



Ministry of Foreign Affairs

Opportunities of Protected Horticulture in Bangladesh

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Netherlands Enterprise Agency



EDGE
Consulting Ltd.

Opportunities of Protected Horticulture in Bangladesh



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i Definition & Abbreviations List

BBS	Bangladesh Bureau of Statistics
EKN	The Embassy of the Kingdom of the Netherlands
GDP	Gross domestic product (GDP) is the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period.
Low Tech Protective Horticulture	Low tech protective horticulture is defined as technologies used that are relatively economic and does not require special equipment. Examples of low tech protected horticulture includes polythene covered farming, net covered farming or any other technologies where the climate is not controlled significantly.
Mid Tech Protective Horticulture	Mid-tech protective Horticulture is defined as farming practices where technology integration is higher where the climatic conditions for farming are controlled to a higher degree with the introduction of polythene based coverings, temperature control to a degree with the aid of cooling fans, pads, windows (exhausts), and use of growing mediums such as coco-peat.
RVO	Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency)
Protected Horticulture	Protected cultivation is a process of growing crops in a controlled environment, which is the temperature, humidity, light and such other factors that may be regulated as per the requirement of the crop ¹ . This assists in a healthier, high yielding, resource efficient, consistent, pest and pesticide free produce. There are diverse types of protected cultivation practices. Some of the commonly used practices are — forced ventilated greenhouse, naturally ventilated polyhouse, insect proof net house, shade net house, plastic tunnel and mulching, raised beds, trellising and drip irrigation. ^{2,3} These practices can be used independently or in combination, to provide a favourable environment to save plants from harsh climate and extend the duration of cultivation or off-season crop production. In terms of greenhouses, different technologies may be utilised to automate and mechanize different parts of the growing process, thereby creating a range of technology levels that can broadly be categorized as low-tech, mid-tech and high-tech.

¹ <https://www.nextias.com/current-affairs/26-04-2022/protected-cultivation>

² <https://ncert.nic.in/textbook/pdf/kepc101.pdf>

³ *Is horticulture the study of plants?* - [aparboricultura.org](https://www.aparboricultura.org), <https://www.aparboricultura.org/is-horticulture-the-study-of-plants>.

1. Preface

The Embassy of the Kingdom of the Netherlands, through RVO - Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency), has been exploring opportunities to support Bangladesh in identifying mutually beneficial business and growth prospects. This is viewed as an extension of efforts to improve bilateral relations between the two countries. Several sectors were examined for potential collaboration and growth opportunities, with horticulture being one of the major sectors. [The Horticulture Sector Study](#) (2021) highlighted the potential of Protected Horticulture for further investigation and consideration, which was further reinforced by the expressed interest of Bangladeshi private and public sector actors who have made multiple high-level visits to the Netherlands over the last 2 years. The high-level exchanges started with a visit of Mr. Abdur Razzaque, Minister of Agriculture for Bangladesh along with a delegation of public sector and private sector representatives to the Netherlands in November 2021. This was followed up by a conclave hosted by the Bangladesh Embassy in the Netherlands in May 2022, in The Hague. In addition, a 3rd delegation led by the Minister of Agriculture was present for Floriade, where Bangladesh had a stall to showcase its agriculture. During two of the engagements, delegations from Bangladesh were hosted by Dutch Greenhouse Delta (DGD) at the World Horti Center to showcase Dutch expertise in protected horticulture.

This research report aims to further explore the potential of protected horticulture in Bangladesh. The report draws on a combination of literature review and field research, including key informant interviews with greenhouse businesses, horticultural experts, and other stakeholders in the horticulture value chain. The report briefly analyzes the economic viability of protected horticulture in Bangladesh, considering factors such as investment costs, operational expenses, and potential returns on investment while elaborating on other aspects that need to be addressed to nurture the industry for the long term.

Given the Dutch expertise in the design, construction, and operation of advanced greenhouses, as well as crop management, irrigation, fertilization, climate control etc. the Netherlands can play a crucial role in supporting the development of protected horticulture in Bangladesh. The country is home to many leading companies in the horticulture sector, with technologies, knowledge and products that can help improve crop yields and overall resource management such as reduced water usage, improved fertilizer usage, better energy efficiency etc.

In addition, this research report aims to provide valuable insights into the potential of protected horticulture in Bangladesh, informing policymakers, agricultural practitioners, and other stakeholders in the sector about the benefits and challenges of adopting this technology. The report concludes with recommendations for further research and interventions to support the adoption and expansion of protected horticulture in Bangladesh, including potential collaborations with Dutch experts and companies.

We hope that this report will contribute to ongoing efforts to improve the agricultural sector in Bangladesh, promoting sustainable and resilient agricultural practices to ensure food security, safety and economic prosperity for the country's farmers and communities, with the support of Dutch expertise and innovation.

2. Executive Summary

Bangladesh's Path to Prosperity:

In the five decades since the independence of Bangladesh, the country is poised to transition from a lower middle-income country to a middle-income country through its graduation from Least Developed Country status in 2026. It has registered average GDP growth rates of more than 6% in the last 10 years and over 8% in fiscal year 2019. Despite the challenges from the COVID-19 pandemic, Bangladesh's economy proved its resilience by achieving a growth rate of 5.2% in fiscal year 2020, which was higher compared to many countries in the region. The success of the economy over the last 15 years has been fueled largely by the manufacturing sector and private consumption which was primarily driven by inward remittances and a growing middle-class. Furthermore, the country is projected to be amongst the top three fastest growing economies globally, in the coming decades. In order for Bangladesh to realize this projection and stay the course of its growth and development, the country needs to ensure the implementation of appropriate strategies and partnerships to maximize its output in a sustainable manner.

Netherland and Bangladesh's Longstanding Partnership:

The Netherlands has been a longstanding development partner for Bangladesh, recently celebrating 50 years of diplomatic relationships. The Embassy of the Kingdom of the Netherlands in Dhaka has been exploring opportunities for mutual growth and prosperity in alignment with the economic and development interests of Bangladesh. A recent study in 2021-22 on the Horticulture value chain of Bangladesh was commissioned by RVO, in which protected horticulture was identified as an area of interest for further investigation. This report is the result of a deeper dive into this segment of horticulture, where the Dutch are pioneers and world leaders.

Protected Horticulture: Prospects in Bangladesh with Dutch Support - the Study

Climate is a major factor for Bangladesh as by 2050, one-third of agricultural GDP may be lost due to climate variability and extreme events – a devastating figure as the agriculture sector represents around half of employment in the country. This is a major concern for the economy, food security and livelihoods thus the government has been focusing on supporting adoption of climate smart agriculture, where protected horticulture may play a very crucial role.

The study was executed by Dutch Greenhouse Delta, a foundation of Dutch businesses along the horticulture value chain, ranging from seed suppliers, greenhouse builders, manufacturers of water and climate control systems, amongst others. The study adopted an explorative approach where extensive consultation was undertaken with sector experts, government agency representatives, private sector representatives ranging from greenhouse businesses, agri-inputs businesses, superstores and exporters. Key informant interviews and consultations were undertaken to draw an indicative picture of how the protected horticulture sector is perceived in Bangladesh and what the future holds for this sub-sector.

Bangladesh's Protected Horticulture Top Line Findings

The study found that the existing policies are broadly conducive of protected horticulture in Bangladesh, as outlined in several key documents including the National Agriculture Policy, where focus on the promotion of protected horticulture has been clearly delineated. However, the study revealed that despite the presence of the policy, its implementation and execution were insufficient. Issues such as imports of chemicals required as nutrients for cultivation, polyethylene coverings, machinery and equipment required in greenhouses construction and maintenance have been identified as areas that

require further support. This leads to a situation where sourcing technologies and inputs required for greenhouse-based cultivation becomes a cumbersome process for businesses already involved in the sector, particularly in the absence of a strong after sales offering at local level. In addition, the absence of adequate education and training on modern protected horticulture has created a knowledge and expertise gap. This further acts as a barrier to entry for new businesses willing to venture into the sub-sector.

It was found that existing players in mid-tech protected horticulture cultivation had established their operations initially out of self-interest for securing safe and nutritious food for their own families, their company staff and eventually moving into commercialization through the premium market. Although only a handful of such businesses are operating in Bangladesh, the experience has been mixed with a few organizations presenting a good business case and finding success, while others have struggled due to certain limitations. The study also found businesses who are currently in the process of establishing new operations and have expressed their interest in exploring the opportunity of further investing in the sector.

Markets are the primary consideration factor for such businesses. The common thread observed for the businesses were that each of them had adopted a mixed cropping practice in their greenhouses to cater to multiple produce demands from buyers, which is different from other countries where the entire greenhouse generally houses only one type of crop or multiple varieties of the same crop. Crops generally cultivated in the greenhouses comprised of tomatoes (cherry, black, etc.), seedless cucumbers, capsicum (green, yellow, red), melons and other leafy greens. Such crops in the local context are termed as Chinese vegetables and are not commonly grown in Bangladesh. They are acting as import substitutions and are in demand at restaurants, hotels and retail outlets. They serve the premium market in Bangladesh where exotic vegetables that are safe and nutritious receive greater demand from consumers. The marketing channel adopted by such businesses were broadly of two types, namely self-consumption where cultivated crops were sold amongst the owners and employees of the businesses and the more commercial channel, where cultivated crops were sold to the premium market through direct to consumer selling either online or through retail outlets and directly to buyers such as hotels and restaurants.

The choice of technology for the businesses were largely mid-tech pad and fan greenhouses with polythene-based coverings (one setup with polycarbonate), drip irrigation, cooling pads, exhaust fans and ventilation windows for their cooling systems and coco-peat as their growing medium. The study revealed that sourcing of nutrients was a major constraint for such businesses as current import policies in Bangladesh identify core chemicals as hazardous items which require government import sanctions (from the customs authority with justifications for use) to be imported. Similarly, the machinery, equipment, coverings etc. are all categorized under industrial usage rather than agricultural usage, leading to higher import costs and operational delays. Given the prevailing circumstances, businesses were found to have innovated alternatives such as localization of certain components such as pipes, local construction materials, substituting out materials such as cooling pads from the garments industry for evaporative cooling etc. However, the impact of these localizations on the performance of the greenhouse is yet to be systematically studied.

Summary of Constraints for growth identified by private sector in Bangladesh include:

- a) **Nutrients and crop protection**
The nutrients required in the hydroponics process are currently not recognised as agricultural chemicals but only as industrial chemicals. Furthermore some of the chemicals are categorised as dangerous chemicals and are difficult to import.
- b) **Availability of seeds**
Special seeds are required for indoor cultivation, which are not widely available in Bangladesh, leading to each business having to pursue their own pathways to ensure seed supply. In addition the right type of seed variety needs to be utilized. For example Dutch seeds work well in the winter, however in the summer the yield is not as expected, whereas Asian varieties perform better as they are more appropriate for the local summer conditions.
- c) **Knowledge and Information**
Research institutes and government agencies do have hydroponics as a topic in their academic curriculum, however the depth of information taught is not adequate to run a fully operational greenhouse, especially one which is focused on the output market.
- d) **Aftermarket services**
There is practically no aftermarket services for the greenhouses in Bangladesh. Thus, there are several issues with the upkeep and maintenance of the greenhouses and the availability of spares and replacements for equipment such as cooling pads and polyethylene coverings etc.
- e) **Seasonality**
All the greenhouses reported winter production as the best in terms of yield, although pricing is considered comparatively not as attractive. There is a notable drop in yields during the summer months however the prices are higher making it lucrative.
- f) **Human Capital**
The businesses all expressed that there is a lack of skilled and trained personnel in the market, thus significant mentoring and trial and error is required. The need for foreign consultant support is thus mandatory at this stage in Bangladesh. Simultaneously it has been identified that foreign consultants from the region have at times provided faulty designs and solutions, which resulted in significant operational challenges. As such locally contextualized designs and solutions need to be adopted with a sound understanding of the local climate.

Workarounds Adopted by Bangladeshi Companies:

The study found that despite the constraints the businesses have been able to function and operate given their efforts and persistence. Some of the work arounds that were adopted by the businesses are:

- a) **Knowledge sharing** – it was observed that the businesses collaborate to share knowledge and information with each other to try to resolve many of the operational issues.
- b) **Input network** – given the sensitive nature of the chemicals required, the businesses collaborate to source and share some of the chemicals, allowing for more of a structured solution of the current process of sourcing the required nutrients.

c) **Localization** – in an effort to overcome challenges around imports of materials, the greenhouse operators have been looking at localized solutions; such as using cooling pad replacements from the garments industry (which does not cool to the same extent as purpose built cooling pads, yet it is a cheaper and more readily available alternative), sourcing substrate (cocopeat) locally, fabricating the steel structure locally etc.

Indicative Costs & Benefits :

The study found that the cost experienced in setting up such greenhouses by the existing players varied since they were established across a number of years and the source of technology varied as well.

The average cost of setting up a greenhouse (excluding the price of land lease/procurement) is roughly € **90 per square meter and** ranged from € **60-100 per square meter based on an exchange rate of € 1 to 115 BDT**. It is important to note that recent exchange rate fluctuations affect the range significantly, as our calculations indicated the range varied from **€ 90 to € 140 per square meter if the exchange rates of the year of establishment were considered.**

The study discovered that various crops were grown, and each business had its unique product lineup. To facilitate comparisons, the study employed an approach that involved conducting calculations under the assumption of utilizing a 22,000 square foot (2044 square meters) greenhouse solely for cherry tomato cultivation. Since each business had distinct strategies, cost structures, overall cultivation areas, investment expenses, and marketing channels, this approach was considered suitable for creating a representative scenario for these businesses.

SUMMARY:

CAPEX			Average
	Greenhouse setup cost (€ 1 = 115 BDT)	€	183,575
	Greenhouse setup cost (exchange rate as per set up year)	€	232,724
OPEX Yearly			
	Salaries (Labor & Staff Costs)	€	9,790
	Cost of Power	€	5,217
	Miscellaneous Costs (maintenance)	€	1,000
	TOTAL	€	15,567
COGS Yearly			
	Cost of Chemicals/Nutrients	€	9,922
	Cost of Seeds	€	620
	Cost of Transport	€	1,971
	Cost of Packaging	€	308
	Miscellaneous Costs	€	93
	Total COGS	€	13,381
EARNINGS Yearly			
	Total Revenue	€	199,043
	Gross Profit (Revenue-COGS-OPEX)	€	170,095

	Depreciation per year at 20% *	€ 36,714
	Yearly Earnings After Depreciation	€ 133,380
	ROI	0.77
	Simple Pay Back Period	1.62

*(A 5 year depreciation was considered since the life cycle of the polyethylene coverings is expected to be 5 years. Please note there are certain items that may have a depreciation at a different rate, but for simplicity a simple 5 year 20% depreciation has been taken.)
The cost of land acquisition is not included and considering the high price of land at the locations in which the greenhouses have been setup, it is likely to at least double the payback period. The figures above have been extrapolated from the information provided by actual businesses, whose names have been coded for anonymity. While CAPEX was calculated considering the average CAPEX from the 3 greenhouses of BDT 21,111,111 (from year of establishment) and working back at a more current exchange rate of €1 to BDT 115, which was also used for the current OPEX, the actual CAPEX in Euros for a greenhouse bought today would be higher as BDT has devalued since year of establishment, whereas greenhouse equipment / input providers sell their goods and services in their own currency, thereby impacting ROI / pay back period. There are several assumptions used in the calculations which have been delineated in the later segment, as such these figures are purely indicative.

Prospects for the private sector from The Netherlands:

The Netherlands, renowned for its advanced and innovative agricultural practices, has a thriving protected horticulture industry. This sector encompasses technology, knowledge and expertise along the controlled environment agriculture value chain. The prospects of Netherlands-based protected horticulture businesses venturing into Bangladesh are promising, fuelled by the potential for technology transfer and knowledge transfer against the backdrop of increased agricultural productivity and mutually beneficial trade relationships in the medium to long run. However, a more enabling import policy environment can catalyse the sector further and improve the business case for exporting inputs to Bangladesh. Nevertheless, the 6 current constraints outlined on page 8 serve as potential opportunities for solutions that can be provided from the Netherlands.

The study also identified Dutch private sector actors, who are well placed to target Bangladesh- a nascent market in terms of greenhouses with a promising consumer market. While the private sector in Bangladesh is particularly interested in mid-tech greenhouse solutions, the government has previously established high-tech greenhouses for research purposes, for example the Jute Research Institute which installed a 200 square meter high-tech greenhouse in 2016⁴. There exists opportunities in new projects under the Ministry of Agriculture and different public agricultural institutions in Bangladesh to bid for tenders for high-tech greenhouses over the next few years. Knowledge transfer and capacity building, are required to support the development of an enabling environment. It will further ensure an adequate availability of manpower and expertise. Therefore Dutch knowledge institutes can capitalize on this

⁴ https://www.cmf-groupe.com/wp-content/uploads/2014/03/CMFEXPORT_RECHERCHE_BANGLADESH_BJRI_BD_EN.pdf
<https://www.hortidaily.com/article/6031101/new-cmf-research-greenhouse-to-boost-bangladesh-jute-industry/>

opportunity; best exemplified by the MOU executed between the Ministry of Agriculture in Bangladesh and Wageningen University. Secondly, components such as fertigation machines, cooling pad & fan systems, drip irrigation equipment and greenhouse covering (polyethene / polycarbonate) are required to be imported to establish greenhouses, presenting further business opportunities as well. In addition, ongoing consultancy is sought from foreign experts to support the master growers periodically. Dutch seed companies like Rijk Zwaan have already established relationships in Bangladesh to supply indoor seed varieties to greenhouses. East West seeds and Bayer have also had a presence in Bangladesh. Whilst in the greater agriculture sector the presence of Dutch companies are prominent, particularly in the potato value chain.

Potential Coordinated Efforts for Future Prosperity

The study identified various opportunities for collaboration and support from the Netherlands in the greenhouse sector in Bangladesh, which can be summarized as follows:

Government Agencies and Research Institutes:

- Support in setting up greenhouses with technical assistance.
- Knowledge sharing in terms of operations and seed variety development.
- Technical assistance to educational institutes to develop human resources.
- Policy level advocacy to smoothen out import issues of fertilizers and other equipment.

Existing Greenhouse Businesses:

- Technical assistance to support the development of human resources.
- Technical assistance to improve summer-based cultivation.
- Support expansion of new greenhouses with improved technical capacities and aftermarket services.

Establishment of New Greenhouses:

- Establish jointly funded demonstration greenhouses that can be tested over a period of time to establish and promote the business case, with an outlook towards commercialization.
- Establish greenhouses as centres of excellence / for research and development purposes in private, public or PPP model. As the Ministry of Agriculture (MOA) is about to undertake large development partner supported projects to transform the agricultural sector, there may be synergies explored that align with projects of the MOA in the long term.

Agro Businesses – Seed / Input Companies and other Businesses (exporters):

- Support Bangladeshi companies through connecting with Dutch businesses in the form of joint ventures, dealerships and/or distributorships for inputs and technology.
- Collaboration with Netherlands-based seed companies.

The study on protected horticulture in Bangladesh revealed that government policies are favorable, but implementation is still in progress. The restricted import of fertilizers and high tariff rates on inputs are hindering the growth of the sector. This is further exposed to exchange rate risks, which may increase costs of set up and trade. The study found potential for mid-tech ranged greenhouse opportunities with interest from reputed agriculture companies and non-agriculture businesses, whereas high-tech greenhouses are sought by government research institutes. The premium market for greenhouse produce is maturing, and businesses aspire to export their produce as well in the future – a possible solution in this regard could be to pool the produce from different greenhouse operators, connect them to exporters, who then coordinate the off-take to foreign markets.

The study recommends a coordinated effort to develop and streamline policies and their implementation, with Dutch expertise being crucial in assisting this process. RVO and the Embassy can potentially facilitate several activities using the tools and instruments available to them. The opportunities expressed by stakeholders, can be furthered by connecting Dutch businesses to Bangladeshi organizations. Despite this being a long-term process, the conducive environment, interest from businesses to engage through collaborations are high presenting a case for agricultural transformation.

3. Background of the Study

The Embassy of the Kingdom of the Netherlands in Dhaka has been exploring business and development opportunities between Bangladesh and the Netherlands, over the last few years. A sectoral study, [the Horticulture study Bangladesh](#), was conducted in 2021-2022 to identify cooperation areas for trade and investment.

The study uncovered several areas of interest and further investigation, which included Horticulture Seeds Collaboration in the form of imports to Bangladesh, authorized dealerships etc., as well as post-harvest technology support and Protected Horticulture. In addition the government of Bangladesh had indicated a desire to support the growth of the Protected Horticulture subsector with current businesses that had already invested in the sector.

At the same time, over the last 2 years Bangladeshi private and public sector actors have made multiple high-level visits to the Netherlands. The high-level exchanges started with a visit of Mr. Abdur Razzaque, Minister of Agriculture for Bangladesh along with a delegation of public sector and private sector representatives to the Netherlands in November 2021. This was followed up by a conclave hosted by the Bangladesh Embassy in the Netherlands in May 2022, in The Hague. During both these engagements, delegations from Bangladesh were hosted by Dutch Greenhouse Delta at the World Horti Center to showcase Dutch expertise in horticulture.

During these events, there was an expression of interest to further explore Protected Horticulture in Bangladesh. Thus RVO – Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency) and The Embassy of the Kingdom of The Netherlands in Dhaka commissioned a study on protected horticulture to better understand the subsector and areas of action.

Dutch Greenhouse Delta (DGD), a foundation which consist of a group of Dutch companies specialized in horticulture, ranging from seed suppliers to turnkey greenhouse solution providers, was awarded the study. DGD has the ambition to contribute to the provision of healthy, affordable, nutritious and safe food that is produced sustainably and locally. DGD's offering includes the entire horticultural eco-system of Fork2Farm, consisting of science, enterprise, education and government, in several focus regions. They specialize in large-scale complex projects and issues relating to food and horticulture in expanding mega-cities in different regions of the world. Their business acumen, knowledge, and expertise allow them to have a realistic view of the potential of protected horticulture. DGD worked with EDGE Consulting Ltd, a Bangladesh-based consulting firm to collect information and execute the study.

3.1 Objective of the study

The commissioned study had the following objectives:

1. analyzing the protected horticulture sector of Bangladesh.
2. identifying ways to strengthen the local private sector with Dutch knowledge and expertise.
3. map effective ways of using the Dutch government's Private Sector Development (PSD) instruments managed by RVO; and
4. identifying potential market opportunities for Dutch businesses.

To realize the objectives the study delved into the following aspects:

- Assessment of various markets fitting the selected protected horticulture farming methods i.e. greenhouse farming.
- Estimation of Market demand regarding certain crops (in terms of type, volume, quality preference, seasonality, price level).
- Analysis of opportunities for mid- and high-tech applications of greenhouse technologies in the nascent covered horticulture industry in Bangladesh.
- Analysis of the technical feasibility of greenhouse farming in Bangladesh, identification of investments and operational costs with an emphasis on energy source.
- Identification at a high level, of the gaps and propose solutions to bridge the gaps for operating protected horticulture farms (i.e. knowledge and skills and availability of inputs).
- Identification of potential local (targeted adaptors), regional and global actors (supply industry, governmental role) and investors.
- Identification of the potential role of the local government, EKN and others to build a strong business case for protected horticulture farming based on greenhouses and agro-clusters.

3.2 Methodology:

Literature review was conducted to develop a comprehensive understanding of the protected horticulture landscape in Bangladesh. Given the emerging stage of protected horticulture in Bangladesh relevant resources were rather limited, however the presence of businesses having already invested in greenhouses (mid tech) enabled practical information to be collected for the study.

A stakeholder mapping exercise was conducted, where active greenhouse businesses and other stakeholders such as seed suppliers, retail stores, related government agencies, exporters and sector experts were identified and consulted. Key informant interviews were undertaken to acquire information regarding the current situation and the prospects of protected horticulture in Bangladesh. Stakeholders ranged from government bodies such as the Bangladesh Agriculture Research Council, Bangladesh Agriculture Development Corporation, Department of Agriculture Extension, Educational institutes such as Bangladesh Agriculture University, Bangladesh Sheikh Mujibur Rahman Agriculture University, to greenhouse based agro businesses such as Paramount Agro, Farm Fresh, Paragon Agro, Shourav Fisheries and Agro and other relevant stakeholders. The collected data was analyzed and synthesized into a report, which was then shared with key stakeholders for observations. A workshop was held for relevant stakeholders to provide further feedback and incorporate into the report.

3.3 Report Structure

The report starts off with introducing Bangladesh, followed by an overview of its horticulture sector. The report then dives into the protected horticulture scenario. Here the findings of the study are elaborated further, highlighting the challenges and solutions that were adopted by the businesses. The report further then sketches out the perspectives of the wider agriculture sector actors in terms of the prospects of protected horticulture in Bangladesh. The report then finally presents the opportunities identified and the conclusions accordingly.

4. Bangladesh

4.1 Overview

Bangladesh, a delta region at the confluence of the Ganges and Brahmaputra rivers, has a population of nearly 170 million packed into an area of 130,170 square kilometers, bordered by the Bay of Bengal in its south. The country's gross domestic product (GDP) at current prices is estimated to be \$416.26 billion as of 2021, according to data from the World Bank. According to PWC, "The Long View"--which sought to project the global economic order by 2050--Bangladesh is projected to be one of the top three fastest growing economies in the world, with an annual growth rate of 5%, shifting its position from 31st to 23rd on the purchasing power parity-based GDP rankings.⁵

Ready Made Garments sector is the major driver of the economy, however almost 40% of Bangladeshis are employed in the agricultural sector, with rice being the single most important product. Between 2010 and 2020, the share of employment in agriculture has decreased by 9 percentage points while the share of employment in industry and services have increased by 4 and 6 percentage points respectively, as service and manufacturing jobs are more economically lucrative. With land being scarce and urbanization reducing available agricultural land, competition for agricultural land is highly competitive.⁶

Agriculture thus will continue to play a crucial role in the economic and social development of Bangladesh, contributing to increased productivity, sustainable food security and job opportunities. According to the Bangladesh Bureau of Statistics, the sector's contribution to GDP in fiscal year 2021-22 is estimated at 11.50%. Despite decreasing arable land, a growing population, the effects of climate change and the COVID-19 pandemic, crop production continues to increase. Small holders are the majority of farmers in Bangladesh, and major crops include rice, jute, wheat, tea, pulses, oilseeds, vegetables and fruits. As such the government has a focus on creating an enabling environment conducive to small holder farmers while at the same time promoting commercial agribusinesses.

⁵ <https://www.pwc.com/gx/en/world-2050/assets/pwc-world-in-2050-summary-report-feb-2017.pdf>

⁶ <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?contextual=employment-by-sector&end=2020&locations=BD&start=2010&view=chart>

4.2 Bangladesh's Climate

Bangladesh has a humid and warm climate with an average temperature of 26°C ranging from 15°C to 34°C. It receives an average of 2,200 mm of precipitation per year, with the north-eastern border regions (Sylhet Region) receiving the most rainfall of 5,000 mm. Humidity is high all year round, especially during the monsoon season (June to October) when warm, moist air is brought in by the Southwest monsoon from the Indian Ocean. Tropical cyclones of strength classification Tropical Storm or above usually make landfall in Bangladesh every two to three years, bringing heavy rainfall, high winds, and storm surges.

The Global Climate Risk Index ranked Bangladesh as the world's seventh most-affected country during 2000–2019. The estimated average annual losses due to disasters are around 1 to 2 percent of GDP. Similarly, Country Climate and Development Report for Bangladesh states it as one of the most vulnerable countries in the world.

Key factors of climate impact on Bangladesh:

- Average tropical cyclones cost Bangladesh about \$1 billion annually.
- By 2050, one-third of agricultural GDP may be lost due to climate variability and extreme events – a devastating figure as the agriculture sector represents around half of employment in the country.
- 13.3 million people may become internal migrants in the next 30 years due to climate impacts on agriculture, water scarcity, and rising sea levels, with higher impacts on women.
- In case of a severe flooding, GDP could fall by as much as 9 percent.

Monthly Climatology of Min-Temperature, Mean-Temperature, Max Temperature & Precipitation 1991-2020 Bangladesh

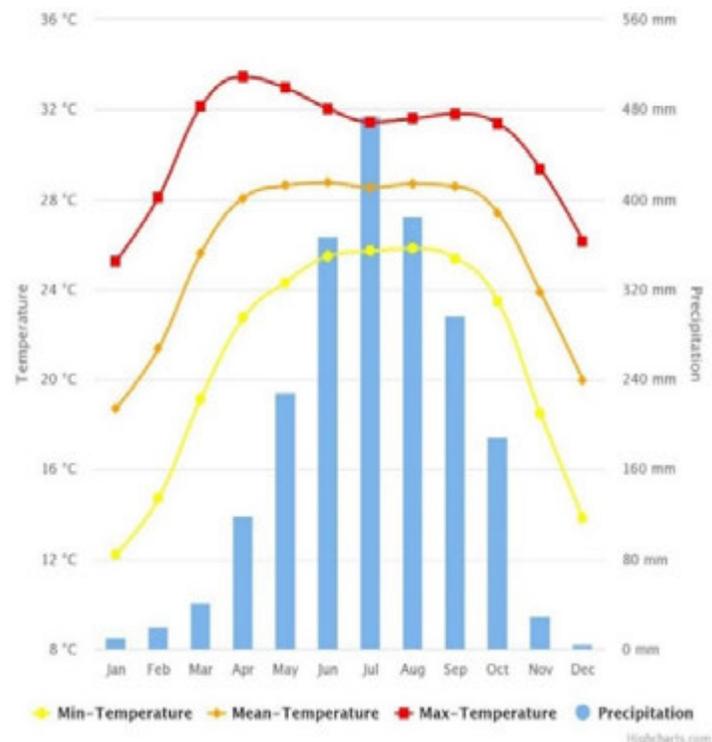


Figure 1 Temperature across a year in Bangladesh (source: Climate knowledge portal)

- The costs of environmental degradation and natural disasters are predicted to rise over time, compounded by higher heat, humidity, and health impact⁷

Cropping in Bangladesh is mostly reliant on open field cultivation, exposing it to risks from climate hazards and infestations of pests and diseases. As mentioned, Bangladesh enjoys a sub-tropical monsoon climate. There are three distinct seasons. From November to February a cool temperature (12-28 °C) and no or little precipitation prevails. Summer continues from March to May with a little rainfall, with temperatures reaching as high as 40 °C. The monsoon prevails from June to October having high rainfall, humidity and temperatures from 25-35 °C.

Thus, going forward climate change is a major factor for consideration for Bangladesh’s agriculture and businesses alike.

4.3 Doing Business in Bangladesh

COUNTRY		BANGLADESH
REGION		South Asia
INCOME GROUP		Lower middle income
	Enabling the Business of Agriculture SCORE (0-100)	44.47
	Supplying seed SCORE (0-100)	18.52
	Time to register a new cereal variety (days)	No practice
	Cost to register a new cereal variety (% of income per capita)	No practice
	Quality of seed regulation index (0-9)	5
	Registering fertilizer SCORE (0-100)	47.08
	Time to register a new fertilizer product (days)	945
	Cost to register a new fertilizer product (% of income per capita)	47.3
	Quality of fertilizer regulation index (0-6)	3
	Securing water SCORE (0-100)	20.00
	Securing water index (0-10)	2
	Registering machinery SCORE (0-100)	49.86
	Time to register a tractor (days)	15
	Cost to register a tractor (% of income per capita)	6.2
	Sustaining livestock SCORE (0-100)	56.67
	Quality of manufactured feed index (0-5)	4
	Quality of veterinary medicinal products index (0-6)	2
	Protecting plant health SCORE (0-100)	60.00
	Quality of phytosanitary regulation index (0-5)	3
	Trading food SCORE (0-100)	43.66
	Time to obtain agriculture-specific export documents (hours)	150
	Cost to obtain agriculture-specific export documents (US\$)	51
	Trading food index (0-7)	4
	Accessing finance SCORE (0-100)	60.00
	Warehouse receipts index (0-5)	3
	Inclusive finance index (0-5)	3

Figure 2 Bangladesh Enabling the Business of Agriculture Score

In 2018, Bangladesh achieved the eligibility status from the United Nations General Assembly committee for graduation from the Least Developed Countries, fulfilling the indicators in all three criteria (i.e., national income per-capita, human assets index, and economic and environmental vulnerability index) and is now well underway to successfully graduate to a Lower-Middle-Income country by 2026.

To encourage investment, the Government of Bangladesh provides various fiscal and non-fiscal incentives, privileges and facilities comprising of exemptions / reduction of corporate income taxes, reduced import taxes on capital machineries and raw materials, reduced VAT, provision of export

⁷ <https://www.worldbank.org/en/news/feature/2022/10/31/key-highlights-country-climate-and-development-report-for-bangladesh>

subsidies and various other banking facilities and privileges.⁸ Furthermore, the Government has identified Agribusiness as a lucrative investment opportunity.⁹ Please refer to Annex 3 for further information.

Bangladesh is ranked 168 across 190 economies in terms of ease of doing business, Bangladesh also scores 44.47 in Enabling the Business of Agriculture.¹⁰ The ranking had been increasing over the years and considering the support and incentives from the government in conjunction with the domestic market, there lies potential for trade and business opportunities in Bangladesh.

4.4 Bangladesh and Netherlands Relations

Bangladesh and Netherlands have long maintained a mutually beneficial relationship where economic, development and sectoral cooperation have been remarkably successful. The most notable cooperation between Bangladesh and the Netherlands presently remains the formulation and implementation of **Bangladesh Delta Plan 2100**. In terms of Business, the Dutch were among the pioneers regarding foreign private investment in Bangladesh. Dutch companies like Unilever, Philips, Organon, Shell, etc. were active in Bangladesh from the early years of its independence. The Netherlands is currently Bangladesh's 4th largest FDI source country with an investment stock of USD 1400.20 million, as of June 2019. The net Dutch investment amounting to USD 802.84 million alone came in Bangladesh in 2018-2019. In recent years, the Dutch investment has been concentrated in power, trade, leather and leather products, cement sectors etc.¹²

Bilateral Trade between the two have also been favorable, in 2020, Netherlands exported USD 251M to Bangladesh. The main products that Netherlands exported to Bangladesh are Special Purpose Ships (USD17.8M), Quaternary Ammonium Salts and Hydroxides (USD 15.1M), and Onions (USD13.6M). During the last 25 years the exports of Netherlands to Bangladesh have increased at an annualized rate of 6.67%, from USD 50 Million in 1995 to USD 251 Million in 2020. Agriculture trade was dominated by Netherlands where the Dutch exported USD 20.9 Million.

Bangladesh exported USD 1.46 Billion to the Netherlands. The main products that Bangladesh exported to the Netherlands were Knit T-shirts (\$221M), Non-Knit Men's Suits (\$179M), and Non-Knit Women's Suits (\$151M). During the last 25 years the exports of Bangladesh to Netherlands have increased at an annualized rate of 9.59%, from USD 148 Million in 1995 to USD 1.46 Billion in 2020

5. Brief Overview of Horticulture in Bangladesh

Bangladesh's agro-climatic conditions make it ideal for horticulture crops production. Three distinct production seasons are there, however vegetable production is mostly concentrated in two seasons in summer and one in winter (Rabi). Summer production is generally more challenging for farmers (because of high rainfall and higher pest and disease pressure), but also more profitable as prices are

⁸ <https://bida.gov.bd/incentives>

⁹ <https://bida.gov.bd/agro-processing>

¹⁰ <https://www.doingbusiness.org/content/dam/doingBusiness/country/b/bangladesh/BGD.pdf>

¹¹ <https://eba.worldbank.org/en/data/exploreconomies/bangladesh/2019>

¹² <http://bangladeshembassy.nl/bangladesh-netherlands-bilateral-relations/>

higher. Production volumes in wintertime are higher, with correspondingly lower prices for certain vegetables.

Bangladesh’s crops and horticulture sector¹³ is forecasted to contribute 5.5% (BDT 2,118,859 million or USD 19,806 million) and had enjoyed a growth rate of 6.14% in the FY 2021-22. The subsector has been declining in terms of percentage contribution but remains a significant sector in terms of value itself. Horticulture cultivation is considered more profitable in comparison to other crops such as rice, as produce can fetch higher market prices.

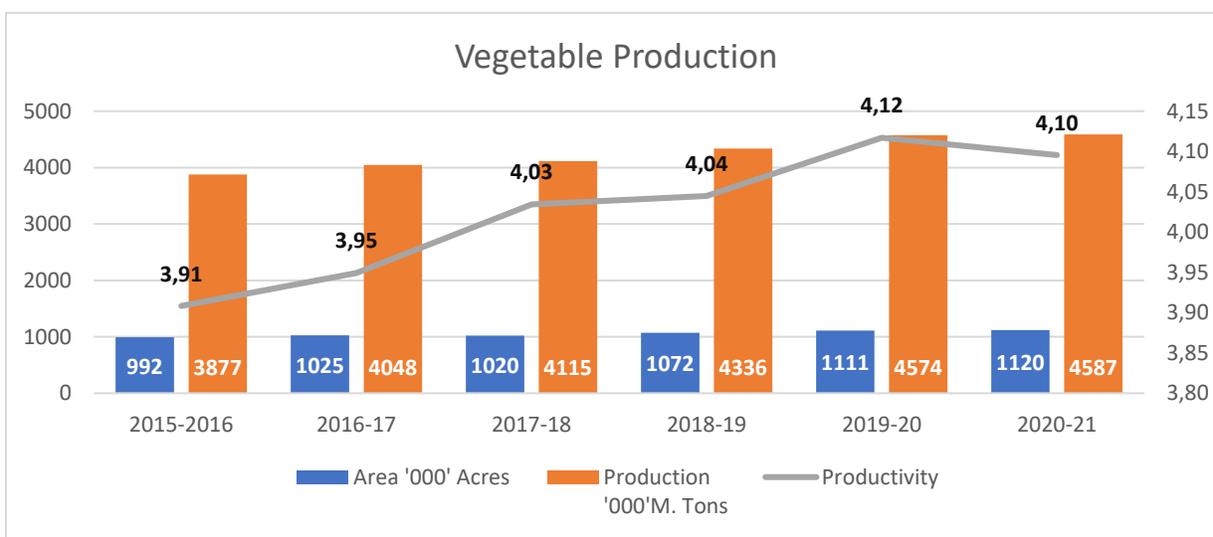


Figure 3: Bangladesh’s Vegetable Acreage, Production

Vegetable production in Bangladesh has been gaining ground and popularity over the last couple of decades, with a mammoth population size, leading to a large domestic market, exports and local processing demand. As such, vegetables continue to be the choice of crop for commercial and semi-commercial farmers across Bangladesh. Vegetable production as a whole continues to increase year on year, although marginally, as reflected in the productivity increase from 3.91 to 4.10 from 2015-16 to 2020-21¹⁴.

Major vegetable crops grown in terms of production volume in Bangladesh are brinjal (eggplant), tomatoes, cabbage, pumpkin, radish, cauliflower etc. Potatoes are also a major horticultural crop for Bangladesh. Production of such vegetables is spread across the country, though significant production zones include the South-Western part of Bangladesh namely Jashore and the north-western part of Bangladesh, namely Rangpur and Jamalpur.

¹³ These include all crops such as cash crops, cereals, fruits, vegetables etc.

¹⁴ BBS- Bangladesh Bureau of Statistic

Table 1 Production Volume of Major Vegetables in Metric Tons

Item	Thousand Metric Tons							
	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Brinjal (Eggplant)	444	450	475	507	516	530	558	587
Tomato	360	414	369	389	385	388	415	448
Cabbage	217	259	296	312	321	331	384	380
Pumpkin	245	278	291	295	303	320	340	365
Radish	252	271	281	281	281	308	287	316
Cauliflower	183	268	268	278	274	307	283	295
Walter gourd	179	198	218	226	232	236	251	252
Beans	110	122	129	137	135	144	170	170
Pointed Gourd	84	84	86	86	85	54	91	98
Spinach	73	76	79	79	82	83	88	98
Cucumber	55	57	60	71	65	73	83	95
Lady's Finger	45	52	54	55	56		56	70
Bitter Gourd	51	52	55	57	58	54	59	59
Ridge Gourd	45	45	47	49	50	52	56	56
Snake Gourd	33	34	37	39	37	38	43	46
Potato	8950	9254		10216	9725	965	9s7	9887
Other vegetables	77	81	87	95	96	963	787	1403

Source: Statistical Yearbook 2021, BBS.

5.1 Exports

Bangladesh recognizes the potential for its export sector, as it already is exporting to 40 countries across the globe with significant market for horticulture produce in the Arabic peninsula (Saudi Arabia, Qatar and Kuwait), the UK and Malaysia, serving primarily the diaspora markets. Exports however remain grossly volatile with one of the reasons being the quality control, as exemplified by many export shipments being rejected due to contamination and not meeting the set standards. There is significant lack in infrastructure and logistics needed to support an efficient export system.

The government currently provides a **flat 20% cash incentive to exports of agriculture produce**¹⁵.

Bangladeshi Good Agriculture Practices (BGAP) policy was introduced in 2020, where Bangladesh Accreditation Board (BAB) was mandated the role of an accreditation body. This policy is expected to help set the precedence in guiding entities to adopt GAP certification and thereby open greater export opportunities. Similarly, Bangladesh Government supports the sector through preferential agriculture credit loans bearing only 8% interest rates as well. 2019-20 export value stood at USD 164 Million, however it is projected to be USD 110 million in 2022-23. There was a dip in exports in 2020-21 due to several factors such as a dysfunctional quality scanner at the airport, competition from India and Pakistan as well as logistics issues in terms of available space in air cargo.¹⁶ Thus we observe fluctuations

¹⁵ <https://www.tbsnews.net/economy/tax-break-incentives-boost-agro-exports-billion-dollars-281386>

¹⁶ <https://businesspostbd.com/front/vegetable-exports-go-down-15-in-fy22-2022-07-14>

in export values across the years as presented in Figure 4. Exporters, despite such challenges, generally remain hopeful and are taking measures such as engaging in contract farming to source crops and are open to collaborate and support businesses to ensure a smoother supply chain for themselves.

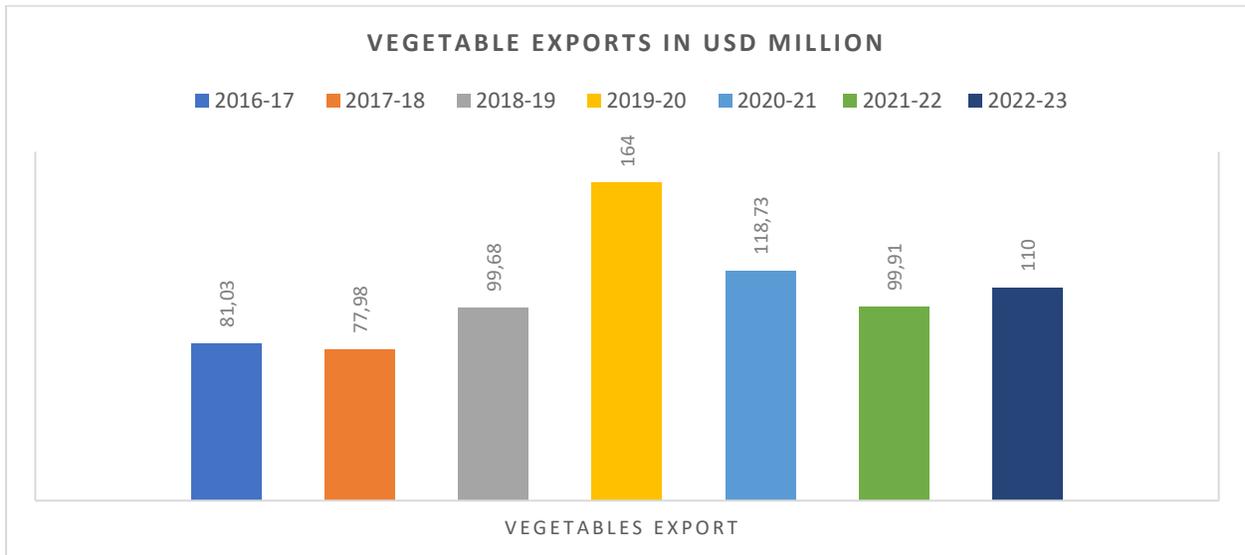
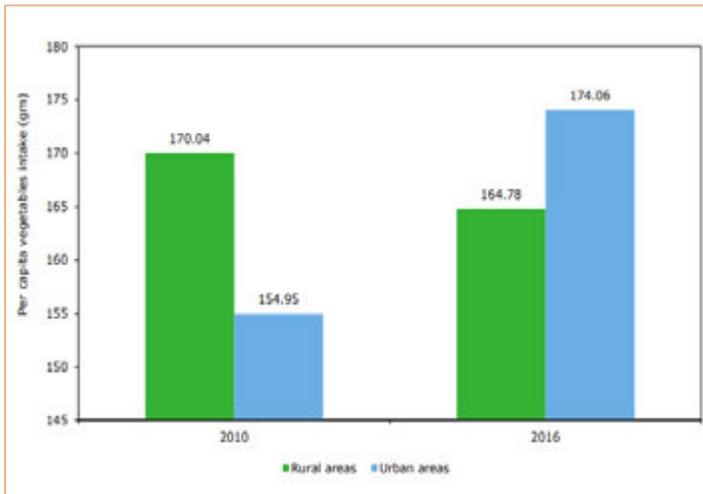


Figure 4 Export Value of Vegetables from Bangladesh; Source: Export Promotion Bureau Bangladesh

5.2 Consumption Patterns

Vegetables are perceived as regular part of one’s diet in Bangladesh, whilst on the other hand a preference is given to fruits. The per capita fruit and vegetable consumption is 203.8 g/day (BBS, 2018)



of which 167 g of this originates from vegetable consumption. These are significantly below WHO and FAO's recommended consumption of fruits and vegetables in total (400 g per person, per day) (FAO/WHO, 2014). Rural and Urban Consumers have different preferences of vegetable intake, as reflected in Figure 5. Observably the intake of vegetables increased for the urban populace of Bangladesh over the 2010-2016 period due to dietary preferences as well as purchasing power of the urban dwellers.

Figure 5 Bangladesh’s per capita vegetable intake in rural and urban areas

At the minimum recommended level demand for vegetables will rise to **21.12 million tons** in **2050** (Basak et al., 2015). Upscale or premium markets have recently seen growth in Bangladesh with a high concentration of such customer base in Dhaka. Food quality and safety is a key factor for such

customers. Consumers' perception on safe vegetable production in Bangladesh¹⁷, indicates that 83% of the surveyed people (sample size 50) in Dhaka city, prefer to purchase pesticides free vegetables and of them 83% are willing to pay more for safer vegetables. 53% in Dhaka based customers are willing to pay 41-50% more for getting pesticide free vegetables, indicating that there can be strong growth within the Bangladesh market itself.

Our discussion with retailers revealed that there has been an increase in footfall in superstores as well as online based orders, due to the convenience provided by such platforms. However, a majority of the market is still dependant on the traditional wet markets. Consultations further revealed that there were no major packaging preferences from customers in general if quality was maintained. Customers generally preferred to buy Brinjal (eggplant), white gourd/pumpkin and cauliflower/cabbage as their choice of vegetables. It is important to note that there is a niche or premium segment of the market who exclusively look for high quality non seasonal vegetables such as cherry tomatoes, lettuce, capsicum (generally referred to as Chinese vegetables, locally), where customers are willing to pay premium prices.

5.3 Policies conducive of protected horticulture in Bangladesh

The Bangladeshi government is aware of the need to prioritize the agriculture sector in light of diminishing arable land and food safety issues arising from urbanization. The National Agriculture Policy of 2018 outlines a goal of establishing demand-driven and export-oriented agricultural sectors, fostering commercial farming through special extension services and contractual manufacturing systems, and providing incentives to farmers to spur commercial agriculture. Additionally, the policy aims to create profitable agricultural products and communication between producers and consumers.

The National Agriculture Policy of 2018 further outlines a comprehensive strategy to support and enable improved agriculture. It includes specialized areas such as rooftop, hydroponic, aero-phonic and precision farming, as well as measures to simplify the importation of high-quality seeds and planting materials. Agricultural mechanization is also a priority, with the goal of transitioning from traditional subsistence agriculture to commercial agriculture. The policy also provides for the identification of crop and area based protective agricultural activities, as well as incentives for the production and import of essential greenhouse equipment. Special focus was also given to increase training and awareness in sustainable protective agricultural development.

The Government is also geared towards developing and implementing strategies as chalked out in the Perspective Plan of Bangladesh 2021-2041, where Six strategic approaches are called for:

- (a) Bringing unfavourable Agro ecosystem under productive sustainable agricultural practices.
- (b) Intensification of crop cultivation in productive agricultural land maintaining sustainability of soil health.
- (c) Sustainably Intensifying Agricultural Production Systems without bringing new land under cultivation.

¹⁷https://www.researchgate.net/publication/355348704_Consumers'_perception_on_safe_vegetable_production_in_Bangladesh

- (d) Increasing Resilience of crop and livestock production systems in the face of climate change.
- (e) Diversification in agricultural output and livelihoods involving more plant species or varieties, or animal breeds, off-farm activities, and employment; and
- (f) Coping with Uncertainty in Developing Responses due to uncertainty about the scale and eventual nature of adaptation needed to address climate change.

Similarly in the Delta Plan 2100 developed by Bangladesh with support from the Netherlands, identified strategies include.¹⁸

- a) Increasing resilience of agricultural production systems.
- b) Diversification in agricultural output and livelihoods.
- c) Lower emissions (GHGs) from agricultural land.
- d) **Encourage establishing commercial farms.**
- e) Introduction of Aquaponics farming system to culture fish and plants together.
- f) Using Nanotechnology in agriculture for processing, distribution, and packaging.
- g) Introduce precision agriculture model.
- h) Encouraging solar power in irrigation.
- i) Improved farm practices and technologies for mediating negative impacts of Climate Change.

All of which point towards greater adaptation of technology and climate smart technologies which will help Bangladesh achieve sustainable gains in the field of horticulture.



5.4 Protected Horticulture in Bangladesh

Bangladesh's agriculture is mostly dependent on open field cultivation, thereby exposing crops to external elements such as unpredictable weather, inefficient utilization of resources, climate change, pest infestations, flooding etc. In recent years there has been a few efforts to bring about change in cultivation practices considering food safety aspects, quality preferences, future demand, and the current premium market in areas such as Dhaka.

Low Tech Protected Horticulture

The potential of low-tech protective horticulture is being realized by farmers and relevant stakeholders across the board. As observed, there exists already adoption of practices such as using plastic coverings and net covering over fields (soil based) for high value crops such as sweet peppers, eggplants, tomatoes, etc. Field observations further indicate higher adoption of such protective practices at nursery level where they cater to the seedlings and sapling market. Low-cost or low-tech greenhouses can remarkably modify the microclimate inside it. It creates a warmer environment required for growing high value horticultural crops like cucumber, tomato, rock melon and watermelon etc. during winter (off season) in Bangladesh when ambient temperature often falls below the cardinal limits of those crops. Thus, this simple technology can effectively be used for season extension and/or off-season production of high value crops to make them available with a premium price in Bangladesh.

The government of Bangladesh is committed to promoting protective agriculture and provides farmers with technical and financial support in different formats under different projects. The Department of Agricultural Extension (DAE) under some of its projects such as 'Enhancing Crop Intensity in Greater Mymensingh Region Project'¹⁹, assists farmers with the design, construction, and installation of poly and net shade houses by providing technical guidance on site selection, soil preparation, drainage, and material selection. The DAE also offers training in the installation, operation, and maintenance of these structures, as well as financial management, marketing, and other business-related skills. The Bangladesh Agricultural Development Corporation (BADC) under certain projects such as its Drip Irrigation Project, provides similar support to farmers, including technical assistance on construction and maintenance, credit facilities for construction and input purchases, and advice on material selection, site preparation, and irrigation. The government has introduced various low-cost financing schemes, including reduced interest rate loans from the Bangladesh Krishi Bank, to encourage farmers to adopt protected and precision agriculture technologies such as net and poly houses, drip irrigation systems, and precision farming tools. Further information is provided in Annex 2.

¹⁹ [Transforming agriculture: Bangladesh moving towards high-value crops \(unb.com.bd\)](http://unb.com.bd)

5.5 Mid Tech Protected Horticulture

On the mid to higher end of the technological spectrum there have been investments made in greenhouses by both knowledge institutes and private companies. These broadly fall in the mid-tech range where the temperature control is undertaken mainly by cooling pads, ventilation fans, shades, windows and in some cases coolers. The study found that there are several such greenhouses that are in place already.

The use of mid tech protected horticulture solutions, either for research or for market-oriented cultivation is in its nascent stages in Bangladesh. It can be broadly divided into two distinct categories namely.

- a) Government and Research oriented.
- b) Private sector led market oriented.

Mid Tech Protected Horticulture in terms of Bangladesh can be defined as greenhouses using drip irrigation system with a structure using mostly polyethylene-based coverings instead of glass.

5.5.1 Government and Research oriented.

Bangladesh faces climate change as a real threat, and the situation is worsened by saline intrusion in its southern region. Research and extension are thus critical components as tools to adapt to the changes. Bangladesh Agriculture sector is thus heavily supported by its government agencies. The aim of improving services and technologies available to the farmers have been a core focus of such institutions from their own mandates. The study consulted with several institutes to gauge the prospects of protected horticulture in Bangladesh.

Consultation with **Bangladesh Agriculture Research Council** revealed that there is a requirement and current plan of setting up a mid-tech to high-tech greenhouse under one of their upcoming projects which aims to undertake research; they explicitly expressed their interest in seed research, speed breeding and propagation. Similarly, discussion with **Bangladesh Agriculture Development Corporation** informed the study that they currently have one greenhouse and are in the process of setting up two greenhouses for seed research and development. They have similarly supported the construction of a greenhouse in Jashore as a proof of concept to farmers. **Bangladesh Agricultural Research Institute (BARI)** similarly has greenhouses for research purposes.

Bangladesh Wheat and Maize Research Institute had recently set up a greenhouse for the purpose of research on wheat. Government universities namely **Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)** and **Bangladesh Agricultural University (BAU)** have very recently set up greenhouses where they are currently undertaking research. **Dhaka University (DU)** has established a greenhouse for similar purposes as well. **Bangladesh Jute Research Institute** has also previously established a 200 square meters high tech greenhouse²⁰.

²⁰ <https://www.hortidaily.com/article/6031101/new-cmf-research-greenhouse-to-boost-bangladesh-jute-industry/>
https://www.cmf-groupe.com/wp-content/uploads/2014/03/CMFEXPORT_RECHERCHE_BANGLADESH_BJRI_BD_EN.pdf

The study thus found that there are efforts to utilize greenhouse technologies for overall research and seed development from the government. Consultation revealed that the set up and construction of the greenhouse were subject to government procurement laws, where bidding processes were adhered to. The technologies were sourced from various places with China being the top supplier though the Jute Research Institute sourced from France. A key aspect identified through the discussion was the need for **technical assistance and training of manpower** to maximize the research efforts.

5.6 Private sector led market-oriented greenhouses.

The study primarily explored the Private sector actors. The study found that there are several greenhouses that are already established which include the likes of **Paramount Agro, Farm Fresh Organics, Shourov Fisheries and Agro Limited, Paragon Agro, Square Food & Beverage Ltd. and Tamishna Group Hydroponics**. These businesses all have a similar origin story where the owners of the group were interested in securing safe food for themselves, family and friends and/or staff initially, with a transition to commercial sales upon maturity of the operations. However one of the most recent investments by Shourov Fisheries and Agro was made purely on a commercial basis from inception. The first was Paramount Agro who started off with 2 greenhouse (22,000 sqft each) with the support and consultation of a Netherlands based consultant, with technology and equipment sourced from the Netherlands. The others following suit, similarly sourced consultants and equipment from either China or India. The technology sourced mostly included evaporative cooling pads, shades, windows, fertigation machines, ventilation fans etc. Given the nascent stage of the industry, it was found that most of the businesses had to pave their own way through trial and error to identify the appropriate processes and solutions; as there is a lack of guidance and availability of after sales service locally. Albeit we found knowledge sharing and support amongst the actors and the government and research agencies, the lack of locally available continuous support and human resources were found to be prominent.

The businesses believed that the blossoming middle income and health-conscious consumer groups ensures them a decent market and with their presence, the consumers can now source safe and good quality produce.



Figure 6 Paramount Agro Greenhouse – one of their units

[Setting up Mid tech Greenhouses in Bangladesh:](#)

The study found that within the handful of mid-tech greenhouses set up in Bangladesh, the timeline of the set up varied, locations varied, as well as the technologies adopted varied. The common thread across the existing greenhouses were that majority of them were set up within the mid-tech range.

The following provides a summary of the current set up by the firms.

Table 2 Technical Overview and set up cost of a few selected Greenhouses in Bangladesh

	Key aspects of the selected greenhouses		
	Company A	Company B	Company C
Year of Establishment	2015-2016	2019-2020	2017-2018
Size of the Greenhouse	2043 sqm or 22,000 sqft	2043 sqm or 22,000 sqft	2043 sqm or 22,000 sqft
Initial Set up Costs in Euros Inclusive construction and imported materials and consultant expenses (approx.)	€ 217,391	€ 202,899	€ 130,435

	Key aspects of the selected greenhouses		
Cost per square meter at current exchange rate of € 1 to 115 BDT	€ 110	€ 100	€ 65
Crop Yield – Cherry tomatoes indicative yield per cropping cycle of 6 months per plant (please note in Bangladesh only two cycles are practiced in a year)	8kg per plant in winter 4kg per plant in summer	6kg per plant in winter 3.5kg per plant in summer	7kg per week in winter 3.5kg per plant in summer
Type of technology	Dripper Systems - Hydroponic	Dripper Systems - Hydroponic	Dripper Systems - Hydroponic
Source of technology	Netherlands	China	China, India
Type of material(s) used the greenhouses cover	Polyethylene 200 micron	Polycarbonate Sheet	Polyethylene 200 micron
Type of climate control	Cooling pads, fans, windows, and fogger/mister	Cooling pads, fans, windows and fogger/mister	Cooling pads, fans, windows and fogger/mister
Type of irrigation and fertilizer system	Drip	Drip	Drip
Type of ventilation system	Windows	Windows	Windows
Type of internal logistics system	manual to move shade nets	manual to move shade nets	manual to move shade nets
Type of water storage system	tanks	tanks	tanks
Type of cooling system in production	cooling pads, fans, mister/fogger	cooling pads, fans, mister/fogger	cooling pads, fans, mister/fogger
Type of substrate	Cocopeat	Cocopeat	Cocopeat
Type of artificial lighting	None	None	None
Type(s) of water used	Ground water	Ground Water	Ground water
Costs of the water	Included within the electricity cost	Included within the electricity cost	Included within the electricity cost

The average cost of setting up a greenhouse (excluding the price of land lease/procurement) is roughly € 90 ranging from € 65-110 per square meter based on an exchange rate of € 1 to 115 BDT. It is important to note that exchange rate fluctuations effect the range significantly, as our calculations indicated the range varied from € 90 to € 140 if the exchange rate from the year of establishment is used. Furthermore it is important to note that the cost of construction, import costs etc. are also included in this estimate.

The businesses had utilized land which they had owned previously with limited alternative uses. Discussions with the wider actors informed the study team that there are several businesses either in the agriculture or readymade garments sector who has access to unutilized land which can easily be utilized for such initiatives, once the business case is widely understood and a more enabling environment is established.

5.7 Market for greenhouse produce.

In gross terms, produce from the greenhouses generally compete with imported vegetables as well as locally grown crops in Dhaka, or simply they compete in the premium high value crops market. Greenhouse based crops thus really compete in the upper niche of this premium market. Despite this competition there is a decent market for greenhouse-based produce, as the players informed that the market holds the potential to grow further, and marketing efforts for the products needs to be properly planned and implemented. The following figure summarizes the marketing channel adopted by greenhouses.

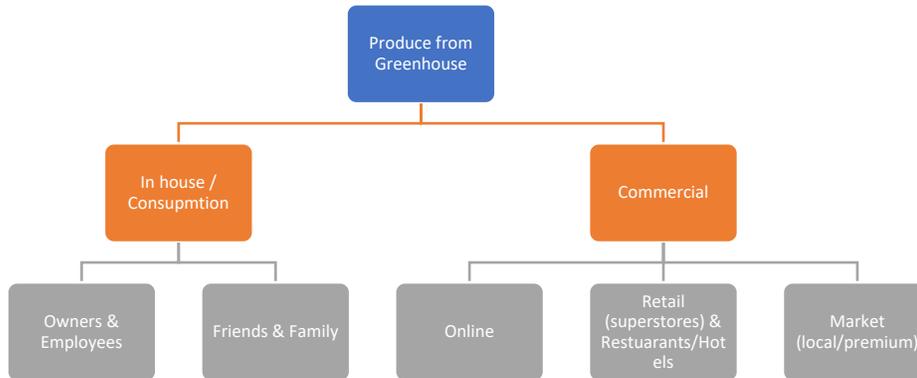


Figure 7 Marketing Channel for Greenhouses

For their commercial sales, greenhouses tend to adopt direct online sales, sales to superstores and sometimes even the local premium market. The marketing approach is customised to each of the businesses themselves and varies as per location and as per the number of years in business. Consultations however informed the study that businesses are confident about the market being able to absorb higher production, which is best exemplified by the expansion in the number of greenhouses established.

Consultations with the greenhouse businesses revealed that their entire production volumes are absorbed by the market and the demand is higher during summer. The information in Table 4 provides a snapshot of a superstore’s demand for high value vegetables. The demand is grossly consistent across the year.

High end retail outlets are a major market for such produce. These high-end retail outlets are geared towards the upper class clientele, who are willing and able to pay for high end products which ranges from consumer goods to food products such as greenhouse cultivated vegetables, imported fruits and vegetables. These entities are mostly geographic centric clusters in Gulshan 1 and Gulshan 2 in Dhaka. A few household names include SHWAPNO (outlets in Gulshan 1 and Gulshan 2), Agora, Dhali, Lavender, Unimart etc.

5.8 Crops Cultivated in the greenhouses.

One of the major decisive factors for the businesses to succeed is the selection of which crops to cultivate. It was found that the businesses went for vegetables that are coined as Chinese vegetables in the local market. These are non-traditional crops or varieties that are traditionally not grown in

Bangladesh. They are in essence import substitution crops, as even till date most of these crops are imported to be supplied to the target markets. Importers also informed that given the current economy (2022-2023's limited foreign reserve, leading to a lot of restrictions in imports) imports are harder to execute.

Table 2 Crops cultivated in Greenhouses.

Tomatoes – Cherry, Beef, Black	Basil Leaf
Capsicum	Bok Choi
Mint	Lettuce
Strawberry	Celery
Cucumber	Leafy Vegetables
Spinach	Chili
Cabbage	Long Beans
Cauliflower	Flowers (gerbera)
Basil	Rock Melons
Honeydew Melons	Other Experimental (grapes)

Commercial production of general crops which are consumed by the mass market, in greenhouses are not feasible in Bangladesh in the current state of the industry and at current price points. With further investment in research and development²¹ that can result in economies of scale and appropriate technological development for the specific country context, the situation may change in the long term. The crops cultivated are also branded or placed as safe to consume and as hydroponic based cultivation, which are free of pesticides use, allowing them to charge a premium on their produce. A common cultivation approach taken by the businesses are a mix of staged cropping in their greenhouses. Entirety of the greenhouses are not cultivated with the same crop. Mixed cropping is adopted as this strategy allows for risk mitigation for the business and also allows for the businesses to be able to provide a range of products, as till date the markets remain limited for any single crop.

In the mid to long term, the companies are also interested to explore possibilities for exporting the produce, subject to feasibility of the business case. One prospect could be to pool the produce from different greenhouses, with the off-take managed by exporters.

Table 4 Demand Estimate of selected crops in retail outlets from Key Informant Interviews

Item	Weekend Demand in Kgs	Weekday Demand in Kgs	Extrapolated Monthly Demand in Kgs
Capsicum (Green)	250	120	1480
Capsicum (Red)	30	20	200
Capsicum (Yellow)	30	20	200
Cherry Tomatoes	40	30	280
Lettuce	20	15	140
Zucchini	30	20	200

²¹ <https://www.priva.com/nl/blog/tuinbouw/equilibrium-capital-en-priva-bundelen-krachten>

The above table is reflective of the fact that demand for such vegetables are still rather limited at certain retail outlets. Greenhouse businesses have thus adopted different strategies where exposure on the supermarkets for sales are limited. Such strategies include having direct links with restaurants and hotels, online stores, and fixed client bases.

The study also found that the general mark up for the outlets on wholesale prices ranges from 35% to 100% subject to crop type, with higher premiums on more exotic produce.

Table 5 Summer vs Winter Wholesale price of produce received by Greenhouse growers from intermediary buyers such as superstores, retailers, hotels, restaurants etc.

Crop	Winter (November to March/April) Prices per KG		Summer (April to Oct) Prices per KG	
	Tomatoes	BDT 250	Euros 2.17	BDT 280
Cherry Tomatoes	BDT 333	Euros 2.90	BDT 450	Euros 3.77
Cucumber (seedless)	BDT 150	Euros 1.30	BDT 180	Euros 1.56
Rock Melon	BDT 350	Euros 3.04	BDT 350	Euros 3.04

Cultivation practice followed: Businesses rarely utilize their full greenhouse space for 1 crop, as there is usually a mix of crops such as capsicum, cucumber, and tomatoes. To be able to draw comparatives, the study extrapolated the information collected from consultations with greenhouse businesses, using indicative figures. The following section thus portrays a hypothetical case where a 22,000 sqft or 2044 sq m greenhouse is utilised to its fullest, however for a single crop, namely **cherry tomatoes**.

Summary of Costs and Returns

CAPEX		Average	
	Current Prices in Euros (1 Euro =115 BDT)	€	183,575
	Prices in Euros (as per set up year)	€	232,724
OPEX		Average Yearly	
	Salaries (Labor & Staff Costs)	€	9,790
	Cost of Power	€	5,217
	Miscellaneous Costs (water, maintenance)	€	100,000
	TOTAL	€	16,007
COGS			
	Cost of Chemicals/Nutrients	€	9,922
	Cost of Seeds	€	620
	Cost of Transport	€	1,971

Cost of Packaging	€	308
Miscellaneous Costs	€	560
Total COGS		
	€	13,381
Revenue	€	199,043
Gross Profit (revenue-COGS- OPEX)	€	169,655
Depreciation per year at 20% *	€	36,715
Yearly Earnings After Depreciation	€	132,940
ROI		0.77
Simple Pay Back Period		1.62
<p>*Depreciation has been assumed on the basis that the life cycle of the polyethylene coverings is expected to be 5 years, however please note there are certain items that may have a depreciation at a different rate, but for simplicity a simple 5 year 20% depreciation has been taken)</p>		

The table is a summary representation of 3 greenhouses currently operational in Bangladesh. It is important to note that each entity set up the facilities at different times. Several key assumptions based on their practices and other factors have been made, which are as follows:

- a) To draw comparisons we have used a common Exchange rate of 1 Euro to 115 BDT.
 - b) We have taken only cherry tomatoes as the crop cultivated across the 22,000 sq ft or 2044 sq m greenhouse - this is not a practice we observed as entities try to de-risk their operations through mixed cropping within the greenhouse.
 - c) Land prices were not factored in as most of the entities had unutilized land, it can be safely assumed given the current land prices subject to the area, the cost of land if factored in, will at least double the payback period if not a more significant impact, or simply the return on investment scenario will be very different.
 - d) Administrative and overhead costs are spread across other business units, as such only direct costs attributable to the greenhouse operations have been considered.
 - e) While CAPEX was calculated considering the average CAPEX from the 3 greenhouses of BDT 21,111,111 (from year of establishment) and working back at a more current exchange rate of €1 to BDT 115, which was also used for the current OPEX, the actual CAPEX in Euros for a greenhouse bought today would be higher as BDT has devalued since year of establishment, whereas greenhouse equipment / input providers sell their goods and services in their own currency, thereby impacting ROI / pay back period
- Note the detailed calculation can be found in Annex 4.

The following table provides a summary of the greenhouses such as area covered, crops cultivated, markets etc.

5.9 Current Scenario of the greenhouse-based businesses: Summary Table

Table 6: Summary of the greenhouses

SI	Name of Business	Area under greenhouses	Crops Cultivated	Market	Plans and Challenges	Comments
1	Paramount	98,000 Sqft / 9,105 square meters 44,000 Sqft + 30,000 Sqft + 24,000 Sqft (2 greenhouse of 22,000 sqft each + 3 houses 10,000 sqft each, 8 houses with 3,000 sqft each)	Tomatoes – Cherry, Beef, Black. Cucumber. Rock Melon; Honeydew Melon; Strawberry	Direct to consumer through own brick and mortar shop and online (branded as O' Natural), Sales to institutions such as Shwapno, Agora, Uni-Mart etc.	Expand to new greenhouses that are mostly locally produced. Challenges include finding good quality seed and quality staff. Technical Challenge is primarily summer based cultivation which requires further lowering of the temperature.	They are considered pioneers in this segment and have established markets. They have also expanded significantly over the years. They act as one of the major sources of technical guidance and information for other businesses as well.
2	Shourav	66,000 Sqft / 6,132 square meters (3 houses with 22,000 Sqft each)	Tomatoes - cherry, Cucumber, Rock Melon,	Upscale wet markets in Dhaka namely Gulshan DCC 1 and 2 markets	Experiment with new high value crops such as saffron and other crops. Challenges include markets, and human resource training.	They had a more commercial approach to the establishment of the business right from the outset. Given prevailing challenges with imports, they have seized an opportunity to supply to importers as an import substitution.
3	Farm Fresh	22,000 sqft / 2,044 square meters	Tomatoes – Cherry. Cucumber. Rock Melon; Honeydew Melon;	Direct to consumer through online shop and Sales to institutions such as Shwapno, Agora, Uni-Mart etc.	Expressed keen interest to get technical solution to improve summer-based production, through economic solution of lowering temperatures in the green house. Expand to new greenhouses. Expressed interest in understanding Organic certification and exports for the long run.	They have a more commercialized approach and are building a business on the greenhouse. They are the only ones who have set up their own NFT based greenhouses in Bangladesh.

SI	Name of Business	Area under greenhouses	Crops Cultivated	Market	Plans and Challenges	Comments
					Challenge primarily is quality human resources, electricity / power management & costs.	
4	Baba Farms	26,000 sqft / 2,415 square meters	Tomatoes, cucumber	Mostly internal sales	Fix current issues with the farm, where challenge lies in reviving the current farm and finding the right human resources to support the change.	Currently not fully operational
5	Paragon	87,120 Sqft / 8,094 square meters (2 houses of 1 acre each)	Roses and Gerbera (flowers)	Local Flower Market in Dhaka	Commercialize the business as much as possible and explore new ideas.	Currently not fully operational to a degree having moved from flowers to vegetables.
6	Square	10,000 Sqft / 929 square meters	Tomatoes – Cherry. Cucumber. Rock Melon; Honeydew Melon;	Own Staff and local market in Pabna	Move towards commercialization.	For private consumption, moving towards commercialization

5.10 Greenhouse Technology Used in Bangladesh

Given Bangladesh’s climatic conditions it is imperative that the right types of technology are adopted. In addition, the design and consultancy is critical as it was found that operations faltered due to incorrect solutions being provided, which businesses find difficult to judge upfront given their lack of experience and expertise with greenhouses (specially first time investors). Careful considerations have to be made also on the costs, maintenance, aftermarket service as well as longevity. One of the most influential factors of consideration is the ability to lower temperatures in such greenhouses, to be able to grow the crops with demand in the market, particularly in the summer months. Our study found that there are several mid-tier technologies that are viable for greenhouse farming in Bangladesh.

The basic structures used in Bangladesh have been observed to be covered with polyethylene coverings, retractable nets were used for shades, evaporative cooling pads, alongside ventilation fans, and fogging systems were also observed. Coolers were also found to be in use as additional means of temperature reduction inside greenhouse. Drip Irrigation is common, with the most common choice of substrate being coco-peat. Albeit fully controlled technologies can be used which are fit for purpose such as research and seed replication, the market of produce is not at a stage where such high-end solutions are yet feasible. Nevertheless, there are opportunities to upgrade the existing level of technology and knowledge.

Nutrient Film Technique – NFT was also found to be used in Bangladesh similarly secondary research found that there are solutions available for rooftops and specialized gardening based on aquaponics technologies.

High-Yield Variety (HYV) Seeds: High-yield variety seeds are developed to produce high crop yields in a short period of time. These seeds are particularly useful in regions where crop production is limited by factors such as soil fertility, water availability, and pest infestation. Greenhouse based cultivation requires specialized seeds as well as the varieties produced in Bangladesh varies from the commonly used seeds in open fields. Thus, it is vital for businesses to be able to source the right kind of seed suitable for greenhouse crop production. Currently sources include Netherlands, Thailand, Japan and Korea as the primary seed suppliers. It was also noted by one of the greenhouse operators that Dutch seeds performed well in the winter, whereas seeds sourced from Asia performed better in the summer as the climate is more similar to Bangladesh in the summer months.



Figure 82 NFT at Farm Fresh Organics



Figure 13 Fertilizing Machine at Shourav Fisheries and Agro Limited and at Paramount Agro. The HortiMax fertigation machine at Paramount Agro is from the Netherlands.



Figure 14 Cooling Pads system at Shourav Fisheries and Agro Limited

Potential for upgraded technologies and improved designs

Our consultations revealed that controlling temperatures during summer is one of the most critical factors hindering the greenhouse production and businesses, while energy, despite being a significant factor was not identified as one of the major hindrances at the current scale of the industry. Considering the current situation on the ground the technologies that can be pursued in the short to medium terms are as follows:

1. Exploring options beyond Pad and fan greenhouses, such as Tropical Greenhouses and a longer-term path towards Semi-closed greenhouses with climate chambers.

Pad and fan greenhouses have been in use for a long time globally. Most fruiting plants are prone to reduced quality and yield at maximum temperatures of more than 30 degrees Celsius, which is prevalent in Bangladesh for a significant part of the year, thereby making summer cultivation challenging. The impact is a reduced viability of pollen and as a result, the produce can be soft, dull, misshapen and smaller in size. As fruit and vegetable production in greenhouses gained popularity, growers in hot climates resorted to pad and fan greenhouses as the evaporation of water can reduce the air temperature significantly. At the same time, to overcome some of the shortcomings of Pad and Fan greenhouses, Semi-closed greenhouses with climate chambers have also been developed, which create a better micro-climate inside the greenhouse with superior air flow management. In addition, in regions with a tropical climate, tropical greenhouse designs have also been developed.

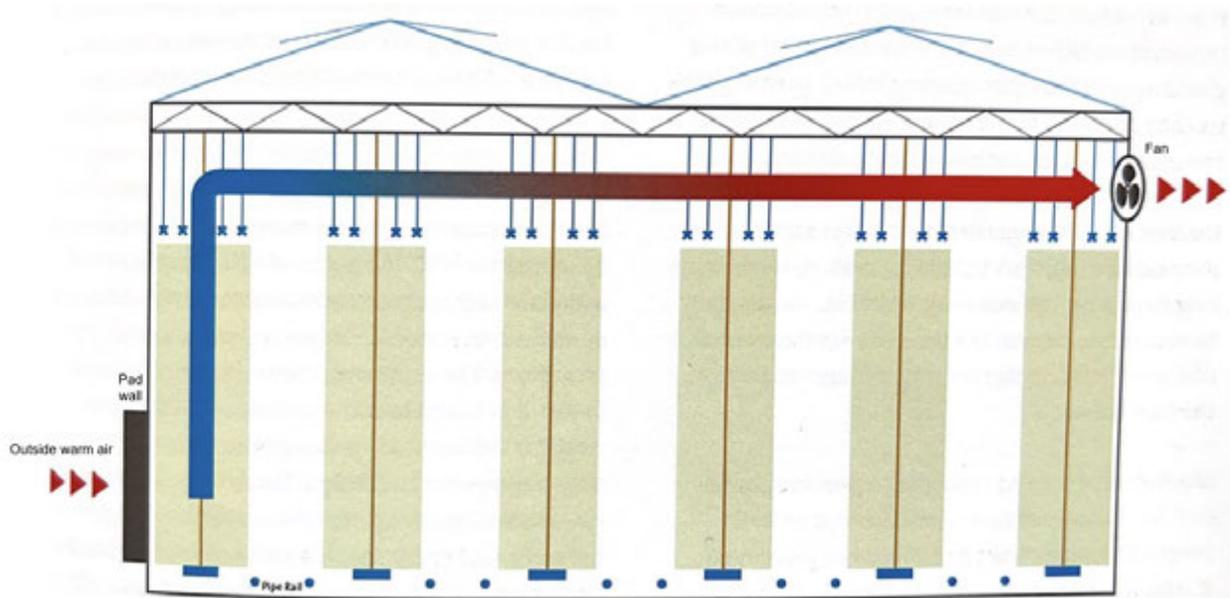


Figure Above: Typical Pad and Fan Greenhouse, which is mostly seen in Bangladesh, showing the air flow and air temperature

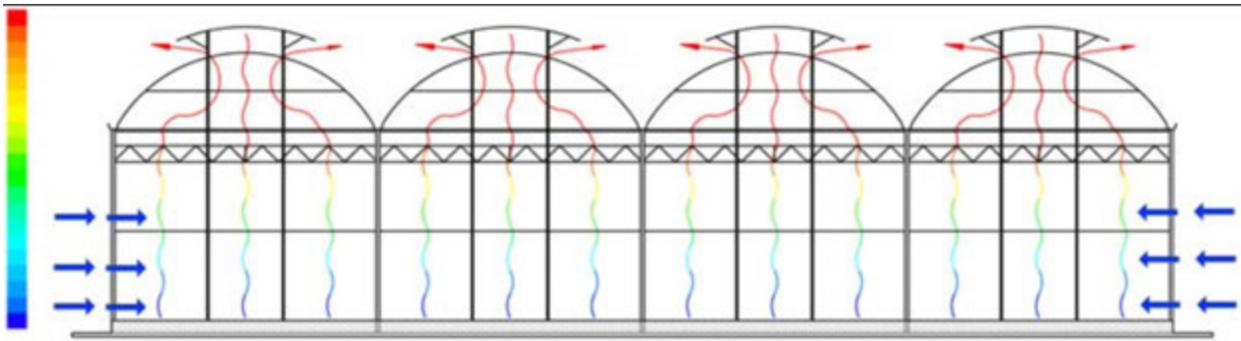


Figure Above: Tropical Greenhouse showing air flow and air temperature

Tropical greenhouse designs have been developed to perform under circumstances found specifically in tropical areas. These structures can be used by themselves as a ‘passive’ greenhouse solution utilizing natural ventilation or can be equipped with more advanced technologies, making it progressively automated and ‘actively’ climate-controlled. The design feature results in a constant natural ventilation of fresh air through the sides of the greenhouse and the exhaust of rising warmer air through the chimney. The result is an ‘active climate’; a constant movement of air without forced-ventilation or wind. Besides having this ‘active climate’, the greenhouse can utilize the sheer air volume to its advantage. There is large volume or ‘air-buffer’ within the greenhouse because of the greenhouse height, which results in a slower and more gradual change of temperature and humidity inside the greenhouse. Historically the performance of conventional greenhouses have been improved through better design, improved control, and building the greenhouses taller. The taller greenhouses allow a bigger buffer of air above the crop. When cool or hot air enters the greenhouse through the vent, there is more air in the greenhouse that mixes with the outside air. The air temperature is, therefore, more stable in a taller greenhouse.

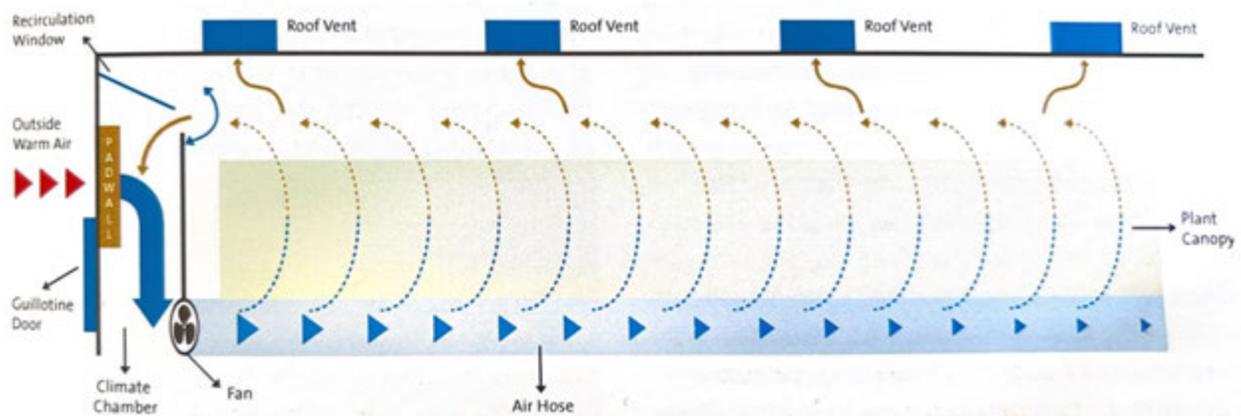


Figure Above: Semi-closed Greenhouse with Climate Chamber

Both pad and fan and the **Semi-closed greenhouse** use the evaporative cooling technique (which can also be added to tropical greenhouse designs), called adiabatic cooling, by using a fan to force air over a cooling pad. In a pad and fan greenhouse, the fan sucks the warm air out of the greenhouse, creating a flow of air over the cooling pad. As the cooled air passes through the greenhouse, the sun warms up the air creating a temperature difference between the pad side and the fan side of the greenhouse. It is not

unusual to experience a temperature difference of 6 degrees (or more) Celsius. This complicates growing high yielding crops because maintaining correct and uniform temperatures is one of the main drivers to achieve this. It also complicates the irrigation management as plants in a high temperature area with lower humidity, require more irrigation. The warming up of the air can only be restricted by reducing the distance between the pad and the fan; generally a maximum distance of 40 meters is accepted, which reduces the size of the greenhouse.

However, a semi-closed greenhouse achieves a much more even climate as it distributes the air evenly through the greenhouse by using **perforated air hoses (as shown in the previous diagram)**. In a semi-closed greenhouse, the air is cooled before it enters the greenhouse in a climate chamber, which allows an even temperature distribution throughout the greenhouse, regardless of its size. The cooled and humidified air is then passed by the plants, allowing all leaves to add moisture to the air. The volume of air is controlled precisely by adjusting the fan speed, which provides the plants with a consistent environment.

The businesses that were consulted mentioned that winter production and yield was much better, as such those who produce well in the winter want to extend their crops into summer, when the prices are more favourable but temperature management is more challenging. Until recently, from a global perspective, this has been achieved with pad and fan greenhouses or through high pressure fogging. However, pests and diseases can pose a more significant threat to production, whereas semi-closed greenhouses can provide solutions to issues related to both pest & disease and heat.

Growers are better able to rely on their climate computers to know if their crops are growing well or not. In the absence of climate computers and sensors, growers need to spend a lot of time in the greenhouse to 'feel' the climate. For example a greenhouse with a 3.5-meter gutter height has the vents so close to the tops of a plant that excessive ventilation results in cold heads.

The cooling of a pad and fan greenhouse relies on the efficiency of the cooling pad wall. It is, therefore, essential that the pad wall is evenly wet. A dry patch allows warm outside air to pass straight into the greenhouse, increasing the temperature. Proper filtering must be part of the pad wall watering system, and a maintenance schedule prevents dry patches due to reduced water flow from clogged filters (it was observed during field visits to greenhouses in Bangladesh that some pad walls were in poor shape / dysfunctional or substituted for pads not purpose-built for greenhouses). Utilization of climate computers would register the flow of water to the pad wall. Monitoring the flow daily is a simple way to see if the performance of the system is affected. In consideration of the above, testing and practical research can be undertaken by incorporating tropical greenhouse design features along with the pad and fan greenhouses with a longer term view of progressively upgrading technology towards a semi-closed greenhouse with climate chamber, sensors, climate computers and other technology, while remaining cost conscious in terms of capital and operating expenditure and understanding the trade-offs with different types of technology in terms of yield, quality, consistency, resource efficiency etc.

2. Automated Climate Control Systems.

Automated climate control systems can regulate temperature, humidity, and carbon dioxide levels in greenhouses. These systems can improve crop quality and yield while reducing energy consumption.

3. Solar-Powered Greenhouses.

Solar-powered greenhouses are equipped with solar panels that generate electricity for heating, cooling,

and lighting. These greenhouses are particularly useful in regions with limited access to electricity, but it can be used throughout Bangladesh as a power backup during electricity load shading.

4. Vertical Farming.

Vertical farming is a technique in which crops are grown hydroponically in vertically stacked layers using artificial lighting. This technique allows for year-round crop production, reduces water usage, and maximizes land usage, though energy usage is high. Our secondary research revealed that this has been implemented at a very small scale, however in recent times the global indoor vertical farming industry has gone through a difficult phase, as such the technology needs to be approached with caution in the current circumstances.

6. Key Observations:

The private sector actors who have paved the way for greenhouse-based cultivation in Bangladesh present a mixed story to a degree, as the study found that there are a few who have been doing well and have developed their markets and operational process over time, whilst some have just started and others have been struggling to stabilize their operations. A few key observations of such private actors are as follows:

- Technologies were sourced from outside the country namely from the Netherlands, India, and China. The study found that since the businesses were new to the area of hydroponics there are various suppliers of technology. Several factors were considered for the decision of investments such as costs, quick access to materials and availability of consultants. Recently established businesses have been sourcing the technology from China and India.
- Investments were made by mostly non-Agro businesses such as companies with primary businesses in Readymade Garments, Pharmaceuticals and Construction. Despite there being significant Agro businesses in the market, it was noticed that agri-based businesses had not entered this sector as yet, though they expressed an interest to explore the possibilities. Different industry players such as Ready-Made Garments Manufacturers, Pharmaceutical company, Construction Companies were the first movers in this arena. This can be loosely summed up to the core idea of such investments stemming from being able to supply quality food to one's family which later expanded to commercial aspects, and their respective investment capacity and appetite. As major agribusinesses typically enter mass market products, they have been in a "wait and see" approach in terms of protected horticulture, which is still serving the premium market at present.
- There is noticeable difficulty during **summer cultivation**, as the temperature maintained within the greenhouses are not consistent. Productivity of major crops such as cherry tomatoes are nearly halved during summer, for example dropping from roughly 8 kgs of tomatoes per plant to 4 kgs for one of the companies and similarly from 7 kgs in winter to 3.5 kgs for another. Please refer to Table 2 Technical Overview and set up cost of a few selected Greenhouses in Bangladesh. The energy costs of reducing and maintaining temperatures are also deemed very high. Interestingly the lower production volume is somewhat offset by the increased prices of produce during the summer.

- All the businesses are experimenting with what can be done with the greenhouses ranging from different crops trials that include grapes, leafy vegetables with even plans for saffron soon.
- A common aim cutting across the businesses is also the intent to produce and tap into export markets in the future. This could be possible if exporters step in to collect the produce from multiple greenhouse and manage the off-take process efficiently.
- Energy issues were not mentioned as a major factor by most of the respondents, at the current scale of the industry. Interestingly one of the greenhouses uses biogas for its power, this is possible due to their core business of poultry. However, most were found to be dependent on power sourced from the government service provider, Bangladesh Rural Electrification Board, which is largely natural gas based. There are inconveniences of power outages, but it was deemed manageable by most. One of the actors reported that they had to bear with additional cost of a generator and diesel which increase their costs significantly.
- The study also found that the companies utilized local construction workers and material to supplement certain parts and equipment's. This ranged from using locally available plastics and blocks.



Figure 97 Shourav Agro – Cherry Tomatoes Cultivation



Figure 18 Farm Fresh Organics Leafy Vegetable Cultivation



Figure 109 Baba Farm Leafy vegetable cultivation



Figure 11 Paragon Agro - Soil based Greenhouse Cultivation

7. Constraints Faced by Private sector actors.

The businesses faced unique problems whilst setting up and running their operations, the consultation led to the identification of several constraints for doing business, which are:

- a) **Nutrients, and crop protection** – the cultivation process is dependent on the solution used for fertilizer or as source of nutrient for the plants. Such chemicals are not recognized by the authorities as agriculture-based chemicals i.e. they do not have the correct HS codes designated to them, hence are taxed heavily under industrial use classification. On top of this complication, a few of the chemicals such as the nitrates are marked as dangerous chemicals and require more complex handling or are banned outright. This creates a situation where the sourcing and use of these chemicals face a lot of red tape, unwarranted hassle and high costs. Thus, policy level advocacy and upgradation of knowledge on the matter is required to ensure all elements of a greenhouse are captured under HS codes for Agriculture. A possible solution could be to mark relevant items as “greenhouse grade” similar to “lab grade”.
- b) **Availability of seeds** – the seeds required for indoor cultivation with high yields are vital, however there are no recognized supplier of such seeds in Bangladesh. This leads to a situation where such businesses must source seeds directly from indoor seed suppliers. We have found that some of the businesses have already established links with the suppliers, however it can be stated that there is limited presence of such entities in Bangladesh. In addition, it was observed that Dutch seed varieties performed better for winter cultivation whereas yields were better in the summer using seeds originating in Asia.
- c) **Knowledge and Information** – albeit the research institutes and government agencies do have hydroponics as a topic in their academic curriculum, the depth of information taught is not adequate to run a fully operational greenhouse, especially one which is focused on the output market. Thus, there is a vacuum of knowledge and information in technical know-how of running and managing greenhouses.
- d) **Aftermarket services** – there is practically no aftermarket services for the greenhouses in Bangladesh, as such there are several issues with the upkeep and maintenance of the greenhouses and equipment such as cooling pads and polyethylene coverings etc. The businesses are thus entirely dependent on imports in certain cases, leading to a situation where sub-optimal operations are undertaken due to dysfunctional parts, inappropriate / incorrect consultancy - given local conditions, delays and long lead times in shipments of spares / consumables and reliance on sub-optimal local substitutes (e.g. cooling pads from Garments industry).
- e) **Seasonality** – There is also a noted drop in production during the summer months that all greenhouses have reported, though it is the most potentially lucrative period from a sales price perspective. Winter production is reported as the best in terms of production, though pricing is not as attractive.
- f) **Human Capital** – the businesses all expressed that there is a lack of skilled and trained personnel available in the market, as such significant mentoring and trial and error is required. The need for foreign consultant support is thus mandatory at this stage in Bangladesh. In addition, faulty designs (e.g. insufficient greenhouse height, orientation of trays, size of exhaust fans) being offered by consultants have resulted in operational challenges.

7.1 Workarounds

The study found that despite the constraints the businesses have been able to function given their efforts and persistence. Some of the work arounds that were adopted by the businesses are:

- a) **Knowledge sharing** – it was observed that the businesses collaborate to share knowledge and information with each other to try to resolve many of the operational issues. Businesses also maintain good communications with consultants - both local and international, some of these approaches are sometimes costly, however they have been yielding good results till date. A few have kept consultants on retainers whilst others are taking part time support to ensure technical assistance.
- b) **Input network** – given the sensitive nature of the chemicals required, the businesses collaborate to source and share some of the chemicals, allowing for more of a structured solution of the current process of sourcing the required nutrients.
- c) **Localization** – to overcome challenges around imports of materials, the greenhouse operators have been looking at localized solutions such as using cooling pad replacements from the garments industry (which does not cool to the same amount, yet is a cheaper and more quickly available alternative), sourcing substrate (cocopeat) locally, fabricating the structure locally etc. This was particularly useful during COVID-19 lockdowns.

8 Stakeholder Perspectives

8.1 Agro- Businesses take on Greenhouses.

The study consulted with several seed companies and Agro- companies in both Bangladesh and The Netherlands to gauge their interest and acquire their perspective on the future of protected horticulture in Bangladesh. The consultation led to the revelation of two areas of interest.

- a) **Seed production:** It is defined as producing seeds, namely potatoes and Cole crop seeds i.e. cabbage, cauliflower. Businesses shared that there might be application of greenhouses in testing out the feasibility of producing such varieties subject to costing and technical feasibility.
- b) **Output Market Production:** ACI, Ispahani, Farm Fresh, Paramount and Seba clearly indicated that there is scope for engaging in larger greenhouses to serve the output market, with specific focus on exports and local premium markets. The major focus areas would be the production volumes where the margins have to make commercial sense for them. This requires a more nuanced approach as despite the presence of other actors who are in the same business, the scale and volumes considered are different for the Agro companies.

There was also interest expressed by such actors to become authorized dealers of Netherlands based companies to supply fertilizers, seeds, turnkey solutions etc. and plug the gap in the aftermarket.

There was noticeable interest as well as some reservations expressed by such players, as companies expressed the need for securing markets and optimal production at the greenhouses and co-investment or access to financing in some cases. The modalities of engagement have been summarized in the opportunities section below.

8.2 Buyers of commodities

Consultation with the buyers of produce (such as super stores) from the greenhouses expressed that there is a growing market for such crops which tend to cater to their premium clientele, who are interested in unconventional products and are cautious about the quality of food that they intake. Albeit there are importers who are in direct competition with such suppliers, the overall comment has been positive as such suppliers allow for greater margins for the businesses. It was revealed that the sub-segment of Chinese Vegetables are growing and the margins for such retailers were roughly 15-20% for such produce at their outlets.

8.3 Exporters Opinions

Exports of horticulture produce in Bangladesh has potential as till date most of the supplies are concentrated in ethnic or diaspora markets. The mainstream markets have been left relatively unexplored. Albeit there are regulatory and non-tariff-based requirements that Bangladesh as a whole has been slow to cater to. However, hydroponics-based cultivation may help unlock some of these markets as traceability, maximum residual levels and other production requisites can be met easily through greenhouse-based production.

Consultation with exporters and their respective association informed the study there lies potential in adoption of protected horticulture for production of **Green Beans** (specific varieties usually grown in the Sylhet division of the country), **Birds Eye Chili**, **Green Chili**, **Snake Gourd** (Chichinga), **Bottle Gourd**, **Red Amarnath**, **Spinach** etc. This will also potentially aid Bangladeshi exporters with ensuring round the year supply to buyers, as greenhouses are likely to support production of off-season crops. The exporters' association has expressed their keen interest in testing out the technical viability if there is any scope of collaboration of support from external factors such as the government agencies and foreign support. However, exporters also highlighted some of the logistical and infrastructure challenges such as cold chain logistics that must be resolved to ensure smooth exports and competitiveness with other countries that are producing the same crops at scale.

8.4 Others

The study also consulted with other actors such as financial institutions. Banks in Bangladesh are mandated to provide viable agriculture loans to agri-businesses, the interest rates are usually favorable sometimes as low as 5%. Consultations indicated that low-cost financing may be made available subject to the proposed business plan and the business's credit record and reputation. Government grants in Bangladesh are not generally available for businesses to set up new businesses, however there might be alternatives such as [Startup Bangladesh Limited](#), a flagship venture capital fund of ICT Division. There is also scope to collaborate with donor funded projects such as USAID funded Feed the Future Bangladesh Horticulture, fruits and non-food crops activity, who are closely working in the horticulture sector. It is also important to note that FAO and UNDP have their interest in supporting rooftop gardening in Dhaka city, where the application of hydroponics and aquaponics are very high potential. Market insights indicate that there is an effort to develop financial products by the Bangladesh Bank, for rooftop gardeners interested in setting up such initiatives.

Summary of interests shown by Bangladeshi Companies

Interests expressed by Bangladeshi Companies can be broadly grouped into 3 categories namely:

a) Initial Interest:

Some of the companies interviewed expressed their interest in engaging in greenhouses and protective horticulture with a level of reservation. This includes the likes of **BSRM, City Group, Square, Gemcon** and others who want to understand the business case and technical feasibility better. Whilst they are confident about their own ability and market insights, a deeper dive into the output market potential, and other factors such as energy costs is necessary. The interest can be converted into hard interests in the form of support ranging from piloting or demonstrations, technical assistance, financial assistance or linkage to low-cost financing, technology support and potential marketing as well.

Strong Interest:

A few of the interviewed parties expressed their strong interest as well, where they are more comfortable in terms of taking a higher degree of risk and have experience in running greenhouses or can envision it's potential in alignment with their business interests. Companies expressing such strong interest includes **ACI, Ispahani, Farm Fresh Organics, Paramount Agro, SEBA Agro and Agro Sal**. They have also expressed their keen interest to partner with Dutch companies as local representatives or agents for helping the greenhouse industry through provisions such as aftermarket support, inputs, chemicals etc. **SEBA Agro** mentioned they have connections to at least 10 large companies – primarily from readymade garments - who have expressed their initial interest to learn more about the prospects of greenhouse technology in the local market. **ACI** similarly expressed their keen interest to collaborate with the Dutch to set up a higher end greenhouse subject to technical and financial assistance foreseen to make the endeavor a success – they would be keen to participate in establishing a demonstration / proof of concept greenhouse. Paramount Agro, Farm Fresh, Baba Farms similarly expressed high level of interest to receiving technical assistance to improve their cultivation performance with emphasis on summer cultivation, with Paramount Agro mentioning their interest to expand their greenhouses through joint venture while Farm Fresh is actively seeking technical solutions.

b) Mixed Interest:

A few companies have expressed mixed interest which requires further work and developing a bespoke solution. This includes potential collaboration of companies to source seeds not only limited to greenhouse specific seeds but also hydroponics related chemicals.

The study had also found several readymade garments or other industry players who were found to have interest this includes the likes of Thengamara Mohila Sabuj Sangha (TMSS) who are planning to set up a potato-based greenhouse, Apex and Dekko Isho group who are assessing the potential of setting up a greenhouse in the long run.

9. Dutch interests and opportunities

The Netherlands is a world leader in greenhouse technologies and has extensive expertise in setting up and managing greenhouse facilities. Each of the constraints and workarounds presented in section 7 and 7.1 presents an opportunity for Dutch expertise to provide possible solutions. In terms of greenhouse

technologies, the Dutch are known for their innovative approaches to sustainable cultivation, which prioritize resource efficiency and reduce the use of harmful chemicals and fertilizers. Thus, the Dutch greenhouse industry can offer several services to Bangladesh, such as:

Climate-controlled greenhouse systems and inputs for protected horticulture: The Dutch greenhouse industry is known for its advanced climate-controlled greenhouse systems that allow for year-round production of fruits, vegetables, and flowers in a controlled environment. These systems enable growers to optimize production, reduce water usage, and minimize the use of pesticides and fertilizers. In addition the input providers, which includes key items such as seeds for indoor cultivation and nutrients, can play a key role to provide the right solutions for the local circumstances.

Sustainable energy solutions: The Dutch greenhouse industry has been at the forefront of developing sustainable energy solutions for greenhouse production. This includes the use of renewable energy sources, such as solar power, as well as energy-saving technologies, such as cogeneration.

Precision farming: The Dutch greenhouse industry is also a leader in precision farming technologies, such as sensor technology and automation, which enable growers to monitor and optimize plant growth, reduce waste, and improve yields.

Horticulture education and research: The Dutch greenhouse industry is supported by a strong research and education infrastructure, including universities, research institutes, and vocational training centers, that provide growers with the knowledge and skills needed to succeed in sustainable agriculture and horticulture production.

Industry collaboration: The Dutch greenhouse industry is characterized by a strong culture of collaboration and knowledge-sharing among growers, suppliers, and researchers. This has led to the development of innovative solutions and the creation of a strong network of industry stakeholder.

Dutch Greenhouse Delta may be engaged by interested Bangladeshi companies to connect them to the right Dutch partners.

10. Identified Opportunities for Collaboration

The core intent of the study was to draw a picture of the current situation of mid to high tech protective horticulture business in Bangladesh and identify opportunities of collaboration and support that the Netherlands embassy and RVO can facilitate to support the sector to grow and prosper over the years. The study having consulted the range of actors within the value chain was able to identify certain opportunities for collaborations, which are listed in the following table:

Table 3 Identified Opportunities in Protected Horticulture

1. Government Agencies and Research Institutes
<p>a. Technical Assistance: Government Institutions such as BARC, BADC and others have already started their journey towards setting up and/or undertaking research where greenhouses have been/will be set up. However, they continue to face issues in terms of human resources. There thus lies opportunities of support from the Dutch.</p> <p>Namely:</p> <ul style="list-style-type: none"> a) Support setting up greenhouses: Dutch based turnkey solution providers can potentially bid for such contracts based on the requisites of such agencies. For example, for BARC’s upcoming project there is an opportunity for Dutch companies in early 2023, as revealed in the discussion with BARC. b) Knowledge Sharing in terms of operations and seed variety development; trainings and support for human resource development were similarly identified across the actors who have identified knowledge as one of the most valuable aspects that need immediate support.
<p>b. Technical Assistance to Educational Institutes such as Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Bangladesh Agricultural University (BAU)</p> <p>The recent investment in setting up greenhouses allows for higher concentration of work for such educational institutes in greenhouse related research and human resource development. Discussion with such actors informed the study specific requisites to be</p> <ul style="list-style-type: none"> a) Update/develop course materials for hydroponics related courses, which will allow for the next generation of students to have a greater theoretical and practical understanding of working in greenhouses. b) Arrange exchange programs with Dutch based universities, this option came about as a major interest area as despite having the set-up, many of the students will welcome the chance to learn hands-on and be able to learn the daily aspects of running and maintaining greenhouse-based research and development. <p>*Note: Such arrangements need to be pursued through MOUs with the Universities. This is a simple process where such identified universities can be approached with expression of interest where areas of interest of collaboration and support can be clarified and portrayed for the university to add and fine tune if needed based on their respective interests and capabilities – one such MOU has been executed between Ministry of Agriculture and Wageningen University.</p>
<p>c. Policy Level Advocacy – the import policy followed by Bangladesh currently categorizes nutrients, chemicals as well as certain equipment required in greenhouse set up and maintenance as industrial and or are labeled as hazardous. This creates a problem for running and maintaining a greenhouse. A structured policy amendment process came across as a common demand from the parties involved.</p> <p>Given the expertise of the Dutch in the overall greenhouse management as well as their expertise in agriculture policy, there is a potential area of collaboration and further work in this segment, which is critical for commercialization of greenhouses for the future in Bangladesh. Certain items could be considered “greenhouse grade”, similar to the classification as “lab grade”.</p>

2. Existing Greenhouse Businesses:

a. **Technical Assistance to support the development of human resources through short courses and exchange programs.**

Greenhouse operators in Bangladesh have been industrious and innovative. They have invested significantly not only in terms of financial resources but also have put in significant efforts in researching and selecting the right technologies for themselves to set up and consequently run greenhouse-based production of their greenhouse ventures. Amongst several obstacles faced by them in realizing their vision one recurring factor has been skilled personnel who are able to run and maintain greenhouses. It was observed that despite educational background on the topic, concentration and practical experiences in the field was limited for most of the personnel available.

Knowledge institutes from the Netherlands can potentially support the development of such human resources, in cooperation with educational institutes such as universities of applied science, introducing programs such as mentorship under PUM scheme or introduce exchange programs with universities, private knowledge suppliers and actual greenhouse businesses where personnel can gain hands-on or practical knowledge.

b. **Technical Assistance to improve summer-based cultivation** – Cultivation during summer time in Bangladesh was identified as a major hindrance by the participants. The current energy costs and the prices of produce in the market does not allow for fully climate controlled greenhouses to be economically viable in Bangladesh. Thus, a technical analysis of cultivation can be undertaken by Dutch companies and agencies to identify solutions to reducing temperatures in the mid-tech facilities and overcoming other technical challenges faced such as germination, fruit weight etc. a major area of assistance was the aspect of identification of more suitable varieties of seeds to yield higher outputs amidst the summer.

c. **Support expansion of new greenhouses with improved cooling and overall technical capacities for businesses currently in the industry.**

The businesses who have set up in Bangladesh have established themselves to varying degrees. They have not only formed a network amongst themselves but also in the forward market. They have gained adequate knowledge on what crops to cultivate and where and how to sell. The ventures are at different stages of maturity and have adopted different strategies, however there lies huge potential amongst the existing players to expand their market. As such, the Dutch can explore opportunities of providing technical assistance to improve their operations, upgrade technology and facilitate co-investments in the form of expanding their square meters as well as increasing their basket of produce.

*Note: **cost sharing** and **grants mechanisms** may be explored, additionally businesses are also open to **low-cost financing** options as well as **joint ventures**.

3. Agro Businesses – Seed/Input Companies and other Businesses (exporters)

a. Seed companies can be supported through connecting such Dutch businesses in the form of dealerships and/or distributorships for various segments ranging from seed/input (nutrients) dealership to turnkey solution providers.

The study had identified seeds of protected horticulture as one of the major determinants of success for the businesses. Currently the supplies of seeds mostly come in from the Netherlands, Korea and other Asian countries such as Thailand.

Bangladeshi input companies recognize the potential of collaborating with Netherlands based seed companies not only in the realms of protected horticulture but as a portfolio in seed business including onions and Cole crops.

b. Jointly Set-up Demonstration or Proof of Business Case

The embassy through RVO can facilitate tri party agreements where a Bangladeshi Firm (or perhaps a government entity) can potentially partner with Dutch businesses to set up demonstration greenhouses which may act as a center of excellence and proof of concept prior to potential scaling up. These centers can act as hubs for training to human resources, both for the government and private sector, testing out various crop cultivation feasibilities as well as research in seed varietal development. A number of companies have expressed their interest to co-invest in such initiatives.

c. Exporters from Bangladesh face high competition from competing countries in terms of costs. Logistics costs, lack of processing centers, cold chains, lack of Global GAP, traceability are few of the major limiters to growth for Bangladeshi Exports. Discussions informed two potential areas of collaboration namely:

- a) Linking exporters with existing greenhouse-based businesses to arrange for trials of crops to be cultivated and exported. The process can be easily facilitated by RVO and / or the Dutch Embassy in Bangladesh or partners such as DGD. This will require alignment of both the exporters and the business to be clearly chalked out, in the medium-term exporters can also be linked to the centers of excellence (once established and operational). (Upon inquiring with a greenhouse business, they have already expressed keen interest to discuss the potential with exporters.)
- b) A joint venture amongst a few exporters who are willing to set up a greenhouse to produce crops specifically aimed at export markets. This can be facilitated through cost sharing, financing or even low interest-bearing loans facilitated through the RVO representatives or partners such as Rabobank, FMO or even local and non-resident Bangladeshi investors.

4. Low Cost Protected Horticulture Support – albeit not within the purview of the study, discussion with stakeholders indicated that there is clear interest of the government to support the adoption of low-cost technologies and protective agricultural practices at field level with small-holder farmers. RVO may explore this opportunity further and collaborations may include but are not limited to:

- a) Supporting NGOs through projects to promote and disseminate protected horticulture practices.
- b) Integrate protected horticulture practices in existing projects aimed at economic development through agriculture value chains.
- c) Integrate and develop courses in academia for low cost protected horticulture practices.

- d) Support farm cooperatives and farmers' groups to establish low-cost poly or net houses through low-cost financing support through local micro-finance or alternate funding mechanisms.

11 Conclusion

The opportunities identified and the following course stated in the study are a reflection of the discussion with the key informants of the study. In conclusion it can be stated that, while the government policies of Bangladesh are favorable to further catalyzing protected horticulture, their implementation is still in progress. The study revealed that the restricted import of agricultural chemicals needed for hydroponic solutions and high tariff rates on inputs such as polyethylene coverings are hindering the growth and scale of the sector. Therefore, a coordinated effort is necessary to develop and streamline policies and their implementation. Dutch expertise in this area can be crucial in assisting the development of feasible policies and steps to ensure their implementation.

The study also found potential for mostly mid-tech ranged greenhouse opportunities in Bangladesh, with several actors already in play, a few setting up and further interests from reputed agriculture companies and business houses. There however seems to be a divide among the agribusinesses and other businesses, who tend to look at the opportunity from different lenses. The study found that business originating from non-agriculture background has invested in the sub-sector already, whilst businesses based on inputs and outputs of the agriculture sector such as seed, pesticide, agricultural machinery and retailers have not till date invested, which may be because of a low awareness of the potential local business case, the technological solutions for the local conditions and any perceived risks, as there have not been any major first movers as yet. Interviews revealed greater interest from well-established Ready-made garments-based businesses or other business groups. Agribusinesses had a more holistic approach in their views where their interest were in the form of collaboration with Dutch based businesses to supply seed and help in providing turnkey solutions to greenhouses with local supply integration. Our understanding of the situation thus also indicates that the market in Bangladesh is not prepared for high-tech greenhouse solutions (other than for research purposes) as of yet, however the market is likely to mature over time.

It was identified that there is a need for knowledge transfer and technology transfer to increase the efficiency of greenhouses, especially during the summer season; an area where most of the businesses are currently struggling to some degree. The matter of human resource capacities similarly came across as a major issue for the businesses operating in Bangladesh, where support from the Dutch were welcomed.

The findings revealed that the premium market for greenhouse produce is still in its early stage, and businesses supplying such produce can capitalize on this growing demand. Marketing for such businesses is critical, and going forward they aspire to act to supply import substituting products. Most greenhouse businesses also aspire to export their produce in the future, presenting an opportunity for collaboration with exporters, thereby potentially opening untapped markets for Bangladesh.

It was also observed that there are scopes of collaboration between unilateral and multilateral donors (such as USAID and World Bank) who are engaged in supporting Bangladesh in Agriculture in various

forms ranging from technical support and financial assistance to grants. RVO can potentially collaborate with such entities (e.g. JICA) and their projects to help protected horticulture practices to grow, as well as support commercial agriculture through greenhouse-based cultivation e.g., USAID funded Bangladesh Horticulture Activity. RVO and the Embassy are well-placed to assist Bangladesh by connecting Dutch-based businesses to organizations that can help materialize opportunities into realities as listed in the report earlier. Although this is a long-term process, the conducive environment and interest from businesses to engage and pursue collaborations are high. Therefore, RVO can potentially facilitate several activities using the tools and instruments available to them and the opportunities expressed by stakeholders.



Annex 1

RVO instruments for Private Sector Development that can be explored for partnerships.

PSD Toolkit - The PSD Toolkit is a set of instruments available to the Embassy and RVO to develop small projects such as sector studies, small training programmes or for the formation of Public-Private Partnerships.

SDGP facility - The SDGP facility supports Public Private Partnerships that contribute to achieving the SDGs through a grant subsidy. This partnership should have at least one Dutch partner. The instrument is temporarily closed for applications.

Impact Cluster - the Impact Cluster is an RVO tool available for the development of integrated value chain clusters. An Impact Cluster is mutually designed by an Embassy, a consortium of Dutch and local businesses and RVO.

DHI -The demonstration projects, feasibility studies and investment preparation studies (DHI) is a subsidy for SMEs with international ambitions in emerging markets. Dutch companies can apply for subsidy for demonstration projects, feasibility studies or investment preparation projects.

FVO - The Fund for Responsible Business supports Dutch partnerships that wish to address the underlying causes of Responsible Business Conduct risks and misconduct in their value chains and implement measures to address them.

PIB - Partners for International Business (PIB) is a programme that allows Dutch businesses to enter into a public-private partnership to realize their international ambitions. This is primarily focused on matchmaking, networking, and economic diplomacy.

Invest International – currently operates the following programmes

- DGGF - The Dutch Good Growth Fund (DGGF) is set up to help Dutch entrepreneurs realize their international ambitions in emerging markets and developing countries (DGGF countries). The fund supports investment, import, export, and investment funds.
- Develop2Build - Develop2Build (D2B) is a Government-to-Government programme offering governments in 37 developing countries and emerging markets direct assistance in setting up infrastructural projects.
- DRIVE- DRIVE facilitates investments in infrastructural projects that contribute towards a good business climate and entrepreneurship in the priority sectors: water, climate, food security, and sexual and reproductive health and rights (SRHR). Public infrastructure projects that have a high development relevance in other sectors also can apply for DRIVE support.

SIB vouchers - SIB vouchers can be used by Dutch businesses, to hire a consultant for market studies, participate in a trade mission or to hire an international lawyer.

PUM - PUM is a volunteer organization of Dutch experts supporting businesses worldwide. 180 PUM representatives are spread over 35 countries across the globe, with 1700 experts being active in 45 sectors.

NUFFIC OKP - The Knowledge Programme offers scholarships, training and institutional partnerships between education institutions in Technical and Vocational Education and Training (TVET) and higher education, in fields related to the priority themes of the Dutch government: • Food and nutrition security • Water, energy and climate • Sexual and reproductive health and rights • Security and the rule of law This is implemented through a number of calls, published on the website of NUFFIC.

YEP Program - The Young Expert Programme allows young experts, both Dutch and local, in the Agro&Food sector to gain experience in an intercultural environment and work on a specific project related to either Water, Agrofood and/or Renewable Energy. Up to 50% of the salary of this young expert is subsidized by the Dutch Ministry of Foreign Affairs.

Atradius Dutch State Business offers a wide range of insurance and guarantee products for Dutch exporters of capital goods, their financiers and/or investors. It also assists in finding other funding through the Dutch Good Growth Fund.

FMO - FMO is the Dutch entrepreneurial development bank. FMO manages funds for the Ministries of Foreign Affairs and Economic Affairs of the Dutch government to maximize the development impact of private sector investments.

Invest International – Impact investment fund of the Dutch government that seeks to support Dutch solutions for global challenges. To achieve the UN SDGs Invest International explores and facilitates tailored project development and investment arrangements that allow new business opportunities to arise.

Annex 2

This section briefly describes the observation at the low-tech segment of the protected horticulture scenario in Bangladesh, albeit this was not a part of the study's core objectives. This is aimed at providing a context of the low-tech protected horticulture context

Low Tech Protected Horticulture

Low technology based protected horticulture in Bangladesh includes the use of net and poly shades to provide a protective barrier to natural aspects such as high rainfall and protection against insects and pests. This also includes traditional practices of natural protection on adoption such as floating gardens.

This is evident in the widespread adoption of the floating gardens concept of agriculture, a form of traditional hydroponics gardening system²², mostly in the Southern regions of Bangladesh, namely in Barisal Division. Albeit this type of technology is not part of the study but the presence and promotion of the technology has been able to create opportunities for farmers to ensure economic gains.

Poly house is an economic option that has also seen high acceptability at farm level as evidenced in [Jhikorgachha](#)

[Upazila](#), of Jashore District **Bangladesh Agricultural**

Development Corporation - BADC has taken up BDT 70.6 million Drip Irrigation project to cultivate flowers and vegetables. Similarly the research and government support in this sector has been gaining traction where we have seen investments in the form of [Wheat research](#), [Dragon Fruit farming](#), [Cumilla Agricultural Research Centre \(CARC\)](#), in greenhouses.



Figure 12 Net covering at field level



Figure 13 Net structure at field level

There are significant efforts by the Department of Agriculture Extension (DAE) and Non-Government Organizations to support and promote net/poly based protective cultivation practices at field level. Due to such efforts there are several poly shades and net shades that has sprouted up across Bangladesh, as farmers also realize the effects of climate change and high pest infestations. Consultations revealed that in Jashore, Rajshahi, Bogura regions, the adoption rate at farm level has been high for flowers as the produce yields greater profit margins.

²² <https://www.bbc.com/future/article/20200910-the-remarkable-floating-gardens-of-bangladesh#:~:text=Floating%20gardens%20are%20most%20common,into%20shape%20and%20making%20rafts.>

Discussion with flower producers identified that the flower market requires different types of support, especially in varietal development along the lines of improved shelf life, longer stems, higher productivity etc. The opportunities in the floriculture segment thus were broadly along the lines of **technology and knowledge sharing, varietal development or souring of improved varieties, perseveration technique and exploring of potential export markets.**

The aspect of improved practices and know-how also crosses over to vegetables produced in shades as well. Vegetable farmers and nurseries were found to enjoy greater yields due to controlled environment specially from the benefits of fending off pests and reducing physical damage of crops during cultivation process. Crops found to be cultivated under sheds are brinjal, tomatoes, cabbage, cauliflower, etc. or simply crops that are prone to pest infestations. The usage of protective practices also allows for nurseries to be able to produce saplings that are healthier, which can be used as early crops in the field. This allows farmers buying such saplings to benefit from the higher prices of early production and safeguard themselves from the lower prices in the middle of the season.

Consultations with different stakeholders identified that there are several opportunities here for technologies and practices to be disseminated for the overall development of the protective practices by farmers. Our study found that the cost of setting up **net house-based nurseries with 300 trays (approx. 1000 sqft) is approx. BDT 1 lac or 900 euros.** These net houses were used for growing seedlings of different fruits and vegetables. The cost for setting up Poly covering based houses at this level were also found to be similar ranging from **500 Euros to 1000 Euros** at field level. Similarly, farmers were found to enjoy higher productivity of 10-20% due to better protection, which translates into higher incomes and reduced food waste.

Interestingly, the study also found that there is a small yet growing service market for building materials and equipment (such as nets and polys) who help farmers set up protective sheds. These nets and polys are generally sourced from China and India, building materials such as steel, bamboos etc. are locally sourced. It was also observed that farmers also use different materials such as bamboo to reduce the costs of construction and have localized some of the requirements. Discussion with the farmers revealed that the products used (poly covers and nets) are of satisfactory quality, costing was also generally found to be market oriented where different price points with different quality is available in the market.

Annex 3 Incentive Summaries

Government of Bangladesh provides various fiscal and non-fiscal incentives, privileges and facilities comprising of exemptions/reduction of corporate income taxes, reduced import taxes on capital machineries and raw materials, reduced VAT, provision of export subsidies and various other banking facilities and privileges. These incentives are subject to revision upon annually enacted Finance Act and individual Statutory Regulatory Orders (SROs).

Investing in agriculture in Bangladesh can be a profitable venture for several reasons. To facilitate and encourage investment,

Under Income Tax Ordinance 1984, section 46BB, newly established firms between July 1, 2019 and June 30, 2024 belonging to the following sectors are eligible for reduced income taxes.

- Agriculture machineries
- Bio-fertilizer
- Biotechnology based agro products
- Insecticides or pesticides
- Locally produced fruits and vegetables processing

The business belonging to the above sub sectors can enjoy tax exemption on a varied rate and reduced tax for various periods depending on the location of the operation.

Types of Tax Exemption

Five-year tax exemption is offered to businesses located in Dhaka Division and Chattogram Division, but excluding the districts of Dhaka, Narayanganj, Gazipur, Chattogram, Rangamati, Bandarban and Khagrachari districts, the period of tax exemption is for five years, which will begin in the month of commencement of commercial production at the following rate.

Period of Exemption	Rate of Exemption
• For the first year	• 90% of income
• For the second year	• 80% of income
• For the third year	• 60% of income
• For the fourth year	• 40% of income
• For the fifth year	• 20% of income

- **Ten-year tax exemption** is offered to businesses located in Rajshahi Division, Khulna Division, Sylhet Division and Barisal Division, but excluding areas under the city corporations. Businesses that set up in the districts of Rangamati, Bandarban and Khagrachari also enjoy this tax holiday period.

Period of Exemption	Rate of Exemption
For the first and second year	90% of income
For the third year	80% of income
For the fourth year	70% of income

Period of Exemption	Rate of Exemption
For the fifth year	60% of income
For the six year	50% of income
For the seventh year	40% of income
For the eighth year	30% of income
For the ninth year	20% of income
For the tenth year	10% of income

Conditions: To enjoy tax exemption or benefits, i) register investments with BIDA, ii) apply to National Board of Revenue (NBR), and iii) receive a certificate from NBR within 45 days of the application.

Others benefits extended are as follows:

Import duty exemption.

- Capital machineries are subject to reduced rate from customs duties

Accelerated depreciation:

The accelerated depreciation method for accounting income taxes can be *availed for machinery and plants (if not enjoying reduced taxes).*

Tariff refund or duty drawback facility

- Tariff (if paid) refund on import of raw materials for export and plants used by an entity that does not enjoy tax exemption.

Bonded warehousing facilities

- For large import for local selling in certain items

Public-Private Partnership (PPP) Projects enjoy additional benefits the following incentives and facilities are provided for certain Public Private Partnership (PPP) projects.

- The business income is 100% exempted from income tax for the next 10 years from the date of commercial operation
- The capital gains from transfer of share capitals, royalty, technical know-how and technical assistance fee paid by such companies are 100% exempted from Income tax for the next 10 years from the date of commercial operation.
- Income Tax exemption for foreign technicians employed in PPP Project Company: The foreign technicians appointed in PPP Project Company will get 50% tax exemption for next 3 years from the date of appointment subject to such company does not cross 5 years from the date of commercial operation i.e. the company who has crossed 5 years from the date of commercial production, their foreign technicians can not avail this benefit.

Special Incentives for foreign investors are as follows:

- The Foreign Private Investment (Promotion & Protection) Act 1980 protects foreign investment from nationalization and expropriation;
- Equal treatment of both local and foreign investment;
- There are no restrictions on issuing of work permits for foreign nationals and employees related to projects;
- Provision of transfer of shares held by foreign shareholders to local investors;
- Royalty, franchise, technical know-how and technical assistance fees can be remitted;
- Repatriation of invested capital, profit and dividend: Full repatriation is allowed for capital invested from foreign sources. Similarly, profits and dividend accruing to foreign investment can be transferred in full. Facilities are provided for repatriation of invested capital, profits and dividends.
- 100% FDI, Joint Ventures, Partnerships, PPPs, Non-equity mode (technology transfer, licensing franchising, contracting etc.), and Foreign Lending are allowed;
- 100% FDI or Joint Venture FDIs are allowed to participate in the primary and secondary stock markets;
- Foreign Investors are allowed to have access to local banks for working capital requirements;
- Intellectual Property Right is protected by law.
- Bilateral and multilateral investment agreements ensure protection of investment.

Incentives for Agri Exporter based exporters are:

- 50% tax exemption for income derived from export.
- No VAT imposition on export goods.
- 20% export subsidy/ cash incentive for exporters of locally processed agricultural products and 100% halal meats.
- Duty-free market access (preferential treatment) to 52 nations.

Annex 4: Calculation For Costing and Revenues

Cultivation practice followed : Businesses rarely utilize their full greenhouse space for 1 crop, there is usually a mix of crops such as capsicum, cucumber, and tomatoes. To ensure comparability we are extrapolating the data to utilize a full 22,000 sqft greenhouse

*Exchange rate used Euro 1 to BDT 115

Cost of Production: Cherry Tomatoes Winter	A		B		C	
	Euro	BDT	Euro	BDT	Euro	BDT
Number of Plants	6,200		5,000		6,000	
Area covered of the Greenhouse (standard size)	22000		22000		22000	
Average Yield per plant in Kgs	8		6		7	
Production Volume in Kgs	49600		30000		42000	
Salaries * (distributed across the sqft of greenhouse area of the business)	€ 4,685	BDT 538,776	€ 3,478	€ 400,000	€ 6,522	€ 750,000
Seed	€ 313	BDT 36,000	€ 304	€ 35,000	€ 313	€ 36,000
Nutrients (cost for the production cycle)	€ 4,448	BDT 511,500	€ 5,217	€ 600,000	€ 5,217	€ 600,000
Energy costs for production cycle	€ 1,565	BDT 180,000	€ 2,087	€ 240,000	€ 4,174	€ 480,000
Transport (for production cycle)	€ 609	BDT 70,000	€ 1,739	€ 200,000	€ 609	€ 70,000
Packaging (for the production cycle)	€ 248	BDT 28,520	€ 150	€ 17,250	€ 210	€ 24,150
Others	€ 180	BDT 20,700	€ 300	€ 34,500	€ 360	€ 41,400
Total Production Cost	€ 12,048	€ 1,385,496	€ 13,276	€ 1,526,750	€ 17,405	€ 2,001,550
Per Kg Production Cost	€ 0.24	€ 27.93	€ 0.44	€ 50.89	€ 0.41	€ 47.66
Sale Price per Kg	€ 3.04	€ 350.00	€ 2.61	€ 300.00	€ 3.04	€ 350.00
Total Revenue	€ 150,957	BDT 17,360,000	€ 78,261	€ 9,000,000	€ 127,826	€ 14,700,000
Gross Profit from Cycle	€ 138,909	BDT 15,974,504	€ 64,985	€ 7,473,250	€ 110,421	€ 12,698,450
Cost of Production: Cherry Tomatoes Summer						
	A		B		C	
	Euro	BDT	Euro	BDT	Euro	BDT
Number of Plants	6,200		5,000		6,000	
Area covered of the Greenhouse	22000		22000		22000	

Average Yield per plant in Kgs	4		3.5		3.5	
Production Volume in Kgs	24800		17500		21000	
Salaries * (distributed across the sqft of greenhouse area of the business)	4685	538776	3478	400000	6,522	750000
Seed	313	36000	304	35000	313	36000
Nutrients (cost for the production cycle)	€ 4,448	BDT 511,500	€ 5,217	€ 600,000	€ 5,217	€ 600,000
Energy costs for production cycle	€ 1,565	BDT 180,000	€ 2,087	€ 240,000	€ 4,174	€ 480,000
Transport (for production cycle)	€ 609	BDT 70,000	€ 1,739	€ 200,000	€ 609	€ 70,000
Packaging (for the production cycle)	€ 124	BDT 14,260	€ 88	€ 10,063	€ 105	€ 12,075
Others	€ 180	BDT 20,700	€ 300	€ 34,500	€ 360	€ 41,400
Total Production Cost	11924		13214		17300	1989475
Per Kg Production Cost	0.48		0.76	87	0.82	95
Sale Price per Kg	3.91	450	3.48	400	3.91	450
Total Revenue	97,043	11160000	60,870	7000000	82,174	9450000
Gross Profit	85,120	9788764	47,656	5480438	64,874	7460525
Profit/Loss from Cherry Tomato Production per year in Euros		A		B		C
Gross Profit Winter	138,909	15,974,504	64,985	7,473,250	110,421	12,698,450
Gross Profit Summer	85,120	9,788,764	47,656	5,480,438	64,874	7,460,525
Total Yearly Profit	224,028	25,763,269	112,641	12,953,688	175,295	20,158,975

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