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Broiler Farming Risk and Stress Management Strategies

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Abstract

The broiler farming sector in tropical area suffer from high temperature and humidity stress and reduced daily bird growth rate. Small scale broiler farms at Sultanate of Oman has been performing poorly due to many constrains, including poor poultry farming practices, climate condition variability, feed grain price increase. The import of frozen poultry with cheap price and feed cost increased after Ukraine conflict and global food security issue significantly affect broiler cost of production and farming economic sustainability. Poultry feeding cost increased by 36% compared to last year due to corn and soybean grain price increased and exposed farmers to high risk and income uncertainties and jeopardize food security sustainability. The study applied Monte Carlo Simulation approach to assess risk management strategies and economic sustainability of three production level, products mix alternative under deferent market constrains. The broiler products mix and marketing constrains were examined considering different risk preference and ARAC of decisions makers. The stress analysis performed to test economic performance of alternative production strategies and identify factors affect broiler farming continuity and resilience. The overall results showed that broiler marketing risk and sale revenue volatilities is a highly uncertain and dynamically integrated complex system. Sale incentive policy need to be addressed and controlled through appropriate risk assessment and mitigation strategies and optimization production operation and control cost increase through vulnerability assessment. The net profit (baseline) scenarios with right production level and products mix following profitable market channels is more risk-efficient and sustainable compared to products mix with over supply production and without fast marketing access support channels. The study performed stochastic efficiency with respect to a function (SERF) and calculate Certain equivalent (CE) figure to rank alternative stress management strategies under stress situation. Stress management analysis showed that demand for parts and fresh products with sale revenue decline are risk averse and has highest CE figures followed by (cost frozen) products at all ARAC. The risk premium and willingness to pay analysis showed that (cost parts) products has highest risk premium figures followed by (cost fresh) and (demand frozen) products compared to baseline. The risk of cost increase needs to be monitored and controlled to avoid inside organization risk vulnerability. Risk premium (RP) needed to change from (cost fresh) to (cost frozen) products is RO 67,553 for risk neutral absolute risk aversion coefficient (ARAC). The study showed risk premium (RP) need to be paid to motivate a change from (demand frozen) alternative to (demand fresh) products activities is RO 24,928 and to change from (demand frozen) to (demand parts) is RO 64,379 for risk neutral absolute risk aversion coefficient (ARAC). Marketing incentive programs and regulating market are needed to understand broiler business risk and avoid significant loss due to sale delay and improve risk mitigation programs and imposed anti-dumping and countervailing duties on broiler products import. The risk of feed cost increase needs to be monitored and subsidized by Government to mitigate broiler farming risk and maintain business sustainability.

Keywords: Stochastic Efficient Risk Function (SERF), Certain equivalent (CE), Risk Premium (PR) Analysis, Monte Carlo Simulation, Stress Analysis, Absolute Risk Aversion Coefficients (ARAC), economic sustainability

1. Introduction

The poultry sector in Sultanate of Oman contributes of 58% of broiler meat self-sufficiency. Poultry commercial farming at Sultanate of Oman breed poultry and produce meat and table eggs at their farms and feed them with concentrates made from raw material, premix and vitamins imported from outside. The medium and small commercial farm sell the processed poultry meat at local market. This type of business creates low net profit as all main inputs of feed ingredients, hatching eggs, medicine and modern houses control technologies imported from outside and exposed to cost and price uncertainties. Moreover, marketing challenges and cheap poultry products are imported from different continents and sold with low price create a press to poultry farming economic sustainability. The risk of poultry cost of production increase and sale revenue decline and variability jeopardize poultry farming economic sustainability and achieving country's food security gools.

The cost of main feed raw materials ingredients such as corn and soybean increased sharply by 36% since early 2021 and put a high pressure on local poultry business profitability. The Government subsidy programs imposed earlier in 2011 to improve local poultry production contributes stopped on year 2016 and it is time to re-imposed subsidy program due to current international situation and Ukraine conflict impact on food security. The uncertainty factors and risk parameters in broiler farming business are the main challenges for farmers and business owner to make good decisions and needs to be analyzed, Danilo Simões et al. (2014). This study investigated uncertainties of cost and sale revenue decline risk to understand and quantify risk and cope with problem anticipation and consequences.

Oman poultry farms suffers from heat stress due to high temperature and relative humidity during summertime and relatively broiler business performance is affected. The Sultanate of Oman located at (15-27°) north latitude with long summer season extended to six months followed by a warm winter and high relative humidity. Broiler farming at costal area of Sultanate of Oman stop poultry farming in summer-time to avoid heat stress problems and farm net profit reduction. Although new control breading houses reduced mortality rate at summer-time, but bird daily weight gain and feed consumption efficiency are still observed and create marketing challenges, Kheiry Ishag (2019). Small size of birds and product below marketing standard range (800 -1200 grams) sold with high discount rate and effect farming net profit. Article by May J. D. et al. (2000) study and compared temperature effect on daily bird growth rate and FCR for 21 days of age and showed that temperature has a high effect on daily bird growth, FCR and body weight after three weeks breeding. May et al., (1998) study showed that environmental conditions improvement increases as body weight increases.

Although it is not possible to predict future accurately, simulations analysis allows to create risk profiles by generating a large number of iterations, including extreme cases, such study allow to identify the effects of marketing and cost factors variation on broiler business profitability in term of probabilistic way, (Albright and Winston, 2019; Lehman and Groenendaal, 2020).

The poultry production risk factors in this study indicates to uncertain of production inputs cost, production level and products sale price. The marketing uncertain incorporated in the study as product sale volume decline and demand available at full price for each product mix i.e. fresh, parts and frozen products and sale price discount need to be given to sale leftover and over supply products. The poultry farming production exposed to yield, input price volatility risk and market changes risk due to over supply products. The risk of poor performance and operation loss due to production and marketing parameters volatility required strategic decision from farmer that cover production and marketing risk and constrains.

Kheiry Ishag (2019) investigated risk of high Temperature Humidity Index (THI) on broiler farming bread for 35 days and 42 days and rank poultry farming system net return and feed subsidy policy according to their economic sustainability. Stochastic efficiency with respect to function (SERF) is used to determine and rank three fungicide application strategies to manage potato late blight disease, Yangzuan Liu et al. (2017). The following authors (Hardaker and Lien, 2010; Hardaker et al., 2004; Meyer et al., 2009) use SERF as a tool for ranking alternatives risk efficiency. Risk analysis of agriculture production systems investigated by using stochastic efficiency with respect to function (SERF) in many studies (G. Lien, et al. 2007, Ascough II. J. C. et al. 2009, and Eihab M. Fathelrahman et al. 2011). Filed plot data, economic budget data, and experimental data used by these studies to investigate and understand problems included in agricultural production risk and economic sustainability. Certain equivalent (CE) and risk premium (RP) analysis used to evaluate risk management strategies by introduction of new technologies and precision agriculture practices, Yangxuan Liu, et al. (2017).

The Monte Carlo models are used as a tool to quantify risk and uncertainty of the related business by many studies. Dynamic models give a range of results that can mitigate and reduce the risk of operation and revenue decline through a range of uncertain inputs estimate and generate accurate results for policy advisers and decision makers. The study used stochastic efficiency analysis to rank broiler farming under different production and marketing constrain over a range of absolute risk aversion coefficient level. Hardaker et al. (2004a) structured and used technique of stochastic efficiency with respect to a function (SERF) to rank risk alternatives options. Gregory K. et al. (2012) also used (SERF) to appraise modified genetic maize crop in South Africa. Mohammad K. et al. (2014), used (SERF) to rank different beef calving and feeding practices in western Canada. Kheiry (2020) used (SERF) and CE figures to rank dairy cow feeding practices strategies according to feeding cost and availability. Stochastic efficiency with respect to function (SERF) technique is consist on ranking risky alternatives in terms of utility function and equal ranking of alternatives with (CE) certainty equivalents figures. The certainty equivalent (CE) is explained as the sure sum of return or wealth at present rather than unsure high return in future. Hardaker et al., (2004b), argued (SERF) rank risky alternatives in terms of (CE) for a defined range of risk aversion simultaneously and not pairwise as in (SDRF). Irene Tzouramani et.al (2011) used stochastic efficiency with respect to function (SERF) to test the economic viability of organic and conventional sheep farming in Greece and found both sheep farming systems are viable. The (SERF) also used to compare and rank alternatives at level of decision maker preferences for different absolute risk aversion coefficient (ARAC), J. W. Richardson et al. (2008). Khakbazan, M. et al. (2022) use SERF and certain equitant (CE) figures to rank silage-based feed diet and cattle breading efficiency for beef backgrounding streets.

In this study, (SERF) technique is used to assess business sustainability of production and marketing broiler models. The effect of product sale revenue decline and cost of production volatility risk on broiler farming net profit calculated for each broiler production level and risk management strategies. Six stochastic models were worked out to construct farm net profit distribution function for each proposed alternative model. Risk premium (RP) analysis performed to measure excess return required by decision maker to compensate change and shift from current production level to increased level of risk from the baseline production level model. The study identified broiler farming stress management strategies and calculated net profit performance risk-efficient and verified models economics sustainability. The broiler production level and marketing constrain models under stress condition were recognized and the most risk efficient model over a range of risk aversion level (ARAC) were identified.

2. Methodology

The poultry business net profit is calculated to quantify the economic performance of alternative production and product mix which maximized business net profit. The conventional normal approach used in business evaluation is to calculate the best estimate available data for cost and revenue for each poultry products and production mix. The single value of net profit doesn't reflect risk of cost, sale product volume and sale price risk. It doesn't also reflect market environment risk in term of range of products sold with full price and product over supply sold with sale discount price. Broiler farming exposed to a significant loss due to fast sale discount and considerable market risk and uncertainty. Accordingly, the model estimate a range of incentive cost, sale volume decline and demand parameters risk and quantify marketing cost and it is effect on broiler farming net profit.

The dynamic simulation model based probability distribution functions of net profit are used to evaluate risk volatility and economic sustainability and to compare different product mix and discount need to be given for each poultry products to increase net profit and achieve business sustainability. The stochastic budgeting and stochastic efficiency methods are used to consider risk and uncertainty variables in the model presented in study area.

2.1 Data Collection

The broiler farming data used in this study is collected from a farm located at Salalah city at Dhofar Region in Sultanate of Oman. Day time temperature range 32-35 °C from April to June and reduced to about 27-29 °C from July to August during Kharef period and increase to 31°C for the rest of the year. The relative humidity percentage range is 50%-65% and increased up to 75% in summer season and increase to 90% during rainy season (kharef) extended from July to September. Broiler farm has 48 houses with dimension of (L84XW14) meter and 12 Fans.

The data collected include broiler farm production level, product mix budget and cost figures for alternatives scenarios and marketing incentive scenarios. The other broiler farming performance parameters such as FCR, meat dressing weight and yield, bird live weight, breeding duration period, daily growth rate, and dressing percentage were collected from the broiler farm and summery at table (1).

2.2 Business Net Profit

The net profit was used as economic performance parameters and calculated by subtracting the total cost of products from the total sale revenue to obtain business net profit. Product cost, sale volume and revenue, and discount given to each broiler products were collected from historical data of the farm. If net profit is a function of all both deterministic and stochastic variables, the resulting outcome gets a range of values instead of a single value obtained in a conventional deterministic financial evaluation. Net profit for each model obtained from below formula.

Simulation model equation:

$$N\tilde{\ }Profit = (\tilde{\ }Ya* \tilde{\ }Pa + Yb* \tilde{\ }Pb + Yc* \tilde{\ }Pc) - (V\tilde{\ }C\ Ya, + V\tilde{\ }C\ Yb, + V\tilde{\ }C\ Yc) - Incentive\ C - FC$$

Where :

N˜Profit Net profit probability distribution for net profit.

˜Ya Fresh product stochastic yield sold per year.

˜Pa Fresh product stochastic market price.

Yb frozen broiler stochastic yield sold per year.

˜Pb frozen broiler stochastic market price.

Yc parts products stochastic yield sold per year.

˜Pc parts products stochastic market price.

FC Fresh , frozen and parts stochastic fixed cost for sale products.

V˜C Stochastic variable cost for sale products (fresh , frozen , parts).

C Incentive cost for Broiler sale products (fresh , frozen , parts)

2.3 Monte Carlo Multiple Simulation and Risk Analysis

Monte Carlo simulation is a computational algorithm model designed to evaluate risk and variability of the input variables of a model. The model identified and tested the effects of range of main uncertain variables on the business net profit. Product cost, production volume, demand variables rage determined for main variable, and a probability density function (PDF) curve fitted to describes the range of uncertainty around expected variable value as shown in table (1). For this purpose, we used historical data of broiler farm at Dhofar Region of Sultanate of Oman. The model included below variables to calculate randomly generated input values taken from the probabilistic distribution function for each variable. Variable distribution best fit selected by Bestfit function and presented below. The model merge inputs data to generate estimated outcome value for each net profit. The process used @Risk 8.2 program to run simulation with iteration of 10 thousand times.

Table 1. Uncertain parameters for products volume, demand and cost of production model

Product	Cost RO	Price RO	Production	Demand	Discount	Cost RO	Revenue RO
Fresh/Kg	1,350	1,460	3,300	3,000	12%	4,455,000	4,765,440
Range/RO	(1,100/1,450)	-	(3,300/4,000)	(2,500/3,550)	(5%/25%)	-	-
Parts/Kg	2,200	2,300	1,000	1,000	10%	2,200,000	2,300,000
Range/RO	(1,950/2,500)	-	(1,000/1,200)	(950/1,200)	(5%/25%)	-	-
Frozen/Kg	1,000	1,100	1,800	1,250	30%	1,800,000	1,798,500
Range/RO	(1,000/1,100)	-	(1,800/2,400)	(1,000/2,350)	(5%/30%)	-	-
Distribution	RiskPert	-	RiskSimTable	RiskPert	RiskLongnorm	-	-

2.4 Products Mix and Marketing Strategy Scenarios

Products mix and marketing strategy are a key variable for broiler business performance and net profit calculation. Frozen products face high competition from local companies and cheap frozen imports from outside. The cost of frozen products is high and product size are below the standard market range (800 -1200 grams). Due to small products size and high cost of production the Company gives high price discount price up to 30% for product leftover. Although the fresh products have high price realization, but it faces many challenges in terms of short shelf life and high expiry. The study examined 12% price discount for fresh product leftover and 10% discount for parts product leftover. The study tested economic performance of three alternatives strategies and marketing scenarios in term of production volume, product over supply and incentive cost for each product as per below table (2). The marketing invective cost calculated for each option and record RO 601 k for option (3) followed by RO 424 k for option (2) and RO 234 k for option (1) as shown in table No (2).

To compare different economic performance of alternative production strategies or model assumptions, the variable that would change from one scenario to the next identified as a decision's variables. The different production variables values for each scenario are taken and modelled with (RiskSimTable) functions. The Multiple Simulations function run by using @Risk 8.2 program to pick up production variable value for each simulation and option.

Table 2. Products mix, demand and marketing incentive cost of each production level model

Product	Demand	Option No (1)		Option No (2)		Option No (3)	
		Production	Incentive Cost	Production	Incentive Cost	Production	Incentive Cost
Fresh	3,000	3,300	52,560	3,500	87,600	4,000	175,200
Parts	1,000	1,000	-	1,100	23,000	1,200	46,000
Frozen	1,250	1,800	181,500	2,200	313,500	2,400	379,500
Total	5,250	6,100	234,060	6,800	424,100	7,600	600,700

3. Result and Discussion

3.1 Production Volume and Product Mix Net Profit Simulations Analysis

The static and deterministic models were performed to calculate the net profit of a broiler farming performance. Net profit simulation analysis performed first under no stressor for three different production volume and products mix models. Option No (1) represent baseline model with 6,100 tons production volume achieved net profit mean of RO 316,533 and 18.2% breakeven point. Option No (2) generate RO 233,698 net profit and 27.6% breakeven point and option No (3) generate the lowest net profit with high marketing incentive cost of RO 600,700 and 34.2% breakeven point. The net profits probability distribution functions (PDF) of three production alternative are performed to evaluate risk volatility and economic sustainability. The economic performance simulation analysis of alternative production strategies and risk factors identification showed that low standard deviation (SD) and net profit range of RO (1,492,193) for option (1) compared to higher standard deviation (SD) and a wide range of net profit RO (1,715,244) for option (3) as presented in table (3) below.

Production plan for option (1) produce a total volume of 6,100 tons poultry meat with 300 tons fresh and 550 tons frozen meat over supply products compared to production of 7,600 tons with 1,000 tons fresh, 200 tons parts, and 1,150 tons frozen over supply products for option (3). The result showed that option (1) is more economic sustainable and risk averse compared to other two models due to low incentive cost given and paid to consumers for option (1) at RO 234,060 compared to RO 600,700 for option (3). Increase in fresh products beyond market demand exposed farmers to market volatility and uncertain sale revenue decline risk. Moreover, the increase in incentive cost for fresh products force the Management to freeze fresh product and sale them as frozen products with high discount price up to 30% of sale piece. The analysis reviled that option (1) is risk averse alternative and support business continuity and economic performance resilience due to dynamic production plan that match with consumption and marketing situation and demand.

Table 3. Economic performance of products mix and marketing strategies scenarios and statistical result

Item	Option No (1)	Option No (2)	Option No (3)
Production volume /ton	6.100	6,800	7,600
Incentive cost RO	234,060	424,100	600,700
Minimum	-319,671	-454,790	-565,412
Maximum	1,172,522	1,143,334	1,149,832
Profit Mean	316,533	233,698	172,024
Profit SD	310,746	319,181	334,652
Skewness	0.1457	0.1486	0.1686
Kurtosis	1.9925	2.0801	2.2277
Breakeven %	18.2%	27.6%	34.2%

Although standard deviation (SD) is the attractive measurement to calculate risk, but it is used to measures total risk, which includes the downside and upside tail end risk and it is not a powerful tool to differentiation non-symmetric probability distribution function of production levels' net profit. The large negative volatility at downside and business loss movement is harmful and need to be control by broiler farming management through optimizing production level with marketing dynamic activities. Downside risk analysis is performed in this study to quantify the worst-case loss due to uncertain production and marketing variables in case of market deterioration and stress situation due to Coronavirus crises and impact of closure of hotel, restaurant, and catering services (HORECA) channels.

Figure (1) shows three different broiler production level, product mix and different Marketing strategies. The net profit probability distribution functions (PDF) stimulated result for three production level and products mix options and breakeven points percentage showed the probability of not achieving net profit (loss) for each production level. The breakeven point for option (1) record 18.2% and for option (2) is 27.6% and for option (3) increased to 34.2% of production level. The Figure also shows the probability of achieving net profit for option (1) is 81.8%, option (2) is 72.4% and for option (3) is 65.8%. Investors and broiler farmer decision's will depend on farmers risk tolerance and risk appetite to accept production level and products mix which balance between potential benefit and threatens according to market dynamic situation.

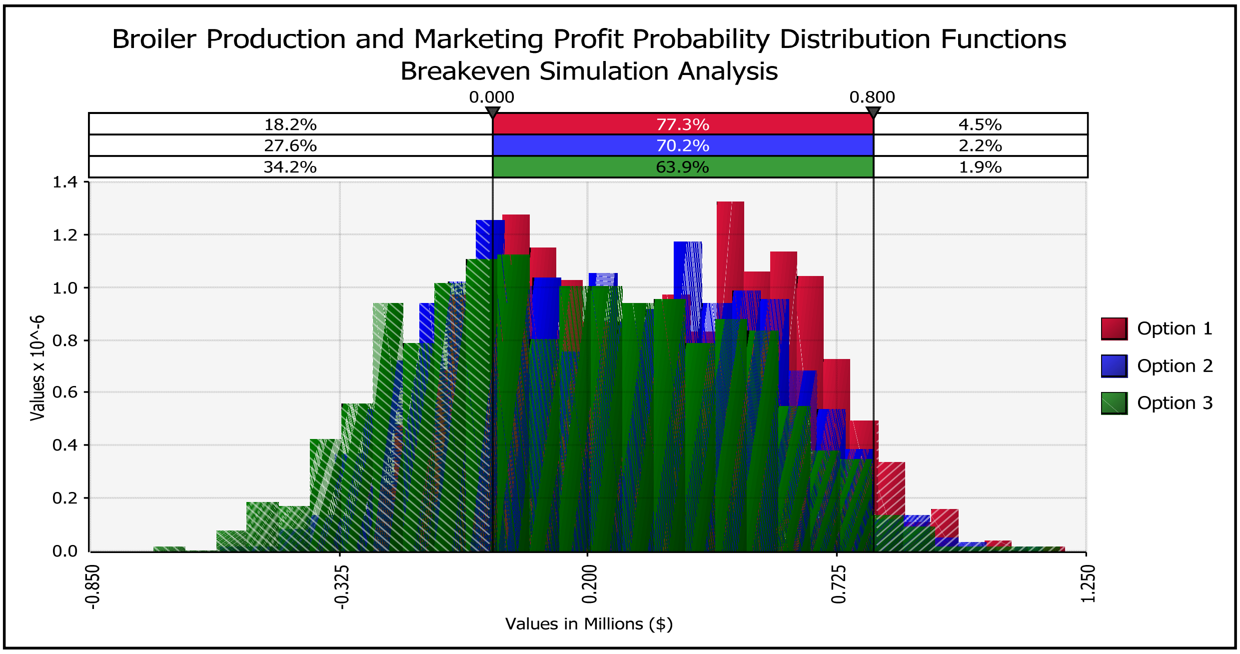

Figure 1. Broiler product mix net profit probability distribution function and breakeven point analysis

3.2 Downside Risk and Tornado Sensitivity Analysis

Downside simulation tornado sensitivity analysis performed to test tail-end distribution for three production level options and rank uncertain parameter effect on broiler farming net profit. Option (1) sensitivity analysis showed that sale incentive has the highest effect on net profit and given high level percentile of incentive will reduce net profit from RO 316 k to RO 52 k, and given low level percentile of incentive will increase net profit from RO 316 k to RO 579 k. Sensitivity analysis for option (1) also showed that the second highest input effecting net profit is cost of fresh followed by cost of parts products. The cost of fresh reduction at downside tail end level will increase net profit from RO 316 k to RO 575 k compared to cost of part reduction which will increase net profit to 485 k as shown in Figure (2) below. Management should concentrate on marketing strategies as sale incentive contribute to net profit variance record 69.9%, followed by cost of fresh of 13.1% and cost of parts of 11.1% on net profit variance changes.

The sensitivity and tornado graph analysis for option (3) showed sale incentive has the highest effect on net profit and given high level percentile of incentive exposed broiler farmers to risk and reduce net profit from RO 172 k to loss of RO (89.7 k), and given low level percentile incentive to fresh and part products will increase net profit from RO 172 k to RO 433 k. The study showed given high discount up to 30% to frozen product cost the company RO 379,500 which need to be controlled by farm operation team through increasing bird size up to market demand level range 800-1200 grams and reducing cost of frozen products.

The second highest input effect net profit for option (3) level of production is cost of fresh which reduce net profit from RO 172 k to RO 26 k, followed by cost of parts which change the net profit to loss of RO (48 k). Monitoring and managing market dynamic for fresh products and given low level percentile incentive will increase farm net profit from RO 172 k to RO 459 k.

The stress analysis of three production level and product mix options reveled that option (3) with a total production of 7,600 tons and market over supple has high risk aversion impact and uncertainty on broiler farming net profit and could not achieved economies sustainability under stress operation and market situation.

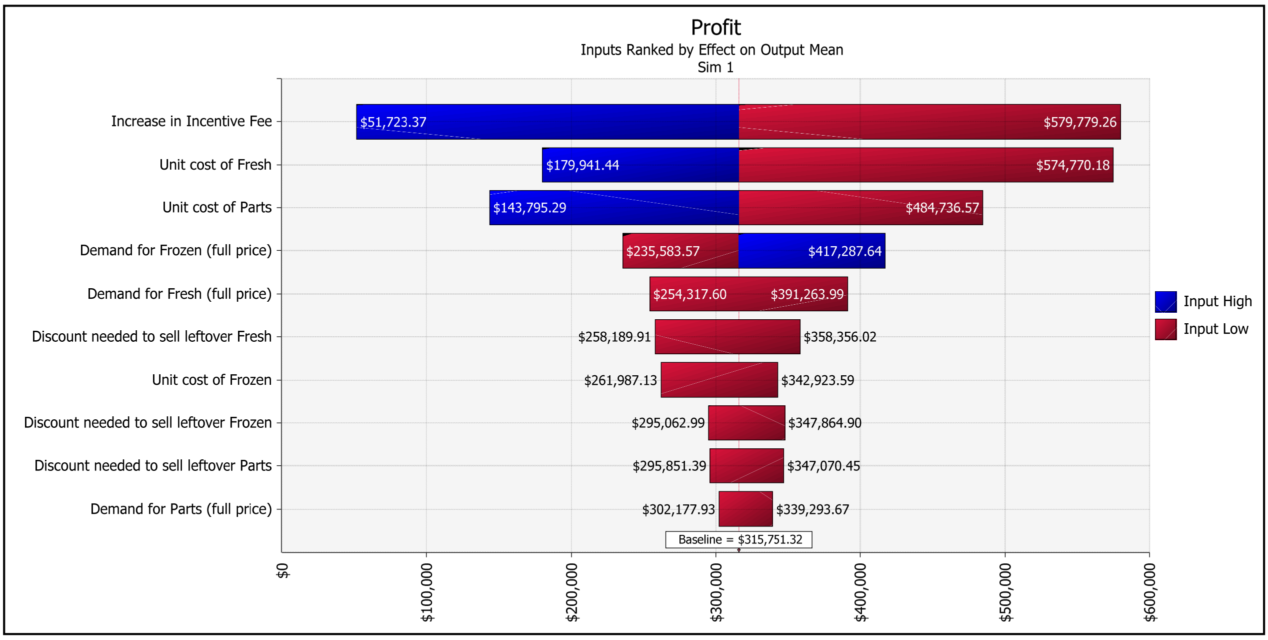

Figure 2. Ranking input parameters effect on net profit and tornado sensitivity analysis

3.3 Monte Carlo Simulations and Stress Analysis

The stress analysis performed to test economic performance of alternative production and marketing stress management strategies and identify factors affect broiler farming continuity and resilience. The stress analysis simulated six scenarios under stressors to test the effect of product cost increase and sale revenue decrease over Baseline scenario. Three scenarios were selected to test production cost at their high level 85-100% of PDFs and three scenarios to test broiler sale revenue at their lower level of 0-25% of probability density function PDFs. The stress analysis built to quantify economic performance of decreased in sale revenue factor and increased on cost of product factor for each product on broiler farming net profit under stress situation.

The stressors were introduced by running the simulations while limiting the PDFs of selected input variables to a specified percentile. The analysis was carried out at two stress levels 0-25% PDFs for sale revenue decline to simulate lowest products revenue and 85-100% for cost parameter to simulate highest possible cost. The stress analysis performed simultaneously to capture the whole effect on broiler business performance and cash flow with stress operation efficiency and market situation.

Table 4. Stress analysis statistics of uncertain parameters distribution of production and marketing model

Name	Stress	Mean NP	Min	Max	SD	BEP. Mean Loss	Skewness	Kurtosis
		RO (000)				(%Var.)		
Baseline	Baseline	316	-368	1,147	326	-	-0.4717	-0.5191
Demand Fresh	0-25%	273	-404	1,129	326	(13.61%)	-0.4570	-0.5084
Demand Parts	0-25%	312	-372	1,144	326	(1.40%)	-0.4729	-0.5188
Demand Frozen	0-25%	246	-412	1,104	322	(22.07%)	-0.4759	-0.4989
Cost Fresh	85-100%	191	-400	777	297	(39.41%)	-0.7309	-0.5872
Cost Parts	85-100%	153	-446	912	308	(51.46%)	-0.5303	-0.5403
Cost Frozen	85-100%	269	-410	1,097	326	(14.99%)	-0.4786	-0.5098

The effect of stress analysis and scenarios outcomes and difference variation between baseline profit and profit outcome under stress was measured and presented at table (4). The expected changes from Baseline profit under no stress and profit after stress of each scenario calculated as percentage breakeven point (BEP) and summarized below. The cost of parts has a highest negative change of (51.46%) from baseline model flowed by cost of fresh (39.41%) and demand for frozen (22.07%) respectively as shown in table (4).

The stress analysis shows that marketing strategy scenarios performs much better than cost scenarios in terms of mean net profit facing stress situation. The marketing strategies should monitor and observe sale revenue of frozen, and fresh products respectively. The production team should concentrate and monitor cost saving of parts, fresh products and cost of frozen products, respectively.

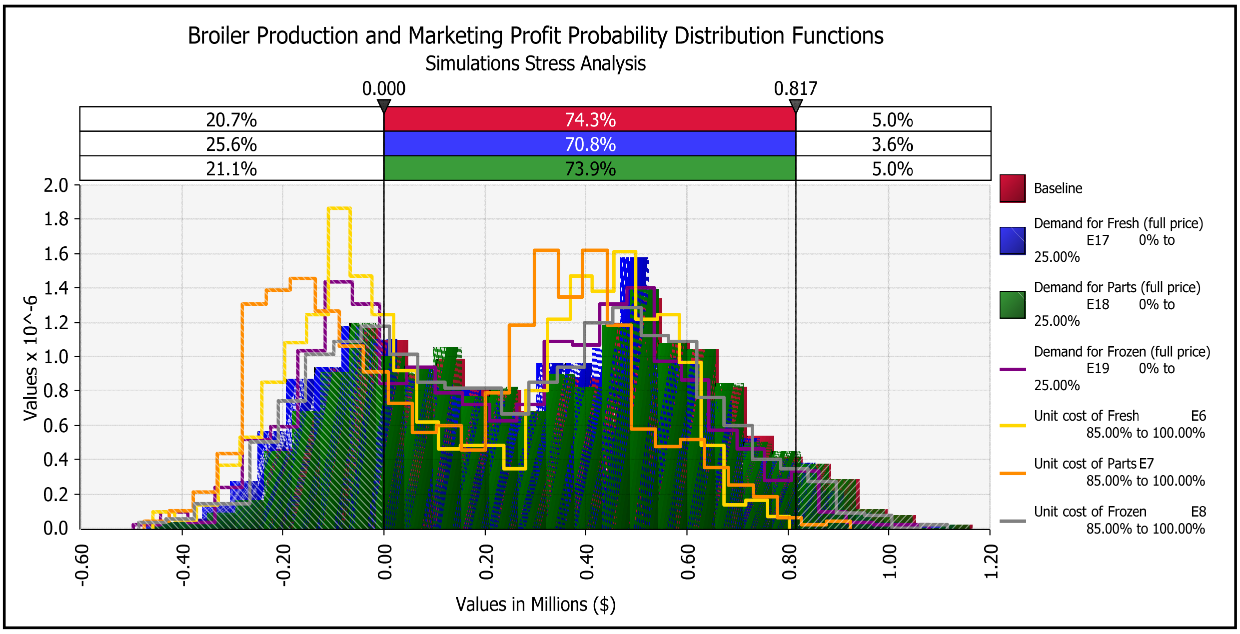

Figure 3. Broiler production and marketing profit probability distribution function stress analysis

3.4 Net Profit Frequency Distribution and Downside Risk Management

The net profit frequency distribution asymmetry in one of important tool to assess and managed broiler farming risk. As farmers like good uncertainty because it increases the potential of gain and increase net profit and dislike bad uncertainty as it increases likelihood of sever losses. The total variance of risk premium which measured by skewness represents total famers participation and asymmetric views of good and bad uncertainty. The skewness risk premium measures the spread between upside and downside net profit components of variance risk premium.

Downside risk analysis refers to the left tail end probability of net profit fall below the mean. It is concentrated on the loss opportunity result from a net profit decrease due to products cost change and sale revenue decline consequent to market conditions deterioration. Downside risk can also be identified as an statistical tool that aims to calculate and quantify the maximum loss can result from uncertainty in the difference between expected and realized net profit in cases cost and market conditions deteriorate.

Two additional frequency distribution were calculated to test distribution of skewness and kurtosis. Skewness measures the degree of variability of a frequency distribution of net profit and it is named third moment around the mean or third central moment. When net profit distribution is skewed to right it called positive skewness, the mean locates to the right of the median and mode, and when net profit distribution is left skewed it called negative skewness and mean is locate to the left of the median and mode and implies many small profits and few large losses.

All models have a negative skewness distribution with left-skewness tail distribution. The highest negative skewness stress scenario are cost fresh -0.7309 followed by cost of parts -0.5303 which indicate high downside volatility and more risk for net profit decrease. The short and medium decisions makers need to look for skewness and kurtosis figures to judge net profit distribution shape because they consider the extremes of data sets at short time period rather than average figures which will take long time period. Kurtosis figures are negative for all scenarios and represent flatter peak and thinner light-tail distributions. The probability distribution function PDF of broiler farming stress management strategies showed a high risk premium figure of cost parts RO (164 k) followed by cost fresh RO (115 k) and demand frozen RO (69 k) compared to Baseline net profit as per Figure (4).

Simulation stress analysis is tested using kurtosis and skewness measurement and indicates that net profit probability distribution of cost fresh model stretches to the left more than baseline model with skewness (-0.7309) and 85% CV. Cost parts has second worsted downside loss with skewness (-0.5303) and 98.82% CV with left-skewed distribution. The high negative skewed cost fresh model means offering downside protection and controlling large losses compared to cost part as shown by left end tail. The analysis also showed cost fresh products control downside risk, but the upside potential and opportunity of taking advantage of a higher realized net profit remains un-covered.

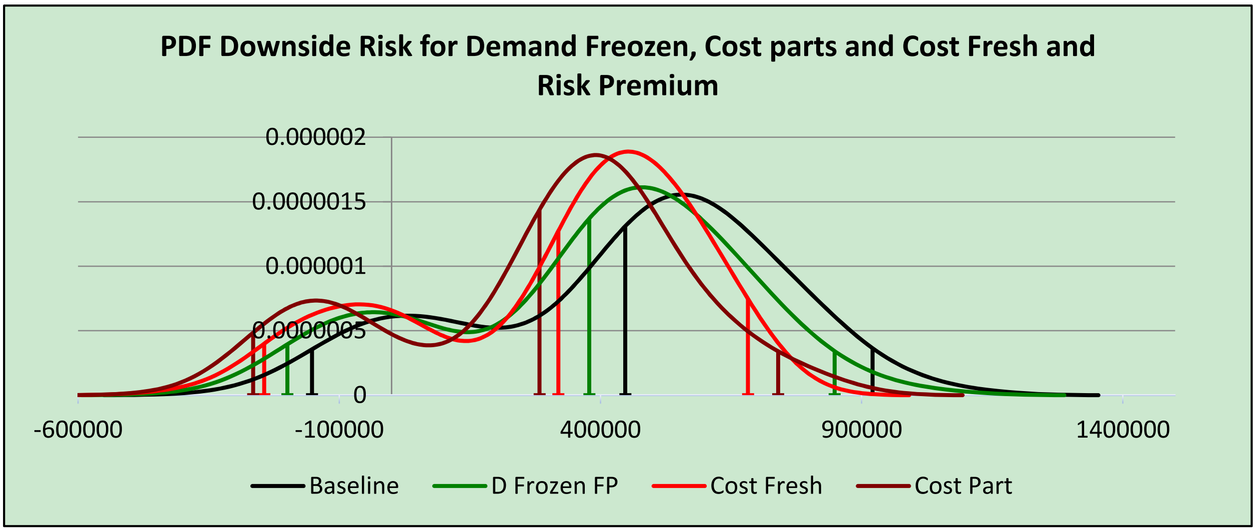

Figure 4. Downside risk alternative comparison of high risk premium alternatives and baseline net profit

Kurtosis measures the peakedness of the probability distribution and the degree of fat-tailness of the net profit. The normal distribution kurtosis equals (0.00-3.00) If the parameter is larger than (3.00) indicate a clustering of points around the mean with non-normal peakedness (Leptokurtic distribution) and if it is low than (0.00) (Platykurtic) with subtle curve and flat tail. The result of the stress analysis showed negative coefficient of kurtosis figures and small probability of generating an extreme net profit, less extreme and light tailed distribution for cost fresh model (-0.587) and cost part kurtosis of (-0.540) which indicates that cost of fresh and cost of parts are less risky without extreme figures at tail-end under stress situation as shown in table (4).

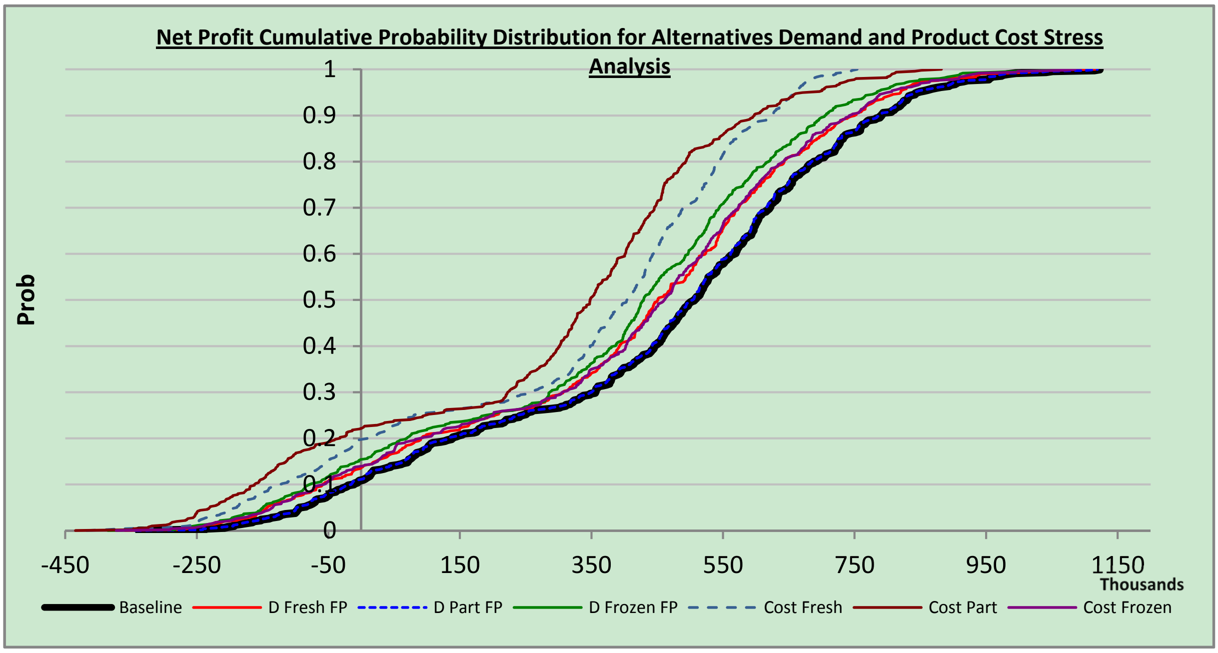

Figure 5. Comparison of 7 CDF of NPs of broiler production and marketing alternatives strategies

3.5 Broiler Stress Management Alternative and Cumulated Distribution Function Analysis

The study test sustainability of broiler products mix Baseline and stress management alternatives of marketing strategies by construction cumulated distribution function (CDF) graph that indicate the range and probabilities of net profit value for different products cost and marketing alternatives. Due to CDF lines cross in the graph we could not be able to rank cost and market alternatives in accord with their economic sustainability by using first and second stochastic dominance with respect function (SDRF). Accordingly, stochastic efficiency with respect to function (SERF) has been used for a better ranking analysis. The analysis showed Baseline model and demand for parts and fresh models are risk efficient alternative followed by cost frozen models as their distribution lines located on the right and preferred to those on the left line, as shown in Figure (5).

3.6 Stochastic Efficiency with Respect to a Function and Risk Analysis

The study used SIMETAR program developed by Richarson et al. (2008), to calculate stochastic efficiency with respect to a function (SERF) to evaluate risk-efficient of stress management strategies and sustainable net profit alternative option. The SERF recognize the most risk efficient alternative of production level for a range of risk preferences by ranking alternatives in terms of (CE) figures. Economic sustainable stress management strategies for product cost and marketing parameters performed to evaluate risk efferent alternative option for a range of risk preference for all absolute risk aversion coefficient. SIMETAR program calculated certainty equivalent value and constructed graphs to rank net profit of different market scenario and cost of production stress level across the specified range of ARAC values. Across two or several alternatives, a higher CE, with the same level of ARAC is considered a best management alternative. Table (5) showed that demand and sale revenue decline for parts and fresh products are risk averse alternative than cost of products volatility risk for at all absolute risk aversion coefficient (ARAC). The range of risk aversion coefficient (ARAC) from 0.00000 which represent risk neutral to 0.000005 which present strongly risk averse. The cost increase for parts and fresh products have lowest CE for all (ARAC) and are not risk averse alternative due to short shelf live and high expiry of fresh products. The cost of parts and fresh products need to be controlled to mitigate risk at stress situation. Fresh products market segmentation policy and targeting high income consumers will reduce expiry and mitigate fresh products cost increase risk.

Table 5. Ranking risk management strategies net profit and certainty equivalent and risk premium for all absolute risk aversion coefficient

		CE			Risk Premium (Baseline over Stress)		
Variables	Stress	Neutral	Moderate	Strong	Neutral	Moderate	Strong
	%	(0.00000)	(0.000003)	(0.000005)	(0.00000)	(0.000003)	(0.000005)
Baseline	-	309,946	164,534	90,562	-	-	-
Demand Parts	0-25%	305,351	160,085	86,219	4,595	4,449	4,343
Demand Fresh	0-25%	265,900	121,962	48,844	44,046	42,572	41,718
Cost Frozen	85-100%	262,660	117,533	43,910	47,286	47,001	46,652
Demand Frozen	0-25%	240,972	101,850	32,073	68,974	62,684	58,489
Cost Fresh	85-100%	195,107	67,983	4,571	114,839	96,551	85,991
Cost Parts	85-100%	146,313	19,383	-43,411	163,633	145,151	133,973

The high value of CE at the same level of ARAC indicates a preferred alternative. Absolute risk aversion coefficient (ARAC) values ranging from 0.00000 to 0.000005 were used in the (SERF) analysis to calculate CE values for each of the product market and sale revenue level and product cost level. Table (5) indicates that demand for parts and fresh are risk averse for all risk aversion coefficient and cost of frozen and demand fresh are risk averse for all risk aversion coefficient, as per Figure (6).

The net profit risk premiums were calculated for each marketing and production scenarios by subtracting CE values from Baseline CE values at given ARAC values. Risk premium is a measure of excess return that is required by decision maker to compensate being subjected to an increased level of risk (reduce revenue or increase cost) from the baseline model. The CE and risk premium for each scenario in the study calculated and summarized at table (5).

Risk premium for broiler market demand stress analysis shows that demand frozen risk has a high risk premium RP followed by demand fresh and demand parts products for all ARAC. The high excess return required to compensate demand frozen product revenue reduction risk and moved to Baseline is mainly due to high discount given to frozen products.

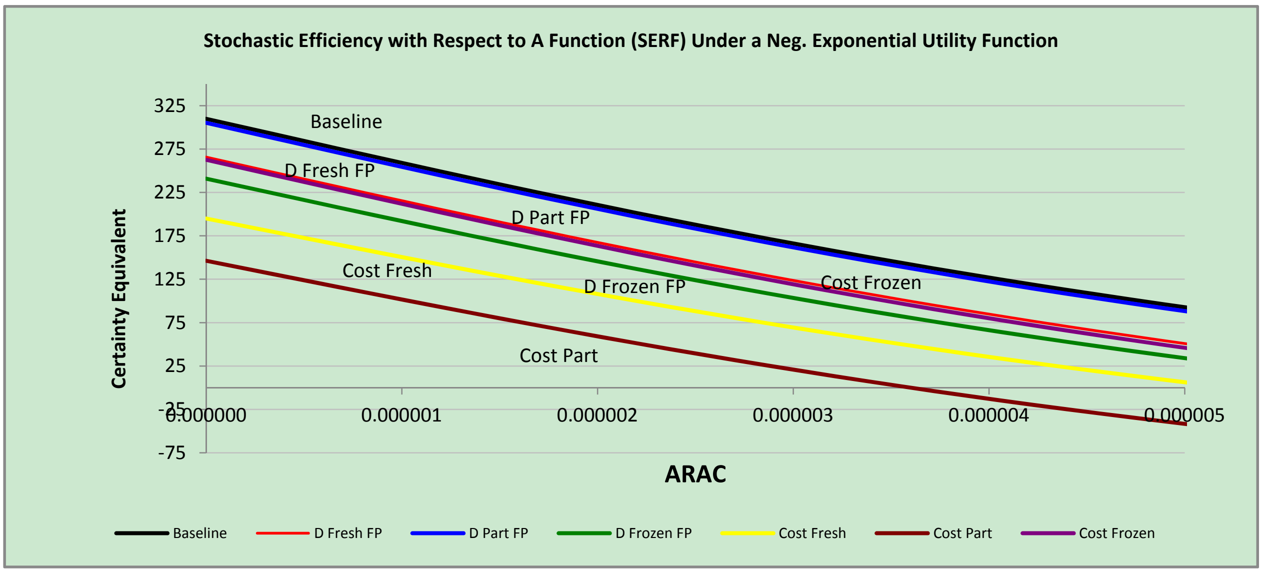

Figure 6. Broiler production and marketing profit probability distribution function stress analysis

The problem of cheap frozen products imported from outside and small size of local frozen products compared to import frozen products need to be solved through market regulating and poultry meat anti-dumping regulation. The risk premium calculated for broiler cost increase stress situation in this study and indicates that pats products cost increase has a highest risk primum followed by cost of fresh products and cost frozen products for all ARAC.

The cost parts products cost increases stress analysis showed a negative CE figure at strong risk averse (ARAC). The decision makers should monitor demand activities and improve demand for frozen and demand for fresh products through improving marketing activities to mitigate revenue reduction risk and reduce cost part and cost fresh products to mitigate cost increase risk factors.

4. Conclusions

This study presents an evaluation of three broiler production level and products mix and marketing incentive activities risk analysis. Stress analyses were performed to test economic performance sustainability of alternative marketing sale revenue reduction 0-25% and cost of production increase stress by 85-100% and identify factors affect business positive cash flow, broiler farming continuity and resilience. The study stimulated net profit for different alternative product mix and marketing policies and use @Risk 8.2 program to perform risk assessment. Stochastic Efficiency with Respect to a Function (SERF) constructed and used to estimate Certainty Equivalent (CE) and Risk Premium (RP) values.

According to CE value the Baseline Model product mix is the best risk efficient alternative for all ARAC followed by demand parts and demand fresh products sale revenue decline and volatility risk. The marketing team should monitor demand frozen, demand fresh and demand parts sale revenue activities to mitigate risk of sale revenue reduction caused by market stress situation. The minimum market incentive and risk premium needed to motivate a change from demand frozen products to demand fresh products marketing activities is RO 24,928 and to change from demand fresh to demand parts is RO 39,451 for risk neutral absolute risk aversion coefficient (ARAC) during broiler farming stress situation. The stress analysis of three production level and product mix options reveled that option (3) with a total production of 7,600 tons and market over supple has high risk impact on broiler farming net profit and could not achieved positive cash flows and economies sustainability under stress operation and market situation.

The Management and operation team should work closely to reduce cost of production of fresh and frozen products to mitigate risk of cost of feed price increase. The minimum incentive and risk premium needed to motivate operation team to change from cost fresh products to cost frozen products to mitigate risk of increase of cost is RO 67,553 for risk neutral absolute risk aversion coefficient (ARAC). The cost of frozen need to be controlled to compete frozen import products and mitigate marketing high risk and payment of high sale discount cost for frozen products.

Sale incentive need to be addressed and controlled through appropriate risk assessment and mitigation strategies by controlling outside factors and optimization production level and control cost increase risk vulnerability. The Government feed subsidy program need to be imposed to achieve business economic sustainability. Moreover, separate production processing operation needs to be considered for frozen products and fresh products to control cost for each product. Frozen and fresh products expiry need to be controlled and reduced.

The analysis also showed that the minimum amount required risk premium (RP) for a net profit maximization for marketing stress activities are lower and risk averse than risk premium (RP) required of operation cost stress activities for fresh and parts products. A full detail marketing studies will help to understand broiler business risk management strategies and improve marketing incentive programs and control poultry meat anti-dumping issues. The Government poultry feed subsidy program will reduce and mitigate cost of production risk and reduce the impact of Ukraine conflict and global food security issue. The marketing risk mitigation needs adoption of income insurance program and market regulation to improve broiler farming income and achieve broiler business resilience and economic sustainability and encouraged poverty alleviation programs.

Conflict of interest.

The author declare no conflict of interest.

Authors Contributions

Not applicable

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Availability of supporting Data

All data are available from local broiler farm data based, monthly and quarter company report are available.

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