German Journal of Veterinary Research

eISSN:2703-1322

Review

Small-scale poultry production in Bangladesh: challenges and impact of COVID-19 on sustainability

Masudur Rahman[1], **Emdadul Haque Chowdhury**[2] **and Rokshana Parvin**[2*]

[1] Nourish Poultry and Hatchery Ltd., Dhaka, Bangladesh
[2] Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Article History:
Received: 04-Jan-2021
Accepted: 23-Jan-2021
***Corresponding author:**
Rokshana Parvin
E-mail:
rokshana.parvin@bau.edu.bd

Abstract

Poultry meat is an important source of animal protein in Bangladesh. Small-scale poultry production plays a crucial role in the socio-economic development and nutritional requirements of rural and peri-urban households and provides an income source for resource-poor areas. Therefore, focusing on small-scale poultry production remains important. However, improper management, disease outbreak, market volatility and many other factors are typically responsible for the sustainability of this rising prospect of small-scale poultry production potential. The recent pandemic coronavirus disease of 2019 (COVID-19) tremendously influenced the sustainability of the small-scale poultry sector. This review addressed Bangladeshi small-scale poultry production and its market value, identified issues, and suggested potential guidelines to sustain the small-scale sector.

Keywords: Bangladesh, Poultry Industry, Small-scale Poultry, Value Chain, Emerging Disease, COVID-19, Sustainability

Citation: Rahman, M., Chowdhury, E. H., and Parvin, R. 2021. Small-scale poultry production in Bangladesh: challenges and impact of COVID-19 on sustainability. Ger. J. Vet. Res. 1(1):19-27. https://doi.org/10.51585/gjvr.2021.0004

Introduction

Poultry is one of the most important sub-sectors in the livestock industry. It contributes unstinting to the economy by creating the employment opportunity for the rural and semi-urban inhabitants, accessible protein sources of diets for the growing population and income sources for millions of people in Bangladesh (Sonaiya and Swan, 2004; Dolberg, 2008; Saleque and Ansarey, 2020).

Commercial poultry production in Bangladesh has emerged as one of the country's fastest growing industries in the last decades. Chickens are the most common raised poultry birds in the country. Along with chickens, some other poultry, such as turkey, quail, duck, geese, and pigeon, also gain popularity day by day (Dolberg, 2008; Roy's Farm, 2020). Poultry meat and egg have become one of the major animal protein sources in Bangladesh due to their affordable price and availability (Saleque and Ansarey, 2020; Light Castle Analytics Wing, 2020). Meat and egg consumption have been increasing in the country with the growth of its per capita (BPICC, 2020). Therefore, poultry farming is considered a poverty reduction strategy in Bangladesh and one of the vital components of the agricultural economy that fulfill various activities, including food, nutrition, income, and savings, social and cultural functions (Rahman et al., 2020). Employment opportunities are decreasing day by day due to rapid population growth. Commercial poultry farming is a great income and employment source being self-dependent (Roy's Farm, 2020).

However, the average meat and egg consumption levels are still low compared to the developed countries. Demand for poultry products has been increasing rapidly in Bangladesh due to the low income and rapid population growth, urbanization, lifestyle changes, and dietary habits. These factors have led to the industry's growth and expansion of markets that created income and employment opportunities for small-scale and poultry producers (Jabbar et al., 2005; Raha and Raha, 2007; Rahman et al., 2014).

Despite the scope of expansion, several barriers restrict the development of small-scale poultry production in Bangladesh. Drop-out of poultry farms is reported and the reasons highlighted are unstable market, high input prices and low product prices, disease outbreaks or natural calamities like flood and others (Jabbar et al., 2011; Islam et al., 2014). Small-scale

producers have weak access to formal institutions of support service for finance, health, inputs and outputs, and the market. They are constrained by the lack of capital, skills, knowledge, and modern technologies (Islam et al., 2014; Rahman et al., 2014). Because of their inability to produce high-quality goods at reasonable costs to enter urban markets, they have captured only a small share of the expanding markets that resulted from the lack of access to knowledge, expertise, technologies, and other infrastructure. This increases the transaction cost of production for small-scale producers (Jabbar et al., 2007). Generally, small-scale farmers are not organized to receive government support, which led them to encounter poor quality management and low-quality output from their poultry farming. Therefore, they sell their product at a lower price to the local market due to the country inappropriate market structure.

In this review, obstacles of small-scale poultry farming and extended guidelines are proposed to fill the poultry business knowledge gaps in Bangladesh.

Material and Methods

Search strategy

The terms "small-scale poultry", "poultry production in Bangladesh", "challenges and poultry production", "sustainability", "economic sustainability", "poultry value chain", and "disease impact" were searched in Web of Science, NCBI, SCOPUS, Elsevier, and Medline, yielding 456 results. The search was refined by research area, and closely related articles were selected (eliminating 249 results) based on the relevance to the title and then the abstract (eliminating 199 results), leaving 50 articles reviewed in full. Information was also collected from the Food and Agriculture Organization of the United Nations (FAO) document repository, The Poultry Site, The Bangladesh Poultry Industries Central Council (BPICC), Department of Livestock Services (DLS) under the Government of Bangladesh websites. Reference lists from selected documents, knowledge of co-authors and field experiences were utilized to enrich the information source.

Assembling of information and summarization

Relevant information was undertaken to verify further information from the preferred literature. The definition of the important terminologies was corroborating with multiple literature reviews. Bangladeshi poultry production systems and sustainability issues were mainly demonstrated by comparing different statements and subsequently dividing them to correlate with their statement. Any bias was excluded during literature selection and extraction.

Results

The poultry industry in Bangladesh and its contribution to the gross domestic product (GDP)

There are mainly two types of poultry farming in Bangladesh: traditional backyard and commercial farming. According to farm size, commercial farming in Bangladesh is categorized into small, medium, and large-scale (Dolberg, 2008; Parvin et al., 2020), following the sectoring approach. The commercial poultry sector using improved technology, and management has started to grow promptly since the early 1990s in response to the demand (Jabbar et al., 2007; Hamid et al., 2016). The country's poultry population has increased from 91 million in 1990 (Jabbar et al., 2007) to 356.318 million in the fiscal year 2019-2020, as reported by the Department of Livestock Services, Government of Bangladesh (DLS, 2020), due to the expansion of the commercial poultry sector.

The poultry sector's total investment has also increased to about 350 thousand million BDT for the last fiscal year (BPICC, 2020). As a result, about 1,50,000 poultry farms are involved in commercial farming (Mandal and Khan, 2017). Consequently, the industry provides employment opportunities for approximately 6.0-8.0 million people, of which the majority are unemployed youth and women (Ahmad, 2019; Saleque and Ansarey, 2020; One Health Poultry Hub, 2020). The annual egg and meat production in 2019-2020 have recorded 17364.3 million and 7.674 million metric ton against the demand of 17659.2 million and 7.437 million metric tons, respectively. Thereby per head eggs, and meat consumption has also increased (DLS, 2020). The contribution of livestock in the total GDP has recorded 1.47% in the 2018-2019 fiscal year with a growth rate of 3.47% (DLS, 2020). The commercial poultry sector in Bangladesh consists of some common features mentioned in Table 1 (Rahman et al., 2017; BPICC, 2020; DLS, 2020; One Health Poultry Hub, 2020).

Commercial poultry production requires a long backward linkage that starts from 'Pure Line' to commercialize Day old chick (DOC). In Bangladesh, poultry production starts from Grand Parent (GP) stock level followed by breeder farming for Parent Stock (PS) to commercial broiler or layer with the close integration with feed mills and hatcheries (Figure 1).

Small-scale poultry farms in Bangladesh

Defining small-scale poultry farms is difficult because it depends on purpose, size, and resources (Khalil et al., 2017). However, small-scale poultry farms refer to a farmer who suffers from a lack of capital with limited access to credit and inputs (Saddullah, 2000) as a realistic experience from the field; the flock size can range from a minimum of 500 to a maximum of 2500 birds. Previous studies have shown that most of the farmers rear about 500 to 3000 birds per batch in their farm, while a small portion rear about 100 to 500 birds (Sheel and Sen, 2013; Rahman, 2014). Another study showed that small-scale broiler farmers use 0.04 to 1 acre land for their farming, employing 1 to 6 workers with a maximum capital investment of around 1 million Bangladeshi Taka (Huque et al., 2011; Rahman et al., 2014, 2020).

Small farms are operated in rural areas with improved traditional methods (Sultana et al., 2013; Saleque and Ansarey, 2020) and are increasingly showing a significant role in accelerating the food and nu-

Table 1: Summary of the poultry industry in Bangladesh

Item	Details
Number of grandparent (GP) stock Farm	16 (8 companies)
Number of parent stock (PS) farm	206 (small and large)
Number of poultry farms as a whole (number)	150,000
Poultry population (number)	356.318 million
Weekly broiler production (number)	Around 17 million
Weekly layer chick production (number)	1.4 million
Weekly chick production (number)	6.7 million
Number of feed mill	198 (Registered)
Industrial feed production	5.3 to 5.4 million metric ton
Poultry meat production	3.1 million kg per day
Commercial egg production (piece)	33 million per day
Share of broiler meat of total meat consumption	Around 40%
Yearly broiler meat consumption per capita	6.8 kg yearly
Yearly egg consumption per capita (piece)	103
Contribution of poultry sector to the GDP	1% (approximately)
Employment in the poultry sector (overall)	6 to 8 million
Investment in poultry (last fiscal year)	BDT 350 thousand million

tritional security of the poorest households (Ahuja and Arindam, 2007; Rahman, 2014; Rahman et al., 2020). However, it is becoming more competitive day by day for the unprofessional management system, including many other factors discussed below.

Poultry Value Chain (PVC)

The importance of poultry and its marketing chain is a starting point for owners and traders to understand the production of small-scale poultry that can lead to household income and well-being (Minot and Hill, 2007; Rota, 2010). Several operations are incorporated into the value chain, such as commercial breeding of DOCs, input supply (feed, vaccine, and medicines), production of broilers or layers, collection, trading and eventually consumption (Khaleda, 2013). In Bangladesh, producers, integrators, dealers, suppliers, whole-sellers, retailers, and traders are involved in the PVC to complete the full marketing cycle (Figure 2.

Dealers all around the country play a vital role in bridging between the large integrators and small-scale farmers (Rashid et al., 2004; Mandal and Khan, 2017). They sell DOC, medicine and feed to small-scale producers and buyback goods to raise cash and sustain the production cycle but do not take responsibility for helping small-scale farmers. Therefore, direct integration is disrupted between small farmers and large entrepreneurs, resulting in additional operating costs. Due to the complex marketing system (live bird market) in the country, farmers cannot sell their products directly to the consumers, as shown in Figure 2. Small-scale farmers are thus deprived of the optimal profitability of existing PVC.

Obstacles in small-scale poultry farming in Bangladesh

General observation

Small-scale farming is gradually becoming more competitive and often passes unpredictable periods sharing profit or loss (Huque et al., 2011). The family members and women typically involved in the rearing are mainly illiterate to secondary educational background and involved in other occupations besides their household activities (Das et al., 2008; Islam et al., 2015). Most farmers do not even have experience in poultry farming, training on biosecurity and management system (FAO, 2010; Pica-Ciamarra and Dhawan, 2010; Rahman et al., 2020).

On the other hand, small-scale farmers are dependent on local dealers for DOC, feeds, medicines, and other operational capital (Rahman et al., 2014; Islam et al., 2015; Mandal and Khan, 2017). Compared to the large-scale farms, small farmers gain less benefit due to high production costs per unit for their small flock size (Rahman et al., 2014; Hassan, 2020). Small-scale poultry producers run their business with rela-

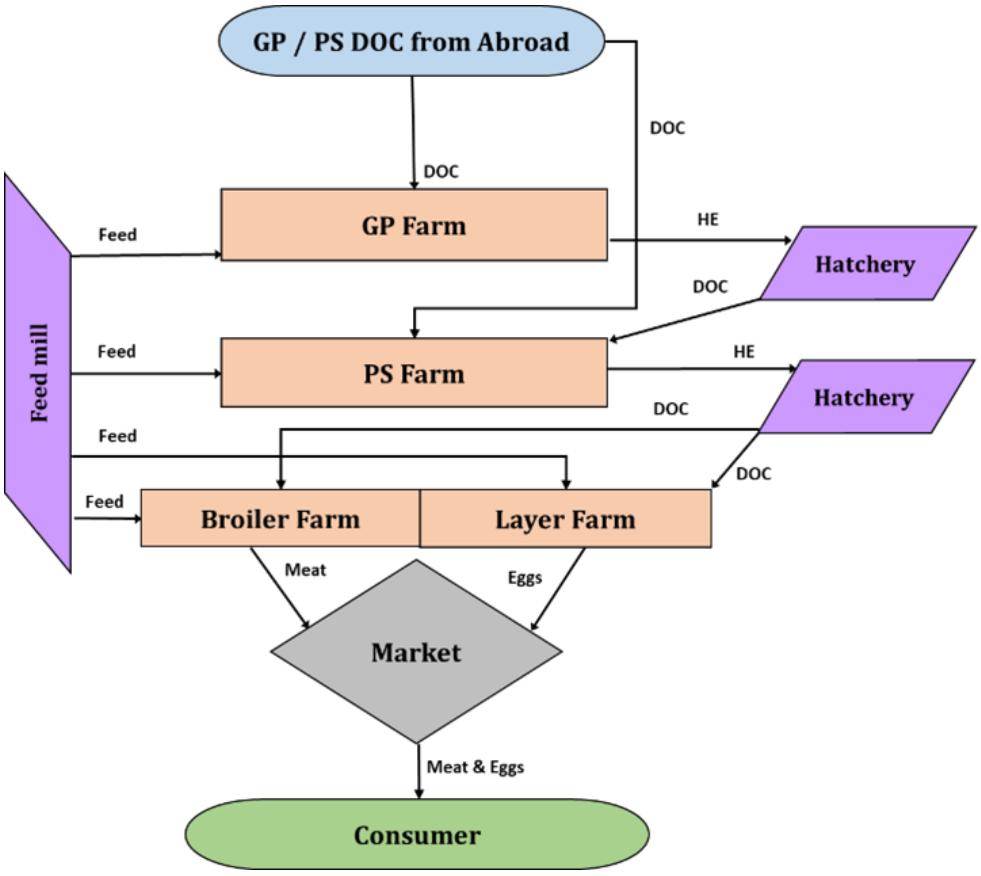

Figure 1: Flowchart of commercial poultry production chain in Bangladesh

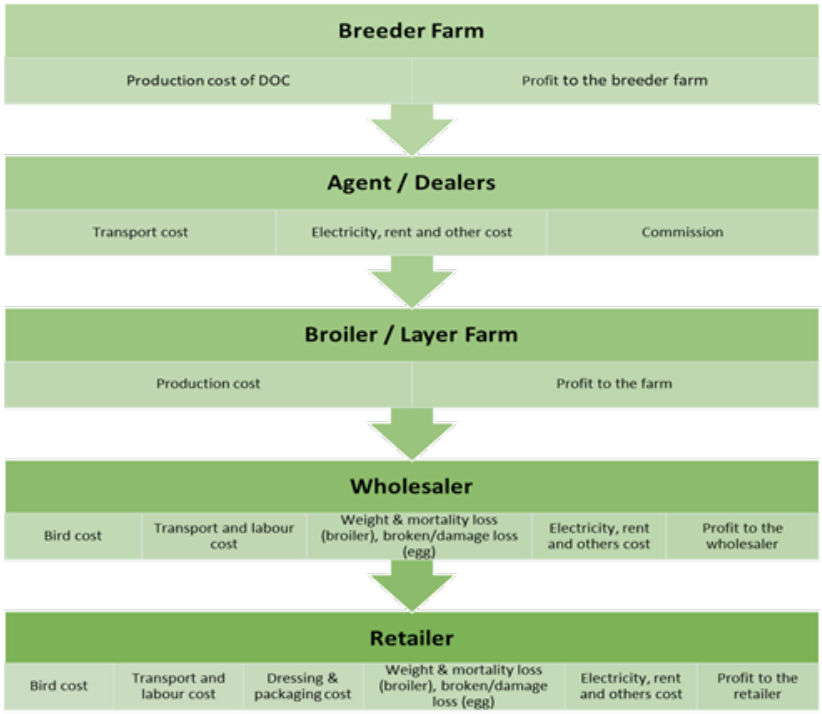

Figure 2: Small-scale farmers are thus deprived of the optimal profitability of existing PVC

tively low profit and bear a significant risk due to fluctuation of the price for input and output (The World Bank, 2008; USAID, 2008; Islam et al., 2015; Mandal and Khan, 2017). The print or electronic media report drop-out of large numbers of poultry farms several times, and the reasons highlighted are unstable market, high input prices and low product prices, disease outbreak or natural calamities like flood and others (Jabbar et al., 2011; FAO, 2012; Islam et al., 2014). Shifting of the farming pattern (among different poultry types) was also seen among the small farmers due to business failure (FAO, 2010; Jabbar et al., 2011). Negative propaganda against commercial poultry meat and egg consumption usually negatively impacts meat and egg resulting in losses for the poultry entrepreneurs.

Impact of emerging and re-emerging diseases on small-scale poultry production

Endemic circulation of Avian Influenza (AI) along with other infectious diseases like Newcastle Disease (ND), Infectious Bronchitis (IB), Infectious Bursal Disease (IBD), Salmonella infections, Mycoplasmosis, Coccidiosis and Aflatoxicosis have a significant drawback for the sustainability of small-scale poultry farms in Bangladesh. The negative economic impact is often related to disease outbreaks either individually (monocausal) or synergy with various other factors (multicausal) related to poultry farming and the marketing system followed by unrestricted, scattered poultry movement throughout the country. The farms are often located in high-density areas and bear high risks of losing their small investment in poultry farming in case of infectious disease outbreaks (Sonaiya and Swan, 2004; Uddin et al., 2013; Mandal and Khan, 2017).

Improper management of poultry rearing and biosecurity practices in small-scale poultry farms allows frequent uncontrollable infectious disease outbreaks with economic losses (Parvin et al., 2020). The endemic spread of H5N1 highly pathogenic avian influenza virus (HPAIV) and H9N2 low pathogenic avian influenza virus (LPAIV) causes substantial financial losses where commodity shortage causes higher prices (Parvin et al., 2018). The poultry market ultimately collapsed, and all the money was lost, especially to small-scale farm owners.

The current Coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), significantly hinders global poultry production growth. Bangladeshi poultry farming has no differences, mainly because the small-scale farmers are suffering severe economic loss for the COVID-19 crisis (Al-Khalaifah et al., 2020; Saleque, 2020). It has caused severe damage to the marketing and distribution networks where farmers have failed to receive necessary supplies such as DOCs, feed, vaccines, medicines, and utensils due to the lockdown measure of controlling the pandemic situation. Additionally, rumors, especially in social media, about SARS-CoV-2 transmission through poultry and poultry products, people are unwilling to eat. Therefore, farmers could not sell their ready products at the desired price. Meanwhile, after selling chickens, many farms can not start new batches that have seriously affected the entire poultry value chain and created an unwanted mismatch between the demand and supply (Mahmud, 2020; Saleque, 2020). Over the last few months, the gross loss of approximately BDT 70 thousand million of the total investment of 350 thousand million has been noted (Saleque, 2020). About 25-30% of poultry entrepreneurs have lost their working capital, where a considerable number of small-scale farmers are also included and eventually suffer tremendous economic losses (Mahmud, 2020; Saleque, 2020). Similarly, the other major poultry companies in Bangladesh have been affected by the restriction of staff movements and transportation between the branches of the company, the export and importation of goods, the closure of banks, the increase in the costs, sales and marketing of imported and local vaccinations and drugs. The effect of the crisis in small-scale poultry production remains unnoticed and estimated poorly, thereby actual loss on poultry meat and egg production is not clear.

Nevertheless, the COVID-19 pandemic globally affecting poultry consumption, transport, the economics of poultry farming, consumer trust, product quality and protection, product types, and disease emergence and re-emergence that continue to pose significant challenges to the current situation and the industry's strategic future (Hafez and Attia, 2020). Considering the crisis mentioned above that hindrances the growth and expansion of small-scale poultry farming in Bangladesh, it is summarized in Table 2.

Recommended guidelines for the sustainability

The equity of small-scale poultry farming is the foundation blocks of commercial poultry that support both vertical and horizontal expansion of the industry. The expansion of small-scale poultry production is related to food security and employment opportunity. Therefore, it is essential to develop and ensure the small-scale poultry sector's sustainability by involving different multidimensional units. Here, we have highlighted some key points that can improve the current situation:

- Poultry production in the country needs more attention from government bodies' policymakers. For example, a firm policy is essential for the entry and exit into the poultry farming business.
- The government can encourage the provision of support services by private sectors and non-governmental organizations (NGOs) that reinforce farmers' collective core competencies through various types of production efficiency, product quality, and easy access to market-oriented services actions.
- Effortless access to low-interest credit from financial institutions helps to handle the resources needed to start farming.
- Farmer's knowledge and skills can be improved by providing training and hands-on practice

Table 2: List of problems for small-scale poultry farming in Bangladesh

Parameters	**Limitation of the small-scale farms in Bangladesh** [1]
Capital	- Generally, small-scale farmers lack resources, use their savings as capital, and often rely on financial loans. - Have no access to formal financial institutes for credit. - The high rate of interest for bank loans in the poultry sector. - Non-institutional microcredit loan with high interest. - Credit receives for inputs from the dealers/agents with high prices.
Education and knowledge	- Most farmers have no institutional training on poultry farming. - Lack of enough educational qualification and farming experience.
Biosecurity and management	- No or minimum biosecurity knowledge. - Less implementation performance. - Weak in decision making and in taking on challenges.
Disease outbreak	- Emerging and re-emerging infectious disease outbreaks like AI, ND, IB, IBD, *Mycoplasma*, *Salmonella* infections, coccidiosis, including other common circulating pathogens.
Adverse condition	- Natural calamities: flood, cyclone, temperature stress. - Current COVID-19 pandemic.
Supply chain	- Dependency on the dealers/agents for DOC feeds, medicines, and other operational necessities.
Market	- Weak infrastructure and marketing system. - Demand and supply miss-match. - Information gap on market stability and estimation. - Poor negotiating capacity.
Competition	- Large entrepreneurs appear to favor themselves. - High per-unit production cost due to small flock size. - Weak forward linkage among the small-scale farms.
Propaganda	- Rumors on commercial poultry and poultry products. - Disease transmission.
Veterinary and extension services	- Poor access to veterinary and extension services of DLS. - Insufficient number of veterinary hospitals and veterinarians. - Lack of skilled veterinarian. - Inadequate extension programs towards the needs. - Incoordination in technical services between government and private organizations. - Less regulatory control.

[1] Sources:(Rashid et al., 2004; Ahuja and Arindam, 2007; Jabbar et al., 2007; Minot and Hill, 2007; Dolberg, 2008; USAID, 2008; Pica-Ciamarra and Dhawan, 2010; FAO, 2010, 2012; Uddin et al., 2013; Islam et al., 2014; Moniruzzaman and Jahan, 2017).

through extension services. Awareness builds up, providing basic biosecurity guidelines (e.g., leaflets), and convincing farmers to implement the proper guideline could help the small-scale farmers.

- A complete and accessible support service package is essential for developing small-scale farmers for poultry operations. Moreover, support services for the farmers should meet their demands, and it should be a long-term perspective.
- Establishing a robust, organized marketing channel and planned guidelines for the farmers, middlemen/brokers can be eliminated, and small farmers will get higher profit.
- Improving infrastructure such as highways, the market, and the information communication system so that farmers can connect on time with the right channel and transport their product without suffering in the right place.
- Farmers' association may be a valuable process to lift their voice against the broker, agent, or middle-forced man's discourse.
- Different organizations, such as the poultry producers association, traders' associations, and intermediaries, may play an important role in PVC's efforts to reduce transaction costs and simplify poultry business through local, regional, and national market integration.
- Vertical integration through contract farming can be an alternative way for small-scale farmers to access all PVC steps and sustain themselves in the markets.
- DLS, the poultry sector and related organizations should build public awareness about poultry meat and eggs' nutritional value. Print-electronic and social media should be more vigilant and authentic in spreading any news that misleads customers.
- Establish adequate legislation to help small-scale poultry farmers without undermining large-scale poultry production facilities. Most importantly, veterinary authority in farming supervision includes applying biosecurity measures, medications, disease outbreak control, monitoring the live bird market, transferring live birds towards the market, improving farm infrastructure, and participating in national control strategies

Conclusions

The organized poultry farming provides a path for the small-scale farmers to improve their production efficiency, reduce transaction cost, and contribute to gaining economic sustainability for the small-scale producers that will help improve their livelihoods. The transformations of small-scale poultry farming can respond to the challenges facing the farmers and can only be driven through deeper national and local understanding and alliances for change governmental policies and public investment.

However, the small-scale farmers need to have greater access to finance, training, day-old chick quality, feed with reasonable prices, poultry health and biosecurity services, innovation, and technology to improve production. The optimum price for their output will boost their income and livelihoods and help them be sustainable for poultry farming.

Article Information

Funding. This research was supported by the experiments done under the project funded by The World Academy of Science (TWAS), grant number No. 20-284 RG/BIO/AS-G–FR3240314166.

Conflict of Interest.The author declares no conflict of interest.

Acknowledgments.Authors are thankful for the technical assistant to Md. Shafiqul Islam and Md. Ripon, Department of Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh.

References

Ahmad, R., 2019. Bangladesh's poultry sector gearing up for export in 5-yr time. URL: https://newssummedup.com/summary/USDA-Bangladesh%E2%80%99s-poultry-sector-gearing-up-for-export-in-5-yr-time-ca8uoy.

Ahuja, V., Arindam, S., 2007. Scope and space for small scale poultry production in developing countries. URL: http://www.fao.org/ag/againfo/home/events/bangkok2007/docs/part3/3_3.pdf.

Al-Khalaifah, H., Al-Nasser, A., Abdulmalek, N., Al-Mansour, H., Ahmed, A., Ragheb, G., 2020. Impact of SARS-con-v2 on the poultry industry in Kuwait: A case study. Frontiers in Veterinary Science 7, 577178. 10.3389/fvets.2020.577178.

BPICC, 2020. Egg industry in Bangladesh. URL: http://www.bpiccpoultry.com/pages.php?pageID=egg-production&mID=2.

Das, S., Chowdhury, S., Khatun, M., Nishibori, M., Isobe, N., Yoshimura, Y., 2008. Poultry production profile and expected future projection in Bangladesh. World's Poultry Science Journal 64, 99–118. 10.1017/S0043933907001754.

DLS, 2020. Livestock economy at a glance 2019-2020. URL: http://www.dls.gov.bd/site/page/22b1143b-9323-44f8-bfd8-647087828c9b/Livestock-Economy.

Dolberg, F., 2008. Poultry sector country review: Bangladesh. URL: http://www.fao.org/3/aak069e.pdf.

FAO, 2010. Smallholder poultry production – livelihoods, food security and sociocultural significance. URL: http://www.fao.org/3/al674e/al674e00.pdf.

FAO, 2012. How can animal health systems support small-scale poultry producers and traders? reflections on experience with HPAI. URL: http://www.fao.org/3/i2739e/i2739e00.pdf.

Hafez, H.M., Attia, Y.A., 2020. Challenges to the poultry industry: Current perspectives and strategic future after the

COVID-19 outbreak. Frontiers in Veterinary Science 7, 516. 10.3389/fvets.2020.00516.

Hamid, M., Rahman, M., Ahmed, S., Hossain, K., 2016. Status of poultry industry in Bangladesh and the role of private sector for its development. Asian Journal of Poultry Science 11, 1–13. 10.3923/ajpsaj.2017.1.13.

Hassan, M., 2020. Socioeconomic state of sample layer farmers in Bangladesh: An investigation based on dhaka and kishorganje districts. URL: https://search.proquest.com/openview/937d679b114df260411395699f6fbc56/1?pq-origsite=gscholar&cbl=38282.

Huque, K.S., Saleque, M.A., Khatun, R., 2011. Commercial poultry production in Bangladesh. URL: http://wpsa-bb.com/wp-content/uploads/2016/04/Keynote-Paper-7th.pdf.

Islam, M.K., Uddin, M.F., Alam, M., 2014. Challenges and prospects of poultry industry in Bangladesh. european journal of business and management. European Journal of Business and Management 6, 116–124. URL: https://www.iiste.org/Journals/index.php/EJBM/article/view/11443/11790.

Islam, M.S., Begum, I.A., Kausar, A.K.M.G., Hossain, M.R., Kamruzzaman, M., 2015. Livelihood improvement of small farmers through family poultry in Bangladesh. International Journal of Business, Management and Social Research 01, 61–70. 10.18801/ijbmsr.010215.07.

Jabbar, M.A., Islam, S.M.F., Delgado, C., Ehui, S., Akanada, M.A.I., Khan, M.I., Kamruzzaman, M., 2005. Policy and scale factors influencing efficiency in dairy and poultry production in Bangladesh. URL: https://hdl.handle.net/10568/402.

Jabbar, M.A., Rahman, M.H., Talukder, R.K., Raha, S.K., 2007. Alternative institutional arrangements for contract farming in poultry production in Bangladesh and their impacts on equity. URL: https://hdl.handle.net/10568/217.

Jabbar, M.A., Rahman, M.H., Talukder, R.K., Raha, S.K., 2011. Exit from Bangladesh's poultry industry: Causes and solutions. URL: https://hdl.handle.net/10568/16379.

Khaleda, S., 2013. The poultry value chain and sustainable development of poultry microenterprises that utilize homestead lands: A case study in gazipur, Bangladesh. Land Use Policy 30, 642–651. 10.1016/j.landusepol.2012.05.010.

Khalil, C.A., Conforti, P., Ergin, I., Gennari, P., 2017. Defining small scale food producers to monitor target 2.3. of the 2030 agenda for sustainable development. URL: http://www.fao.org/3/i6858e/i6858e.pdf.

Light Castle Analytics Wing, 2020. Structured poultry industry growing in size. URL: https://www.lightcastlebd.com/insights/2020/01/structured-poultry-industry-growing-in-size.

Mahmud, R., 2020. One health poultry hub, COVID-19 and the future for Bangladesh's poultry sector. URL: https://www.onehealthpoultry.org/blog-posts/covid-19-and-the-future-for-Bangladeshs-poultry-sector/.

Mandal, M.A.S., Khan, A.L.F.R., 2017. Poultry industry in Bangladesh: Which way to sustainable development? URL: http://wpsa-bb.com/wp-content/uploads/2018/07/Keeynote-paper-10th-Show-17.pdf.

Minot, N., Hill, R.V., 2007. Developing and connecting markets for poor farmers. 2020. focus brief on the world's poor and hungry people. URL: http://conferences.ifpri.org/2020chinaconference/pdf/beijingbrief_minot.pdf.

Moniruzzaman, M., Jahan, S.M., 2017. Exploring business ecosystem of poultry industry in Bangladesh. IOSR Journal of Agriculture and Veterinary Science 10, 01–12. 10.9790/2380-1002020112.

One Health Poultry Hub, 2020. Poultry production in Bangladesh. URL: https://www.onehealthpoultry.org/where-we-work/Bangladesh/.

Parvin, R., Begum, J.A., Nooruzzaman, M., Chowdhury, E.H., Islam, M.R., Vahlenkamp, T.W., 2018. Review analysis and impact of co-circulating H5N1 and H9N2 avian influenza viruses in Bangladesh. Epidemiology and Infection 146, 1259–1266. 10.1017/S0950268818001292.

Parvin, R., Nooruzzaman, M., Kabiraj, C.K., Begum, J.A., Chowdhury, E.H., Islam, M.R., Harder, T., 2020. Controlling avian influenza virus in Bangladesh: challenges and recommendations. Viruses 12. 10.3390/v12070751.

Pica-Ciamarra, U., Dhawan, M., 2010. Small-scale poultry farming and poverty reduction in south asia from good practices to good policies in Bangladesh, Bhutan and India. URL: http://www.sapplpp.org/files-repository/smallscalepoultryfarmingandpovertyreductioninsa.

Raha, S., Raha, S., 2007. Poultry industry in Bangladesh: Is it growing? PSI Structural Genomics Knowledgebase 10.22004/ag.econ.200331.

Rahman, K.M.M., Hossain, M.J., Rana, M.S., 2020. Livestock and poultry rearing by smallholder farmers in haor areas in Bangladesh: Impact on food security and poverty alleviation. The Bangladesh Journal of Agricultural Economics, volume = 41, number = 1, sciwheel-projects = Rok , 73–86URL: http://bjae.bau.edu.bd/home/article/view/50.

Rahman, M.M., 2014. Analysis of economic sustainability of small-scale broiler farms in Bangladesh- a of the broiler farms in Bogra and Shirajgonj District, Bangladesh. PhD thesis, University of Leipzig, Germany.

Rahman, M.S., Jang, D.H., Chan-Ju, Y., 2017. Poultry industry of Bangladesh: entering a new phase. Korean Journal of Agricultural Science 44. 10.7744/kjoas.20170027.

Rahman, S., Begum, I.A., Alam, M.J., 2014. Livestock in Bangladesh: distribution, growth, performance and potential. Livestock Research for Rural Development 26. URL: http://www.lrrd.org/lrrd26/10/rahm26173.html.

Rashid, S., Sharma, M., Zeller, M., 2004. Micro-lending for small farmers in Bangladesh: Does it affect farm households' land allocation decision? The Journal of Developing Areas 37, 13–29. URL: https://www.jstor.org/stable/4192957?seq=1.

Rota, A., 2010. Value chains, linking producers to the markets. URL: https://silo.tips/download/value-chains-linking-producers-to-the-markets.

Roy's Farm, 2020. Poultry farming in Bangladesh: Starting guide & information for beginners. URL: https://www.roysfarm.com/poultry-farming-in-Bangladesh/.

Saddullah, M., 2000. Animal based smallholding farms in developing countries with special reference to Bangladesh. Journal of International Development and Cooperation 6, 23–33.

Saleque, M.A., 2020. Mitigating the impact of COVID-19 on poultry sector. URL: https://www.aci-bd.com/all-news/mitigating-the-impact-of-covid-19-on-poultry-sector.html.

Saleque, M.A., Ansarey, F.H., 2020. Poultry industry: Challenges and solutions. URL: https://www.daily-sun.com/printversion/details/502289/Poultry-Industry:-Challenges-and-Solutions.

Sheel, S.K., Sen, B.K., 2013. Poultry contract farming in Bangladesh with special reference to aftab bahumukhi farm limited (ABFL). Journal of Business Studies 34, 85–108. URL: https://www.fbs-du.com/news_event/14664804555.pdf.

Sonaiya, E.B., Swan, S.E.J., 2004. Small-scale poultry production technical guide. URL: http://www.fao.org/3/y5169e/y5169e00.htm.

Sultana, F., Khatun, H., Islam, A., 2013. Small scale broiler farming at santhia upazilla of pabna district of Bangladesh. Bangladesh Journal of Animal Science 41, 116–119. 10.3329/bjas.v41i2.14129.

The World Bank, 2008. High–value agriculture in Bangladesh: An assessment of agro-business opportunities and constraints. URL: http://documents1.worldbank.org.

Uddin, M.E., Qijie, G., Uddin, M.E., Qijie, G., 2013. Prospects and challenges of privatization of agricultural extension service in Bangladesh. PSI Structural Genomics Knowledgebase 10.22004/ag.econ.198158.

USAID, 2008. Final report. rapid assessment 2008 for the department of livestock logistics, management system. URL: https://publications.jsi.com/JSIInternet/Inc/Common/_download_pub.cfm?id=12245&lid=3.