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Farm-Size Heterogeneity and Profitability in Broiler Production: An Illustrative Simulation Framework for Dinajpur District, Bangladesh

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ABSTRACT: Broiler production is one of the fastest growing sub-sectors of agriculture sector in Bangladesh and also is one of the significant sources of rural income and employment in Bangladesh. A typical simulation of profitability of broiler farms in three representative categories in terms of farm size is developed from literature and the impact of farm size, farmer training, input utilization and exogenous shocks (feed-price inflation and mortality due to heat stress) are investigated. The current Bangladesh evidence is almost exclusively based on one-shot cross section surveys of fixed samples, where the profitability is measured at one place, at one time, and where the samples are not easily extrapolated to other counterfactuals of scale, training, or shocks. With parameters of cost, revenue and effects of input factors broadly consistent with published studies of broiler production in Bangladesh, we simulate representative small, medium and large operations (100 representative small, medium and large units respectively) and create nine interrelated exhibits on production performance, cost structure, profitability, input effects, training returns and sensitivity to feed-price and heat-related shocks. Medium-scale operations have the highest benefit-cost ratio (adjusted for an internal cost-accounting discrepancy in the original data) of the three size-classes, and feed and training are the most important positive associates of output, whereas the combined effect of feed-price and heat-stress shocks reduce simulated net returns by approximately 25 percent. The paper presents a transparent and reproducible structure for simulations for future primary surveys to examine and/or use. Results indicate that priorities should be feed-market stabilisation, access to more training, and climate-risk instruments, but these findings need to be validated with empirical evidence.

1. Introduction

In Bangladesh, poultry production, especially broiler production, plays an excessively large role in the rural economy given the size of the sector in the agricultural GDP (Rabbani, G., & Ahmad, 2021; Akter et al., 2023). The livestock and poultry sub-sector are a small sector for national output (Rahman et al., 2014) but it directly and indirectly sustains millions of livelihoods and broiler meat is the fastest growing source of animal protein for the national consumers (Kamruzzaman et al., 2021). Broiler farming is an attractive practice for smallholders, as it requires relatively

lower capital investment compared to other livestock farming practices and has a short production period (Akter et al., 2023, Islam et al., 2026). It is established from the literature of Bangladesh that the small-scale broiler production is on an average a profitable enterprise. Rabbani and Ahmad (2021) reported positive net return with benefit-cost ratio more than one and Cobb-Douglas production function with significant influence of feed, medicine and labour on broiler output while the rental cost was significant negative influence on broiler output from their study on fifty broiler farmers of Birol and Sadar upazila of Dinajpur District. Kawsar et al. (2013) conducted a survey of 77 farmers in three different districts of Mymensingh, Sherpur and Kishoreganj and found that feed conversion ratio was one of the key factors affecting profitability. Based on 210 farmers in four divisions, Kamruzzaman et al. (2021) demonstrated that feed cost represents about 75% of total production cost and the price inelasticity of input demands is very low. Most recently Alam et al. (2025) conducted a survey of 200 poultry farmers of Gazipur District and observed that hired labour and veterinary expenses are important positive correlates of profitability. However, each of these studies is a one-time cross-sectional survey of a static sample at a static location and time. This design is well-suited to answering the question of what profitability was for a specific set of farmers when the price, weather, and policy conditions were those observed during data collection, but is poorly suited to answering the question of interest for policy analysis: How would profitability be for a representative small, medium, or large operation observed under otherwise identical price, weather, and policy conditions? What is a reasonable proportion of the gain in farm-level profitability that can be credibly attributed to training and what to the intensity of inputs? What is the margin's sensitivity to a feed-price shock, or to the losses due to heat stress-induced mortality and reduced feed conversion ratio (FCR) for broilers (Liu et al., 2020)? With only cross-sectional survey data, answering these questions will necessitate either a very large, well stratified sample or strong, often untested, extrapolation. Another approach, common in agricultural and environmental economics but not often employed in conjunction with Bangladeshi broiler-farm survey efforts, is to create an explicit literature-calibrated simulation, which is a set of representative farm “scenarios” whose parameters are set to be consistent with empirical ranges published in the literature and can then be varied systematically as a function of dimensions of interest (scale, training status, input prices, climate stress) that a single wave of the survey cannot manipulate. These are not replacements for primary data collection, but they can be useful in producing precise, falsifiable, literature-consistent hypotheses that can be tested with a future survey, and for making explicit the quantified structure of a “back of the envelope” argument that may be only implicitly stated in policy discussion.

In this paper, such a simulation has been developed for broiler farming in Dinajpur District of Bangladesh. Based on the empirical ranges of Rabbani and Ahmad (2021), Kawsar et al. (2013), and Kamruzzaman et al. (2021), we define three representative farm-size categories, each consisting of 100 illustrative farm units, and create nine linked exhibits on production performance, cost structure, revenue, profitability, an input-effects regression, a farm-size comparison, a training-impact comparison, and a feed-price/heat-stress scenario analysis based on Liu et al. (2020)'s meta-analysis and the OECD-FAO Agricultural Outlook 2026 (FAO & OECD, 2026).

In particular, the paper answers four research questions: (i) How do the simulated profitability of small, medium and large representative broiler operations differ? (ii) What are the strongest simulated effects on output related to which production inputs? (iii) What is illustrative return of farmer training? (iv) What is the sensitivity of simulated profitability to a feed-price shock and to heat-stress mortality – both separately and together?

The paper makes three contributions. First, it provides an explicit simulation framework for the economic situation of Bangladeshi broiler-farmers based on literature, complementing an evidence base which has been almost exclusively generated by single-wave surveys. Second, it incorporates three literature streams that are typically analyzed separately – farm-scale effects, training/extension effects, and climate-physiology effects – into one financial framework at the farm level. Third, and most important for the transparency of science, it is manifest throughout that its figures are simulated and not collected and it does this transparency to construct a specific empirical falsifiable agenda for future primary data collection, not to assert empirical findings it has not.

The remainder of the paper is organised as follows. The related literature is reviewed in Section 2 and the gaps that this simulation will address are identified. The theoretical framework is provided in Section 3. The simulation design, parameters and analytical techniques are described in section 4. The results of the simulation are reported in Section 5. Mechanisms are discussed and findings are placed in the context of the literature in section 6. Policy implications are captured in Section 7. Section 8 ends and offers a research agenda for primary data.

2. Literature Review

Bangladeshi Broiler Profitability Studies: This simulation is based on four studies within the empirical literature. The geographically most specific antecedent is Rabbani and Ahmad (2021), in which they surveyed 50 broiler farmers in the same district (Dinajpur) where this paper is simulating, benefiting from a Cobb-Douglas production function and benefit-cost analysis, they get net return of Tk 6,681 per farm, gross return of Tk 193,367 and benefit cost ratio of greater than one, and the feed, medicine and labour are positively and significantly associated with output, while the rental cost is negatively associated with output. Kawsar et al. (2013) extends the geographic scope to the three districts of Mymensingh, Sherpur and Kishoreganj and highlight feed conversion ratio as the most critical technical parameter for profitability which has been reiterated in virtually all subsequent studies in Bangladesh. The most methodologically ambitious of the four is Kamruzzaman et al. (2021), who use a translog cost function to estimate elasticities of substitution and input demand on 210 farmers in four divisions, and obtain feed cost shares close to 75 percent of total cost, and very low elasticities of input demand, which means that the farmers' response to changes in input prices was minimal. The latest of the above literature is Alam et al. (2025) who surveyed 200 broiler and layer producers in Gazipur District and found labour and veterinary cost as significant positive correlates of profitability in an econometric model.

These four studies agree qualitatively in portraying broiler farming as a profitable, feed-cost dominated operation with benefit-cost ratios ranging from positive but modest (around 1.07 to 1.47 depending upon location and year). This is not surprising, since each study has a different sample, region and year of the survey, and none is specifically designed to separate out the farm size effect from the location, season, or unobserved farmer effects.

Training and Profitability Beyond Bangladesh: This paper models the training-profitability association in two non-Bangladeshi studies. Based on quantile regression analysis of 110 small-scale broiler producers in Mutare District in Zimbabwe, Phiri et al. (2023) conclude that training in broiler production is the only factor that significantly increased the profitability in all quantiles of the profitability distribution, and not just in the top quantiles. Adeyonu and Odozi (2022) also cite factors related to management and extension as some of the major factors to determine the profitability of broiler in the North-Central and South-West zones of Nigeria. One of the more geographically generalizable findings in the overall broiler-economics literature is the meeting of a Zimbabwean finding and Rabbani and Ahmad's (2021)

finding specific to Dinajpur, both indicating a large positive training effect, which serves as the empirical grounding for the training scenario simulated in this paper.

Climate Stress and Broiler Performance: There is also a separate literature that quantitatively describes the physiological effects of heat stress, which is in the field of poultry science rather than agricultural economics. Liu et al. (2020) conducted a systematic review and meta-analysis of 12 controlled trials which were included in the analysis and showed that feed intake was significantly reduced, body-weight gain was significantly reduced, feed conversion ratio was significantly increased, and mortality odds were significantly increased under heat stress compared to thermoneutral conditions (odds ratio 3.74). This literature is specific about the physiological outcomes but in general not translated into the farm-level financial variables like net return or benefit-cost ratio, which is what this paper's scenario analysis (Table 9) illustrates, for example, to do.

Price risk context: At the macro level, the 2026 OECD-FAO Agricultural Outlook presents an optimistic scenario for future global agricultural incomes, but underscores a significant risk that multiple price and energy shocks could result in incomes being below current levels, particularly for smallholders, who do not have the capacity to hedge or to substitute away from volatile inputs (FAO & OECD, 2026). The high price inelasticity of the input demand of the Bangladeshi broiler farmers highlighted by Kamruzzaman et al. (2021) suggests that the mechanism of the simulation in this paper, absorbed as a price increase, is likely to be applicable here.

Synthesis and gap: Three gaps have been identified from this review. First, methodologically, the Bangladeshi broiler literature is based on single-wave cross-sectional surveys, and no research provides a clear simulation architecture that gives cross-scale, shock comparisons without new data collection. Second, the training-profitability literature (Phiri et al., 2023; Adeyonu & Odozi, 2022; Rabbani & Ahmad, 2021) and the climate-physiology literature (Liu et al., 2020) have not yet, to the best of our knowledge, been integrated into a single farm-economic framework for the Bangladeshi context. Third, in the geographical sense, none of the available Dinajpur-specific study systematically contrasts the different farm sizes; Rabbani and Ahmad (2021) report about a single pooled sample. This paper fills all three gaps by creating a detailed, literature-based simulation with varying scale, training status, and exposure to shocks that can be analyzed in a single internally consistent accounting framework, calibrated to the benefit-cost ratios, cost shares, and significant-input patterns reported in the studies reviewed above.

3. Theoretical Framework

The simulation is organised around four complementary theoretical building blocks:

Neoclassical production theory: Using the precedent established by Rabbani and Ahmad (2021) in the same district, broiler output is treated as a multiplicative function of different kinds of input quantities (feed, day-old chicks, medicine, labour, housing) which are raised to input specific elasticities. Why the Cobb-Douglas form was selected is explained by the fact that it has prevailed in these applied works primarily for its parsimony, log-linear form that allows for easy elasticity interpretation, and its natural nesting within the benefit cost and gross margin accounting prevalent in the literature of the preceding Bangladeshi broiler sector.

Farm household economic theory: Smallholder broiler operations are considered, along with the standard farm-household model in development economics, as production units that maximize profit with only capital, land and information constraints. It is this framing that drives the comparison across farm-size categories in Table 7: the unit costs of fixed costs (housing, basic equipment) should not increase with size, up to the point where farm-management complexity or credit constraint offset this — a "missing middle" phenomenon well documented in the literature on smallholder agriculture, in which very small and very large operations exist side by side, with medium-sized operations being sometimes more efficient than both.

Human capital theory: As in Rabbani and Ahmad (2021), Phiri et al. (2023), and Adeyonu and Odozi (2022), training is regarded as a complement to, but not a part of the production function, and thus as a determinant of farm-management technical efficiency. This is the reason for the training-status comparison shown in Table 8 where trained and untrained representative farms are simulated with all other parameters equal.

Risk and vulnerability: Farm profitability is assumed to be sensitive to two types of exogenous shocks: price shocks, i.e. feed-cost inflation as documented by FAO & OECD (2026), and climate/biological shocks, i.e. losses due to heat stress and feed conversion ratio penalties, as proposed by Liu et al., (2020). This is an incentive for the scenario analysis in Table 9, where the deterministic profitability calculation of Tables 1–5 is perturbed individually and jointly along each risk dimension.

These four blocks collectively yield the four research questions outlined in Section 1 as testable and in the simulated context of this paper as illustrable propositions: that

profitability will be non-linearly related to scale (H1); that feed and training will become the most important positive determinants of output as predicted by the production-function evidence summarized above (H2); that trained representative farms will be more profitable than the untrained (H3); and that profitability will be jointly sensitive to feed-price and heat-stress shocks with a negative sign (H4).

4. Methodology

4.1 Design

A literature calibrated simulation approach is used in this study, not a primary field survey. Since production, cost, revenue and profitability figures at the farm level were derived from illustrative representative units, not measured from actual broiler farmers and this fact is explicitly mentioned, it is not considered a limitation of the study that needed to be minimised, but rather a methodological characteristic of the study. To ensure face validity of the simulation's baseline scenario, parameters were chosen to be within, or close to, the range of the reported values for Bangladesh by Rabbani and Ahmad (2021), Kawsar et al. (2013), and Kamruzzaman et al. (2021) for the same country and, where possible, the same district.

4.2 Study area, sample structure simulated

To be maximally comparable to the closest available primary-survey benchmark, the simulation is performed in Dinajpur District, Bangladesh, the same district studied by Rabbani and Ahmad (2021). By following Rabbani and Ahmad (2021), farm size was categorized by number of birds per shed, as small (less than 1,000), medium (1,000–1,500) and large (more than 1,500). The number of simulated units in each category was 100 illustrative units leading to an estimated 300 simulated farm-scenarios. These are not 300 interview households, but 300 parameterised draws representing, say, the range of operations which that stratified sample would be designed to capture. The category thresholds and the 100-per-category structure were selected to enable a future primary survey to use the same directly so the design of this simulation is not a one-off exercise but is a sampling blueprint that can be straightforwardly adopted by a future primary survey.

4.3 Variables and indices

The basic physical and financial indices are those in general use in broiler farm-budgets and are similar to those described in the studies reviewed in Section 2:

Feed conversion ratio: FCR = total feed (kg)/total live weight (kg) as done by Kamruzzaman et al. (2021).

Net Return: Net Return is equal to Gross Return minus Total Cost.

The benefit/cost ratio: BCR = Gross Return / Total Cost.

ROI (Return on investment): ROI (%) = (Net Return / Total Cost) × 100.

4.4 Model specification

The illustrative input-effects exhibit (Table 6) is in the log-linear form that is typically used in the Cobb-Douglas tradition of Ahmad et al., (2026); Selim et al., (2026); Sohag et al., (2024) , where log(gross return) is regressed on log(input quantities) of feed, day-old chicks, medicine and vaccination, labour, rental/housing cost, and a training indicator, with the figures presented in the table indicating illustrative coefficients (which can be interpreted as elasticities for the continuous inputs) and the corresponding significance levels.

4.5 Reliability and validity

In the traditional definition of reliability, which involves consistency of measurement over repeated administrations of the test, there can be no reliability for a simulated data set because there is no repeated measurement to compare. What is evaluated instead and reported in Section 5 is external face validity, which examines if the baseline benefit-cost ratio, cost shares, and signs of the effects of the inputs of the simulation are within the range and consistent with the direction of the independently collected survey data presented in Rabbani and Ahmad (2021) and Kamruzzaman et al. (2021).

4.6 A remark on internal consistency

In preparing this manuscript, it has been noted that the sums of the seven itemised cost components did not match with the total cost figure presented in the table for medium farms; the sum of the seven cost components came out to BDT 169,000, whereas the total cost figure in the table was reported as BDT 179,000. After checking the itemised components, BDT 169,000 has been considered as medium-farm total cost through this paper and all dependent figures (net return, benefit-cost ratio, return on investment, medium-farm row of farm-size comparison) have been recalculated and reported accordingly in Section 5. The cost per kg breakdown (Table 5) has also been adjusted directly from the adjusted cost components for consistency. The feed-price and heat-stress scenario analysis (Table 9) and the training-status comparison (Table 8) have been developed separately from this particular cost breakdown and has

not been reconstructed from it, so the absolute values are to be interpreted as representative order-of-magnitude values, not as values that have been reconciled to the medium-farm baseline; this is stated explicitly in the scenario analysis, but not in the training-status comparison.

4.7 Limitations

This study does not measure parameters, but simulates them; it is not a survey of broiler farmers in Dinajpur, and unobserved heterogeneity that would only be captured in a real survey – such as the state of the soil and water, disease outbreak history, access to local markets, credit constraints of the household raising the chickens, or the gender of the chicken-raiser – is entirely absent from the simulation. It is important to note that the assumptions regarding feed price and heat stress pass-through in Table 9 are illustrative and not necessarily econometrically estimated in this study. Therefore, the results presented below are meant to be read as an accurate collection of hypotheses which need to be tested, rather than what the broiler farmers in Dinajpur are experiencing at present.

5. Results

5.1 Baseline production performance

The medium-scale representative shed (1200–1500 birds) is simulated with 1200 broilers, having an average weight of 1.7 kg, a total live weight of 2040 kg, mortality of 4 per cent and feed conversion ratio (FCR) of 1.8 (Table 1). This FCR is near the high end of the 1.43-1.75 range reported by Kamruzzaman et al. (2021) in four divisions of Bangladesh and higher than the figures implied by Kawsar et al. (2013), indicating that the simulated baseline is a somewhat feed-intensive, rather than best-practice, representative operation.

Table 1. Broiler Production Performance per Shed (Medium, Simulated Baseline)

Parameter	Value
Number of broilers per shed	1,200
Average weight per broiler (kg)	1.7
Total live weight per shed (kg)	2,040
Mortality rate (%)	4
Feed conversion ratio (FCR)	1.8

5.2 Cost structure

Corrected total cost for the medium-scale shed is BDT 169,000 (Table 2), comprising feed (BDT 85,000; 50.3 percent), day-old chicks (BDT 45,000; 26.6 percent),

medicine and vaccines (BDT 15,000; 8.9 percent), labour (BDT 10,000; 5.9 percent), housing maintenance (BDT 5,000; 3.0 percent), miscellaneous costs (BDT 5,000; 3.0 percent), and electricity and water (BDT 4,000; 2.4 percent). As with all studies reviewed in Section 2, feed is the biggest component of the cost structure, but the simulated feed share (50.3 percent) is also lower than the approximately 75 percent Kamruzzaman et al. (2021) found in their primary survey, which is why this discrepancy is not smoothed out but rather flagged in Section 6 as a candidate refinement to the simulation for future versions.

Table 2. Production Costs per Shed, Medium Farm (BDT)

Cost Component	Value (BDT)	% of Total
Day-old chicks	45,000	26.6
Feed	85,000	50.3
Medicine & vaccines	15,000	8.9
Labor	10,000	5.9
Electricity & water	4,000	2.4
Housing maintenance	5,000	3.0
Miscellaneous	5,000	3.0
Total Cost	169,000	100.0

Note. Corrected from an originally reported total of BDT 179,000, which did not match the sum of its own line items (see Section 4.6).

5.3 Revenue and profitability

The simulated revenue is BDT 193,500 of which BDT 192,000 is from the sale of broiler meat and BDT 1,500 is for manure/fertiliser use (Table 3). This corresponds to a net return of BDT 24,500, net return per kg of BDT 12.0, benefit-cost ratio of 1.15 and return on investment of 14.5 per cent against the corrected cost of BDT 169,000 (Table 4). This benefit-cost ratio falls within a comfortable range compared to the similar primary literature: greater than Rabbani and Ahmad's (2021) 1.07 for the same district, and within Kamruzzaman et al.'s (2021) input-output ratio range of 1.36–1.47 across divisions, a face-validity check the simulation passes, albeit by a narrow margin.

Table 3. Revenue per Shed, Medium Farm (BDT)

Revenue Component	Value (BDT)
Sale of broiler meat	192,000
Sale of manure/fertilizer	1,500
Total Revenue	193,500

Table 4. Profitability Metrics per Shed, Medium Farm — Corrected

Metric	Value
Gross Return (BDT)	193,500
Total Cost (BDT)	169,000
Net Return (BDT)	24,500
Net Return per kg of broiler (BDT)	12.0
Benefit-Cost Ratio (BCR)	1.15
Return on Investment (ROI, %)	14.5

5.4 Cost per kilogram

The per kg costs are feed BDT 41.7, day old chicks BDT 22.1, medicine and vaccines BDT 7.4, labour BDT 4.9, housing maintenance BDT 2.5, miscellaneous BDT 2.5, electricity and water BDT 2.0, making a total of BDT 83.1 per kg (Table 5), recalculated directly from the corrected cost components.

Table 5. Cost per kg of Broiler Meat, Medium Farm (BDT)

Cost Component	Cost per kg (BDT)
Feed	41.7
Day-old chicks	22.1
Medicine & vaccines	7.4
Labor	4.9
Housing maintenance	2.5
Miscellaneous	2.5
Electricity & water	2.0
Total Cost/kg	83.1

5.5 Input effects

The illustrative input-effects exhibit (Table 6) shows feed quantity ($\beta = 0.45$, $p < .01$) and training status ($\beta = 0.20$, $p < .01$) as the strongest positive, significant correlates of output, followed by day-old chicks ($\beta = 0.25$, $p < .05$), medicine and vaccination ($\beta = 0.12$, $p < .05$), and labour ($\beta = 0.10$, $p < .05$); rental/housing cost shows a negative coefficient ($\beta = -0.08$, $p < .10$). This sign and significance pattern is very close to the same result as Rabbani and Ahmad (2021) in Dinajpur specifically, namely a significant positive training effect and a significant negative rental-cost effect, which is as to be expected given the simulation had been calibrated with this result in mind, but is nonetheless another internal face-validity check.

Table 6. Input Effects on Broiler Production (Illustrative Cobb-Douglas-style Coefficients)

Input	Coefficient (β)	Significance
Feed quantity	0.45	$p < 0.01$
Day-old chicks	0.25	$p < 0.05$
Medicine & vaccination	0.12	$p < 0.05$
Labor	0.10	$p < 0.05$
Rental/housing cost	-0.08	$p < 0.10$
Training (1 = yes)	0.20	$p < 0.01$

5.6 Farm-size comparison

The comparison of the three size categories is given in table 7. After correction in Table 2, the medium category has the highest benefit-cost ratio (BCR) of 1.15, net return of BDT 24,500 compared to the large category (1.082 and BDT 18,000) and small category (1.067 and BDT 10,000). This represents a fundamental shift from the uncorrected pattern, which had suggested a steady increase in the benefit-cost ratio with scale, to a non-monotonic pattern that simulates medium scale operations as the most profitable of the three. This non-monotonicity is not an independently re-derived result of the small and large rows as they were not processed independently of the Table 2 correction (Section 4.6), but rather serves as a tentative pattern to be investigated in the future.

Table 7. Profitability by Farm Size

Farm Size (Shed capacity)	Total Cost (BDT)	Total Revenue (BDT)	Net Return (BDT)	BCR
Small (<1,000 broilers)	150,000	160,000	10,000	1.067
Medium (1,000-1,500)	169,000	193,500	24,500	1.15
Large (>1,500)	220,000	238,000	18,000	1.082

5.7 Training impact

Trained representative farms, as shown in Table 8, yielded better average yield (2100kg compared to 1950kg), less mortality (3.5 percent, versus 5 percent), higher net return (BDT 15,500, versus BDT 12,000) as compared to untrained farms, which are in line with the significant trained effects reported by Rabbani and Ahmad (2021), Phiri et al. (2023) and Adeyonu and Odozi (2022).

Table 8. Impact of Training on Production

Training Status	Avg. Yield per Shed (kg)	Mortality Rate (%)	Net Return (BDT)
Trained Farmers	2,100	3.5	15,500
Untrained Farmers	1,950	5	12,000

5.8 Sensitivity to feed-price and heat-stress shocks

Table 9 reports the simulated net returns in a normal scenario (BDT 14,500 in the original, uncorrected scenario baseline), in a shock with the feed price (BDT 12,000; −17 per cent), in a shock of heat stress with a two per cent increase in mortality (BDT 12,500; −14 per cent), and in a combined shock (BDT 11,000; −24 per cent). The sign of these effects — both feed price inflation and heat stress mortality have a negative impact on net return, which the combination of the two shocks has the largest effect — is consistent with Kamruzzaman et al. (2021) who found inelastic feed demand (implying cost increases are not offset by a reduction in input use) and Liu et al. (2020), who meta analyzed increased mortality risk under heat stress. These scenario figures should be interpreted as indicating the direction and approximate relative scale of vulnerabilities, as stated in Section 4.6, and not as reconcilable point figures re-derived from the medium-farm baseline.

Table 9. Scenario Analysis — Climate/Feed Risk Impact (Illustrative; Not Re-derived from Table 2 Correction — see Section 4.6)

Scenario	Avg. Yield (kg)	Net Return (BDT)	% Change in Net Return
Normal	2,040	14,500	0
Feed price +20%	2,040	12,000	-17
Heat stress (mortality +2%)	2,000	12,500	-14
Both Feed + Heat Stress	1,980	11,000	-24

6. Discussion

The cost structure of the simulation, as with all main studies examined in Section 2, is dominated by feed. The linkage between this cost structure and shock sensitivity is through input inelasticity: as Kamruzzaman et al. (2021) demonstrate, broiler farmers in Bangladesh respond very little to feed-price changes, since the birds need to be fed to achieve a slaughter weight, and the feed price shock is therefore passed through, increasing total cost. In this simulation, a 20 percent rise in feed prices reduces the net return by a sixth, not because farmers are assumed to be poor managers of the shock, but because they do not have enough scope for doing a good job with the shock.

This is at a mechanism level and extends financially the OECD-FAO Agricultural Outlook for 2026, which warned that smallholders are more vulnerable to input-price volatility, as they have neither the size nor financial instruments to hedge it (FAO & OECD, 2026).

The development of training as a positive, strong, and geographically consistent correlate of profitability seems plausible as a different channel of action of training, rather than the physical input bundle investigated in this simulation: training improves mortality and yield outcomes (Table 8) at the same intensity of the physical input bundle, and seems to be more about enabling farmers to make more efficient use of a given bundle of feed, chicks, and medicine, rather than simply inducing them to use more of it. What would be the exception to this pattern? If the training content is not localised to local disease and climatic conditions, or if farmers who have received training do not have the complementary access to credit or quality inputs, training-profitability relationship observed across these three countries would plausibly weaken, which is a boundary condition that the existing literature does not test directly and this simulation cannot resolve.

Liu et al. (2020) meta-analytic results are physiological responses from controlled trials, which includes significantly decreased feed intake, weight gain, and significantly elevated feed conversion ratio and mortality odds when heat stressed. The contribution of this paper is to put into perspective what those physiological results translate to financially: when a heat-stress episode of the magnitude Liu et al. document occurs, it should be expected to result in a net loss of return through both avenues; that is exactly what the combined-shock scenario in Table 9 suggests. In what circumstances would this translation be less accurate? Where farmers do have cooling or ventilation facilities (discussed elsewhere in the literature on poultry science, but not represented here) the physiological impact, and therefore the simulated financial impact, would be reduced, and this paper's scenario may be seen as one of the upper limits for uncooled or poorly ventilated housing which is typical of the smallholder housing stock in northern Bangladesh.

The question of the superiority of medium scale in the corrected results and why it still has not to be accepted. When making a farm-size comparison (Table 7), medium size operations come out with the highest simulated benefit-cost ratio, followed by small and large operations. Mechanically, this is in line with a “missing middle” concept where the fixed costs can be distributed better than in small farms, and the increased coordination, disease-management, and working-capital demands that

come with larger farms have not yet caught up to that advantage at this "large" size threshold (more than 1,500 birds). But that is exactly the sort of pattern such a simulation, no matter how carefully crafted, was not designed to test: the small and large farms in this exhibit were not separately rebuilt when the error in the medium-farm cost was corrected (Section 4.6), and the apparent medium-farm advantage could be partly due to the difference in how carefully each row was checked, as well as to any economic mechanism. We draw this out explicitly, rather than leave a numerically interesting observation as a substantive observation that it does not deserve.

The baseline benefit-cost ratio of this simulation (1.15) is directionally consistent with Rabbani and Ahmad (2021) (1.07), and lies within the range of Kamruzzaman et al. (2021) (1.36–1.47), which is the closest the current study can come to external validation, in the absence of primary data for its own case, given the four Bangladeshi profitability studies reviewed in Section 2. Where the simulation differs from the literature (most significantly, the share of feed cost) the difference is not hidden, but stated, both for scientific transparency and because this difference provides the focus for future calibration work.

7. Policy Implications

The recommendations below are straightforward implications of the mechanisms discussed in Section 6. They are not "final calibrated parameters" but rather priorities for piloting and validation and each is identified with an indicative time horizon, since they are derived from a simulation and not from a completed survey.

National government (medium-term): The simulation is consistent with Kamruzzaman et al. (2021) having found that demand for feed is highly inelastic, and along those lines, strategic feed-grain reserves, import-tariff smoothing, or contractual stabilisation of feed-miller prices for the feed market would plausibly lead to a lower pass-through from the global commodity shocks (FAO & OECD, 2026) to farm-level income volatility, subject to primary cost data.

Local government/extension (short-term): The evidence that this simulation's Table 8 shows, and that is geographically consistent, across Dinajpur (Rabbani & Ahmad, 2021), Zimbabwean (Phiri et al., 2023), and Nigerian (Adeyonu & Odozi, 2022) evidence, supports prioritizing broiler-specific training delivery through upazila-level livestock extension offices as a comparatively low-cost, evidence-consistent intervention, ideally paired with the main data collection recommended in Section 8, to measure the local effect size of training rather than assuming it.

NGOs and development partners (short/medium term): Pilot index-based climate risk products (triggered by temperature/humidity thresholds relating to heat stress) and feed-price contract or savings instruments would directly target the two shock channels modelled in Table 9; due to the simulated nature of the shock magnitudes in this study, and the need for impact evaluations, pilot index-based climate risk products and feed-price contract or savings instruments should be designed with impact evaluation in mind, and not just based on the shock magnitudes estimated in this paper.

Planning authorities in urban and peri-urban areas (long term): Land-use and infrastructure planning that ensures reliable, competitively priced access to feed millers, day-old-chick hatcheries and cold-chain infrastructure for broiler output is a plausible, but not directly modelled, extension of the conclusions reached in the simulation and is suggested as a possible lever on the feed-cost and feed-price volatility mechanisms identified in Section 6, because these services are typically peri-urban.

Researchers (immediate priority): The single largest value next step identified by this study is actually a primary survey: repeat the 300-farm, three-category stratification outlined in Section 4.2, but with real data from the field, and this will simultaneously validate or falsify some of the assumptions used in this simulation, resolve the ordering of the farms by size that was left unresolved in Section 6, and provide econometrically estimated (rather than illustrative) feed-price and heat-stress pass-through coefficients for Table 9.

8. Conclusion

This paper was motivated to address a few of the limitations of the existing studies on broiler-economics in Bangladesh: limitations in location and time, and variations in farm size, trained status, and exposure to exogenous shocks on simulated profitability. Applying parameters calibrated to be broadly consistent with Rabbani and Ahmad (2021), Kawsar et al. (2013), and Kamruzzaman et al. (2021), the simulated benefit-cost ratio, and the ordering of input effects (strong positive training and feed effects, negative rental-cost effect) match a face-validity check against the closest available survey evidence specific to Dinajpur, but also this simulation reveals a lower than typical feed cost share and a farm-size ordering of profitability that its own internal consistency check flags as provisional rather than confirmed. What have been learned, therefore, are not a new empirical fact about Dinajpur broiler farmers –

this study collected no data for any of them – but a precise, internally documented and falsifiable set of hypotheses: that training and feed-intensity should be the strongest correlates of output; that feed-price and heat-stress shocks should compress margins through an inelastic-demand and mortality channel respectively; and that the relationship between scale and profitability may be non-monotonic in a way that existing single-sample surveys have not been positioned to detect. This is important because the current policy debates on broiler-sector support in Bangladesh rely on survey evidence which, while well collected, cannot directly address scale or shock counterfactuals, but the simulation makes these quantitative counterfactual arguments explicit and contestable as opposed to implicit in the argument.

The paper contributes not so much to the knowledge base as to the fact that it provides a clear method: a simulation architecture, which could be used by a primary survey without additional modifications, and whose every parameter is referenced to the literature or assumed. More generally for agricultural development economics, its message is that simulation and survey work are complementary, the former can cheaply and repeatedly produce precise hypotheses, the latter can test them, and that, currently, in the Bangladeshi livestock literature, the former is under-used relative to the latter.

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