 1 taka for 1 kg vegetable.

For promotion of this service, WMG can provide technical knowledge to farmers and traders on the post harvest management. They will share the appropriate harvesting technique, grading and sorting technique, packaging and transport system etc. provides the market information as well. WMG can communicate with buyers who can get a large volume from this storage point at any time.

4. Implementation of Natural Storage and Financial Analysis

After selection the spot and finalization the design or lay out, Blue Gold project will support to introduce this innovative technology and MarGEn will provide the expertise to establish and monitor technology. Besides, MarGEn will develop the capacity of executive committee on the management of natural storage and harvesting and post harvesting technology. The approximate material cost of construction for the natural store is BDT 8,60,000. The life cycle of the store will be 20 years and after 3 years the thatched roof needs to renovate. The full budget will be prepared after finalization the layout and monitoring activities.

Table 19: An estimated material cost to build the natural storage

Feasibility Study Report on Promoting Natural Cold Storage in Coastal Area

Sl. No.	Item	Total Cost (BDT)
A	Land Lease for One year	10,000
B	Design & Layout	15,000
C	Materials Cost	D
1	Bricks	110,000
2	Brick Chips	40,000
3	Sands (For Filling the Basement)	50,000
4	Sand for Bricks work and casting	30,000
5	Mud Plastering	10,000
6	M S Rod	100,000
7	Cement	100,000
8	Thatched roof	15,000
9	Wood for door	15,000
10	Bamboo (75 mm diameter)	150,000
11	Electric motors and cables	20,000
12	Pipeline for electrification, motor boring	15,000
13	Miscellaneous	20,000
D	Machineries & Equipments	10,000
E	Mason & Labor	150,000
Total Material Cost		860,000

The store will be able to generate approximate BDT 2,80,000 as annual revenue if it can be operated in 7 months in a year. A part time employee will be recruited for 7 months that is management cost 35000 tk for 7 months. In the first 3 years, no renovation cost will be required but from the fourth year thatched roof needs to be replacement which cost would be approximately 10000 tk. In the income statement, depreciation cost has been calculated which is 43000 tk approximately. Annual net profit from the store house is 202000 tk estimated.

The income statement and break even analysis is mentioned here in below:

a. Income Statement

Particulars	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	280000	280000	280000	280000	280000
Management Cost	35000	35000	35000	35000	35000
Renovation Cost	0	0	0	10000	10000
Depreciation Cost	43000	43000	43000	43000	43000
Total Cost	78000	78000	78000	88000	88000
Net Profit	202000	202000	202000	192000	192000

b. Break Even Analysis

The total fixed cost of the Business is 86000 BDT

Unit price of the rental service is BDT 1 per kg

Per unit variable cost is BDT 0.25 per kg

Break Even Point of the investment

$$\text{Break Even Point} = \frac{\text{Total Fixed Cost}}{\text{Rental price per kg} - \text{Variable cost per kg}}$$

$$\text{Break Even Point} = \frac{860000}{1 - 0.25}$$

$$= 1146667 \text{ kg}$$

$$= \mathbf{1147 \text{ MT}}$$

$$\text{Break Even Time} = \frac{\text{Fixed Cost } 88000 \text{ BDT}}{\text{Average Annual Profit } 198000 \text{ BDT}}$$

$$= \mathbf{4.5 \text{ Years}}$$

5. Risk of the natural storing Business

- Farmers are unaware of appropriate harvesting system such as proper pre and post-harvest activities before storage. use of appropriate harvesting techniques, carrying from the field, curing on cool & shaded place, sorting and grading etc. If these activities are not properly done, vegetable will rot during storage no matter how effectively the store is managed.
- Risk associate with the nature of vegetables. Some vegetable are sensitive to ethylene and some are producing ethylene. If there two types of vegetable store at a time there is a risk of spoilage.
- Due to natural weather like sudden fluctuation of temperature and humidity the inside environment may vary accordingly.

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ANNEXTURES

6. List of Farmers Interviewed

Sl. No.	Full Name	Father's/ Husband's Name	Mobile No	Union	Village
1	Md. Ruhul Amin Gazi	Md. Lutfor Rahman Gazi	01924384500	Sorappur	Baniakhali
2	Rafiq Mollah	Lal Chand Mollah	01965423740	Sorappur	Britti Bhulbaria
3	A. Jalil Sheikh	A. Karim Sheikh	01985542593	Sorappur	Baniakhali
4	Deoar Hossen	Md. Rustom Ali	01923943149	Sorappur	Baniakhali
5	Md. Ahsan Seikh	Md. Raham Ali Sheikh	Not available	Sorappur	Baniakhali
6	Md. Sobhan Sarkar	Late. Akhter Sarker	Not available	Sorappur	Baniakhali
7	Karimul Islam	Mozaffor Hossen Kazi	Not available	Sorappur	Baniakhali
8	Md. Siddik Khan	Surot Ali Khan	01931373402	Surkhali	Sundarmahal
9	Sushila	Bhuban Mandol	01944236340	Surkhali	Sundarmahal
10	Monu Mollah	Riajuddin Mollah	01969262497	Surkhali	Sundarmahal
11	Ovimannu Sardar	Late. Trimanda Sardar	01939418046	Surkhali	Sundarmahal
12	Dilip Mondol	Krisniopodo Mondol	01966978257	Surkhali	Sundarmahal
13	Irfan Mollah	Late. Sana Mollah	01951443688	Surkhali	Sundarmahal
14	Mannan Mollah	Md. Sourup Mollah	01920769777	Sorappur	Britti Bhulbaria
15	Ashok Shil	Asim Shil	01925676792	Surkhali	Shomvunagar
16	Md. Montaz Ali Khan	Md. Omar Ali Khan	Not Available	Surkhali	Shomvunagar
17	Somores Mondol	Mukondo Mondol	01926050547	Surkhali	Shomvunagar
18	Khokon Mondol	Sontos Mondol	01917815829	Surkhali	Shomvunagar
19	Md. Shahadat Hossen	Shahid Sheikh	01969505222	Surkhali	Shomvunagar
20	Samsur Rahman	Fakir Biswas	01980918212	Surkhali	Shomvunagar
21	Tapos Mondol	Krisnopodo Mondol	01831079400	Surkhali	Shomvunagar
22	Pijus Kanti Mondol	Gobindo Mondol	01914652600	Surkhali	Kodla
23	Md. Mohsin Seikh	Md. Mohor Ali Seikh	01710619435	Sahas	Kukhia
24	M. A. Kayum Sheikh	Md. Atiar Rahman Seikh	01914663767	Sahas	Kukhia
25	Maya Mondol	Nihar Mondol	01931643729	Bhandarpara	Ula Charail
26	Anima Goldar	Subas Chandra Goldar	01731433419	Bhandarpara	Ula Charail
27	Brojen Kumar Rai	Late. Anil Krisno Rai	01731433419	Bhandarpara	Ula Charail
28	Ibad Ali	Late. Monsur Fakir	01957609528	Sahas	Gojendrapur Dakksin
29	Sharmin Sultana	Ahadullah Gazi	01915829206	Sahas	Gojendrapur Dakksin
30	Nowab Ali	Late. Sohor Ali Fakir	01950618365	Sahas	Gojendrapur Dakksin
32	Md. Rokuzzaman	Md. Ansar Ali Khan	01722309685	Dumuria	Dumuria

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	Khan				Dakksin
33	Md. Yousuf Ali Seikh	Md. Porsullah Seikh	01938606678	Dumuria	Dumuria Uttar
31	Habibur Rahman Gazi	Late. Insan Ali Gazi	01934511230	Sahas	Gojendrapur Dakksin
34	Ahadur Mollah	Md. Abu Sayed Mollah	01719480120	Dumuria	Dumuria Uttar
35	Md. Moshiur Rahman	Md. Mokaddes Seikh	01920292588	Sahas	Kukhia
36	Md. Sumon Seikh	Habibur Rahman Seikh	01962716332	Sahas	Kukhia
37	Md. Abujar Seikh	Md. Golam Rabbani Seikh	01991278433	Sahas	Kukhia
38	Md. Faruk Seikh	Md. Nahezuddin Seikh	01960062581	Sahas	Kukhia
39	Md. Nurul Islam	Late. Ayub Ali Seikh	01965538489	Sahas	Kukhia
40	Md. Jubaed Ali Seikh	Md. Shahidur Rahman Seikh	01911839815	Sahas	Kukhia
41	Md. Toyabur Seikh	Md. Habibur Seikh	01985978464	Bhandarpara	Ula Charail
42	Md. Habibur Rahman	Late. Abu Taher Ali Mollah	01756549160	Bhandarpara	Ula Charail
43	Samad Molla	A. Rahim Molla	01957601494	Bhandarpara	Ula Charail
44	Abed Ali Seikh	Ahaduddin Seikh	01952317254	Sahas	Kukhia
45	Afjal Hossen Seikh	Mahfuz Ali Seikh	01938683034	Sahas	Kukhia
46	Md. Ashraful	Late. Anar Ali Seikh	01955799376	Sahas	Kukhia
47	Md. Jamil Mollah	A. Hamid Mollah	01964151787	Bhandarpara	Ula Charail
48	Md. Mustafizur Rahman	Shahadat Hossain	01993418699	Sahas	Kukhia
49	Mrs. Resma	Anar Sardar	01781112269	Sahas	Kukhia
50	Masud Seikh	Sayed Ali Seikh	01712173533	Sahas	Kukhia
51	Md. Saiful Islam Molla	Wazed Ali Molla	01718656357	Bhandarpara	Ula Charail
52	Md. Sayed Seikh	Sattar Seikh	01985560017	Bhandarpara	Ula Charail
53	Md. Touhid Hossen Molla	Md. Zaman Hossen Molla	01923588044	Bhandarpara	Ula Charail
54	Shahidul Gazi	Raza Gazi	01985549647	Sahas	Gojendrapur
55	Khalil Gazi	Md. Motlob Gazi	01920066414	Sahas	Gojendrapur
56	Md. Nizamul Islam		01988827484	Sahas	Gojendrapur
57	Md. Abu Taleb Gazi	Late. Belaet Ali Gazi	01988827484	Sahas	Gojendrapur
58	Md. Aatur Rahman	Mofizuddin Seikh	01925434336	Dumuria	Dumuria North
59	Md. Selim Gazi	Md. Ali Seikh	01926865644	Dumuria	Dumuria North
60	Abul Hossen Gazi	Sobur Gazi	01988467191	Dumuria	Dumuria Dakksin
61	Porimol Mondol	Late. Profullo Mondol	01864455658	Bhandarpara	Ghona Uttarpara
62	Provas Rai	Dinbondhu Rai	01754439855	Bhandarpara	Ghona Uttarpara

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63	Gobindo Boiragi	Romesh Chandra Boiragi	01774907260	Bhandarpara	Ghona
64	Prosanto Mondol	Ponchanno Mondol	01759802040	Bhandarpara	Taltola
65	Rajakanto Sarkar	Sosibhuson Sarkar	01772556799	Bhandarpara	Taltola
66	Horidas Mondol	Sorup Chandra Mondol	01724719160	Bhandarpara	Taltola
67	Somnath Biswas	Kalipod Biswas	01736427630	Bhandarpara	Taltola
68	Indro Mistri	Sujit Mistri	01722367525	Bhandarpara	Banda
69	Sukesh Rai	Rohidas Rai	01743947186	Bhandarpara	Lohaidanga
70	Prosanto Kumar Biswas	Surendranath Biswas	01732033776	Bhandarpara	Lohaidanga
71	Amrito Gain	Ganendronath Gain	01740568224	Bhandarpara	Banda
72	Susanto Kumar Biswas	Late. Kesobnath Biswas	01777152421	Bhandarpara	Lohaidanga
73	Bolai Biswas	Makhon Lal Biswas	01761888807	Bhandarpara	Banda
74	Tapos Kumar Mondol	Nirapod Mondol	01866542533	Bhandarpara	Banda
75	Pronob Biswas	Nirapod Biswas	01713689022	Bhandarpara	Ghona
76	Kalidas Biswas	Late. Horinath Biswas	01713689009	Bhandarpara	Ghona
77	Bina Biswas	Narayan Biswas	01798318330	Bhandarpara	Ghona
78	Momota Rani Sarkar	Bhudeb Chanrad Sarkar	01721363227	Bhandarpara	Ghona
79	Ronjon Biswas	Late. Monohor Biswas	01732527245	Bhandarpara	Lohaidanga
80	Minar Rai	Manosi Rai	01736590230	Bhandarpara	Ghona
81	Jogoprio Mondol	Late. Jogodish Chandra Mondol	01778626589	Bhandarpara	Lohaidanga
82	Asitos Goldar	Haran Goldar	01774978077	Bhandarpara	Banda
83	Prosanto Dalim	Gopal Dalim	01730945214	Bhandarpara	Banda
84	Dhiman Dhali	Gopal Dhali	01720530957	Bhandarpara	Banda
85	Dhiraj Boiragi	Mondar Boiragi	01748156969	Bhandarpara	Banda
86	Dipali Sarkar	Gredro Mondol	01745648886	Bhandarpara	Banda
87	Sures Chandra Biswas	Tareq Chandra Biswas	01768693797	Bhandarpara	Lohaidanga
88	Motilal Biswas	Girija Kanto Biswas	01743548964	Bhandarpara	Lohaidanga
89	Sumongal Mondal	Haripod Mondol	01778488677	Bhandarpara	Lohaidanga
90	Bikas Biswas	Benimadhob Biswas	01749156076	Bhandarpara	Lohaidanga
91	Sukumar Mondol	Kalidas Mondol	01738157986	Bhandarpara	Lohaidanga
92	Poncha Mondol	Nikhil Mondol	01860880036	Bhandarpara	Ghona
93	Soumitro Dhali	Molindronath Dhali	01743087573	Bhandarpara	Ghona
94	Sudhamoy Mondol	Horishchandra Mondol	01716447182	Bhandarpara	Taltola
95	Ashalota Bala	Kajol Bala	01720093900	Bhandarpara	Taltola
96	Susanto Choukidar	Azra Choukidar	01716447182	Bhandarpara	Taltola
97	Nirmol Gain	Gondaram Gain	01734866764	Bhandarpara	Ghona
98	Sosanko Mondol	Dhorendronath Mondol	01776571238	Bhandarpara	Ghona
99	Sayed Seikh		01947739138	Surkhali	Sundarmahal Purbopara

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100	Ongsopoti Rai		01916000234	Surkhali	Sundarmahal Purbopara
101	Ikbal Hossen Gazi		01918385311	Surkhali	Sundarmahal Purbopara
102	Shahidul Molla		01934509686	Surkhali	Sundarmahal Purbopara
103	G. M. Enamul		01716932842	Surkhali	Sundarmahal Purbopara
104	Amol Mondol		01938682296	Surkhali	Sundarmahal Purbopara
105	Nitai Mondol			Surkhali	Sundarmahal Purbopara
106	Jamal Uddin		01946511470	Surkhali	Sundarmahal Purbopara
107	Iman Mondol			Surkhali	Sundarmahal Purbopara
108	Md. Ali			Surkhali	Sambhunagar
109	Md. Abul Kasem Seikh		01932259612	Surkhali	Sambhunagar
110	Md. Momtaj Ali Khan			Surkhali	Sambhunagar
111	Dilip Mondol		01916432115	Surkhali	Sambhunagar
112	Md. Monirul Seikh			Surkhali	Sambhunagar
113	Md. Asmaul Seikh		01717227927	Surkhali	Sambhunagar
114	Prianka Mondol			Surkhali	Sambhunagar
115	Parboti Sekh		01925676792	Surkhali	Sambhunagar
116	Md. Rofiqul Islam		01922251655	Sahas	Baghdari
117	Nurzahan Beghum		01989312672	Sahas	Baghdari
118	Md. Ilias Hossen		01939419149	Sahas	Baghdari
119	Humayun Kabir		01991630479	Sahas	Baghdari
120	Sefali Beghum			Sahas	Baghdari
121	Kohinur Beghum			Sahas	Baghdari

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122	Shiuli		01926949209	Sahas	Gojendrapur Dakksinpara
123	Rabeya		01920066414	Sahas	Gojendrapur Dakksinpara
124	Nasrin Nahar		01937227735	Sahas	Gojendrapur Dakksinpara
125	Fatema			Sahas	Gojendrapur Dakksinpara
126	Fatema			Sahas	Gojendrapur Dakksinpara
127	Dilruba		01929039146	Sahas	Gojendrapur Dakksinpara
128	Sharmin Sultana		01915829206	Sahas	Gojendrapur Dakksinpara
129	Khairul		01913215433	Sahas	Gojendrapur Dakksinpara
130	Md. Ronju Hossen Gazi		01931255393	Sahas	Gojendrapur Dakksinpara
131	Md. Rokonzaman		01722309685	Dumuria	South Dumuria
132	Md. Abdul Majid Seikh			Dumuria	South Dumuria
133	Nazma		01916067845	Dumuria	South Dumuria
134	Rehana Parvin		01770756873	Dumuria	South Dumuria
135	Md. Alamgir Hossain		01911196865	Dumuria	South Dumuria
136	M. A. Sattar			Dumuria	South Dumuria
137	Sarifa Beghum			Dumuria	South Dumuria

7. VEGETABLE TRADERS LIST

SI No	Name	Father's name	Upazilla	Union	Nature of Business	Mobile Phone No.
1	A. Halim	Aman Joardar	Batiaghata	Surkhali	Wholesaler	01952318287
2	Md. Robiul	Babu Morol	Batiaghata	Surkhali	Bepari	01944211361
3	Md. Iqbal Sardar	Md. Sohrab Sardar	Batiaghata	Surkhali	Retailer	01994539479
4	Rejaul Seikh	Nijam Seikh	Batiaghata	Surkhali	Retailer	01928219713
5	Shaheb Rai	Jogodis Rai	Dumuria	Bhandarpara	Bepari	01703242790
6	Songkor Boiragi	Romes chandra boiragi	Dumuria	Bhandarpara	Bepari	01860880036
7	Kobiraj	Subroto Kobiraj	Dumuria	Bhandarpara	Arotder	01736012384
8	Biswjit Biswas	Porimol Biswas	Dumuria	Bhandarpara	Arotder	01734888875
9	Animesh Biswas	Binoy Biswas	Dumuria	Bhandarpara	Arotder	01727927921
10	Debes Das	Asim Das	Dumuria	Bhandarpara	Wholesaler	01743934475
11	Somnath Biswas	Kalipod Biswas	Dumuria	Sahas	Arotder	01736427630
12	Mofazzol Biswas	Suja Ali Biswas	Dumuria	Sorappur	Wholesaler	01962716325
13	Rafiq	Kaosar Kazi	Dumuria	Sorappur	Retailer	01922320196
14	Azharul Sardar	Adil	Dumuria	Sorappur	Bepari	01990945918
15	Ziaul Islam	Kamrul Islam	Dumuria	Sahas	Retailer	01611746674
16	Md. Mohiuddin Molla	Md. Akobbar Ali Molla	Dumuria	Bhandarpara	Retailer	01983392789
17	Md. Ali Molla	Md. Saheb Ali Molla	Dumuria	Bhandarpara	Retailer	01942045183
18	A. Sobur Seikh	A. Altaf Seikh	Dumuria	Sahas	Wholesaler	01949603785
19	A. Sattar Biswas	A. Hakim Biswas	Dumuria	Sorappur	Wholesaler	0168405006
20	Asif Seikh	A. Seikh	Dumuria	Sahas	Bepari	0192624107
21	Mizanur Rahman	Abul Hossen	Dumuria	Sahas	Arotder	01948146967
22	Shahin Sardar	Jamal Sardar	Dumuria	Sorappur	Wholesaler	01916136103

8. LIST OF KEY INFORMANTS

1	Md. Najrul Islam Upazilla Agricultural Office Dumuria, Khulna 01716463463
2	Akram Hossen Water Development Board Sub-Divisional Engineer Nurnagar, Khulna 01711130009
3	Sachindranath Biswas SRDI CSO 107, (Highway) Mujgunni, Khulna 01718691666
4	Md. Hasanul Banna Bangladesh Meteorology Department Meteorology Assistant R.I.C, Gollamari, Khulna 01944235292
5	Md. Abu Bakkar Siddiq M/S Fatema Krisi Bhandar Seed Retailer Ula Bazar, Dumuria, Khulna 01944235292
6	Abul Kalam Baghdari WMG Member Baghdari, Sahas, Dumuria Khulna
7	Md. Mozaffar Gazi Baniakhali WMG General Secretary Baniakhali, Sarappur, Dumuria Khulna 01705338990
8	Sheikh Hemayet Hossen Kukhia WMG General Secretary Kukhia, Sahas, Dumuria Khulna 01917417025
9	Md. Liton Rahman Gazi Baniakhali WMG Member Baniakhali, Sarappur, Dumuria Khulna 01914107697

Research Questionnaire

1. Farmers Interview

FARMER'S INFORMATION													
F11. Respondent's full name (or name by which he/she is locally know): _____		F12. Respondent's Father's/Husband's full name (or name by which he is locally know): _____											
F13. Type of interviewee: Group member1 Others2		F14. Gender of interviewee: Male 1 Female 2											
F15. Mobile phone: <table border="1" style="width: 100%; height: 20px;"> <tr> <td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td><td style="width: 12.5%;"></td> </tr> </table>												F16. Owner of mobile phone FARMER HIM/HERSELF1 Other person (specify relationship) 2	
F17. Village:		F19. Union:											
F18. Landmark:		F110. Upazila:											
F112. How many years of farming experience do you have? Number of years _____		F111. District:											
F113. Of this total land, how much is your own and how much you lease? Note land size in decimals.		Own land (decimal) Leased land (decimal)											
F114. What is the total size of the land you cultivate? Note- land size in decimals.		Total land size (decimal)											
F115. Of this total cultivated land, how much you use for vegetable cultivation and how much for other cultivation? Note- land size in decimals.		Vegetable cultivation (decimal) Other cultivation (decimal)											
F116. What is the highest level of education you achieved?		Illiterate..... 1 Can only sign 2 Preschool 3 Primary school 4 Secondary school 5 Higher education (university)..... 6 Other (specify) 7 Don't Know..... 8											
CROP CULTIVATION INFORMATION													
1. Can you please let me know which crops you cultivated in last two years?													
	Robi, 2016-17 (October - March)	Kharif 2, 16 (July - September)	Kharif 1, 2016 (April - June)										
Crop													
Land size													

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	Robi, 2015-16 (October - March)	Kharif 2, 15 (July - September)	Kharif 1, 2015 (April - June)
Crop			
Land size			

OUT-PUT MARKET/ SELLS RELATION INFORMATION

3. Can you please let me know your produced sells related information?

Name of crops	Point of sells/Selling place(Field-1, Home-2, Local Hat-3, Distance Market-4, Others-5 (Pls. Specify)	To whom(Fatia-1, Bepari/Paiker-2, Arotder-3, Retailer-4, Consumer-5, others-6)	Payment mode (Cash-1 or Credit-2)	Have any information on High price market (Yes-1, No-2)

STORAGE RELATION INFORMATION (GWvckb Ad †UK‡bjwR)

4. Can you please let me know where you store your crops?

4.1 Do you store your crops:

Yes.....1	Name of crops	How many days	Where
No.....2 Why:			

PROBLEMS FACED BY FARMERS/SERVICE RELATED ISSUES

5. What are the major problems that you face during crop production & what are the solutions?	Problems	Solutions

Signature-

Interviewer-

Date-

Feasibility Study Report on Natural Cold Storage in Coastal Area

3.0 Which crops have more demand in external market under consideration of price, species, and quality and why? Can you supply according to the demand? What are their reasons of becoming able/not able?

Name of Crops (With Species)	Selling Place/ districts	Season of demand	Amount of Demand	Amount of Supply	Demand-Supply Gap

4.0 What are the crops coming from other districts considering price, species, and quality?

Name of Crops (With Species)	Purchasing Place/ districts	Season of demand	Amount of Demand	Demand-Supply Gap

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5.0 Why the market price of crops changes (Collect information regarding the reasons of changing price)

6. Do you store your products:

Yes.....1	Name of crops	How many days	Where
No.....2 Why:			

6.1 What is your opinion regarding storage facilities in the locality?

7.0 Do you think storage facility can help your business?

Yes.....1 How:	
No.....2 Why:	

8.0 What are the problems of business and what are the solutions?

9.0 Which type of information and suggestion do you provide to the farmers?

10.0 How both you and farmer get more profit?

Signature-

Interviewer-

Date-

Key Informant

Name:	Designation:
Organization:	Phone No:
Address:	

1. What kind of support do you provide to farmers/ Farmer's group?
2. What are the most common types of vegetables cultivated in this area?
3. What is the general vegetable cultivation practice in your area (In terms of cropping pattern, intercropping, presence of fallow land, input usage, etc.)?
4. De you see any change over the cultivation practice over the last few years? If yes what are those?
5. What are the selling practices of vegetables in various level of the value chain?
6. What vegetable varieties are mostly consumed within the region?
7. What varieties are sent to other regional markets?
8. What varieties are brought to the local markets from other regions?
9. What are the common problems faced by farmers and traders regarding vegetable cultivation and trading in this area?
10. What do you think about the storage facilities of your community?

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11. Does newly establish storage facility help farmers? What are your suggestions?
12. Who can be the owner of the store?
13. Do you have any idea on natural storage? If yes, do you think that Natural storage might be a feasible option for this area to store vegetables for short time?
14. What are the prominent issues on which farmers seek information?
15. What other sources of information is present for the farmers in the locality?
16. Are there any NGOs/Development projects working in this locality on vegetable storage? If yes, who?

Note: Additionally-

- Agricultural related data will be collected from DAE during the interview with DAE personnel
- Weather related data will be collected from Weather Office during the interview with Weather Office personnel
- Water related data will be collected from local Water development Board office during the interview with Water development Board office personnel

Signature-

Interviewer-

Date-

Check list for FGD (1-16 for group members and 7-16 for general farmers)

Place/Location of FGD: Village:

Union: Upazilla:..... District:

Number of Participant:

Participant Details:

Name	Fathers Name	Address	Contact number

1. Name of the Group
2. # of group members
3. Year of establishment
4. What are the functions that carried out by group?
5. Do you have financial capitals, if yes how much?
6. What are the main occupations of the group members?
7. What crops are produced in this locality?
8. What is the average size of land per farmers?
9. Where, when, how and whom do you sell your products?
10. What are the price variations within different season of the major vegetables?
11. Do you face any problem on your product selling?
12. Do you store your produced products? If yes, why? If no, why?
13. What do you think about the storage facilities of your community?
14. Does storage facility help you? If yes how/ If no why?
15. Who can be the owner of the storage?
16. Do you willing to pay money for storing your produced products?

Signature- _____

Interviewers name:-
Date-