Ministry of Foreign Affairs

Horticulture study Bangladesh

Commissioned by the Netherlands Enterprise Agency

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Ministry of Economic Affairs and Climate Policy

HORTICULTURE STUDY BANGLADESH

FINAL REPORT

OCTOBER 2021

COMMISSIONED BY: NETHERLANDS ENTERPRISE AGENCY

REF NO: # 202011095 / PST20BD02

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Contents

List of Figures

List of Tables

List of Annexes

Abbreviations

ADB	Asian Development Bank
BADC	Bangladesh Agricultural Development Cooperation
BAPA	Bangladesh Agro-processing Association
BARI	Bangladesh Agriculture Research Institute
BAU	Bangladesh Agriculture University
BBS	Bangladesh Bureau of Statistics
BDT	Bangladeshi Taka
BSA	Bangladesh Seed Association
BSST	Bangladesh Society of Seed Technology
B2B	Business to Business
CS	Certified seed
DAE	Department of Agricultural Extension
DGGF	Dutch Good Growth Fund
EKN	Embassy of the Kingdom of the Netherlands
EPB	Export Promotion Bureau
EU	European Union
FAO	Food and Agriculture Organisation
FMO	Entrepreneurial Development Bank
FS	Foundation seed
F1	First generation (seed)
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
G2G	Government to Government
K2K	Knowledge to Knowledge
LDC	Least Developed Country
LMIC	Lower Middle-Income Country
MACS	Multi Annual Country Strategy
MPDI	Multidisciplinary Digital Publishing Institute
MSV	Mobile Street Vendor
NAK	Nederlandse Algemene Keuringsdienst (Netherlands Inspection Service)
Naktuinbouw	Netherlands Inspection Service for Horticulture
NFP	Netherlands Food Partnership
NPK	Nitrogen – Phosphorus – Potassium fertiliser
NPPO	National Plant Protection Organisation
NVWA	Nederlandse Voedsel en Warenautoriteit (Netherlands Food and Consumer Product Safety Authority)
OP(V)	Open Pollinated (Varieties)
PSD	Private Sector Development
PVP	Plant Variety Protection
RVO	Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency)
R&D	Research and Development
SDG	Sustainable Development Goals
SDGP	Sustainable Development Goals Partnerships
UMIC	Upper Middle-Income Country
UPOV	International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WE4F	Water and Energy for Food
WUR	Wageningen University and Research Centre

1. Executive Summary

The gross domestic product (GDP) of **Bangladesh** grew strongly over the last two decades, increasing five-fold, from USD 53 billion in 2000 to USD 303 billion in 2019. With a population of 167 million, the country has reached a GDP per capita of USD 1,900 in 2020 and is on the path to graduation from the category of Least Developed Countries (LDCs) by 2026. Also, Bangladesh has made substantial progress with Sustainable Development Goals (SDGs) in terms of poverty reduction, education and health.

At the same time, urbanisation and industrialisation trends have accelerated, with 38% of the population currently earning their income from agriculture, down from 65% in 2000. It is projected that by 2040, the majority of Bangladesh's population (100 million people) will live in cities. As Bangladesh is seriously affected by climate change, occurrence of salinisation and unpredictable weather patterns negatively impact farming and food production. These two trends - **urbanisation and climate-related challenges** – create a new and complex situation: available agricultural land declines while the demand for more, and more nutritious food, is increasing.

The Netherlands and Bangladesh have a long relationship, which is currently transitioning from 'aid to trade', anticipating on Bangladesh's planned graduation from the LDC group of countries. The focus of the bilateral cooperation in the period 2018 to 2022 is primarily on integrated water management, agriculture, private sector development and gender. Given the ample **Dutch expertise and technology in horticulture**, Dutch actors are well positioned to play a key role in addressing the challenges of the Bangladeshi horticultural sector while positioning themselves as partners for the local stakeholders.

In Bangladesh, **horticultural farming** represents 7% of total crop production and 4% of total farming area. Paddy rice is still by far the largest crop grown in the country, both in terms of production volume (48%) and land use (75%). Bangladesh produces over 150 vegetable crops, with onion, garlic, tomato, brinjal, cabbage, cauliflower, gourds and chillies the most important ones. In total, over 6.5 million tons of vegetables are produced annually, including 1.9 million tons of summer vegetables, 2.5 million tons of winter vegetables, 1.8 million tons of onion and 466 thousand tons of garlic.

The total value of **imported vegetables** in 2019 was USD 203 million. Most important imported vegetables are onion (USD 96 million), garlic (USD 75 million) and tomato (USD 13 million). The total value of **vegetable exports** was USD 141 million in that year. Biggest export markets are countries in the Middle East, United Kingdom and Italy. Exports are mainly destined for the large Bangladeshi diaspora. There is, however, a growing interest among local horticultural producers to address export markets with products such as mango, tomato, brinjal and pepper and processed fruit and vegetable products.

Main **challenges** of the horticultural sector are:

- Limited availability of quality seeds of improved varieties (OP and hybrid), and a substantial counterfeit market (seed retailers offering expired seeds, fake seeds, etc.).
- High costs of nutrients, as micronutrients are not produced locally and enjoy no tax benefits.
- Limited access to, and uptake of, quality seeds and other inputs by horticultural farmers.
- Climate change risks (floods, droughts, salinisation).
- High postharvest losses due to poor postharvest treatment and transport, inadequate storage, lack of cold storage and poor market infrastructure.
- Price volatility.
- Lack of technical knowledge and low level of mechanisation.
- Lack of business models for service provision to address postharvest challenges (storage, transport, markets etc.).

- Limited availability of affordable finance and lack of agricultural insurance.
- Limited high-end market (most consumers are price sensitive, rather than quality conscious).

Several **opportunities** for collaboration of the Netherlands and Bangladeshi (private and public) actors have been identified for the horticultural sector. It is important to note that there is a growing interest among agri-businesses to scale, improve, modernise and add value to locally grown horticultural products. As the growing urban population drives the demand for quality, nutritious food, some of the leading **agri-businesses** have started responding to this trend and investing in various parts of the value chain, including improved seeds, protected horticulture, post-harvest infrastructure and services.

In the **vegetable seed** sub-sector, quality, certified seeds have gained ground, creating opportunities to introduce new and improved varieties of known crops, but also the seeds of new, currently less customary crops. Demand for vegetable seeds is projected to reach 4,500 tons by 2024. In this sub-sector, several collaboration opportunities have been identified:

- Representation: Some of the Bangladeshi seed companies are interested to represent Dutch seed companies and sell their seeds through their market channels. Interested companies in Bangladesh indicate that variety demonstrations and organisation of field days will be important to kick-start sales and build a loyal customer base.
- Joint projects or ventures: variety trials, seed production and distribution, saline-and drought-tolerant varieties, seed preservation technology. Given the strong interest of Bangladeshi seed companies, several partnerships and / or clusters can be developed in this area, utilising various Dutch and global supporting programmes.

Given the fact that **greenhouse farming** is both a means to extend the production season and utilise out-of-season advantages, and an effective solution for adaptation to climate change, particularly in saline-affected areas, potential for greenhouse farming has been established and the government is encouraging investments in the protected farming facilities and technology. Larger commercial companies are also interested to establish greenhouse farming; however, given the current level of vegetable prices in Bangladesh, high-tech greenhouse technology is economically challenging. Therefore, low- and mid-level greenhouse technology might be more suitable, especially during the monsoon season. For nurseries, solutions such as substrate and seeding machines can be introduced. These opportunities can be facilitated through impact clusters or other supporting programmes.

Post-harvest services, such as collection, aggregation, storage, sorting and grading are limited. While substantial increases in horticultural productivity have been noted at farm level in the past decade, post-harvest losses have remained high (35-45%). Supermarkets, retail chains and other high-end users (hotels, restaurants) are expected to drive the development of controlled supply chains including cold chains and certification. Interest to invest in post-harvest technologies has also been noted at some of the sector leaders that have the financial and technical capacity to adopt new technological solutions.

In onion (seed, production, post-harvest technology), an Impact Cluster could be formed. Onion is the largest vegetable crop of Bangladesh with a total area of more than 170,000 hectare. Importantly, Bangladesh is not yet self-sufficient in onion and there are sizable imports of onion year-on-year. Also, onion yields are still low at around 10.5 t/ha (compared to 17.0 t/ha in India). So, there is a clear need for improved varieties and technologies that can bridge the yield gap. On the Dutch side, a consortium of companies at all stages of onion production (seed, crop protection, and good agricultural practices) and post-harvest handling could assist in this, creating opportunities for trade and joint investments.

Horticultural farming systems (seed, farmer training, access to inputs). Given the dominance of smallholder farming in Bangladesh and the specific challenges of such production systems, Bangladeshi public and knowledge stakeholders are interested in collaboration with Dutch counterparts and in public-private partnerships. SDGP could be a suitable instrument to introduce novel solutions and models for inclusive, climate-resilient, sustainable horticultural production systems.

Water and horticulture (building on the Delta plan, addressing salinity, water management). There is ample space to develop larger scale public-private interventions. Integration of water management and horticultural farming might be one of the possible topics. Circular horticultural chains could be another.

Key recommendations for development of the institutional framework for the horticultural sector are:

- Development of a research agenda for climate change adaptation. More research and development is needed in this area and both Bangladesh Agriculture University and Bangladesh Agriculture Research Institute (the Horticulture Research Centre) can play a role in testing low-cost technologies like rain shelters, agricultural fleece and salt tolerant varieties. Together with the Department of Agricultural Extension (at district level) and the private sector, innovations can be demonstrated and out-scaled to farmers. The Horticultural Wing of the Ministry could play a coordinating role for developing the research agenda. K2K instruments (RVO and Nuffic) can be explored to facilitate such cooperation.

- Supporting the government to implement a sound phytosanitary system. Looking at the ever stricter phytosanitary standards in the European Union and the increase in exports of Asian vegetables, Bangladesh's Plant Quarantine Wing needs to further professionalize its services. This includes both the inspection capacity (to detect harmful organism in export shipments) and the efficiency in issuing the right certificates.

- Supporting the government to develop a system for Plant Variety Protection (and potentially become a member of UPOV). The Netherlands has large experience in supporting different countries in becoming UPOV-ready. The Dutch Ministry of Agriculture has already for a number of years established a PVP Toolbox that can act on requests of Embassies to support PVP activities. In the case of Bangladesh support for drafting the PVP Regulations and subsequently building the capacity of the PVP Office were mentioned as key priorities.

- Introduction of a local standard of Good Agricultural Practices. In a number of Asian and African countries a local (simplified) standard for Good Agricultural Practices has been developed. The standard (that comes with a label) informs consumers that the fruits and vegetable are of high quality and are safe. Often the initiative of a local GAP standard lies with the industry, in particular larger supermarkets and wholesalers. Government organisations like the Horticulture Wing of the Ministry can play a supporting role.

- Development of a market information system for vegetable prices. As the Department of Agricultural Marketing is collecting price data on a daily basis, the dissemination of these data to farmers could be further improved.

- Development of a Horticulture Strategy or Road Map. The above recommendations could be integrated into a more comprehensive Horticulture Strategy or Road Map. Given the specific position of the horticulture sector, its particular role in exports, health and nutrition attributes, fruit and vegetables' perishable nature and the concern for food safety issues, a dedicated strategy or road map is worth considering. If taken on board, it is recommended to design a multistakeholder process (with a number of reiterative steps) with the sector to make such a document.

2. Introduction

2.1. Study background and objectives

The Netherlands is a long-standing partner of Bangladesh. Key areas of co-operation have been water management, water supply and sanitation (WASH), sexual and reproductive health and rights (SRHR) and gender, food security and nutrition, sustainable value chains and human rights. Due to the strong economic growth and substantial progress in achieving the development objectives, Bangladesh has recently become a Lower Middle-Income Country (LIMC), on the way to graduate from the category of Least Developed Countries by 2026.

In the light of these developments, the Netherlands relationship with Bangladesh has evolved, shifting from aid to trade. In the coming years, a broader bilateral relationship will be developed, with increased focus on economic relations (trade and investment), international co-operation, knowledge partnership and policy dialogue at government level.

Agriculture, and horticulture in particular, is one of the sectors of mutual interest for both countries. Therefore, the Netherlands Embassy in Dhaka is interested to explore **cooperation opportunities in horticulture** for both local and Dutch companies and other stakeholders. Specific areas of interest are:

- The private seed sector; in line with the Dutch dominance in vegetable breeding and related services like seed coating and the production of seedlings.
- Post-harvest management; focusing on reducing losses and increasing shelf-life (e.g. through agro-processing and cold storage facilities).
- Protected horticulture (greenhouses and greenhouse technologies).
- Sustainable production practices and increasing nutrient use efficiency.
- Food safety, phytosanitary issues and plant breeders' rights; also looking at the leading position of the Dutch NVWA and Naktuinbouw, as well as knowledge institutes like Wageningen UR.

In December 2020, a consortium of Advance Consulting, Resilience and Edge Consulting was commissioned by the Netherlands Enterprise Agency to implement a comprehensive study of the horticulture sector in Bangladesh, zooming in on specific opportunities for Dutch companies and knowledge institutes.

Key **objectives of the study** are:

- Providing a sector overview of the main dynamics and issues that govern the horticulture sector;
- Conducting an in-depth analysis of a number of horticultural value chains (informal, formal – domestic and formal – export-oriented);
- Providing recommendations on business opportunities for Dutch companies and knowledge institutes to strengthen the Bangladeshi horticultural sector;
- Assessing how Dutch PSD instruments can be utilized to trigger Dutch investments by Dutch companies and knowledge institutes.

2.2. Study approach and methodological framework

The **selected approach** for this assignment builds on a framework that was developed in 2017: 'Agricultural sector development: Guidelines for aid & trade support in Dutch PSD partner countries'[1]. The document provides tools for operationalisation of the agenda for Dutch priority sectors in developing countries and emerging markets, including in-depth analysis of the sector's competitiveness and inclusive growth potential.

For the purpose of this study we have modified the agricultural sector guidelines into a methodological framework that incorporates the aspects highlighted in the Terms of Reference (PST20BD02), including the activity steps (desk study, mission, analysis, reporting and dissemination), taking into account specific Covid-19 restrictions.

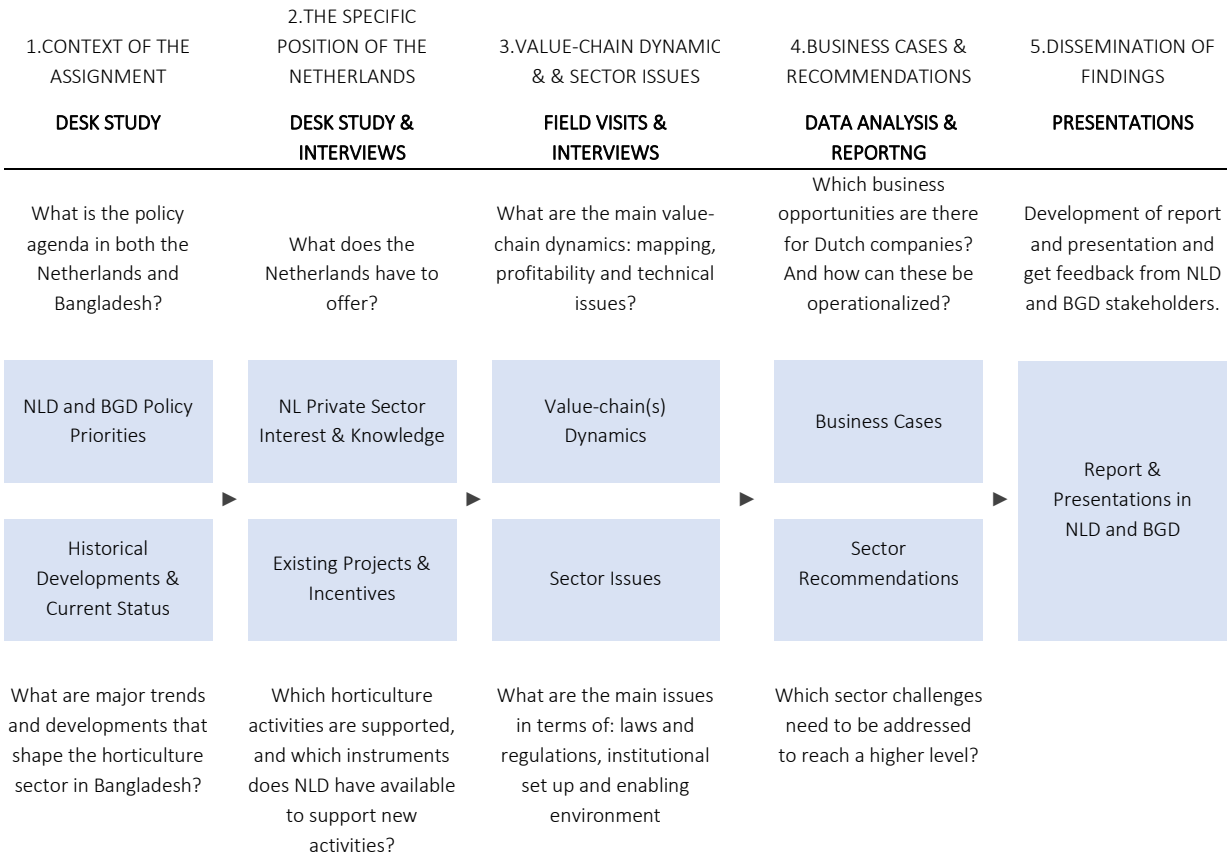

Figure 1: Methodological framework for the Bangladesh horticulture sector study

The above framework shows the five steps and analytical tools we have utilized for this study. Based on the discussions with RVO and the Netherlands Embassy in Dhaka, the activities of the study aimed at: a) delivering a comprehensive and actionable report about the Bangladeshi horticultural sector, its challenges and opportunities, and b) identifying interested parties and collaboration models to promote and establish new trade and investment relations, and (technology, knowledge) partnerships. Sub-sectors of particular interest are seeds, protected horticulture and post-harvest technologies.

[1] Westenbrink G, G Beers, F Joosten, Y Dijkxhoorn, J van den Broek, J van der Lee, N de Groot (2017); Agricultural Sector Development. Guidelines for Aid & Trade Support in Dutch PSD-partner countries. MinLNV.

2.3. The Netherlands and Bangladesh – cooperation and priorities

The Netherlands and Bangladesh have a long relationship, which is currently transitioning from 'aid to trade', anticipating on Bangladesh's graduation to an Upper Middle-Income Country (UMIC) by 2024. The focus of the bilateral cooperation in the period 2018 to 2022 is primarily on **integrated water management and agriculture, private sector development and gender**. The agricultural programme focuses on value chain development to increase productivity and income of smallholder farmers, on mobilisation of private sector participation and on improving the food system as a whole. In the context of climate change adaptation, agriculture is addressed as a part of the integrated water management programme. More detailed information about the relevant Dutch and Bangladesh policies can be found in Annex B.

Under the Multi Annual Country Strategy (MACS) 2018-2022[2], which provides the framework for the transition from aid to trade in the bilateral relations, the Embassy of the Kingdom of the Netherlands (EKN) in Dhaka intends to deepen its support to food security and economic cooperation activities. To this end, a series of market studies of the agricultural sector has been commissioned, among which this study of the horticultural sub-sector.

Given the ample **Dutch expertise and technology in horticulture**, Dutch actors are well positioned to play a substantial role in addressing the challenges of the Bangladeshi horticultural sector while positioning themselves as partners for the local stakeholders. Bangladeshi horticulture copes with various challenges such as implementation and enforcement of regulations, food safety, weak infrastructure, impact of climate change, and development of environmentally and socially sustainable strategies for the smallholder-based sector with the view of increasing farmer income and food security.

Building on the long bilateral cooperation between the two countries, there are opportunities for Dutch private, public and knowledge stakeholders to offer effective support and advice to their Bangladeshi counterparts. Cooperation on the nexus of water and agriculture presents good possibilities to utilise Dutch expertise in both areas. For the private sector, there are opportunities in the sub-sectors of **seed, protected horticulture and post-harvest technology.** In terms of crops, an initial assessment has showed that onion, tomato, cabbage (brassicas), radish and brinjal have high potential for developing mutual cooperation. Up to now, however, Bangladesh has not been on the radar of Dutch horticulture companies; hence, their awareness of business opportunities in Bangladesh is limited. In the last few years, however, several companies started exploring the market, in particular those involved in sales of agricultural inputs.

A range of **instruments** (Annex D) is available for interested Dutch companies and other stakeholders to develop their activities in Bangladesh. Some of them can offer financial and technical support to individual companies but there is also potential to develop a cluster of companies and coordinated market development in Bangladesh.

[2] Ministry of Foreign Trade and Development Cooperation (BHOS) (2019), Multi-annual Country Strategy Bangladesh

2.4. Key stakeholders in the Netherlands

Private sector stakeholders

Seed sector

In the 2017 Enabling Business for Agriculture report[3], the Netherlands ranks no. 1 for 'Seeds' according to the World Bank, based on both the quality of its laws and regulations as well as its implementation capacity. This applies to both the variety registration services and quality assurance systems, which are supported by organisations like Naktuinbouw, NAK and NVWA in collaboration with Ministry of Agriculture. The horticultural sector contributes 2.7% to the Netherlands GDP, earning over Euro 21 billion in revenue as per 2019.

In 2019, an assessment[4] was done of the challenges and needs of the Dutch seed sector with regard to export. Key challenges mentioned were:

- Bottlenecks in relation to variety registration, i.e. the procedures as well as requests for parent materials for registration/testing;
- Problems with seed import (shipments of samples/small seed lots for testing; import during registration/certification);
- Illegal propagation (practices not clearly defined; penalties insufficient);
- Lack of seed regulatory procedures, time-consuming procedures and high level of uncertainty; this includes lack of PVP (Plant Variety Protection), resulting in rules and demands quality, phytosanitary, labelling that are not in line with the objective of seed import. Even if the regulations are clear, the implementation practice is often not in accordance with the regulations.

Consultations held with Plantum's international committee in the frame of this assessment revealed that there is limited knowledge among Dutch seed companies of the Bangladeshi horticultural sector and its demand for seed, rendering low interest to invest in business development in Bangladesh. At the time of the consultations, priority countries of the Dutch seed sector were India, Indonesia, China, Ethiopia and Nigeria. Bangladesh is currently also not on the priority list of the Top sector Horticulture and Planting Materials.

In addition to seed companies, key stakeholders in this sub-segment, representing the sector, are Seed NL and the Top sector Horticulture and Planting Materials.

Protected horticulture

Dutch greenhouse technology and growing systems are globally renown, generating 80% of its revenue abroad, compared to 20% in the Netherlands[5]. In 2019, export of agricultural machinery, greenhouse materials and machinery used in the foodstuffs sector grew with 8% to a value of Euro 9.9 billion[6]. It is due to research and innovation in protected horticulture that Dutch farmers have reduced dependence on water for key crops by as much as 90% while eliminating the use of chemical pesticides in greenhouses.[7]

[3] The World Bank (2017), Enabling the Business of Agriculture 2017, Country Profile The Netherlands
[4] WUR / Resilience (2020), Scoping Study for a Seed Laws Toolbox
[5] Wageningen Economic Research and Statistics Netherlands (CBS) (2020), Study Dutch Agricultural Exports
[6] idem
[7] https://dutchreview.com/news/innovation/second-largest-agriculture-exporter/

Key export markets of the greenhouse sector are still Europe (70% of the total exports), followed by Russia, China, Central and North America. Many Dutch companies start generating export income in Western Europe before venturing to other regions and continents.[8] Dutch expertise and technology in protected agriculture holds large potential to solve global challenges in the area of sustainable food production. However, commercial uptake of high-tech greenhouse solutions in low-income countries with predominantly smallholder-based systems has been limited. As the demand for horticultural crops in these countries is growing, some of the Dutch companies have started developing hybrid low/mid-tech solutions, sometimes in collaboration with local partners.

Main Dutch stakeholders in this segment representing the sector are Top sector Horticulture and Planting Materials, AVAG (Greenhouse Technology Centre), Dutch Greenhouse Delta and companies involved in development and construction of greenhouses and related technologies (e.g. climate control, water management, biological pest control).

Post-harvest technology and solutions

The Netherlands can offer a wide range of post-harvest products, technologies and IT solutions for agriculture and horticulture in particular. As there is a wide infrastructure gap for handling perishable produce in Bangladesh, there is opportunity for Dutch suppliers of material handling machinery and equipment, (cold) storage, primary value addition (sorting and grading solutions), packaging and IT-enabled solutions that support tracking, tracing and quality management throughout the logistics process.

Key stakeholders in this segment are private sector providers of cold storage, storage, sorting, grading and packaging solutions. Some of these companies are also represented at Top sector Horticulture and Planting Materials.

Public sector

Naktuinbouw (the Netherlands Inspection Service for Horticulture) is the Dutch designated body, regulated by the Ministry of Economic Affairs, that promotes and monitors the quality of products, processes and production chains in the horticulture sector. Its key tasks are inspections, laboratory testing and variety registration. Through various G2G, PVP (Plant Variety Protection) Toolkit and other projects, Naktuinbouw supports peer organisations globally to establish and improve their structures, focusing on the UPOV model (International Union for the Protection of New Varieties of Plants). The organisation has not yet been involved in Bangladesh but has the capacity and the experience to support the Bangladeshi counterparts to enhance its service delivery.

NVWA (Netherlands Food and Consumer Product Safety Authority) has not yet worked in Bangladesh but was requested by the Embassy of Bangladesh in the Netherlands to provide an insight into the organisation of the food safety regulations and inspections in the Netherlands. Following a presentation given by NVWA to a Bangladesh delegation in The Hague, there was a clear interest from the Bangladeshi side to continue the communication and obtain Dutch advice. However, up to now, no concrete follow-up was given to this initiative. In addition to food safety issues, NVWA can play a role in supporting its Bangladeshi counterparts with organisation of phytosanitary control services.

[8] WUR/LEI report for AVAG (2013), Greenhouse technology suppliers conquer the world

Knowledge sector

Wageningen UR (Wageningen University and Research) has been active in Bangladesh for many years, supporting a range of programmes and projects, and delivering studies and reports on various topics, among which horticulture. Bangladesh is one of its focus countries. WUR has worked in partnership with several local universities and has a local representative in the country. Together with several Dutch expert organisations, WUR has been instrumental in the development of the Delta Plan 2100, offering long-term scenarios and solutions for sustainable management of the Bangladesh delta. As such, Wageningen UR has ample knowledge of the country and can offer expertise to both the private and public sectors to ensure sustainable development of the horticultural sector and support organisations and knowledge partners. Transformation of the horticultural sector from low risk / yield / input to high risk / yield / input will require an integrated approach whereby attention needs to be paid to cost effectiveness, the environment, and the social position and recognition of farmers.

Other knowledge institutions that could contribute to the strengthening of Dutch-Bangladeshi horticultural cooperation are high schools such as HAS and Aeres.

Partnerships, projects and programmes

The Netherlands Food Partnership (NFP) was officially registered in January 2021 and is currently finalising its strategy and operational plans. NFP partners, AgriProFocus and the Netherlands Food Knowledge and Business Platform, have longstanding experience in delivering Dutch food systems solutions in a broad range of countries. Bangladesh is not a focus country for NFP, but the organisation is active in Southeast Asia (Indonesia, Myanmar) and has an interest to expand its activities to Bangladesh. NFP is well positioned to support (coalitions of) Dutch private sector and their entry to new markets.

Although potato is not within the scope of this study, in Bangladesh it is considered a horticultural crop, with many farmers engaging in both potato and vegetable farming. Therefore, exchange with and learning from Impact Cluster Potato may be beneficial for any projects and programmes following this study. The currently on-going Impact Cluster Potato supports several Dutch companies to introduce improved products and solutions for potato post-harvest handling in Bangladesh (seed potato, palletising, storage). Some of these solutions are relevant for the horticultural sector as well. Also, challenges identified during the implementation of the Potato Cluster should be considered when developing new horticultural interventions, such as slow and unclear import procedures (particularly for demonstration equipment), reluctance at farmer level to adopt new varieties and financial constraints.

Solidaridad has worked in the Bangladeshi horticulture sector for over a decade. The organisation has implemented major projects in the southern coastal area such as SAFAL and SDGP. Through its integrated approach, Solidaridad empowers smallholder farmers to improve their production, strengthen their organisation and gain market access. Based on its long experience in the sector, Solidaridad has identified several areas of improvement that still hamper the development of horticulture in Bangladesh: high post-harvest losses due to poor logistics, transport and absence of cold chain, lack of processing facilities, challenges with traceability and certification (limiting export potential) and limited access to (affordable) technology such as greenhouses. Horticultural production is largely smallholder-based and local aggregators and traders are also relatively small and locally-oriented, with limited capacity to act as a supply chain organiser or to invest in improved logistics. Given the fact that Bangladesh is a major fruit and vegetables producer, there are opportunities for value adding and export, provided that reliable supply of quality produce is secured.

3. Horticultural sector Bangladesh – an overview

3.1. Summary of key findings

The economy of Bangladesh has grown at a considerable rate in the past decade, reaching GDP per capita of USD 1,900 in 2020. The country has also made substantial progress with Sustainable Development Goals (SDGs) in terms of poverty reduction, education and health. At the same time, **urbanisation and industrialisation trends** have accelerated, with 38% of the population currently earning their income from agriculture, down from 65% in 2000. It is projected that by 2040, the majority of Bangladesh's population (100 million people) will live in cities.

Bangladesh is seriously affected by **climate change** – frequent cyclones, floods, salinisation and unpredictable weather patterns negatively impact farming and food production. Urbanisation and salinisation cause a **decline in available agricultural land** while at the same time, economic growth in combination with increasing urbanisation will drive the **demand for more, and more nutritious food.**

Paddy is still by far the largest crop grown in the country, both in terms of production volume (48%) and land use (75%). **Vegetables** represent 7% of total crop production and 4% of total acreage. Bangladesh produces over 150 vegetable crops, with onion, garlic, tomato, brinjal, cabbage, cauliflower, gourds and chillies the most important ones. In total, over **6.5 million tons of vegetables** are produced annually.

There are two major trends and developments taking place in the Bangladeshi vegetable sector. One is more from a biophysical origin and the second is more market-driven.

Increased pressure on land, water and nutrients

Because of climate change, salinization and urbanisation, the amount of land that can be utilized for agriculture is decreasing. At the same time the growing, and increasingly affluent, urban population will demand more and better quality vegetables. This creates tension on the production systems and will necessitate farmers to do more with less. A general trend of sustainable intensification will arise, that focuses on increasing yields, water use efficiency, nutrient use efficiency and pesticide use efficiency (and effectiveness). In addition, labour will become more expensive which will lead to needs for increased labour productivity and hence (simple forms) of mechanisation.

Changing food systems and diets

The second major development is driven by a combination of increased urbanisation and economic growth. By 2040 more than half of Bangladesh's population will be living in cities, totalling close to 100 million people. At the same time the economy is expected to continue to grow by 8% on an annual basis, reaching Upper Middle-Income Country (UMIC) status somewhere in the 2030s. These two developments will further increase the demand for more nutritious foods, as well as convenience food (e.g. ready-made salads, sliced and diced vegetables). In addition, a top-10% of health conscious and wealthier consumers will put greater emphasis on quality, food safety and use of hygienic practices, and a separate niche market can develop for this segment (e.g. in supermarkets, hotels and restaurants, and specialized fruit and vegetable shops).

3.2. Horticultural sector Bangladesh – Facts and figures

Country development

Similar to the majority of low-and-middle-income countries in Asia, Bangladesh is experiencing rapid population growth. Over the past 20 years, the number of inhabitants grew by 30% to a total of 165 million (see Figure 2 below). However, annual growth rates are expected to reduce with the population size stabilizing at around 190 million in 2050. Another important development is a further urbanization trend. It is projected that from 2037 onwards the majority of Bangladesh's population will live in cities. This will have a major impact on food systems, dietary preferences and agricultural supply chains.

The agribusiness sector as a whole has a large, untapped potential to generate higher value addition and exports, meet growing domestic demand for food that is more nutritious, and create jobs across the value chain. Bangladesh can significantly increase domestic production and scale up exports of agricultural produce by closing large productivity gaps. On average, Bangladesh lags behind the regional peers (India, Pakistan) and global averages in terms of yields, outperforming the competition in mango and rice only[9]. Bridging the yield gap and increasing the share of higher value products will have a positive impact on farmer income and create more opportunities – mango, tomato and gourds earn a farmer much higher margins than rice.

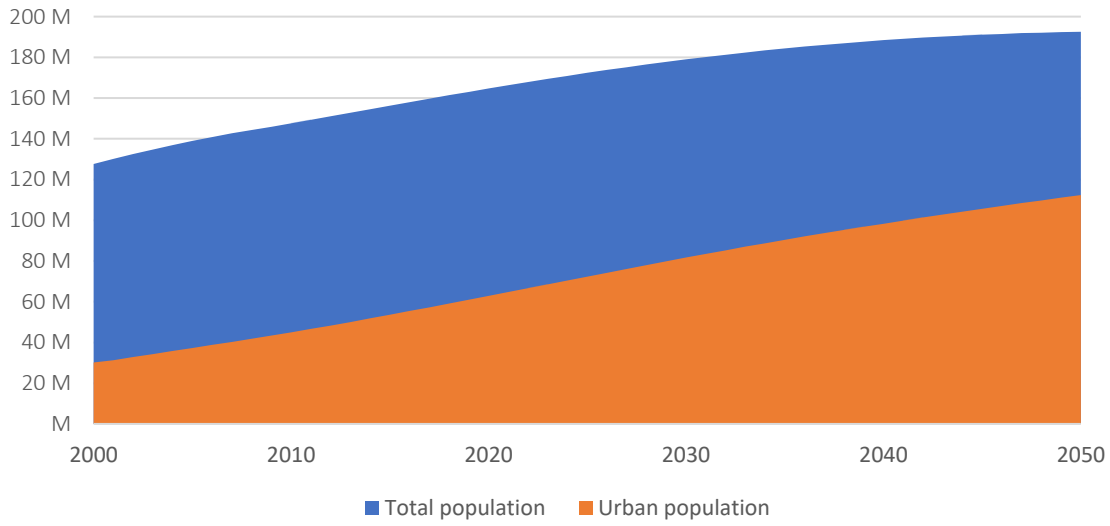

Figure 2: Population of Bangladesh, 2000-2050[10]

[9] The World Bank (2021), Creating Markets in Bangladesh, Unleashing the Private Sector to Sustain Development Success

[10] United Nations Conference on Trade and Development (UNCTAD) (2020), UNCTADstat

The gross domestic product of Bangladesh grew strongly over the last twenty years and increased almost five-fold, from USD 53 billion in 2000 to USD 303 billion in 2019. This increase is reflected in its GDP per capita, which grew from USD 418 in 2000 to USD 1,855 in 2019[11]. The substantial increase in output can mainly be attributed to an increase in services, manufacturing and industrial sectors (see Figure 3 below). The contribution of agriculture to GDP has consistently declined over the last decades, and recorded a relative share of 12% last year. In the same line, employment in agriculture declined to a share of 38% in 2020, where it was 65% in 2000. The relative decrease in importance of the agriculture sector is projected to continue in the next decades.

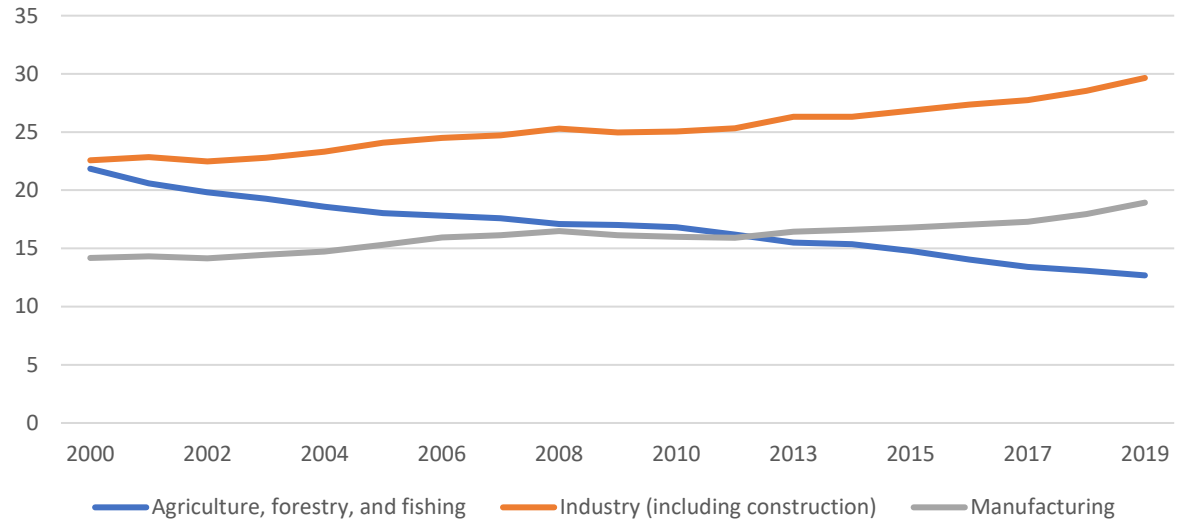

Figure 3: Value added per sector (as % of GDP)[12]

As incomes rise, the average diet of the Bangladeshi population diversified towards improved nutritional intake. Bangladesh is currently ranked as the 140th country when it comes to vegetable consumption but showed a large per capita increase from 13 kg in 2000 to 22 kg in 2017. This trend is also projected to continue[13]. World Bank expects that the demand for fruit and vegetables will increase with 65% and 38% respectively in the period 2015-2030.

Crop production

In the last decades, the government of Bangladesh put a lot of emphasis on ensuring food security. By increasing the production of rice, the country almost achieved self-sufficiency. Paddy, therefore, is still by far the largest crop grown in the country, both in terms of production volume (48%) and land use (75%). Vegetables represent 7% of total crop production and 4% of total acreage (see Figure 4).

[11] The World Bank (2020a), World Development Indicators
[12] Idem
[13] Food and Agriculture Organization of the United Nations (FAO) (2020), FAOSTAT

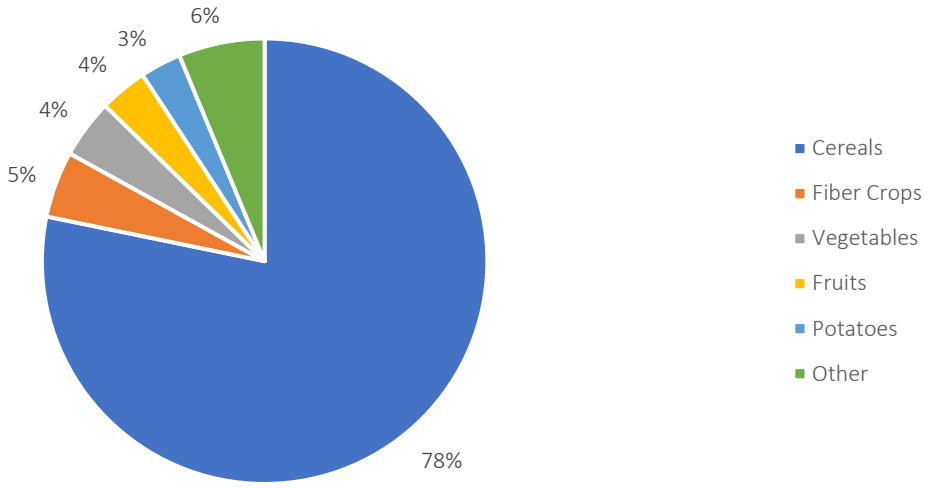

Figure 4: Acreage of crop production (% of total acreage)[14]

Three distinct production seasons can be identified for vegetables, two in summer (Kharif-1 and Kharif-2) 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. Production volumes in wintertime are higher, with correspondingly lower prices. Main vegetables produced in Bangladesh are onion, garlic, tomato and brinjal (an eggplant type). The top-10 of the crops produced in Bangladesh is listed in Table 1 below combined make up close to 75% of all vegetables produced in the country. The category 'Other' includes, amongst others: green beans, green bananas, pumpkin, different types of other gourds, Indian spinach, amaranth, other leafy vegetables and cucumber.

Table 1:Volume of vegetable production in FY 2018-2019[15]

Crop	Metric Tonnes	% of Production	Acres	% of Acreage
Onion	1.802.868	27,7%	426.157	22,1%
Garlic	466.389	7,2%	177.262	9,2%
Tomato	387.653	5,9%	69.697	3,6%
Brinjal	530.610	8,1%	129.419	6,7%
Green Papaya	352.816	5,4%	21.776	1,1%
Cabbage	320.332	4,9%	46.915	2,4%
Radish	308.395	4,7%	64.434	3,3%
Cauliflower	284.327	4,4%	49.869	2,6%
Ridge Gourd	237.223	3,6%	47.177	2,4%
Chillies	149.473	2,3%	239.203	12,4%
Other	1.675.983	25,7%	653.906	34,0%
Total vegetables	**6.516.069**	**100%**	**1.925.815**	**100%**

[14] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019
[15] Idem

Climate change

Bangladesh is often cited as one of the most vulnerable countries to climate change. Bangladesh's topography and geographical location make it particularly susceptible to extreme weather events including cyclones, floods, salinisation and storms. These events negatively impact farming and food production. It has been estimated that by 2050, one in every seven people in Bangladesh will be displaced by climate change. Up to 18 million people may have to move because of sea level rise alone. Hotspots of climate change vulnerability, where both biophysical and socio-economic vulnerability are the highest, are in the central and western coastal area, the north-western highlands, and along the main rivers[16].

Regional variation

The total land size of Bangladesh is 14.7 million hectares, out of which more than half is regarded as arable land. This percentage has declined over the last two decades due to trends like urbanisation and salinisation. At the moment approximately 60% of agriculture land is irrigated[17].

Bangladesh is divided into eight divisions. Each division is split into a number of districts; totalling 64[18]. Based on soil, topography and climate, the government identifies a variety of agro-ecological zones. As such, the country consists of 30 agro-ecological zones, which in turn are grouped into twenty major physiographic units.

Both in terms of production volume and acreage the following five districts can be considered as the main vegetable production hotspots in Bangladesh: Pabna, Rajshahi, Faridpur, Rajbari and Kushtia (see Figure 5 and Figure 6). Together these five districts account for almost 30% of total vegetable production.

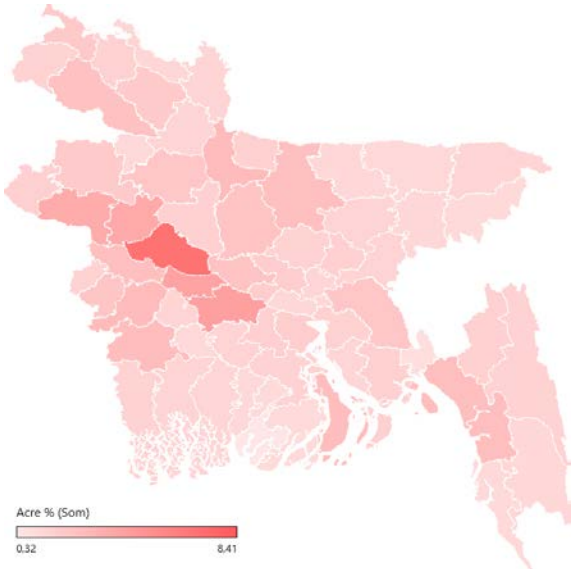

Figure 5: Vegetable acreage per district in FY 2018-2019[19]

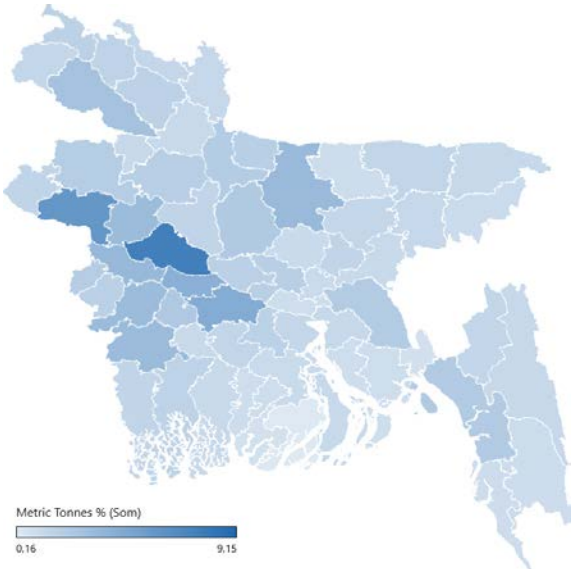

Figure 6: Vegetable production per district in FY 2018-2019[20]

[16] Ministry of Foreign Affairs of the Netherlands (2018), Climate change profile: Bangladesh
[17] Food and Agriculture Organization of the United Nations (FAO) (2020), FAOSTAT
[18] OHCA (2020), Bangladesh - Subnational Administrative Boundaries
[19] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019
[20] Idem

A closer look at the top producing vegetables regions, shows that the cultivation of onions has a huge influence on the five identified hotspots. The top onion producing regions correspond with the top vegetable producing regions. Zooming in on the production regions of the other top vegetable crops provides a different picture. Figures 7 to 12 show the geographic spread of the top producing regions for onion, garlic, brinjal, tomato, cabbage and radish.

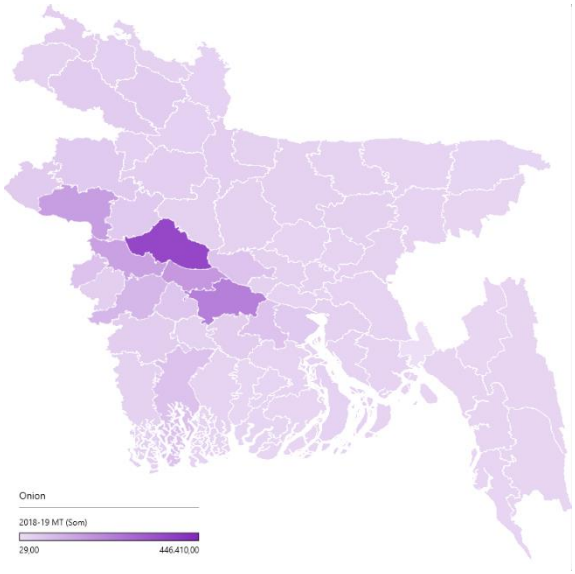

Figure 7: Onion production volume per district in FY 2018-2019[21]

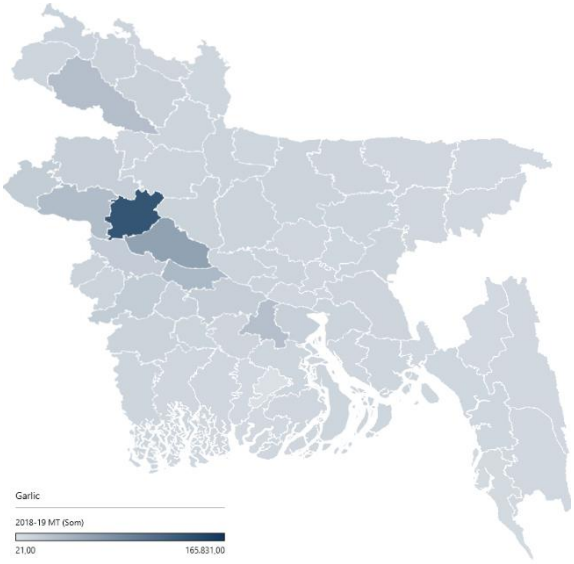

Figure 8: Garlic production volume per district in FY 2018-2019[22]

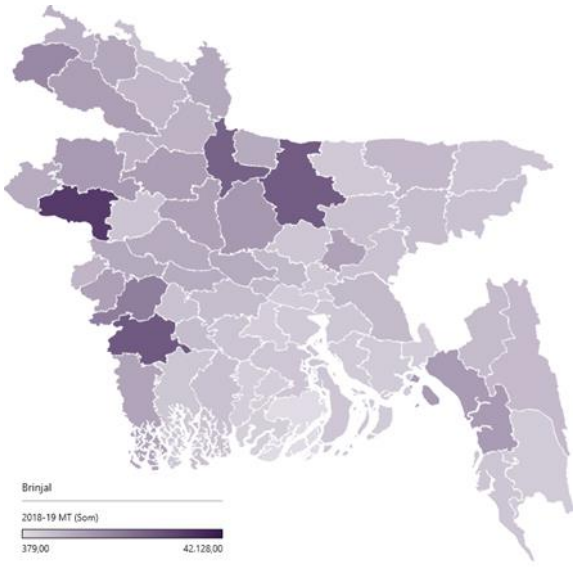

Figure 9: Brinjal production volume per district in FY 2018-2019[23]

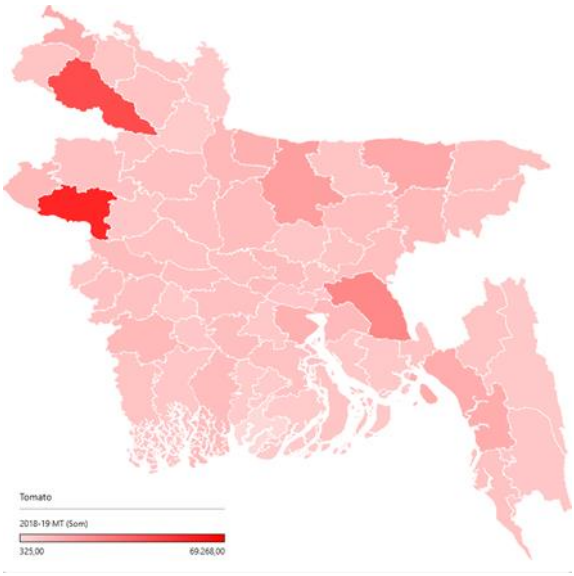

Figure 10: Tomato production volume per district in FY 2018-2019

[24]

[21] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019
[22] Idem
[23] Idem
[24] Idem

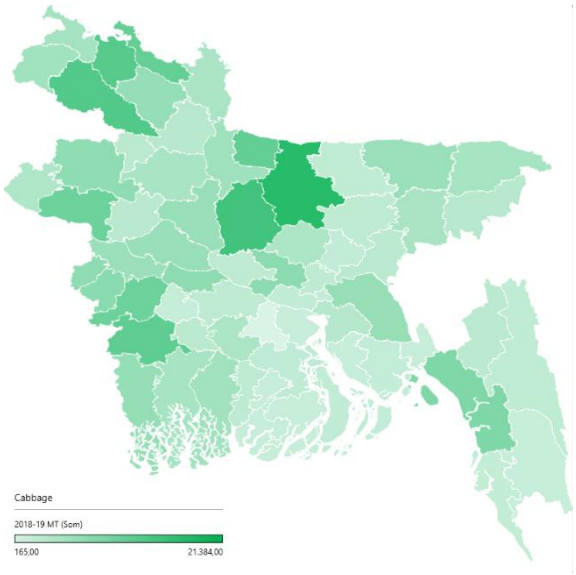

Figure 11: Cabbage production volume per district in FY 2018-2019[25]

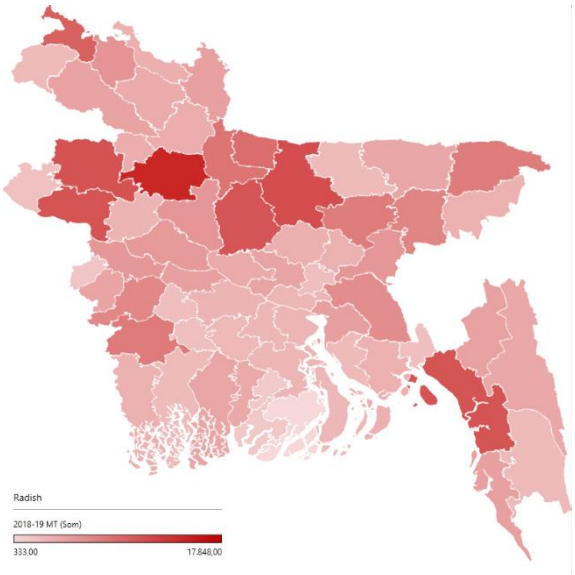

Figure 12: Radish production volume per district in FY 2018-2019[26]

The five districts with the highest production of onion and garlic both make up more than two thirds of the total onion and garlic production of Bangladesh. The districts in which the two crops are produced have a lot of overlap; with the exception of Natore, which stands out as the main garlic hotspot of Bangladesh. Brinjal production is more evenly spread across the country, with Rajshahi the top producing district. At the same time, the top-5 districts only produce 30% of total brinjal production. Tomato production is concentrated in the districts of Rajshahi and Dinajpur, together these two produce close to a third of the total. Cabbage and radish are also more evenly spread across the country. The-top 5 producing districts only produce a quarter of the total.

More detailed information on the top producing districts of onion, garlic, brinjal, tomato, cabbage and radish can be found in Table 2 overleaf.

[25] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019
[26] Idem

Table 2: Top producing districts of top 6 vegetables in FY 2018-2019[27]

Crop	District	Production MT	Production % of crop
Onion	Pabna	446,410	24,76%
	Faridpur	264,025	14,64%
	Rajbari	182,485	10,12%
	Rajshahi	163,482	9,07%
	Kushtia	151,477	8,40%
	Other	*594,989*	*33,00%*
Garlic	Natore	165,831	35,56%
	Pabna	65,057	13,95%
	Rajbari	35,713	7,66%
	Rajshahi	29,894	6,41%
	Dinajpur	27,454	5,89%
	Other	*142,440*	*30,54%*
Brinjal	Rajshahi	42,128	7,94%
	Jessore	33,214	6,26%
	Mymensingh	32,340	6,09%
	Jamalpur	30,767	5,80%
	Jhenaidah	22,834	4,30%
	Other	*369,327*	*69,60%*
Tomato	Rajshahi	69,268	17,87%
	Dinajpur	52,663	13,59%
	Comilla	27,226	7,02%
	Mymensingh	17,505	4,52%
	Sunamganj	13,459	3,47%
	Other	*207,532*	*53,54%*
Cabbage	Mymensingh	21,384	6.68%
	Tangail	17,753	5.54%
	Dinajpur	15,538	4.85%
	Nilphamari	14,878	4.64%
	Jessore	13,776	4.30%
	Other	*237,003*	*73.99&*
Radish	Bogra	17,848	5.79%
	Mymensingh	13,507	4.38%
	Naogaon	12,980	4.21%
	Rajshahi	12,897	4.18%
	Chittagong	12,801	4.15%
	Other	*238,362*	*77.29%*

[27] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019

Trade

As mentioned above, at the current level of demand, Bangladesh has become almost self-sufficient in vegetable production. For other agricultural commodities, the country still depends on imports. The total value of imported vegetables in 2019 accounted to USD 203 million (see Figure 13 below). Most important vegetables that were imported include: onion (USD 96 million), garlic (USD 75 million) and tomato (USD 13 million). Among others, smaller quantities of onion are being imported from the Netherlands.

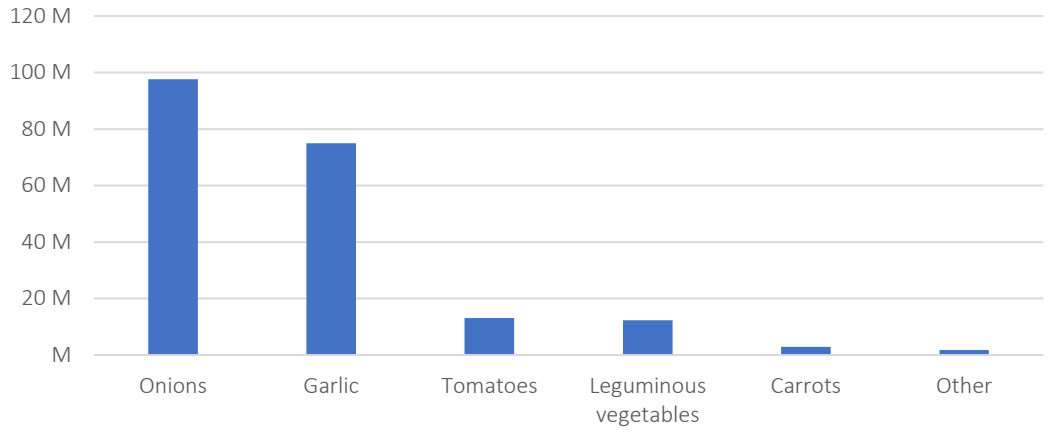

Figure 13: Vegetable imports by Bangladesh in 2019[28]

The total value of vegetable exports was USD 141 million in the 2019-2020 fiscal year. Most dominant export markets are countries in the Middle East, United Kingdom and Italy (see Figure 14 below). Exports are mainly destined for the large Bangladeshi diaspora population of these. There is, however, a growing interest among local horticultural producers to address export markets with products such as mango, tomato, brinjal and pepper. Processed horticultural products, such as processed jackfruit ('vegetable meat') are also stimulated by the Ministry of Agriculture, which sees revenue generation potential from exporting such products to Middle East and other foreign markets.

Phytosanitary standards and certification are some of the issues limiting the export to the EU. High cargo charges also contribute to a weak business case for export to overseas destinations.

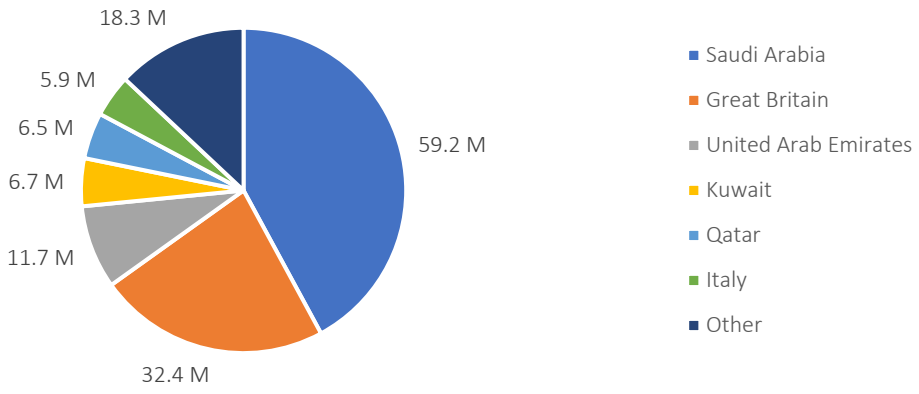

Figure 14: Vegetable exports to selected countries[29]

[28] International Trade Centre (ITC) (2020), Trade Map
[29] Export Promotion Bureau (EPB) (2020), Product Wise Export (Goods) for the Month of July-June 2019-20

Vegetable seeds market

The Ministry of Agriculture estimates the current sales of quality vegetable seeds in Bangladesh (formal sector) at 2,400 tons. While BADC is the largest supplier of seeds for the rice sub-sector, private companies are the main supplier of seeds for vegetable farming. In 2019, 1,670 tons of vegetable seeds were imported[30]. Pathuakali Science and Technology University conducted research on the seed sector in 2018 and concluded that the total demand for vegetable seed in the country amounts to 4,500 tons. This figure is much higher than the current sales of seeds as it includes the informal sector (farmers propagating their own seeds) as well. According to the research, 15% of the seed is imported, 30% is produced and distributed by seed companies while the remaining seeds are propagated by local farmers, representing the 55% share of the informal sector.

The value of the vegetable seeds market in Bangladesh is estimated at USD 80 million, but given the increasing utilisation of quality OP and hybrid varieties, the potential market is at least double that size. Projections, however, depend very much on the crop mix - different vegetable crops require very different quantities of seed per planted area, creating large variations in total values. Also, for some crops, farmers use more hybrid varieties than for others. The import value is estimated at USD 28 million.

For example, 100% of cauliflower varieties used in the country are currently bought on the formal market, while for brinjal it is 46%, for tomato and chilli 57%, and for onion 84%. Currently 100% of farmers are buying cauliflower seed from the formal market while only 37% of farmers buys formal brinjal seeds. The share of farmers using registered tomato and chilli seeds is 88% and 41% respectively. For onion, 87% of farmers buys from formal sources.[31] Based on these figures and the expected market developments, the formal demand for tomato seed can be estimated at 5 tons per annum, representing a value of around USD 3.5 million based on the average price of USD 700 per kg. Demand for brinjal varieties is over 30 tons, representing a value of about USD 6 million while for cabbage varieties, it is estimated at USD 1 million (average price USD 210 per kg, 5 tons of seed required).

According to the Access to Seed Index, which monitors the global seed market, there are 21 global vegetable seed sector companies active in Bangladesh[32] as listed in the table below, of which two have headquarters in Bangladesh (Lal Teer Seeds and BRAC). On top of that, another 20 medium-sized local seed companies are active in the country. Seed companies produce, process and market OP (open pollinated) and hybrid vegetable seed varieties. They also import hybrid and OP varieties from India, China, Thailand, Japan Vietnam, Korea, Taiwan and, to a smaller extent, from other countries. Few of them also have their own R&D facilities for variety development and pre-commercial trials of new varieties. The largest local vegetable seed producing companies are Lal Teer Seed, United seeds, Metal, Mollika, 3S, Supreme, BRAC and Ispahani. Lal Teer is currently the market leader.

[30] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019
[31] Bangladesh Development Studies (2016), Formal vs. Informal Seeds: Adoption and Productivity Differences
[32] Access to Seeds Index (2020), Bangladesh Country Profile 2019

Company	Crops in portfolio		Company activities in country					
Companies selected for the Access to Seeds Index	Field crops	Vegetables	Breeding location	Testing location	Seed production	Processing location	Sales	Extension services
Acsen HyVeg		●		●			●	
Advanta	●	●	●	●	● *		●	●
Bayer	●	●			● *		●	●
Bejo		●					●	
Bioseed							●	
BRAC Seed and Agro Enterprise **	●	●	●	●	●	●	●	
Charoen Pokphand	●	●					●	
Corteva Agriscience	●						●	
East-West Seed		●		●			●	●
Kalash Seeds		●		●			●	●
Known-You Seed		●		●			●	
KWS	●						●	
Lal Teer Seed **	●	●	●	●	● *	●	●	●
Limagrain		●					●	
Mahyco							●	
Monsanto							●	
Namdhari Seeds							●	
Nongwoo Bio		●		●			●	
Nuziveedu Seeds	●	●		●			●	●
Sakata		●					●	
Syngenta							●	

Figure 15: Global seed companies in Bangladesh[33]

Seed producing companies do not concentrate exclusively on vegetable seeds – Lal Teer is the only local producer with a focus on vegetable seeds, but Lal Teer also markets a range of cereal and rice seeds. For other major seed producers, vegetable seeds represent less than 10% of their total output.

Horticultural farmers in Bangladesh are well aware of the range and benefits of improved (OP and hybrid) varieties. Introduction of new varieties, however, requires extensive demonstrations and training. If farmers can see at a demo-location that a product has higher germination as well as high yield, shorter growing period and the right size and shape, the product has a good chance to sell well. For commercial vegetable farmers, the price of vegetable seeds is thus not a critical factor, but brand loyalty is. For small and marginal farmers, price is an important factor as they have limited financial capacity and poor access to finance. Counterfeit seeds have been a persisting problem in the Bangladesh market, given the weak control and limited awareness of both farmers and seed retailers.

3.3. Specific horticultural sector issues and challenges

Inputs

Seeds

Agricultural growth is dependent on the availability of good quality seeds of high yielding varieties (as well as other inputs). The requirement of quality seeds of all crops (including rice and cereals) in 2017-18 was 1.25 million tons. It is projected that this demand will steadily grow in the coming decades,

[33] Access to Seeds Index (2020), Bangladesh Country Profile 2019

causing shortages in seed supply, both in terms of quantity and quality[34]. The total demand for vegetable seeds is estimated at 4,500 tons. As much of the seeds are still procured from own farm or from small local suppliers through informal chains, total quantities of currently supplied seeds are difficult to determine. The utilisation of quality seed of improved varieties, however, has increased in the past decade, triggering productivity improvements across the sector.

Seed farmers in Bangladesh either produce under a contract with a seed company or as independent producers, selling their seed output to collectors (middlemen). While the first group has a guaranteed offtake and price, the second group is more dependent on the market conditions, with collectors playing an important role in determining the price. As collectors mostly sell the seed in the region of its origin, there is a persisting shortage of seeds in areas with no seed production. Overall, seed multiplication is profitable; farmers usually grow a range of crops and varieties to spread the risk. Key challenges in seed production are limited availability of basic seed and parental lines, and technical support, weak transport network causing disruptions in supply, particularly in the rainy season, and risks related to natural disasters.

A recent World Bank report[35] states that lack of a conducive, regulatory framework for seed development and production is an important reason for the shortages in the supply of quality seeds in the market. It can take considerable time to complete the trials and registration process for new varieties (although, based on interviews with the local seed companies, this issue is not considered a serious obstacle). Seed market inspections, however, are inadequate, sustaining a large counterfeit seed market. As shown in the following chart, Bangladesh lags behind in seed supply compared both to its South-East Asian neighbours and globally. The chart also summarises other challenges (relevant for horticulture) that agri-businesses face in Bangladesh, such as registering a technology and registering a fertiliser product.

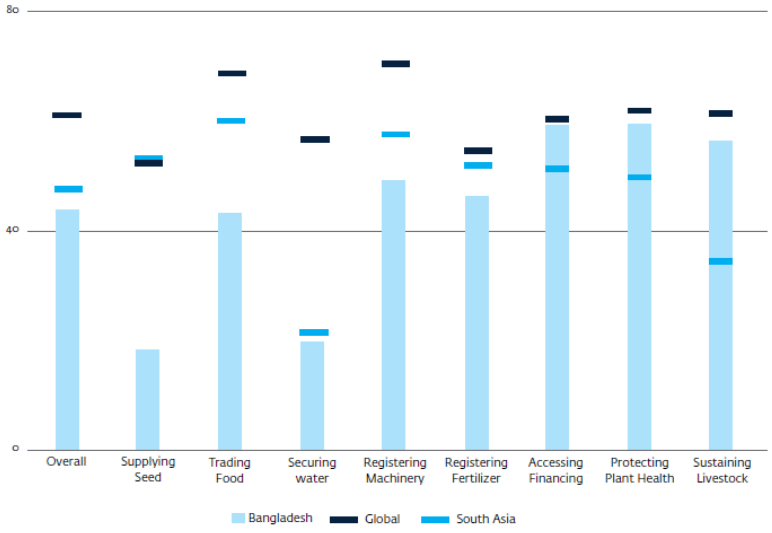

Figure 16: Enabling the Business of Agriculture, WB, 2021

Fertilisers

After attempts to open the fertiliser market to the private sector in the 1980s, fertiliser is currently a government-dominated sector, whereby the Department of Agriculture Extension (DAE) provides the estimated demand for fertilisers and Bangladesh Agricultural Development Cooperation (BADC) purchases and distributes it through its own channels and selected distributors. Due to good access and pricing (partly thanks to subsidies), almost all smallholder farmers apply fertilisers on their fields. Fertiliser use in Bangladesh skyrocketed in the last decades from 160 kg/ha in 2003 to 299 kg/ha in 2015. However, fertiliser use efficiency is low and applications could be more crop- and soil-specific

[34] The World Bank (2020b), Promoting Agri Food Sector Transformation: Policy and Investment Priorities
[35] The World Bank (2021), Creating Markets in Bangladesh, Unleashing the Private Sector to Sustain Development Success

(based on soil fertility analyses). Besides preserving the environment, better use of fertilizers can also improve yields and reduce cost price.

Irrigation

The majority of agricultural land is irrigated. Groundwater is the main source for irrigation and is used for more than 75% of agricultural fields. Climate change will impact water availability and temporal variability. In order to meet future water demands, water use efficiency has to increase. Efficiency can be increased by finetuning water demand of crops, e.g. through the use soil moisture sensors and possibly drones.

Climate-related challenges

In different regions of Bangladesh, vegetable farming is impacted by different climate-induced events. In the coastal region, increasing salinity of the groundwater and fresh water streams up to 100 km inland is harmful for vegetable yields. With little means to cope with failed harvests, many small farmers (mostly male) from southern regions leave for urban centres in search for jobs, leaving their families in an even more vulnerable position. In the northwest of the country, farmers are affected by extended periods of drought and lack of rainfall while large areas of the country are also exposed to the risk of floods that can wipe out the entire harvest. Therefore, there is a growing need for strategies and solutions to improve the resilience of Bangladeshi smallholder-based vegetable production systems.

Drought-tolerant and saline-tolerant seeds have been introduced at a limited scale, but the results of these hybrids have been good, demonstrating a strong potential for this market segment to be further developed. To benefit from the more tolerant varieties, farmers require additional training and services. Solutions to cope with climate-related challenges are furthermore sought in integrated landscape management and protected horticulture.

Processing and post-harvest operations

Postharvest operations consist of actions like sorting, grading, packaging and transport. These processes can help in improving quality and shelf-life of harvested crops. A study by the Department of Horticulture (2010)[36] indicated that postharvest management is a big issue. Use of basic packaging materials and open trucks for long distance transport results in postharvest losses of fruits and vegetables ranged from 24% to 44%, depending on the crop. Personal communication with market actors indicates that the situation has slightly improved since 2010; though losses are still high, with estimations ranging between 25% and 35%.

Supply chain issues and logistics

A smooth supply chain and proper logistics are essential for matching supply and demand. As perishable products, vegetables greatly benefit from a short and fast route from farmer to end customer. The current vegetable supply chain of Bangladesh is not functioning well[37]. On the Logistics Performance Index of the World Bank, Bangladesh can be found on the 100th place in 2018[38]. The share of transport in cost structure is high by global standards and particularly high 48% of total revenue) for high-value products like perishable horticulture crops. Of this total cost, inventory carrying costs (storage) account

[36] Bangladesh Department of Horticulture (BDoH) (2010), Post Harvest Loss Assessment: A Study to Formulate Policy for Loss Reduction of Fruits and Vegetables and Socioeconomic Uplift of the Stakeholders
[37] Asian Development Bank (ADB) (2019),- Dysfunctional Horticulture Value Chains and the Need for Modern Marketing Infrastructure: The Case of Bangladesh
[38] The World Bank (2018), Logistics Performance Index, Retrieved from https://lpi.worldbank.org/

for 30% and direct logistics costs account for 70%, of which a little more than half is taken by transport costs, with the rest coming from indirect costs (formal and informal fees).

Furthermore, limited capacity and high congestion in the main ports and market centres present additional challenges. In the summer of 2022, however, the new Padma Bridge is expected to open. This bridge will connect the south-west of the country to northern and eastern regions, and will have a big impact on the transport of agriculture products. Travel times and hence transport costs to the markets in Dhaka are expected to decrease significantly[39].

3.4. Horticultural sector in the context of food security

Based on the recommended nutritional intake of vegetables of 220 g per day, Bangladesh requires 13 million tons of vegetables per annum. However, current nutritional intake is far below the norm. In 2015 FAO reported that average vegetable consumption per person per day is 56 grams while later reports provide a figure of 62 grams per day. Some of the reasons for low vegetable consumption are dietary habits (traditional, rice-based diet dominating), high price of vegetables and low awareness of the nutritional needs.

Population growth, better awareness of nutritional needs and an increasing demand for healthy food due to the growth of urban middle class are expected to push the demand for vegetables in the coming years. The current production gap of about 6.5 million tons is therefore expected to further increase. So, although the productivity of the horticultural sector in Bangladesh has improved in the past decade, it will need to further improve if the country aims to meet the needs of its population through own vegetable production. Hence, it is expected that farmers will increasingly turn to high-yielding varieties and improved farming methods. At the same time, threats of climate change (salinity, droughts, floods) require research and introduction of improved, saline- and drought-tolerant varieties and varieties with adjusted and shorter growing cycles.

Furthermore, leading Bangladeshi conglomerates have started investing in various parts of the value chain: agro-processing, agricultural machinery and equipment, inputs, post-harvest infrastructure, in response to the growing external and domestic demand for quality, nutritious food.

[39] http://www.padmabridge.gov.bd

4. Horticultural value chains

4.1. Size, organization and stakeholders in the horticultural value chain

In this section, an overview is provided of the structure of a typical formal horticultural value chain, highlighting key relations, actors and stakeholders. Then, based on the findings regarding the size and importance of different crops, five value chains have been selected for a more detailed analysis: tomato, brinjal, radish, cabbage and onion. Furthermore, given the important role of improved seed varieties in the production of vegetables, an analysis of the vegetable seed value chain is provided.

Total vegetables production in Bangladesh was 6.5 million tons in 2018-2019 season, including 1.9 million tons of summer vegetables, 2.5 million tons of winter vegetables, 1.8 million tons of onion and 466 thousand tons of garlic[40].

19% of winter vegetables and 16% of summer vegetables[41] are consumed by the farmers' households, leaving about 80% to be sold on the market. Out of that, 25-30% is sold directly at the farmgate or at the local market and consumed locally while the remaining vegetables enter the chain that supplies towns and cities across Bangladesh, with Dhaka as the main urban market. Not more than 2% of the vegetables are grown and marketed under contract farming schemes, serving high-end market (hotels, restaurants, export, some institutional buyers).

The following five districts in the central / western Bangladesh can be considered the vegetable production hotspots, both in terms of production volume and acreage: Pabna, Rajshahi, Faridpur, Rajbari and Kushtia. Together, these five districts account for almost 30% of the total vegetable production of Bangladesh. Other important production regions are Rajshahi and Dinajpur (tomato), Mymensingh (cabbage) and Bogra (radish). Seed production is concentrated in the north-western Rangpur division.

The horticultural value chain comprises **three key groups of actors**:

1. **Input suppliers**: Seed and agricultural input producers and distributors;
2. **Primary producers**: Horticultural farmers;
3. **Horticultural produce traders**: Local buyers / wholesalers / retailers.

1. **Input suppliers**: Within this group, several types of private and public sector entities are active.

- Seed producers are both private sector companies and public organisations. The government agency Bangladesh Agricultural Development Corporation (BADC) is the largest seed supplier in the country for rice and cereals, but is less active in vegetable seed multiplication. Among private sector seed companies, Lal Teer is the largest local producer and distributor of vegetable seed. Another 20 medium to large seed companies (foreign and local) are active in Bangladesh. Numerous smaller seed producers are active in the informal market.
- Horticultural nurseries are operated both by seed companies and by independent farmers who specialise in cultivation of vegetable seedlings. This segment is still relatively small as farmers prefer to use their own seedbeds and undertake transplanting from there.

[40] Bangladesh Bureau of Statistics (BBS) (2020), Yearbook of Agricultural Statistics 2019
[41] Shahnewas Kabir (2018), A Seminar Paper on Status of Vegetable Production and Marketing in Bangladesh

- Seed traders range from large, national dealers with extended distribution networks to smaller, regional dealers, retailers and informal mobile venders. In total, it is estimated that over 17,000 dealers, 160,000 retailers and 4,500 mobile vendors are active in the sector. While there is some specialisation among large dealers, local retailers usually offer to farmers a range of agricultural products including seeds, agricultural inputs and basic farming tools and equipment. Recent research has established that a growing number of young, educated people have become active in seed marketing - 32% of vegetable seed sellers were found to be under the age of 30 and with at least a high school diploma. Majority of seed sellers are members of the Bangladesh Society of Seed Technology (BSST), indicating that most of the retailers and wholesalers are aware of standards related to seed quality and storage. Seed traders use various marketing strategies to attract and retain customers, such as seed selection, branding, packaging, labelling and providing support services.
- The agricultural inputs (fertilisers, chemicals) market was liberalised in the 1980s, but the government remains heavily involved in fertiliser import, production and distribution. Currently, the government agency BADC is by far the largest supplier of fertilisers. Urea and triple superphosphate (TSP) are the most used fertilisers, followed by diammonium superphosphate (DAP), single superphosphate (SSP), nitrogen phosphorus, potassium, and sulphur (NPKS). Although urea is produced locally, it does not meet the demand; hence, the government imports and distributes significant quantities of urea every year. Also, substantial quantities of TSP are imported, given the fact that local production is limited. BADC distributes the fertilisers through its own channels and a limited number of private distributors.
- In the supply of crop protection products (e.g. fungicides, insecticides and herbicides), several global and local companies are active; the most important being Syngenta, Bayer Crop Science, Partex Agro and Petrochem. These companies utilize a dispersed network of national, regional and local dealers to bring the products to farmers. As mentioned, at the local level, retailers often distribute seeds as well.

2. Primary producers.

There are about 16.5 million farming households in Bangladesh according to the National Agricultural Census of 2019, majority of which grow vegetables to some extent, usually in rotation with rice. Vegetable farmers are in the rule small scale - according to the recent estimates of USAID (2019), 60% of Bangladesh's landowners cultivate one acre or less. A very small share (less than 1%) represents large commercial vegetable growers.

3. Horticultural produce traders

The chain from farmers to end consumers is a lengthy one with several intermediaries named *farias*, *beparis* and *aratdars*, as shown in Figure 17. Each stage in the supply chain has intermediaries that play an important role in linking two parties to each other. *Farias* collect the produce locally, *beparis* aggregate the produce at local markets and urban centres, and *aratdars* are licenced commission agents or auctioneers.

Typically, vegetable transport takes place in the late morning to afternoon. In Dhaka, which is the largest consumer of vegetables in Bangladesh, produce from the horticultural districts enter the city between midnight and early dawn. The capital city is a key market with Karwan bazar as the main hub of vegetable trade. The vast majority of traders are based here and superstores and institutions like hospitals, restaurants and hotels also primarily source from Karwan bazar.

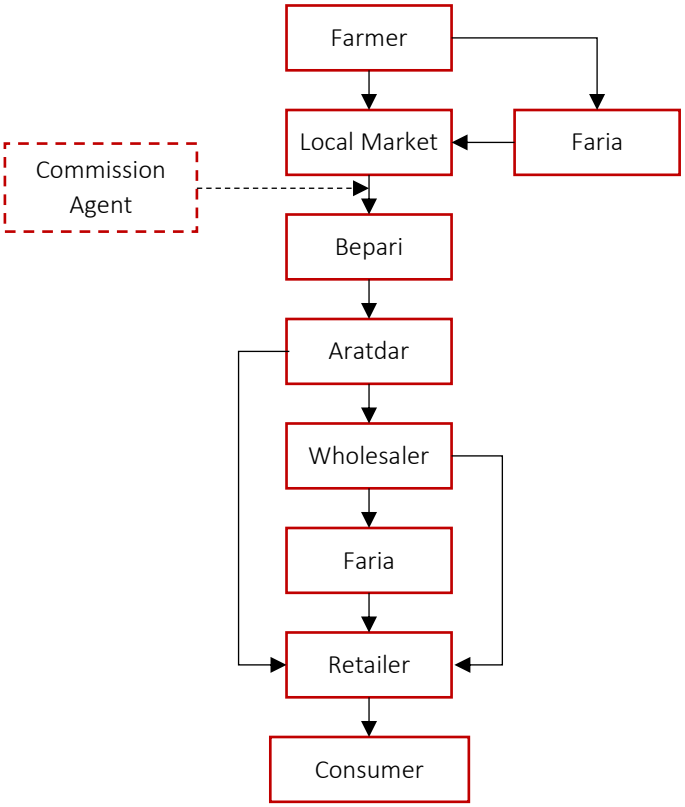

Figure 17: Simplified supply chain

Recently, several parallel supply chains have come into operation, targeting high end customers through retail shops and online sales. These chains aim to offer quality, traceable products that meet food safety and, in some cases, organic standards. As the country moves through the transition phase toward urbanization, supermarket retailers are expected to take on a bigger role in consolidating and retailing fresh produce and other food products. This is expected to ultimately drive improvements upstream and will encourage suppliers to invest in better production, as well as harvesting and post-harvesting handling techniques. Supermarket retailers are also more likely to invest in refrigerated transport and temperature-controlled warehouses and distribution centres.

Various **service providers** are active in the horticultural value chain, including transport companies, storage and finance providers, certification agencies, extensionists and market operators. Frequently, the same provider takes on different roles. For example, a seed or input provider offers finance and / or extension services to farmers, or a transport company offers aggregation and storage.

Not more than 1% of the horticultural output is aimed at further **processing**. Main processed products are tomato, pumpkin and chili. Processed food industry (including but not limited to horticultural processing) accounts for approximately 12.3% of all manufacturing production value of Bangladesh. The exact share of the horticultural processing is not available, but the sub-sector of fruit and vegetable processing is relatively small compared to other food processing (baked goods, confectionery, dairy, cereals, beverages). There are about 250 medium-sized food manufacturing enterprises in the country that generate USD 8.3 billion in revenue annually.

The institutional framework of the horticultural value chain comprises public sector entities, sector associations and knowledge institutions. Multilateral and bilateral donors are also involved through various projects aimed at advancing the sector and improving farmers' livelihoods through improved horticultural production. The government of Bangladesh is involved in the horticultural sector through the Ministry of Agriculture and various agencies operating under the Ministry, such as Department of Agricultural Extension (DAE), Horticulture research centre (BARI), Plant protection wing, Plant variety protection office and the Seed wing. More information about the institutional environment is provided in Chapter 5.

Key associations of horticultural stakeholders in Bangladesh are Hortex and BSA. Hortex is the sector association of horticultural exporters. Bangladesh Seed Association (BSA) is an apex organisation of producers and traders in the seed sector with 800 members. BSA is not focused on vegetable seeds in particular but represents also cereal, potato, jute and other seed suppliers. Other relevant organisations include Bangladesh Agro-processing Association (https://bapabd.org/) and the Feed the Future Innovation Lab for Horticulture (https://horticulture.ucdavis.edu/countries/bangladesh). A more elaborate representation of a typical horticultural value chain is provided below.

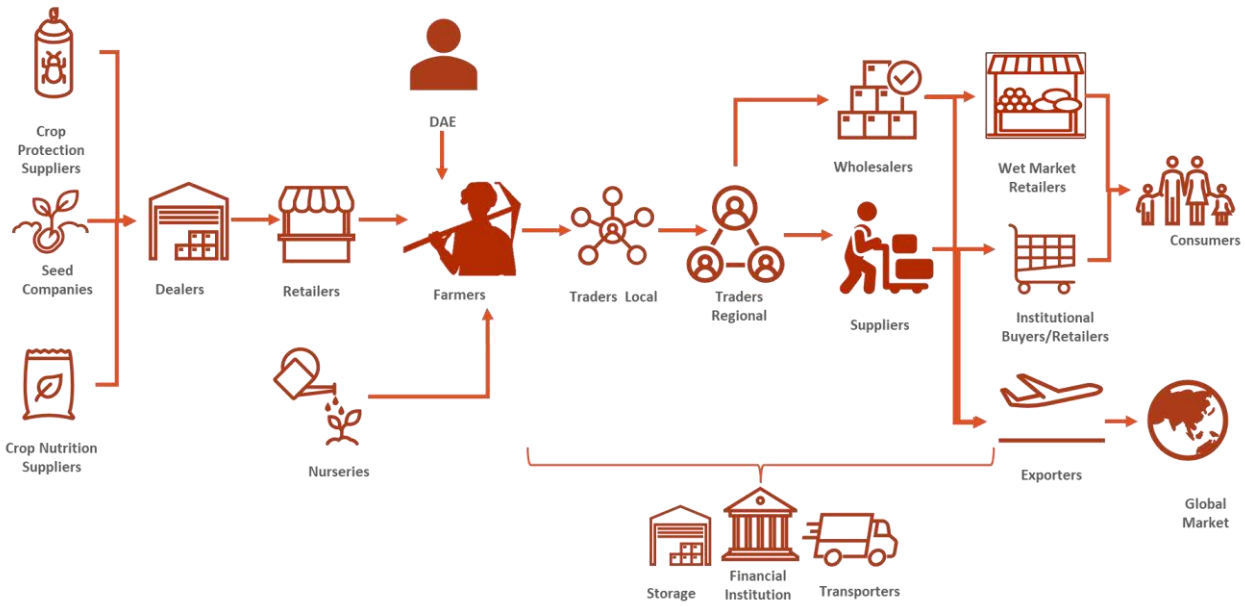

Figure 18: Typical horticultural value chain in Bangladesh

Distribution of value in the horticultural value chain varies for different crops, but on average, farmers' share in the consumer price of horticultural produce is less than 20%. Traders (*foria* and *aratdar*) jointly account for up to 45% of the final price (this does not include any additional services or value addition)[42]. Farmers are also highly exposed to production risks, which make them vulnerable for the impact of climate change. Usually, two or three good harvests of vegetables like onion, tomato and cauliflower are followed by a bad harvest. On the other hand, when production is low and retail prices increase, higher revenues at the point of sales do not trickle down to farmers who in the rule receive the price as defined by local traders. As the majority of horticultural farmers in Bangladesh are not organised in cooperatives, they have little means to exercise any power during negotiations. Given the high price volatility of horticultural crops between years and seasons, farmer' income remains uncertain. For example, wholesale prices fluctuated by more than 600% for tomato, 180% for potato, and 55% for onion in 2016.

[42] Asian Development Bank (ADB) (2019), Dysfunctional Horticulture Value Chains and the Need for Modern Marketing Infrastructure: The Case of Bangladesh

4.2. Key issues in horticultural value chain

While the specific challenges in the value chains of the five selected vegetables will be elaborated in the next sections, the key issues affecting all, or the majority, of horticultural value chains are summarised here. Special attention is given to horticultural value chains dedicated to value addition and to export.

In **input supply:**

- Limited availability of quality seeds of improved varieties (OP and hybrid), and a substantial counterfeit market (seed retailers offering expired seeds, fake seeds, etc.).
- High costs of nutrients, as micronutrients are not produced locally and enjoy no tax benefits like other horticultural inputs. While the government subsidises fertilisers (urea, NPK), the micronutrients market (zinc, potash etc.) is open to the private sector and has been growing considerably in the last decade.

In **crop production:**

- Lack of technical knowledge and low level of mechanisation. Most of the work in horticulture is still done manually and although progress in farming practices is noted, farmers mostly follow traditional cultivation practices. Irrigation practices are traditional as well.
- Limited access to, and uptake of, quality seeds and other inputs. Use of quality inputs has increased substantially in the last decade but there is still room for improvement.
- Limited market access.
- Climate change risks (floods, droughts, salinisation). Winter season is shortening, which is a new threat to horticultural farmers.
- Price volatility. Market prices are volatile, with seasonal gluts pushing the prices down, while off-season prices are more rewarding. There is also the cyclical tendency of farmers to cultivate more if last season prices were higher for a specific crop, leading to higher production and fall in prices in the next season ('pig cycle' dynamics). Natural calamities such as excess rain, flood and droughts are affecting production and prices as well, making it harder for farmers to plan.

In the **marketing and sales** of horticultural products:

- High postharvest losses due to poor postharvest treatment and transport, inadequate storage facilities, lack of cold storage (both at production areas and in wholesale markets) and poor market infrastructure. (ADB has estimated that a reduction of postharvest losses by 75% for all agricultural crops would represent annual saving of USD 1.8 billion, valued at export premium prices[43]).

[43] Asian Development Bank (ADB) (2019), Dysfunctional Horticulture Value Chains and the Need for Modern Marketing Infrastructure: The Case of Bangladesh

- Lack of business models for service provision to address postharvest challenges (storage, transport, markets etc.). Transport services, however, earn relatively high revenue as their role is essential in supply chains of perishables such as vegetables.
- Limited availability of affordable finance and lack of agricultural insurance.
- The main wholesale market in Dhaka does not suffice any more: its area cannot be expanded, it lacks sewerage and wastewater treatment and its water supply is inadequate. The access is directly from the main road, which creates congestion. Other issues are lack of cold storage, unhygienic sanitary facilities, inadequate management and lack of funds. This results in poor maintenance and weak organisation of licence allocation and fee payments.
- Although the market for premium products is growing, the vast majority of consumers is highly price sensitive, rather than quality conscious.

Horticultural value chains supplying **processing** companies are small and limited in number, given the low level of processing in the country (95% of the agricultural output is sold unprocessed). Both issues are interrelated as lack of sufficient supply of standard quality produce makes it challenging for (potential) processors to invest in new facilities while limited demand from processors does not motivate farmers to invest in dedicated production. Processing companies, therefore, tend to work with larger farmers and / or establish their own farms, to ensure stable supply and quality of raw materials. There are only a few larger processing companies in Bangladesh - majority of agri-food businesses are microenterprises, usually engaged in retailing.

Both the Bangladesh government and the private sector are eager to grow **horticultural exports**. Currently, horticultural export mainly targets the diaspora market in the UK, Middle East and Italy. However, several crops have been identified with good export potential, such as mango, tomato, brinjal and pepper. Phytosanitary standards and certification are some of the issues limiting the export to the EU. High cargo charges also contribute to a weak business case for export to overseas destinations. According to the branch organisation Hortex, key issues limiting Bangladesh horticultural exports are:

- Lack of infrastructure (quality packhouses), as required for export.
- Lack of quality packaging materials (currently substandard packaging is used in exports).
- Weak transport infrastructure.
- Limited capacity and possibilities to obtain GAP certification.
- Lack of accredited laboratories for testing and certification of Maximum Residue Limits (MRL).

4.3. Key horticultural value chains

Five horticultural value chains were selected for further study based on the findings of the desk study and initial interviews with the Netherlands Embassy in Dhaka, the Bangladesh Embassy in The Hague and the Netherlands Enterprise Agency. These are: tomato, onion, radish, brinjal and cabbage. A summary of the value chain analyses for the five crops is provided in this section while the extended version is attached in the Annex E.

There are three growing seasons in Bangladesh: Kharif-1 (summer, from mid-March to mid-July), Kharif-2 (late summer, from mid-July to mid-November) and Rabi (winter, November to March).

Tomato value chain

In Bangladesh, tomato is primarily a winter crop, but in recent years it has increasingly been grown during the Kharif (summer) season as well. Tomato is produced across Bangladesh, with major production areas in Rajshahi, Dinajpur, Comilla, and Mymensingh districts. The structure and functioning of the value chain, with lots of small producers and buyers, is similar in all production areas. Annually, Bangladesh produces 380,000 tons of tomato.

Tomato is an important commercial, cash crop that farmers have broadly adopted as a means to increase their income; profits from tomato cultivation are relatively high, both for farmers and for other value chain actors. Farming output, however, can still be improved considerably as tomato yield were only 14 t/ha in Bangladesh compared to 19 t/ha in India in 2016–2017[44].

Tomato is a culinary staple for Bangladeshis. It is widely used in curries and salads (fresh), but it is also the most important vegetable for processing. It is processed into tomato sauce and ketchup, both at household / cottage scale and at industrial scale. Certain quantities of tomato are imported to supply the industrial processing sector.

Seed requirements for tomato are 75 grams per acre or 6-8 thousand seedlings per acre. The national demand for tomato seeds is estimated at about 5 ton (half of which are hybrids and half are OP/open pollinated varieties). Hybrid tomato varieties are sold at up to Euro 800 per kg. 88% of tomato farmers use hybrid seeds.

The use of pesticides is abundant in tomato farming as the crop is very susceptible to pest and diseases.

The distribution of profits (in BDT per kg) in the commercial tomato value chain, based on hybrid varieties, is summarised in the following chart.

Figure 19: The distribution of profits in the commercial tomato value chain

Tomato value chain – issues and opportunities

- Tomato used to be primarily a winter crop, but currently it is increasingly grown year-round, with new types of tomato being introduced such as cherry tomatoes. There is a clear demand for quality seeds, particularly of varieties suitable for processing and those with longer shelf life.
- Use of hybrid seed varieties in tomato farming is increasing (overall hybridisation rate stands at 88%). Seed cost represents 5% of the total production costs at farmer level on average.

[44] Asian Development Bank (ADB) (2019), Dysfunctional Horticulture Value Chains and the Need for Modern Marketing Infrastructure: The Case of Bangladesh

- A range of local hybrid varieties is available and accepted by farmers (Lal Teer offers 11 varieties, ACI offers 3).
- Harvest and postharvest / marketing costs represent close to 50% of the total farming costs.
- Postharvest losses are up to 40% due to the use of open trucks and large size baskets. Introduction of plastic crates in post-harvest handling can improve the situation.
- There is a growing tomato processing industry (e.g. PRAN) whose need is not fully met by local production.

Onion value chain

Onion is a staple for cooking in Bangladeshi culinary practices. Practically all households buy onions throughout the year. Onion is not only grown locally but also imported in significant quantities, mainly from India and China. Recently imports have been registered from other countries, among which the Netherlands. Local production amounts to 1.8 million tons annually.

Onion seed is sown from the beginning of October to early December and is harvested from late April to mid-June. Seed requirements per acre are between 2-3 kg or 200-300 kg in case of bulbs. Higher yielding varieties and seedlings are available in the market and their share is increasing; however most onions are produced from farm saved seed and used for own consumption. Nearly 70% of the local production of onion comes from Pabna, Faridpur, Rajbari, Rajshahi and Kushtia districts. Productivity at a national level is roughly 4.2 tons per acre or 10.5 tons per hectare, which is lower than in neighbouring India (17 ton/ha) as reported in 2016–2017[45].

The position of different actors in the value chain and their average earnings (BDT per kg) are provided below.

Figure 20: The distribution of profits in the commercial onion value chain

Onion value chain – issues and opportunities

- In Bangladesh, onion is the horticultural crop with the highest share of imports (out of all vegetable imports). Any production increase will lead to import substitution; hence there is a large potential to increase domestic production.
- There is a large yield gap in onion farming – productivity improvements can have substantial impact. Increasing the application of high-yielding hybrid seeds can have a large impact.
- Hybrid varieties represent 14% of the production costs for farmers.

[45] Asian Development Bank (ADB) (2019), Dysfunctional Horticulture Value Chains and the Need for Modern Marketing Infrastructure: The Case of Bangladesh

- Appropriate storage facilities have the potential to decrease post-harvest losses, which are currently high.

Brinjal value chain

Brinjal (eggplant), was originally a winter crop. Thanks to the advancements in variety development it is now a year-round crop, with different varieties offered on the market, depending on the region (each production region has its own preferred variety). For farmers, it is a profitable off-season crop. Bangladesh produces 530,000 tons of brinjal annually. Winter brinjal is sown from October to mid-November and harvested from late November to mid-April. Seed requirements per acre are approximately 75 grams per acre or in case of seedlings 6-8 thousand per acre.

In addition to widespread local consumption, brinjal is also exported to different diaspora markets of Bangladeshi in a number of Middle Eastern and European countries. Prices fluctuate considerably, with spikes in off season i.e. early December, and during the month of Ramadan when it is used as one of the staples in the Iftar times (fast breaking meal).

It can be estimated that hybrid varieties of brinjal have a market size of approximately 20 ton, of which nearly 12 ton is supplied by Lal Teer Seeds. Farmers also procure seedlings from nurseries and other sources directly, for transplanting in their fields.

Brinjals are highly susceptible to pests and diseases, and it is generally observed that the use of pesticides is abundant. Farmers in the southern region of Bangladesh tend to cultivate brinjal earlier and also use excess quantities of pesticides. The use of pheromone traps has also increased significantly in the brinjal cultivation.

Farmers' share of the profits (BDT per kg) in the brinjal supply chain is relatively high, as shown hereunder.

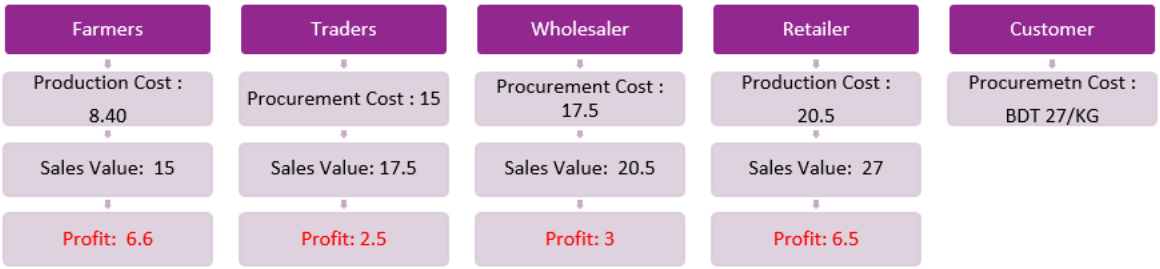

Figure 21: The distribution of profits in the commercial brinjal value chain

Brinjal value chain – issues and opportunities:

- Bangladesh imports quality brinjal seeds from different countries (mostly China, Thailand and India).
- Brinjal is sensitive to pest attacks; so pest-resistant varieties and improved crop protection are likely to improve productivity. Currently, pesticides constitute a major cost component for cultivations (39%), while seeds comprise 4% and fertilisers nearly 15% of the production cost.
- Bangladesh has many local brinjal varieties that are preferred by local consumers but also have a good potential for export (ethnic markets). Phytosanitary compliance is a challenge for exporters.

Cabbage value chain

Cabbage is one of the main vegetables in Bangladesh. The country produces 320,000 tons annually. It is a winter crop that is usually sown from late October to mid-November and harvested from early January to mid-March. Seed requirements per acre are 105-117 gram of seeds or 6-8 thousand seedlings. Early and late varieties of cabbage are particularly profitable in the Bangladeshi market.

Over the years the production of cabbage has increased significantly and is expected to rise further. Prices vary per season, being the lowest during the peak production, dropping to as low as BDT 5 per piece of roughly 800 g to 1 kg cabbages. During off-season (May to December) prices can go up to BDT 35-40 per piece. Advanced farmers therefore tend to engage in early variety cultivation. Cabbage is however a more sensitive crop requiring more care in comparison to other vegetables. Production is also labour intensive.

In the cabbage value chain, the profits are distributed as follows.

Figure 22: The distribution of profits in the commercial cabbage value chain

Cabbage value chain – issues and opportunities:

- Cabbage is primarily a winter crop, so there is a demand for summer varieties. Production of cabbage in Bangladesh has grown in the last years and the summer season in particular shows high growth rates.
- Cabbage seed prices are relatively high in comparison to other vegetables, yet the earnings are high for farmers, hence varieties and inputs that ensure high productivity can gain markets easily. Most farmers use hybrid varieties, so improved varieties with a wider sowing period, suitable for the summer season, will have good potential while also contributing to the distribution of production volumes and market stabilisation.

Radish value chain

Radish is one of the mass-produced vegetables in Bangladesh. 300,000 tons are produced annually. Radish, unlike various other vegetables, is easier to cultivate and does not require major inputs. Costs are primarily labour costs involved in harvesting and marketing. Radish prices are highly volatile - incidences have been reported of many farmers refusing to even harvest from their fields due to the prices falling below harvesting costs. However, these are isolated cases and farmers do stand to benefit from radish cultivation since the cost remains low and there are limited competing crops in the season.

The cultivation season starts from mid-August to early October and it is generally harvested from early January to mid-February. Radish cultivation is relatively evenly spread across the nation, with higher production in Bogra, Mymensingh, Naogaon, Rajshahi and Chittagong. Seed requirements per acre are approximately 3-4 kg. Usage of packaged seeds, i.e. quality seeds of improved varieties, is higher, and the practice of using farm-saved seed has gone down significantly over time. Given the approximate acreage of radish and the seed requirement it can be estimated that the seed demand is roughly 225 tons per year.

From the selected value chains, radish is the least cost- and labour-intensive, also delivering the lowest profits to farmers.

Figure 23: The distribution of profits in the commercial radish value chain

Radish value chain – issues and opportunities

- Although it does not generate high profits, radish requires little labour and inputs and is therefore widely grown in Bangladesh. It also does not compete with other crops in terms of sowing and harvesting time.
- The use of packaged (high quality) seed has increased while the practice of farm-saved seed has decreased. Varieties with a wider sowing period might find good uptake so that production can be spread more evenly across seasons.

Vegetable seed value chain

Key vegetable seed production areas are in the northwest of the country, in the Rangpur division. All districts of the Rangpur division are involved: Lalmonirhat, Rangpur, Kurigram, Dinajpur, Nilphamari, Thakurgaon, Meherpur and Panchagarh. The conditions for seed multiplication in terms of temperature and humidity are favourable in this region; furthermore there are areas that are dedicated to seed multiplication, which minimises the risk of pests and diseases being transferred from other vegetable farms.

The total demand for vegetable seeds is estimated at 4,500 tons per annum, of which 40% represents the demand for summer varieties and 60% for winter varieties. Local production (private sector and government sources) meets 83% of the demand for summer varieties and 80% for winter varieties[46]. The remaining demand is met by import, mainly from India, China and Thailand. The current import value of vegetable seeds is estimated at USD 28 million. There is a difference in the seed that comes from import: 90% of seed of hybrid varieties is imported, compared to 10% of seed of OP varieties.

[46] Study Findings, Ministry of Agriculture and Nil Sagor Seeds

Overall, horticultural farmers in Bangladesh have become increasingly aware of the benefits of improved, hybrid varieties. For all vegetable crops, the use of high-yielding varieties has grown in the past years. Local suppliers such as Lal Teer have invested substantially in bringing quality seeds to farmers through an extensive distribution network, numerous demonstrations, field days and training sessions. Hence, farmers have become interested in using improved varieties and when they are convinced of the benefits of a variety, their loyalty to a brand is high.

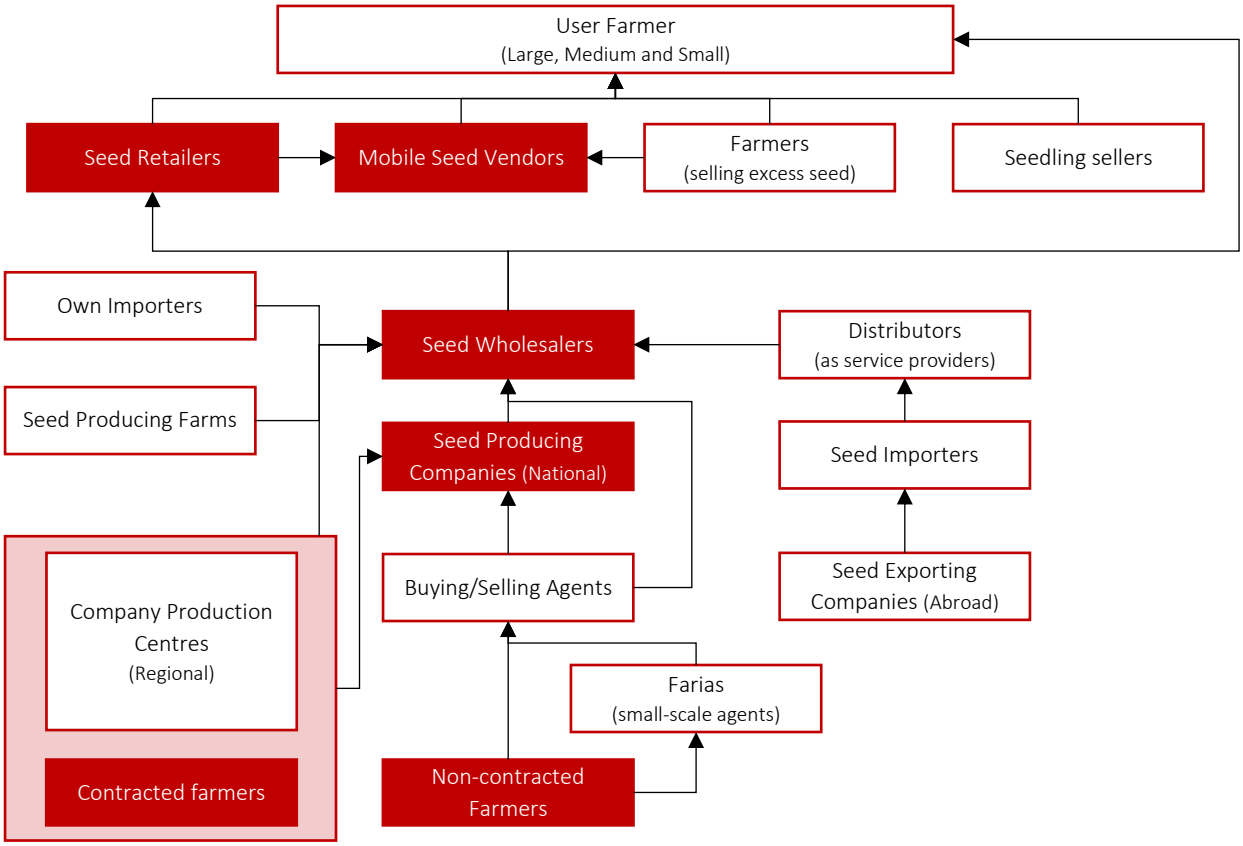

Figure 24: Vegetable seed value chain

Key actors of the vegetable seed supply chain are seed companies, contract and non-contract farmers, dealers (wholesalers), retailers and mobile vendors, as shown in Figure 24.

Seed companies

As mentioned in the Chapter 3.2 in the Vegetable seed sector section, over 40 global and national seed companies are active in Bangladesh. They engage in production, import, processing and marketing of OP (open pollinated) and hybrid seed varieties. Seed companies do not concentrate exclusively on vegetable seeds – Lal Teer is the only local producer with a focus on vegetable seeds, but Lal Teer also markets a range of cereal and rice seeds. For other major seed producers, vegetable seeds represent less than 10% of their total output. Larger seed companies have own R&D facilities for variety development and pre-commercial trials. Key local vegetable seed producing companies are Lal Teer Seed (currently market leader), ACI, United seeds, Metal, Mollika, 3S, Supreme, BRAC and Ispahani.

Bangladesh seed companies produce OP and hybrid vegetable varieties through the contract farming system. Usually, farmers are contracted for longer term (more than one year). In case of hybrids, farmers receive parental lines from the seed company and produce the first generation (F1). When ready, F1 seeds are bought back by the seed companies, which have their own processing and storage facilities where seeds are kept under controlled conditions and repacked before distribution.

Contract farmers

Contract farmers produce vegetable seeds in their field as per the contract with seed companies. The company provides training and technical support for these farmers. Furthermore, the company provides stock seeds (foundation seed and parental lines) to the contract growers and buys back the F1 seeds when ready for further processing and packaging.

Non-contract farmers

It is difficult to estimate the number of non-contract farmers who produce OP varieties for own use, as well as for the market. Such farmers sell their excess output to retailers or mobile seed vendors. This informal market is volatile and the quality of seeds distributed through this channel is low as non-contract seed growers do not receive any technical support.

Dealers/ Wholesalers

There are over 17,000 registered seed dealers or wholesalers in Bangladesh, who buy vegetable seeds from seed companies. They order and collect the seeds from seed companies and sell them to local retailers or mobile vendors. In some cases, dealers also sell directly to end users (farmers). Dealers are very important for seed companies as they are the ones who promote new varieties and provide instructions and advice to farmers. Dealers earn a commission of about 5-15% on the sales of seeds. In many cases, dealers also have their own seed production or source from farmers based on contract farming.

Retailers

There are approximately 160,000 seed retailers in Bangladesh that purchase vegetable seeds from dealers or wholesalers and sell them to the end users (farmers). Retailers are located both in market centres and in villages. Retailers also sell seeds to mobile street vendors, who cater to the more remote farmers, playing an important part in last-mile distribution. Retailers are in the rule micro- and small businesses dedicated to supplying seeds and other agricultural inputs and products in a certain area.

Mobile Seed Vendors (MSVs)

About 4,500 MSVs are estimated to be active in Bangladesh. They collect the seed from the company dealers as well as from the non-contract growers. MSVs sell seeds in local markets, or hat-bazaars, located in peri-urban and rural areas, including remote rural areas. They are an informal actor within the seed value chain and as such they are not registered with the government. Seed companies do not have direct relations with MSVs.

Bangladesh Agricultural Development Corporation (BADC)

Government agency BADC is the single most important actor in the cereal and rice seed value chains. In many ways it acts like a private seed company; it obtains OP seeds from BARI and BINA (Bangladesh Institute of Nuclear Agriculture), and produces foundation seed (FS) and certified seed (CS) of OP varieties through its network of contract growers. BADC buys back the seed from the contract growers. After processing and packing, BADC sells the seeds to farmers through their own distribution channel comprising around 7,000 dealers. BADC dealers supply the seeds to the retailers and MSVs. The share of BADC in vegetable seeds, however, is negligible.

5. Horticultural sector – institutional environment

5.1. Government institutions

Under the Department of Agricultural Extension a number of Wings are in place that govern different aspects of the horticulture sector. The three most important ones are the Horticulture Wing, the Seed Wing and the Plant Quarantine Wing. In addition, this chapter looks at the Bangladesh Agriculture Research Institute (BARI), and in particular the Horticulture Research Centre, as well as the Bangladesh Agricultural University. For each of these institutions the responsibilities and activities are described.

Ministry of Agriculture – Department of Agricultural Extension – Horticulture Wing

The horticulture wing is one of the eight wings of the Department of Agricultural Extension. The wing primarily deals with three activities: education, technology, and research and technology transfer. The Department of Agricultural Extension has 76 centres across Bangladesh. The wing thus plays an active role in the production and sales of seedlings. Apart from these activities the Department also implement projects with organisations like UNICEF and FAO. These activities range from promoting floating vegetable cultivation, safe (organic) production, post-harvest management, promoting medicinal plants, and introducing new crops like dragon fruit and strawberry. The Department and Horticulture Wing develop Annual Plans, but there is no overarching horticulture policy. Horticulture is included in the National Agriculture Plan and Delta 2100 Plan. The main challenges that the Wing experiences are limited resources and staff capacity to support the sector, e.g. in the area of technology demonstration (like simple shade net houses, with seed trays and quality seed, for demonstrating professional seedling production). Something similar could apply for rain shelters and agricultural fleece to promote vegetable production during the heavy rainfall seasons. In general, there is a need for low-cost technologies that can increase productivity.

Ministry of Agriculture – Department of Agricultural Extension – Plant Quarantine Wing

The Plant Quarantine Wing of the Ministry of Agriculture is the formal National Plant Protection Organisation (NPPO). The organisation is tasked with plant quarantine and phytosanitary standards, and is responsible for issuing phytosanitary certificates for exports of vegetables. The process of issuing phytosanitary certificates is done online. Companies can submit their requests online and submit the required documents. Phytosanitary inspection mostly take place at the central packhouse Shyamnagar (and a few at the airport). The amount of interceptions at the destination ports is low. The EUROPHYT annual report of 2019 indicates that products from Bangladesh were intercepted on 50 occasions (because of harmful organisms) and 42 times because of other reasons (mostly the absence of a plant passport). As such Bangladesh ranks among the countries with the highest number of interventions (e.g. alongside countries like China, the Dominican Republic, Israel, Kenya, Nigeria, Peru and Uganda). Table 3 shows the interceptions of Bangladeshi products in the EU for the period 2016-2021:

Table 3: Interceptions of Bangladeshi products in the EU for the period 2016-2021[47]

Bangladesh		2016	2017	2018	2019	2020	2021 Till April
Interceptions	Harmful organisms	98	9	28	50	13	8
	Other (e.g. paperwork)	46	12	27	42	31	15
	Total	**144**	**21**	**55**	**92**	**44**	**23**

Interceptions were highest in 2016 with especially fruit flies and thrips commonly found in shipments of gourds, brinjal and mangoes. Because of the high levels of interceptions Bangladesh imposed a self-ban on brinjal exports in 2017. During 2017 growers were better organized and trained, and the EU helped with setting up a testing facility in Symabazar. The EU also helped with support for the inspections. In 2019 there were 50 interceptions on the basis of harmful organisms; mostly citrus scab or more commonly called 'citrus cancer', and fruit flies for mango. At the moment Bangladesh is in discussion with USAID and USDA for capacity building activities. Especially in terms of paperwork quite a number of shipments have been intercepted; this is mainly due to the fact that the plant passport is absent. More inspections at the packhouse and airport could prevent these shipments leaving the country. In general, it's worth exploring how the Dutch phytosanitary service could support the further professionalization of the Plant Quarantine Wing of Bangladesh.

Ministry of Agriculture - Seed Wing

The Seed Wing of the Ministry of Agriculture oversees the implementation of the Seed Law and Seed Policy. As such, its primary objective is to serve as a Secretariat for the National Seed Boards. One of the most important tasks of the National Seed Board is the registration of crop varieties. Depending on the type of crop multi-annual trials need to be performed to assess its value for cultivation and use. Testing is thorough for so-called priority crops like rice; but vegetables are not designated as priority crops and the registration process is rather straightforward. For a seed company they need to have a registered dealership and submit the seed variety registration form to the Seed Wing. The variety registration application form is provided in Annex F. A one-season, one-location trial suffices with supporting documents (from trials implemented elsewhere). Imports of vegetable seeds are also quite straight forward and require an import permit. For obtaining the import permit the dealer requires a phytosanitary certificate, and business registration documents.

For vegetables the seed wing doesn't experience major challenges. However, with respect to the recently approved Plant Variety Protection Law, the Wing would appreciate support for the drafting of the regulations and subsequent training of staff of an envisaged Plant Variety Protection Office.

Bangladesh Agriculture Research Institute – Horticulture Research Centre

The Bangladesh Agricultural Research Institute (BARI) conducts research on a wide variety of crops, including cereals, tubers, pulses, oilseeds, vegetables, fruits, spices and flowers. Besides variety development, the institute also carries out research in the area of soil and crop management, disease and insect management, water management and irrigation, development of farm machinery, improvement of cropping and farming system management, post-harvest handling and processing, and socio-economic studies related to production, processing, marketing and consumption. They also have

[47] *European Commission (2021) EUROPHYT*

six special crop research centres, one of these centres is called the Horticulture Research Centre. The centre focuses on varietal development and post-harvest technology.

Like the horticultural wing indicated, there is a huge demand for low-cost technologies that can help farmers deal with heavy and unpredictable rainfall. Both rain shelters and shade houses are mentioned. Shade houses to protect the vegetables against too much sun and heat; and rain shelters to protect them against excessive rain. In addition, the research centre would like to focus more activities on climate change adaptation, e.g. through the testing of more salt tolerant vegetable varieties. The last topic mentioned is the introduction of post-harvest technology and in particular storage. It is estimated that 40% of all vegetables are lost due to inefficient logistics, lack of storage facilities and inadequate packaging materials. The research institute is especially interested in testing low-cost technologies for the storage and preservation of crops like onion, carrot and potato.

Bangladesh Agriculture University (BAU)

The Bangladesh Agriculture University (BAU) is the leading university for agriculture related studies in Bangladesh. The University is involved in both education programmes and research. BAU already works together with Wageningen University and Research (WUR) and has been involved in a number of projects supported by the Netherlands government (e.g. Blue Gold and NUFFIC). In discussion with representatives of BAU the following topics were mentioned as key priorities for Bangladesh's vegetable sector: climate smart agriculture (droughts, floods, salinization) looking at low-cost technologies that can support farmers (e.g. protected cultivation).

Main findings and recommendations

In general, all government organisations indicate that they are under-resourced in terms of staff and funding. Specific requests were formulated for support on low-cost climate smart technologies (e.g. together with the Horticultural Research Centre (as part of BARI) and/or the Horticulture Wing of the Ministry. In terms of regulations and inspection capacity, especially support for the drafting of Plant Variety Protection regulations was mentioned, as well as capacity building support to reduce the number of interceptions in the EU (of Bangladeshi fruits and vegetables). More specific recommendations for this are provided in chapter 6.2 and 6.3.

5.2. Sector issues and bottlenecks

The main sector issues can be organized around four topics that bring together the main sector trends (distilled from chapter 3) and findings of chapter 5.1 (institutional organisations):

- Climate change: production threats and need for adaptation measures
- Vegetable exports: competitiveness and government support
- Price volatility: predictability of prices and lack of transparency
- Increased urbanization and purchasing power

Climate change: Production threats and need for adaptation measures

The sector challenge most often mentioned by representatives from the government and private sector is that of climate change. Already vegetable farmers are experiencing more erratic rainfall patterns, and increased incidences of cyclones, floods and droughts. In particular, many stakeholders mentioned

shortening of the winter season and salinization of agricultural fields due to sea level rise. Coming to grips with these already existing and worsening threats requires action at both national (e.g. water management) and field level (e.g. protected cultivation and use of more salt tolerant varieties). Therefore, products, models and technologies that contribute to adaptation (and possibly mitigation) to climate change related risks are strongly required in Bangladesh. Opportunities for cooperation arise in joint research, technical assistance, development and introduction of new varieties and farming models.

Vegetable exports: competitiveness and government support

The second issue that we observed is the gradual increase of vegetable (and fruit) exports. Exports in 2019/2020 were up to USD 140 million per year. These exports are to a large extent destined for the Gulf countries (i.e., Saudi Arabia, UAE, Qatar and Kuwait), but also a number of EU countries with large Indian and Bangladeshi migrant communities import a lot (i.e. UK and Italy). Specific challenges that affect the export vegetable sector are compliance with phytosanitary standards and high cargo costs. With respect to the phytosanitary standards Bangladesh experiences high numbers of interceptions (both because of harmful organisms and paperwork issues). Given the EU's stricter regulations on imports of specific fruits and vegetables recently (following the new EU Directive, 2019/523), and especially for mango, citrus, eggplants and chilies. In terms of cargo costs, Bangladesh will need to compete with countries like Ghana, Kenya and Uganda for the exports of Asian vegetables and keep prices in sync with these countries. Smaller issues that need to be tackled to increase competitiveness of the export vegetable sector include quality packaging materials (and in particular the carton boxes) and GAP certification.

Price volatility: predictability of prices and lack of transparency

For the domestic market the largest complaint heard by producers and government representatives is that of price volatility. Due to its perishability and high price elasticity prices for vegetables fluctuate heavily during the year. The lack of predictability and transparency of market prices discourages farmers to invest in higher quality inputs and equipment (as returns for these investments are uncertain). Several solutions can be considered for this, including changing the production planning, broadening the crop portfolio and contract farming. In addition, government or research institutes can establish a market information system, so as to provide more transparency on market prices (e.g. on a weekly basis).

Increased urbanisation and purchasing power

Increasing urbanisation and growing middle class are the triggers for the development of the horticultural sector in terms of diversity of crops, product quality, food safety and delivery models. The number of middle-income and affluent consumers is expected to increase to 34 million by 2025. With the gross per capita income reaching USD 1,900 in 2019, increase in demand for quality food as well as a change in dietary preferences for safe and nutritious food have become palpable. The demand for fruit and vegetables in the capital of Dhaka is expected to increase from 2.0 million tons in 2017 to 6.6 tons in 2025.

This trend is expected to drive the demand for quality vegetables, as well as convenience food (e.g. ready to eat, sliced and diced, mixed pack vegetables). In many countries in Southeast Asia a combination of economic growth and increased focus on a healthy lifestyle has led to sharp rise in the demand for fruits and vegetables. In this regard, the emphasis on quality and food safety is likely to spur the demand for local GAP certification. Specialised wholesalers and retail outlets can benefit from this trend focusing on quality products and well-processed vegetables (at a premium price). In the past

years, some of the new entrants have developed controlled, traceable supply chains to meet the growing demand for quality products. Although carrying a strong potential for growth, this market can still be considered niche.

Insurance

Given the fact that vegetables are highly weather sensitive, insurance might be a suitable solution to stabilise farmer income. There have been developments in the agriculture insurance segment, with the likes of Green Delta Insurance having developed and implemented livestock related insurances. Similarly a few other development projects are also working in this space, such as Syngenta Foundation, piloting insurance products for two crops (beans and tomatoes).

6. Cooperation opportunities and in the horticultural sector

6.1. Private sector opportunities and recommendations

Seeds

Application of quality, approved or certified seeds by Bangladeshi farmers has considerably increased in the last decade. Formal seed value chains currently supply up to 100% of the seeds for some crops (e.g. cauliflower), while informal sources still dominate for others (e.g. beans, garlic). In Bangladesh, the National Seed Board publishes the seed standard for all the crops (see Annex G). Private sector, NGOs and BADC are the main distributors of quality seeds while informal sources comprise farmers' saved seeds, local markets and mobile seed vendors (although these also distribute certified seeds). Due to the lack of knowledge at farmers' and distributors' level, and limited inspection capacity, cheaper counterfeit products are broadly marketed as well, creating unfair competition for the producers of certified seeds. A recent study[48] has showed that seed marketing in Bangladesh is challenged by lack of market information, poor institutions and arrangements and weak transport and infrastructure, rendering the seed marketing system inefficient. Particularly the farmers in more remote areas have poor access to, and awareness of, quality seeds.

As the demand for vegetables is growing, with certified seeds gaining ground, there are opportunities to introduce new varieties of known crops, but also the seeds of new, currently less customary crops. Although such new horticultural crops have become available in Bangladesh, traditional taste preferences and social customs hamper stronger expansion of vegetables such as broccoli, cherry tomato and red cabbage, to name a few. Seed companies have been introducing new crops and varieties, which give good results in terms of yield and income, but broader uptake will require a stronger push, including awareness and promotional activities. For Dutch seed companies, crop diversification represents an opportunity, both in terms of marketing own vegetable varieties and in joint activities with local companies in promoting their varieties, given that some of the seeds are not suitable to be multiplied locally.

The following table shows the current share of 'formal' seeds in the overall supply, as a percentage of total seeds per crop and as a percentage of farmers using certified seeds.

Table 4: Share of formal seeds[49]

Crop	% of formal seeds out of total seeds	% of farmers using formal seeds
Tomato	57	88
Brinjal	46	37
Cauliflower	100	100
Okra	51	42
Beans	8	11
Lentils	34	35
Green chilli	57	41
Onion	85	87
Garlic	0	0

[48] Mustafiz, Shahriar, Akira Nakayasu, and Mamoru Itabashi. (2021), Marketing of Vegetable Seeds: Practice and Behavioral Inclinations of Vegetable Seed Sellers and Farmers in Selected Areas of Bangladesh

[49]

A range of certified seeds is available in the market, including those of OP and hybrid varieties. The prices also differ considerably. For example, small independent seed farmers sell tomato seeds at an average of USD 165/kg while the final retail price reaches up to USD 900/kg for the highest quality hybrid seeds produced by seed companies. Average sales prices of seeds for key vegetable crops are given in Table 5. As mentioned, there are large differences in pricing depending on the supplier, the season, the climate conditions and the import situation. For example, the price of onion seed increased from BDT 3,000 to BDT 12,000 (from USD 35 to USD 140) in 2020, after India banned onion export. A more detailed overview of seed pricing is given in Annex H.

Table 5: Average seed price

Crop	Average seed price (USD / kg)
Tomato	709.0
Onion	46.3
Cabbage	218.1
Brinjal	179.5
Radish	7.3
Bitter Gourd	115.2
Bottle Gourd	90.4
Sweet Gourd	141.3
Cucumber	252.1
Khira Cucumber	123.0
Wax Gourd	136.7
Sponge Gourd	104.4
Ridge Gourd	121.4
Snake Gourd	92.3
Chilli	457.2
Okra	19.8
Cauliflower	432.7
Kohlrabi	132.2
Carrot	107.2
Country Bean	6.7
Yard Long Bean	8.8
Indian Spinach	7.1
Spinach	3.0
Red Amaranth	4.5
Green Amaranth	3.8
Stem Amaranth	11.6
Kang Kong	3.6
Coriander	3.0
Pumpkin	146.7
French Bean	3.2
Broccoli	115.8

Depending on the structure of the value chain, distributors (traders, wholesalers, retailers) add 12-35% to the farmgate price of seeds. Independent traders, who buy directly from seed farmers and sell to other independent dealers and retailers, incur larger additional costs after buying the seeds; therefore their share in the total price is up to 35%. Their largest expense is transport, but they are also involved in cleaning, grading, treatment and packaging of seeds, and in some cases awareness, promotion and farmer training. Traders that buy graded, sorted and packaged seeds from seed companies usually earn about 12-15% of the seed price. On top of that, local retailers charge another 5-10%. Seed companies usually conduct promotion and training activities by themselves as they have a brand that they need to protect. Brand loyalty is quite strong in Bangladesh; when a farmer has seen the yield increase, the farmer will continue buying the same brand. This is a challenge for new entrants that wish to introduce new brands; a substantial period of field demonstrations is likely to be needed, supported by promotion and after sales support.

Larger seed companies are involved in seed multiplication based on contract farming, offering guaranteed purchase and price to its contract farmers. The following table provides an example of the price structure along the seed value chain for seeds produced by specialised companies.

Table 6: Price structure along the seed value chain

	Unit	Tomato	Brinjal	Cabbage	Radish	Onion
Seed price company to dealer	USD / kg	593.6	150.5	183.9	5.9	38.5
Seed price dealer to retailer	USD / kg	674.5	171.0	209.0	6.7	43.7
Seed price retailer to farmer	USD / kg	710.0	180.0	220.0	7.0	46.0

A recent study published in the MDPI's Agriculture Journal in 2021[50] investigated the business case for seed farmers, showing that seed farming is a profitable business. The study was conducted in three seed production areas and collected information from 100 farmers and 100 retailers. Average costs and revenues of seed farming for key crops that were included in the study are summarised in the Table 7 (the figures differ to some extent from national averages). The selling price in the table represents the farmgate price level.

Table 7: Average costs and revenues of seed farming

Seed for crop	Labour costs (USD)	Fertilisers & chemicals (USD)	Total costs (USD)	Average selling price (USD)	Net profit (USD)
Tomato	124.8	7.6	132.4	165.1	32.6
Brinjal	288.7	13.2	301.9	333.6	31.7
Cabbage	226.3	8.0	234.4	258.0	23.6
Pumpkin	416.3	9.9	426.2	466.8	40.6
Bottle gourd	177.0	4.3	181.3	201.5	20.2
Broccoli	225.1	8.0	233.2	222.9	-10.3
Cauliflower	279.6	5.3	284.9	243.6	-41.3
Cucumber	164.6	7.7	172.2	210.3	38.0

[50] Mustafiz, Shahriar, Akira Nakayasu, and Mamoru Itabashi. (2021), Marketing of Vegetable Seeds: Practice and Behavioral Inclinations of Vegetable Seed Sellers and Farmers in Selected Areas of Bangladesh

Protected horticulture

Horticultural farming in protected conditions is negligible in Bangladesh. Except for research stations of local universities, there are a few private sector companies that have engaged in greenhouse farming at any substantial scale. One example is Paramount group, which has established hydroponics farming with support from the Netherlands and is currently producing a range of fruits and vegetables for the Dhaka high-end market such as cherry tomatoes, melon, strawberry and capsicum. Other major users of greenhouse tunnels are seed growers and nurseries.

Potential for greenhouse farming for small scale farmers has been established and the government is encouraging investment in the technology. Greenhouse farming is both a means to extend the production season and utilise out-of-season advantages, and an effective solution for adaptation to climate change, particularly in saline-affected areas. Water and fertiliser consumption in greenhouses is optimised and use of chemicals for plant protection can be minimized (also making use of biological control), resulting in net savings on growing inputs. Despite the potential advantages, utilisation of greenhouse technology is low. Main reasons are the investment costs, limited awareness and knowledge at farmer level and the fact that Bangladesh has three open field growing seasons so that farmers are used to plant their crop mix of rice, vegetables and cereals / pulses / oilseeds, utilising the land throughout the year.

The last report on the status of greenhouse farming in Bangladesh dates from 2008[51]. At the time, 2 ha of land was used for protected horticulture. Main users were public universities and research stations, such as BARI seed production centre. A private sector company (Bangla-Dutch Agro Farm) operated the largest greenhouse (1.2 ha), producing a range of vegetables for local hotels and restaurants. Only low-cost and mid-range greenhouses were in operation at the time, and currently this is still the case. The simplest greenhouses are made of local bamboo and covered with plastic sheets. More durable polyethylene sheets with better isolation cost USD 1,750 per ton, or about USD 1,500 for 1,000 m2. Key suppliers of greenhouse materials come from India and China.

In addition to Paramount, which is currently the leading company in protected horticulture, other private and public stakeholders from the sector have also shown interest for protected horticulture solutions. Ministry of Agriculture and BARI are keen to promote greenhouse horticulture solutions to farmers to improve their income and climate resilience. A more detailed exploration of this sub-sector is required to establish the opportunities and the scope of potential collaboration of Dutch and Bangladeshi parties.

Post-harvest technology

The weak organisation of the horticultural value chain in Bangladesh, with its many small primary producers and traders, and a large informal market, is not conducive for service providers. Post-harvest services, such as collection, aggregation, storage, sorting and grading are limited. While substantial increases in horticultural productivity have been noted at farm level in the past decade, post-harvest losses have remained high (35-45%). Despite the fact that post-harvest losses have been acknowledged as one of the key challenges of the horticultural value chain, the interventions to improve the situation have been limited.

[51] Saha, Chayan & Sarker, A. & Alam, M. & Rabbani, M. (2008). Status of greenhouse cultivation in Bangladesh

Currently, the growing urban population drives the demand for quality, nutritious food. In response to this trend, some of the leading agri-businesses have stepped up and started investing in various parts of the value chain, including post-harvest infrastructure. Companies engaged in horticultural processing tend to establish their own supply chains, organising the farmers, training them and providing aggregation facilities to serve their own needs. Other companies deploy innovative models to connect farmers to finance, offer them improved inputs and / or guaranteed offtake, including interventions to improve post-harvest handling (plastic crates, temperature-controlled storage). Cold chain is essential for preserving the quality and extending the shelf life of perishable products, but at present, it is virtually non-existent. It is expected, however, that the growing retail sector (supermarkets) in urban centres will drive the development of cold chain.

In terms of post-harvest technologies, there are opportunities for providers of economical, small- to medium-range solutions for crop collection, storage, sorting and grading. In the sub-sector of onion, given its relative concentration in a few production areas, there is a strong need to improve post-harvest infrastructure. Some of the companies that focus on service provision are interested to develop efficient post-harvest chains at scale, introduce collection centres and post-harvest processing. As post-harvest technology is currently sourced mainly from India and China, price competitiveness is important. There are, however, large business conglomerates that are primarily looking for quality and technology and knowledge transfer; some of these companies have expressed interest to collaborate with Dutch technology suppliers.

Horticultural processing

Horticultural processing constitutes a small part of the overall food processing industry, which is worth USD 8.3 billion annually. Fruit and vegetable processing companies cope with various challenges, given the smallholder-based, scattered structure of the production. However, the growing demand for ready-made, pre-packed and convenience food, is expected to stimulate investments in processing. It is likely that additional support will be required to prepare small-scale producers to participate in processing-oriented supply chains. Main processed products are tomato paste and fruit juices.

6.2. Public sector recommendations

Looking at the vegetable sector threats and opportunities of 5.2, the following recommendations are proposed:

- Develop a research agenda for climate change adaptation, particularly for the vegetable sector. In particular, this agenda should include aspects of how to deal with heavy rainfall, floods and increased salinization. More research and development is needed in this area and both Bangladesh Agriculture University and Bangladesh Agriculture Research Institute (the Horticulture Research Centre) can play a role in testing low-cost technologies like rain shelters, agricultural fleece and salt tolerant varieties. Together with the Department of Agricultural Extension (at district level) and the private sector, innovations can be demonstrated and out-scaled to farmers. The Horticultural Wing of the Ministry could play a coordinating role for developing the research agenda.
- Support the government implementing a sound phytosanitary system. Looking at the ever-stricter phytosanitary standards in the European Union and the increase in exports of Asian

vegetables, Bangladesh's Plant Quarantine Wing needs to further professionalize its services. This includes both the inspection capacity (to detect harmful organism in export shipments) and the efficiency in issuing the right certificates.

- Development of a market information system for vegetable prices. The Department of Agricultural Marketing is collecting price data on a daily basis. However, this data is not presented in a very accessible way nor is it used by farmers for production decisions. As such, market prices can be communicated to farmers by short message service (SMS) or an app-based system accessible for farmers with smartphones. Price information could be collected on a daily or weekly basis from the most important wholesale markets in Dhaka and Chittagong.
- The sector could develop a local standard of Good Agricultural Practices. In a number of Asian and African countries a local (simplified) standard for Good Agricultural Practices has been developed. The standard (that comes with a label) informs consumers that the fruits and vegetable are of high quality and are safe. This type of standard often includes aspects of ensuring: a clean water source (for irrigation), proper selection and application of pesticides, and hygienic handling and packing practices. Often the initiative of such a local GAP standard is lies with the industry, in particular a number of larger supermarkets and wholesalers (e.g. like Global GAP). Government organisations like the Horticulture Wing of the Ministry can play a supporting role.
- Development of a Horticulture Strategy or Road Map. The above recommendations could be integrated into a more comprehensive Horticulture Strategy or Road Map. Given the specific position of the horticulture sector, its particular role in exports, health and nutrition attributes, fruit and vegetables' perishable nature and the concern for food safety issues, a dedicated strategy or road map is worth considering. Many other countries have developed such a document, providing guidance to the sector's transformation. The focus and scope of this report did not allow for the development of a road map. If taken on board, it is recommended to design a multistakeholder process (with a number of reiterative steps) with the sector to make such a document.

6.3. Collaboration opportunities

Several Dutch-Bangladeshi collaboration opportunities have been identified for the horticultural sector, ranging from scientific research and crop trials to joint production and distribution of vegetable seeds.

Both public and private sector actors in Bangladesh are interested in collaboration. The collaboration opportunities listed below are based on the initial business case analyses, the interest of potential partners, the available support and co-funding instruments. The list is not exhaustive as it is expected that more partnerships will develop following the presentation of this study and the matchmaking events. More information about various funding instruments is provided in Annex D.

- Onion (seed, production, post-harvest technology). An Impact Cluster could be formed around onion farming, given the fact that onion is the largest vegetable crop of Bangladesh with a total acreage of more than 425 thousand acres (or more than 170 thousand hectare). Importantly, Bangladesh is not yet self-sufficient in onion and there are sizable

imports of onion year-on-year (Furthermore, onion yields in Bangladesh are still low at around 10.5 t/ha (compared to 17.0 t/ha in India). Bangladeshi onion farmers mainly rely on farm saved seed and older open pollinated varieties. As such there is a clear need for improved varieties and technologies that can bridge the yield gap. On the Dutch side, a consortium comprising of companies at all stages of onion production (seed, crop protection, and good agricultural practices) and post-harvest handling could assist in this, creating opportunities for trade and joint investments.

- Vegetable seeds sub-sector offers a range of collaboration opportunities.
    - Representation: Some of the Bangladeshi seed companies are interested to represent Dutch seed companies and sell their seeds through their market channels. A number of Dutch seed companies don't have strong presence in Bangladesh, and these could be matched with Bangladeshi counterparts. Interested companies in Bangladesh indicate that variety demonstrations and organisation of field days will be important to kick-start sales and build a loyal customer base.
    - Joint projects or ventures: variety trials, seed production and distribution, saline- and drought-tolerant varieties, seed preservation technology. Given the strong interest of Bangladeshi seed companies, several partnerships can be developed in this area. Supporting instruments to explore the possibilities of bilateral partnerships (feasibility studies, investment preparation) include the Dutch DHI programme, Top Sector Horticulture (Seed money) and SDGP. When applicable, other suitable European organisations (such as the develoPPP programme of GIZ or NORAD in Norway) and global programmes (e.g. WE4F, Australian DFAT - Business Partnerships) could be approached as well. For the implementation of joint projects or establishment of joint ventures, funding is available at DGGF and FMO in the Netherlands. In addition, for the introduction of Dutch technology, products and services on the Bangladeshi market, support could be explored from the PSD (Private Sector Development) programme at RVO (joint missions, presentation at fairs, DHI instrument and impact clusters).
    - Research and Development: Bangladeshi government agencies and knowledge institutions are interested in joint R&D activities. K2K instruments (RVO and Nuffic) can be explored to facilitate such cooperation. In particular work on climate smart agriculture has been highlighted in this report, looking at building resilience against floods, droughts and salinization.
- Protected horticulture. Although Bangladesh has very little protected horticulture, larger commercial companies are interested to invest in protected cultivation. At the current stage of Bangladesh's development, and low average prices of vegetables (due to almost year-round production), only low-tech greenhouse/tunnel technology will be viable. With average tomato prices of EUR 0,20 per kg and for brinjal of EUR 0,27 per kg, it will be difficult to earn back the capital investments of tunnels and greenhouses. As such cheaper solutions like rain shelters and agricultural fleece will be more suitable, especially during the monsoon season. For nurseries some technology can be introduced, e.g. in terms of

substrate and seeding machines. As part of the matchmaking and possible trade mission, these can be further explored, and B2B linkages can be facilitated.

- Postharvest handling. Bangladeshi government institutions (BAU, BARI) and several larger Bangladeshi corporations are interested to invest in advanced technologies, both in the horticultural production (e.g. hydroponics) and post-harvest handling (sorting, packing, cooling, automation). Such sector leaders have the financial and technical capacity to adopt a range of new technological solutions, offering various opportunities for trade and cooperation.
- Horticultural farming systems (seed, farmer training, access to inputs). Given the dominance of smallholder farming in Bangladesh and the specific challenges of such production systems, Bangladeshi public and knowledge stakeholders are interested in collaboration with Dutch counterparts and in public-private partnerships. SDGP could be a suitable instrument to introduce novel solutions and models for inclusive, climate-resilient, sustainable horticultural production systems.
- Water and horticulture (building on the Delta plan, addressing salinity, water management). There is ample space to develop larger scale public-private interventions. Integration of water management and horticultural farming might be one of the possible topics. Circular horticultural chains could be another.
- Public partnerships. Interest has been expressed both in Bangladesh and in the Netherlands to cooperate on issues of phytosanitary systems, certifications (Global GAP / local GAP) and plant variety protection.
    - In particular the Netherlands is known for its risk-based management (and careful planning of inspections), as well as automating and digitizing the processing of phytosanitary certificates. For Bangladesh both elements are important as currently quite a number of shipments are being intercepted in the EU either because of the presence of harmful organisms, or faulty or absent paperwork. Sound coordination should take place with the Plant Quarantine Wing of the Ministry to further explore collaboration, as also USAID and the USDA have the intention to support this government service.
    - Regarding the variety protection, Bangladesh is in the process of developing a system for Plant Variety Protection (and potentially becoming a member of UPOV). Also here the Netherlands has gained much experience supporting countries in becoming UPOV-ready. The Dutch Ministry of Agriculture has already for a number of years established a PVP Toolbox that can act on requests of Embassies to support PVP activities. In the case of Bangladesh support for drafting the PVP Regulations and building the capacity of the PVP Office were mentioned as key priorities.
    - At the moment the Netherlands Food Partnership (NFP) and Seed-NL are in the process of developing a Seed Laws Toolbox. The Toolbox's focus and scope is wider than strictly Seed Laws and can involve a scoping study to assess key barriers to entry for Dutch seed companies. In addition, it could help in organizing a seed trade mission from the Netherlands to Bangladesh.

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This publication was commissioned by the ministry of Foreign Affairs.

Publicationnumber: RVO-199-2021/RP-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.