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Farming Risk Assessment

Research on the Power Consumed

Highlights

Impact of Farm Mechanization

Measures and Marketing Strategies

Discovering Thoughts, Inventing Future

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Contents of the Issue

i. Copyright Notice
ii. Editorial Board Members
iii. Chief Author and Dean
iv. Contents of the Issue

1. Broiler Farming Risk Assessment Market Risk Premium Measures and Marketing Strategies. *1-17*
2. Research on the Power Consumed by Drives of Machines for Working with Greenhouse Soil. *19-24*
3. Innovative and Affordable Feed Solutions for Enhancing Cattle Finishing in Tanzania. *25-30*
4. Impact of Farm Mechanization on the Psychological Health of the Farmers: A Holistic Study in West Bengal, India. *31-36*

v. Fellows
vi. Auxiliary Memberships
vii. Preferred Author Guidelines
viii. Index

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Broiler Farming Risk Assessment: Market Risk Premium Measures and Marketing Strategies

By Kheiry Hassan M. Ishag

Abstract- The broiler farming business faces challenges due to many reasons such as technical innovation, finance uncertain parameters and dynamic marketing complex. Broiler farms at Sultanate of Oman has been performing with challenge and many constrains, including poor farming practices, climate stress and variability, feed grain price increase. The risk assessment of broiler business indicated high impact of products unit cost of productions, market dynamic risk and financial sustainability. Market competition and cheap frozen chicken products imported from outside significantly affect the local broiler market risk and uncertainty and marketing strategies. The study applied stochastic budget Monte Carlo Simulation approach to calculate market risk primum and reform market strategies and align them with acceptable risk tolerance comfort level of the stakeholders' perceptions. Three production levels, products mix models, were tested under two different scenarios to measure market risk and market strategies.

Keywords: risk tolerance, broiler unsystematic flock uniformity, stochastic efficient risk function (SERF), certain equivalent (CE), market risk premium analysis, monte carlo simulation, absolute risk aversion coefficients (ARAC), profit sustainability.

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Broiler Farming Risk Assessment: Market Risk Premium Measures and Marketing Strategies

Kheiry Hassan M. Ishag

Abstract- The broiler farming business faces challenges due to many reasons such as technical innovation, finance uncertain parameters and dynamic marketing complex. Broiler farms at Sultanate of Oman has been performing with challenge and many constrains, including poor farming practices, climate stress and variability, feed grain price increase. The risk assessment of broiler business indicated high impact of products unit cost of productions, market dynamic risk and financial sustainability. Market competition and cheap frozen chicken products imported from outside significantly affect the local broiler market risk and uncertainty and marketing strategies. The study applied stochastic budget Monte Carlo Simulation approach to calculate market risk primum and reform market strategies and align them with acceptable risk tolerance comfort level of the stakeholders' perceptions. Three production levels, products mix models, were tested under two different scenarios to measure market risk and market strategies. The study performed stochastic efficiency with respect to a function (SERF) to calculate certain equivalent (CE) figure to rank alternative market's scenarios under uncertain situations. The overall results showed that unit cost, followed by broiler market risk and sale revenue volatilities, are highly affecting profit in integrated complex system. Quadrant analysis was performed to understand broiler market dynamics impact to chicken products market shares and market growth and accordingly develop comprehensive market strategies business objectives. Fresh whole chicken products recognized as high market shares and slow market growth and identified as a leader in the marketplace that generates consistent revenue. Frozen products are recognized as low market shares and slow market growth that cannot generate sufficient cash to sustain healthy financial. The study pointed out that frozen products have potential and need heavy investment to balance between steady market share and business growth to achieve financial stability and business sustainability. Frozen products serve only 15.7% of the total Company market share and might be repositioned to serve niche markets. Both operation and market risk measures and quantification enabled organization for effective fresh products repositioning strategy to algin with current market trends. The significant sale discount of 17% and lowering frozen price increased sale revenue but cannot be recognized as comprehensive strategies for market share increase due customers perceive the product as less valuable and below market standard weight. Risk premium of RO 48,256 is a risk due to unsystematic market volatility challenges and inefficient operation practices produced unsalable small whole chicken size at 6,557 tons production level. In conclusion, the risk premium of RO 0.209 per one kg of chicken meat is compensation between current broiler farming practices return and higher uncertain future return and represent cost of offsetting broiler business difficulty by developing broiler business in other informed decisions and directions.

Keywords: *risk tolerance, broiler unsystematic flock uniformity, stochastic efficient risk function (SERF), certain equivalent (CE), market risk premium analysis, monte carlo simulation, absolute risk aversion coefficients (ARAC), profit sustainability.*

I. Introduction

Oman's poultry meat market is characterized by high demand for quality poultry meat products derived by steady population growth, high income and changing in dietary preference. The poultry sector in Sultanate of Oman produced 132,600 tons which represent 62% of broiler meat self-sufficiency for year 2022. Poultry commercial farming at Sultanate of Oman breed poultry and produce poultry meat and table eggs at their farms and feed them with high cost of concentrates feed made from raw material, premix and vitamins imported from outside. Small scale farm sale live birds to local markets, while medium and large farms sell processed chicken meat to restaurants, hotels and big malls at local and reginal market. Poultry business encompasses various critical stages such as farm operation, supply chain disruption, slaughterhouse and meat processing units, market distribution and retails. This type of business is exposed to risk and creates low net profit as main inputs of feed ingredients, hatching eggs, medicine and modern houses control technologies imported from outside and exposed to high capital cost, supply chain disruptions, operation constraints and sale price uncertainties. Moreover, marketing challenges and cheap poultry products imported from different continents and sold at low prices create high pressure for poultry business economic sustainability. Unit cost increase of poultry meat products, market dynamic and uncertainty, and sale revenue volatility remain challenging and jeopardize poultry business to achieve sustainable growth and the country's food security gools. Market price volatility, food scarcity, extreme weather, soaring prices of raw materials are some risks that can disrupt the sustainability of the supply chain of chicken meat. It is essentially important for smallholder farmers to incorporate risks management approach in their chicken meat and egg productions, argued Armijal, et al. (2023). He identified 25 risk events and 45 risk agents by using

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Risk of House (ROH) approach to mitigate and overcome supply chain risk management for layer farms.

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 margin and profitability in 2023. The Government subsidy programs imposed earlier in 2011 to improve local poultry production contributions stopped on year 2016. In year 2019 COVID spread over the world and cause supply chain disruptions in addition to international situation and Ukraine conflict which impact on food security, Kheiry Ishag (2024). Market volatility and uncertainty factors and risk parameters in broiler farming business are the main challenges for farmers and business owner to make informed and good decisions and needs to be analyzed, said Danilo Simões et al. (2014). This study investigated and quantified uncertainties of poultry products unit cost, market dynamics and sale revenue volatility impact to understand and quantify risk and cope with problem anticipation and consequences. Broiler risk management should involve and provide insights information for effective decision-making using the board-approved risk appetite to identify which risks to take to achieve strategic objectives. The study quantifies risk tolerance boundary for different levels of production scenarios with limited market demand capacity for fresh and frozen broiler meat products.

Oman poultry farms suffer 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 stops poultry farming in summer-time to avoid heat stress problems and farm net profit reduction. Although new control breading houses reduced mortality rates at summer-time, but bird daily weight gain and decreased of feed consumption efficiency are still observed and created marketing challenges, Kheiry Ishag (2019). Small size birds and whole chicken meat products below the marketing standard range (900 - 1200 grams) sold at a high discount rate and affect farming net profit, Guro Vasdal et al. (2019). 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 of breeding. May et al., (1998) study showed that environmental conditions improvement increases as body weight increases. Gajanan K. et al., (2024) Investigated body weight and meat quality at the slaughterhouse. This study investigated discounts given to customers for small whole chicken size and its effect on market demand and net profit. Although it is not possible to predict future accurately, simulations analysis allows us to create risk profiles by generating a large number of iterations, including extreme cases, such study allow us to identify the effects of marketing and unit cost factors variation on broiler business profitability in term of probabilistic way, (Albright and Winston, 2019; Lehman and Groenendaal, 2020). With the right strategy, tools and approach, businesses can turn what appears to be a poor market situation into greater profitability and improved market positioning in the long-term.

Several poultry production risk assessment factors identified in this study to understand the impact of global and macroeconomic uncertainty on raw materials cost, business production volume level and chicken products sale price. The marketing uncertain incorporated in this study by using cumulative distribution function (CDF) to test effect of sale discount given to consumers to sale over supply chicken meat products on profit, Lima, R., Sampaio, R. (2018). The market demand available at full price for each product mix i.e. fresh, parts and frozen chicken meat products and sale price discount need to be given to sale products leftover and market over supply products were also incorporated in the study. The risk of poor technical practices performance and marketing parameters volatility required strategic decision that covers production and marketing risk and constraints, Chavas et al. (2004). The study calculated risk premium that compensates for poor technical farming and market uncertainties and estimates extra return to investors over risk free business cash flow and quantified risk premium for different marketing stagiaries. The Monte Carlo models are used as a tool to quantify risk and uncertainty of the related business by many studies, (Luiz Silva et al., 2014; Gray E. Machlis, et al. (1990); Niloufar M. et al. 2024).

Dynamic models give a range of results that can mitigate and reduce operation risk and sale revenue decline impacts 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 scenarios under different production level 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 models. 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 Ishag (2019; 2020) used (SERF) and CE figures to rank poultry farming systems and dairy cow feeding practices strategies according to feeding cost and feed availability. Stochastic efficiency with respect to function (SERF) technique consists of ranking risky

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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 of the 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), Richardson J. W. 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. Risk analysis of agriculture production systems investigated by using stochastic efficiency with respect to function (SERF) in many studies (Lien G., et al. 2007; Ascough II. J. C. et al. 2009, and Eihab M. Fathelrahman et al. 2011).

In this study, (SERF) technique is used to assess broiler business sustainability of different production levels and marketing strategies models. Six stochastic models were worked out to construct farm net profit distribution function for each proposed marketing alternative model. Risk premium (RP) analysis performed to measure excess return required by decision makers to compensate change and shift from current risk free production level to potential uncertain future return. The study identified broiler farming marketing alternative strategies and calculated net profit performance risk-efficient and verified models economics sustainability.

The journey of broiler business entrepreneurship is inherently filled with risks and uncertainties. However, successful risk-takers possess a unique combination of characteristics that enable them to navigate broiler business challenges effectively by cultivating resilience, adaptability, strong vision, optimism, a willingness to learn, decisiveness, and strong networking skills, entrepreneurs can position themselves for success in an ever-changing landscape. Management by embracing these traits not only enhances their ability to take calculated risks but also contributes to sustainable business growth and innovation within their ventures.

II. Methodology

The poultry business net profit is calculated to quantify the economic performance of alternative production level and product mix scenarios and achieve business sustainability. The conventional normal approach used in business evaluation is to calculate the best estimate available data for cost and revenue for each poultry products level and production mix. The single value of net profit generated by conventional methods doesn't reflect risk of cost of production, sale product volume and market demand uncertainty. It doesn't also reflect market demand environment risk in terms of range of products sold with full price and product over supply sold with sale discount price. Broiler farming business in this study was exposed to a significant loss due to sale discounts given to consumers and considerable market risk and uncertainty. Accordingly, the model was constructed to estimate a range of unit chicken meat cost, sale volume decline and market demand parameters risk and quantify marketing uncertainty 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 product to increase net profit and achieve business sustainability. The stochastic budgeting and stochastic efficiency methods are used to consider operation and market risk and uncertainty variables in the model presented in study area. Technical broiler farming practices such as flock uniformity, feed conversion ratios (FCR), bird live weight growth, and its impact to products market share and market growth were also investigated in this study.

a) Marketing Historical Data and Data Collection

The broiler farming data used in this study is collected from a broiler 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 increases 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 increased to 90% during rainy season (kharef) extended from July to September. Broiler farm has 48 houses with dimensions of (L84XW14) meter and 12 Fans.

The data collected include historical broiler farm production level for fresh and frozen chicken meat, product mix combination and figures for alternatives market demand and chicken meat sold during year 2017 – 2020. Broiler operation farming performance parameters such as flock uniformity and chicken salable meat, dressing weight percentage and carcass yield, broiler live weight, breeding duration period, daily bird growth rate were collected from the broiler farm for comprehensive comparative and simulation analysis. Farm production data and marketing data collected and analyzed to test farm performance efficiency under different market scenarios. The whole chicken product size has a significant impact on market demand and broiler chickens desired weight that meet market

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specifications is crucial factor to achieve market potential demands. These factors were studied to understand farm operation efficiency parameters and thereby enhance customer satisfaction and business sustainability.

Understanding historical companies' market share and market potential demand will help decision makers to optimize broiler business performance. The market demands parameters such as customer chicken products preferences, market share and market growth data were collected and analyzed by using scatter plot analysis. The Market demand is not fixed, but changes over time and across different segments of the market and it represents the maximum potential sales that company can achieve in the market. Increasing products market share may not necessarily increase demand and Company decision of whole chicken product price reduction on demand investigated and answered by comprehensive scenario simulation analysis.

b) Broiler Business Net Profit Multiple Simulation Model

Net profit was used as an economic performance indicator and uncertain parameters incorporated in the model to calculate sale revenue, products' cost and business net profit. The net profit calculated by subtracting the total cost of products from the total sale revenue to obtain simulated business net profit probability distribution. Two different scenarios used, and each scenario has three product volumes and product mix alternatives. The first scenario represented potential return with normal market promotion, whereas the second scenario represented market risk demand volatility parameters. Product cost, sale volume and revenue, and discount given to each broiler products were collected from historical farm data and included in the Model. If net profit is a function of 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 scenario (1) and (2) for three production levels were obtained for each model from the formula below.

i. *Multiple Simulation Model Equation*

$$N\tilde{} \text{ Profit} = (\tilde{}Ya^{*}\ \tilde{}Pa + Yb^{*}\ \tilde{}Pb + Yc^{*}\ \tilde{}Pc + \ldots.) - (Co\ Ya, + Co\ Yb, + Co\ Yc + \ldots..) \quad \text{Scenario (1)}$$

$$N\tilde{} \text{ Profit} = (\tilde{}Ya^{*}\ \tilde{}Pa + Yb^{*}\ \tilde{}Pb + Yc^{*}\ \tilde{}Pc + \ldots.) - (Un\tilde{}Co\ Ya, + Un\tilde{}Co\ Yb, + Un\tilde{}Co\ Yc + \ldots..) \quad \text{Scenario (2)}$$

Where:

N˜	Profit Net profit probability distribution for net profit.
˜Ya	Fresh product stochastic yield sold.
˜Pa	Fresh product stochastic market price.
Yb	Frozen product stochastic yield sold.
˜Pb	Frozen product stochastic market price.
Yc	Fresh parts products stochastic yield sold.
˜Pc	Fresh parts products stochastic market price.
Un C	Fresh product stochastic cost for sale products.
Un ˜C	Frozen product Stochastic cost for sale products.

c) Operation and Marketing Uncertain Variables and Simulation Risk Analysis Model

The study used Monte Carlo simulation model to evaluate risk and uncertain input variables of a model. The model identified and tested the effects of main uncertain variables on the business performance and net profit. Product mix unit cost, production volume, market demand at full price and discount needed to sale remaining products were tested and evaluated by the model. The uncertain variables rage determined for main variables in model by using Standard Deviation (SD) that describes the range of uncertainty around each expected variable and presented 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 using (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.

d) Products Mix, Production Volume Alternatives and Marketing Scenarios

Products mix and marketing strategy play a key variable for broiler business performance and net profit calculation. Frozen products face competition from local companies and cheap imports products from outside. The unit cost of frozen products is high compared to import products. The Farm's whole chicken products below the standard market range (900-1200 grams) consist of 17.41% of total production. Due to small chicken size and high unit cost of production Company

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gives a high discounts rate i.e. 17% to sale leftover products. Although fresh products have high price realization, they face challenges in terms of shelf-life short duration, transportation cost, high expiry and high shelf rent rebates.

Table 1: Uncertain Parameters for Products Volume, Market Demand and Cost of Production Model

Items	Uncertain Variables	Variable Range	Mean	SD
Product Cost RO/kg	Fresh	1,100 – 1,350	1,242	46 8
	Fresh Parts	1,500- 2,500	1,999	189.1
	Frozen Parts	1,300 – 2,000	1,799	122.0
	Frozen	950 – 1,100	1,006	27.6
Production Volume Tons	Fresh	3,462 – 3,500	3,462	-
	Fresh Parts	1,469 – 1,850	1,469	-
	Frozen Parts	595 – 1,000	595	-
	Frozen	1,031 – 1,300	1,000	-
Market Demand (Full Price) Tons	Fresh	3,462	3,433	140
	Fresh Parts	1,469	1,479	94
	Frozen Parts	595 – 0.595	150	127
	Frozen	1,031- 800	883	71
Sale Promotion Discount %	Fresh	0.0% - 2.0%	9.40%	4.42%
	Fresh Parts	0.0% - 5.0%	9.06%	4.02%
	Frozen Parts	0.0% - 5.0%	9.06%	4.02%
	Frozen	5.0% - 17.0%	10.35%	5.38%

To compare economic performance of alternative production and marketing strategies, model assumptions determined variables that would change from one scenario to another to identified decision's variables. Different production variables values for each scenario modelled with (RiskSimTable) functions. The Multiple Simulations function is run by using @Risk 8.2 program to pick up production variable value for each simulation and option.

III. Result and Discussion

a) Broiler Production and Marketing Comparative Analysis

The present study aimed to compare historical broiler production parameters such as bird growth, live body weight, dressing percentage and warm carcass weight. The whole chicken weight range compared from 2017 to 2020, and analysis showed increasing trend of small birds below 1000 Grams and decreasing trend of big birds above 1000 Grams, as per Figure (1). The poor flock uniformity and total production below market standard (900 Gram) increased from 14.73% in 2017 to 17.41% in 2020. Small whole chicken products created marketing challenges and forced Management to reduce sale prices and reduced sale revenue, Table (2).

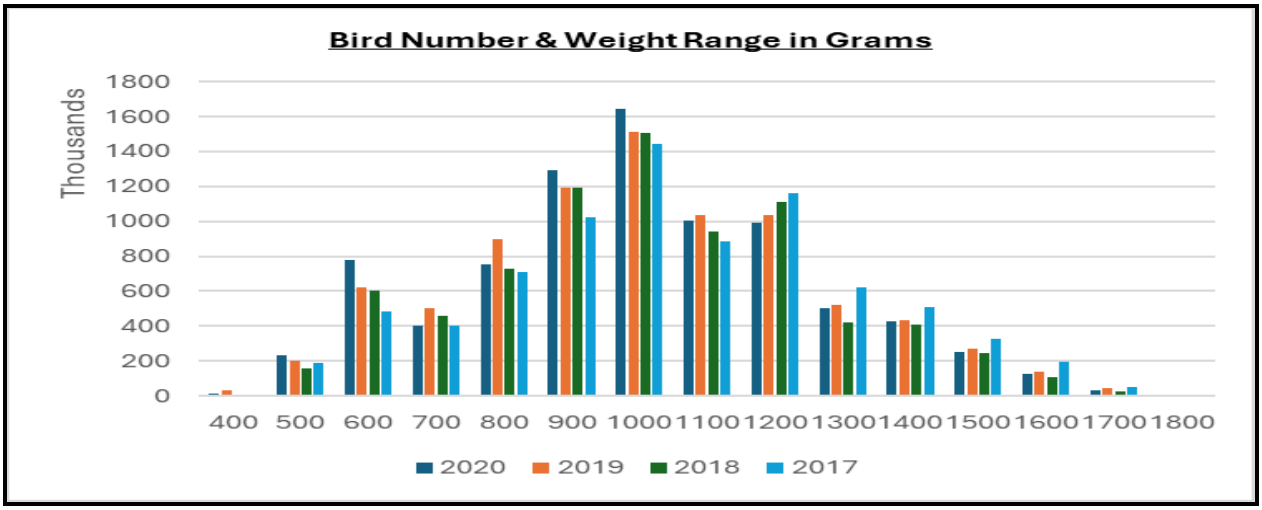


Figure 1: Bird Number and Weight Range in Grams for 2017 to 2020

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Although total chicken meat production increased the total salable meat reduced from 71% to 69% due to poor flock uniformity and chicken processing plant inefficiency. Historical data analysis showed that fresh chicken products' percentage increased from 38.76% to 41.06% and cut-up chicken products increased from 34.17% to 38.41%. The frozen whole chicken products percentage reduced from 27.07% to 20.53% but at the same time whole chicken size range from 900-1000 Grams increased from 2,601 tons to 2,880 tons and created high pressure for marketing team to increase sale discount to 17% which reduced sale revenue by RO 578,137. Table (2) presents production carcass percentage and chicken meat products category percentage compared to sale revenue figures.

Table 2: Production Carcas Weight, Marketable Meat and Market Share Volatility for Year 2017-2020

Year Weight/ Gram	2020	2019	2018	2017
900	15 %	14%	15%	13%
1000	19%	18%	19%	18%
1100	12%	12%	12%	11%
1200	12%	12%	14%	15%
1300	6%	6%	5%	8%
1400	5%	5%	5%	6%
Total Production/ton	8470	8520	8008	8390
Total Salable Meat %	69%	68%	71%	70%
Total meat below 900 Gram/ton	1,474	1,554	1,344	1,236
Fresh chicken Products /Kg %	41.06%	44.88%	49.03%	38.76%
Frozen chicken Products /Kg %	20.53%	26.03%	18.23%	27.07%
Cut-Up chicken Products /Kg %	38.41%	29.09%	32.74%	34.17%
Sale Revenue after Discount RO	9,731,778	9,948,479	10,497,634	10,309,915

Broiler Farm data analysis showed statistical means, standard deviation, skewness and kurtosis figures for (2017-2020). Farm production mean standard Deviation (SD) showed a wide spread in production values within a single year data, whereas coefficient variation (CV) figures showed production mean variation percentage comparison between two or more years. The analysis showed production variation and unsalable meat increased, Table (3).

Table 3: Historical Data Broiler Flock Uniformity, CV and Statistical Bird Weight Result

Year	2020	2019	2018	2017
Mean	604 566	607 728	572 035	599 179
SD	497 740	476 498	486 199	464 475
C.V. %	82.330	78.406	84.994	77.518
Min	7 141	7 747	6 178	14 665
Max	1 646 144	1 513 780	1 507 210	1 445 197
Skewness	0.7456	0.554	0.7300	0.5873
Kurtosis	-0.3178	-0.8256	-0.5976	-0.6154
Averg. Live Weight/kg	1.380	1.430	1.380	1.500

b) Broiler Production Volume and Product Mix Net Profit Simulations Statistical Analysis

The descriptive statistics analysis was performed to quantify risk and calculate the net profit of three different broiler farming performance. The probability distribution functions (PDF) analysis performed for three levels of production i.e. 6,557, 6,800 and 7,650 tons to calculate net profit probability distribution for each production level. The net profit probability distribution skewed to the left and breakeven point of not achieving positive profit increased from 9.0% to 13.6% and to 22.1% with production levels increased from 6,557 to 6,800 to 7,650 tons respectively.

Net profit simulation analysis performed for three different production volumes and products mix scenarios. Option No (1) represents baseline Broiler SD1 model with 6,557 tons production volume achieved net profit mean of RO 460,219 and 8.8% breakeven point. Option No (2) represents Broiler SD2 model generated RO 400,964 net profit and 13.3% breakeven point and option No (3) represents Broiler SD3 model with the lowest net profit and high Value at Risk (VaR) and SD represents high market risk. The analysis showed that Baseline model (Broiler SD1) is the best production volume and product mix broiler performance with high profit and low standard deviation SD.

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The net profits probability distribution functions (PDF) of three production alternatives 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 (1,957,957) for option (1) compared to higher standard deviation (SD) and a wide range of net profit RO (2,418,148) for option (3) as presented in table (4) below. The analysis showed that option (1) reduces performance variability and focuses on effective use of resources and reduces waste and undesirable chicken meat products.

Production plan for option (1) produced a total volume of 6,557 tons poultry meat with 3,462 tons fresh and 1,469 tons fresh parts, 595 tons frozen parts and 1,031 tons frozen whole chicken. Whereas production plan for option (3) produced a total volume of 7,650 tons poultry meat with 3,500 tons fresh and 1,850 tons fresh parts, 1,000 tons frozen parts and 1,300 tons frozen whole chicken. The analysis showed Baseline option (1) is more sustainable than option (3), as illustrated by table (4). Market risk management can improve business opportunities by producing quality products rather than increasing whole frozen chicken market share of undesirable products.

The descriptive analysis shows that reducing high risk fresh products by 5% and increasing low risk frozen products by 5% increased marketing risk and increased the value at risk (VaR) from (-100,000) to (-364,000) with 95% confidence level and increased breakeven point from 8.8% to 22.7%. Poor flock uniformity and discount given to sale small whole chicken product were the main operation problems behind this dilemma.

Table 4: Statistical Result of Broiler Performance Under Market Uncertain Challenges Scenario Model:-

Item	Option No (1)	Option No (2)	Option No (3)
Production volume /ton	6 557	6 800	7 650
Minimum	-498 983	-589 034	-858 074
Maximum	1 458 974	1 427 041	1 560 074
Profit Mean	460 219	400 964	334 557
Profit SD	345 552	352 798	426 521
Skewness	0.0368	0.0383	0.0382
Kurtosis	2.5972	2.5926	2.6019
Value at Risk (VaR)	-100 000	-171 000	-364 000
Breakeven %	8.8%	13.3%	22.7%

Although standard deviation (SD) is an attractive measurement to calculate risk, it is used to measure total risk, which includes the downside and upside tail end risk and it is not a powerful tool for differentiation non-symmetric probability distribution function of production levels' net profit. The large negative volatility at downside and business loss movement is harmful and needs to be investigated and 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 and small whole chicken size product and its impact on market demand and consumer preference of hotel, restaurant, and catering services (HORECA) channels.

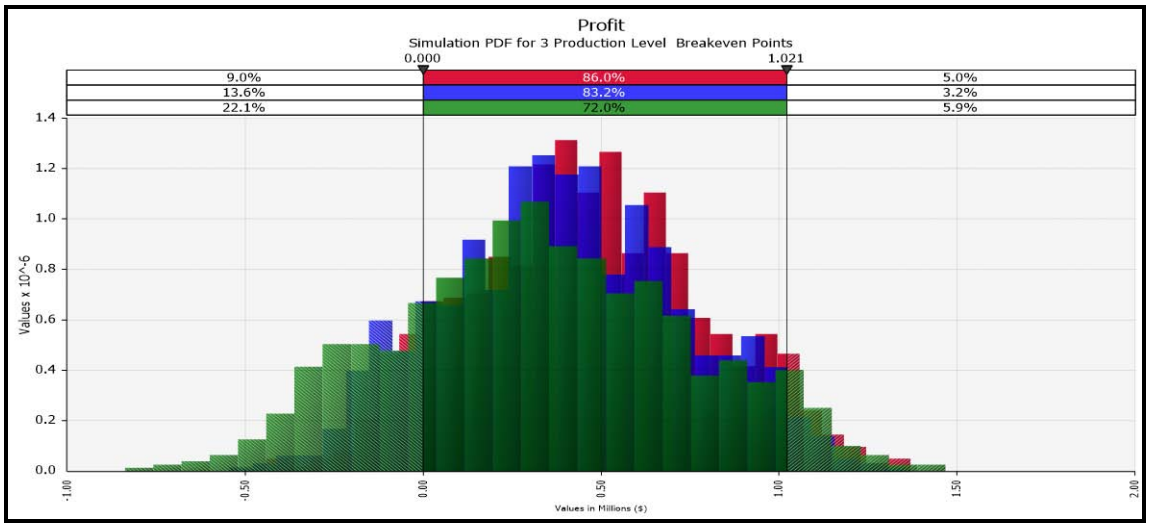


Figure 2: Broiler Product Mix Net Profit Probability Distribution Function and Breakeven Point Analysis

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Figure (2) shows three different scenarios of broiler production level, product mix and different Marketing strategies. The net profit distribution functions (PDF) stimulated for three production level and products mix options and showed the probability of achieving a target net profit of RO 460k for each production level. The point of not achieving positive net profit for option (1) record 8.8% and for option (2) is 13.6% and 22.7% for option (3). The Figure also shows the probability of achieving positive net profit for option (1) is 91.0%, option (2) is 86.4% and for option (3) is 77.9%. Investors and broiler farmer decisions will depend mainly on farmers' risk appetite and risk tolerance to understand which risk to accept, and production level and products mix that balance between potential benefit and threatens according to market dynamic situation.

c) Downside Risk and Tornado Sensitivity Analysis

Downside simulation tornado sensitivity analysis performed to test tail-end distribution for three production level scenarios and rank uncertain operation and marketing parameter effect on broiler farming net profit. The poor flock uniformity observed and reduced salable meat to 70% and increased risk of new marketing strategy implementation even with 17% marketing discount given to consumer. The Value at Risk (VaR) model introduced as an objective quantitative measure of downside risk especially when the random payoffs are not normally distributed with (0.0382) skewness and (2.6019) kurtosis. The VaR calculates the worse cause and loss and recorded RO (-100k) for option (1) and increased to RO (-364k) for option (3) with confidence level of 95%. The VaR measures downside risk at various levels of risk aversion level according to decision makers' willingness and ability to pay for risk.

The sensitivity and tornado analysis shows that unit cost of fresh and frozen parts has higher impact on target net profit of RO 460K, followed by market demand of whole fresh and whole frozen chicken and frozen parts. The operation team should work out a plan to reduce unit costs and improve flock uniformity through increasing live body weight and carcass weight up to market demand level range 900-1200 grams. Many technical parameters affect daily body weigh growth and flock uniformity such as quality hatching eggs, feed quality, hygiene and biosecurity, house ventilation and temperature and humidity control and supply chain management control.

The marketing team should work out a plan to increase demand for fresh and frozen whole chicken and sign a hedging contract to mitigate sale price volatility risk. Promotion programs should also carefully be calculated and monitored to maximize net profit of sale leftover small frozen whole chicken through balancing marginal cost with marginal revenue figure. Figure No. (3) ranks and shows quantitative figures impact of each variable on target net profit value of RO 460,000.

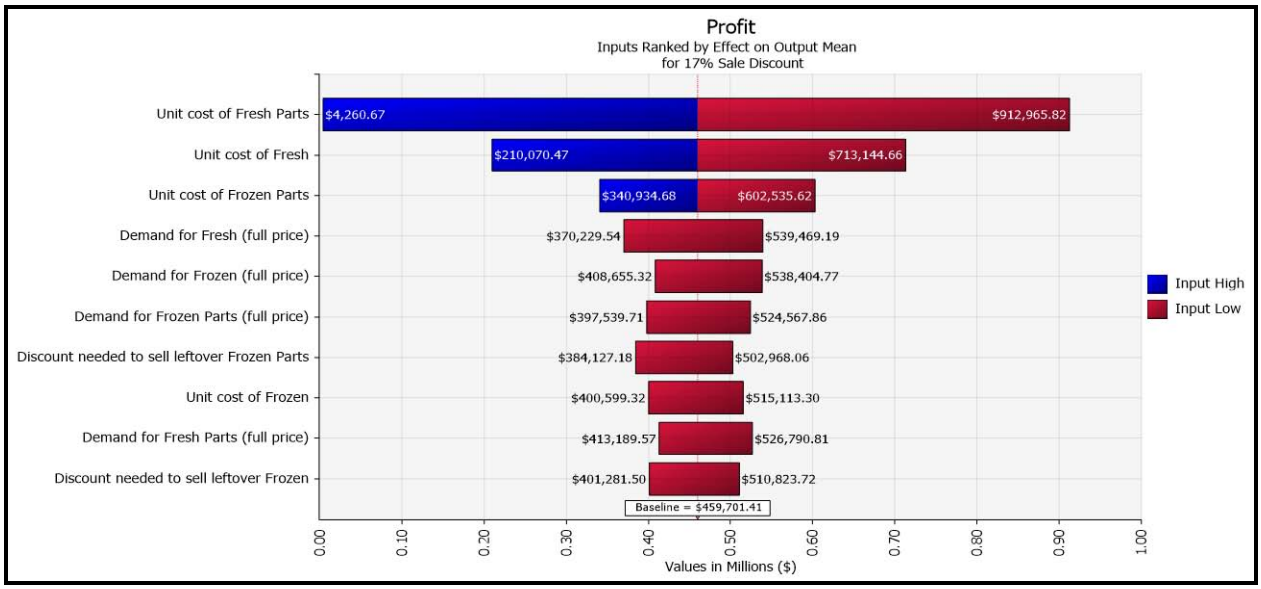


Figure 3: Ranking Input Parameters Effect on Net Profit and Tornado Sensitivity Analysis

d) BCG Matrix Tool Analysis and Market Strategy

The Boston Consulting Group (BCG) Matrix tool analysis performed to test market performance of alternative production and marketing strategies and identify broiler products market share and products competitiveness and marketing strength. The scatter plot analysis was performed by collecting historical data and simulated two products groups, i.e. fresh and frozen chicken meat, to test market share and growth strength for each product. Product market demand stress analysis examined low and high demand reductions effect on net profit for three levels of market

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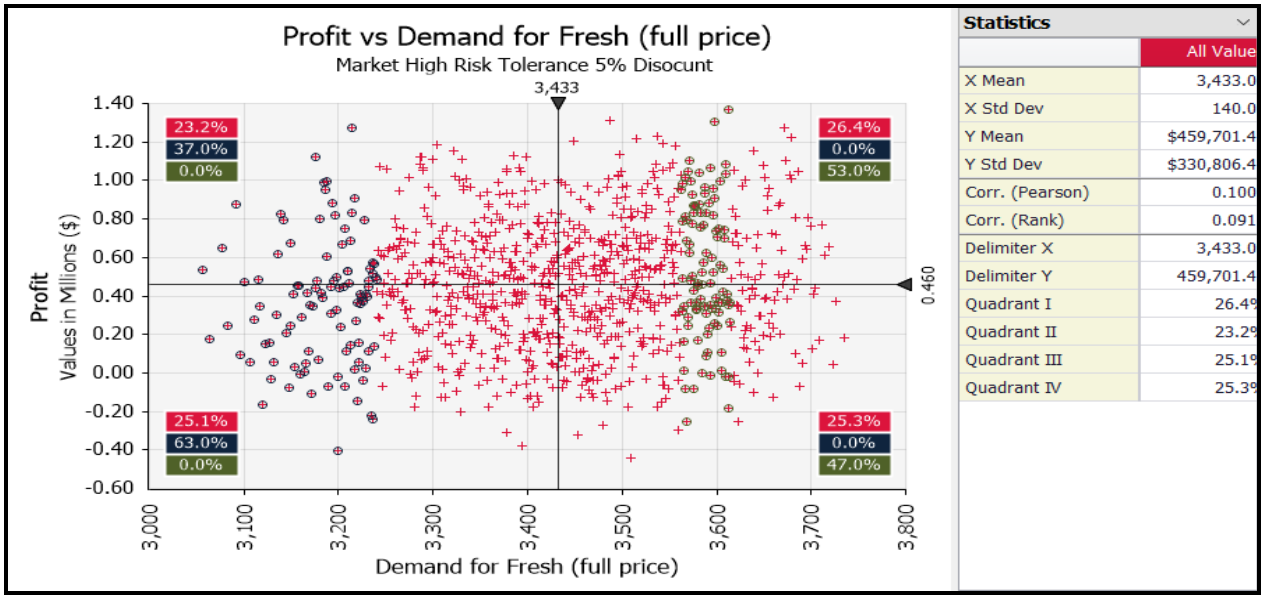
demand. Three models for each product under different market demand stress positions performed by using quadrant analysis and result presented at Table (5).

Quadrant analysis is a business strategic tool used to evaluate organization products' strategical position to build effective market strategy. The analyses divide data into four categories based on two criteria, to represent the effect of market demand on net profit. The quadrant analysis helps in identifying fresh and frozen products' market demand strengths and weaknesses and explains their market demand shares and net profit growth opportunity. Fresh products showed high market demand share and potential profit growth. It is cash generated products and needs to be supported by the marketing team to maintain healthy financial. Frozen products showed low market shares and low growth, and Mangment should invest to increase potential growth and sustain profit growth.

Table 5: Target Profit Vs Market Demand Share for Fresh and Frozen Products and Market Stress Analysis

Item	All Value	Demand reduction 0-10%	Demand reduction 80-90%	All Value	Demand Reduction 10-20%	Demand reduction 60-70%
	Fresh High Risk 5% Discount			Frozen Low Risk 17% Discount		
Mean X (Demand)	3,433	3,181	3,587	883	816	895
SD X	140.0	44.94	15.205	70.516	3.301	6.741
Mean Y (Profit) RO	459,701	370,229	539,469	459,701	408,655	538,405
SD Y	330,806	324,539	350,431	330,806	335,676	367,511
Correlation Pearson	0.100	0.039	-0.078	0.048	0.050	-0.026
Quadrant I	26.4%	00.0%	53.0%	21.0%	0.0%	61.0%
Quadrant II	23.2%	37.0%	00.0%	28.6%	45.0%	00.0%
Quadrant III	25.1%	63.0%	00.0%	31.2%	55.0%	00.0%
Quadrant IV	25.3%	00.0%	47.0%	19.2%	0.0%	39.0%

The unit cost stress analysis shows that reducing fresh unit cost will increase fresh market demand shares and market growth with potential of increasing market demand more than market growth. Reducing the unit cost of frozen will increase market demand and growth but with a probability of increasing market demand share more than increasing profit growth. The frozen products identified as low risk tolerance and steadily sustainable profit growth and fresh products recognized as high risk tolerance products with high market demand share potentials.



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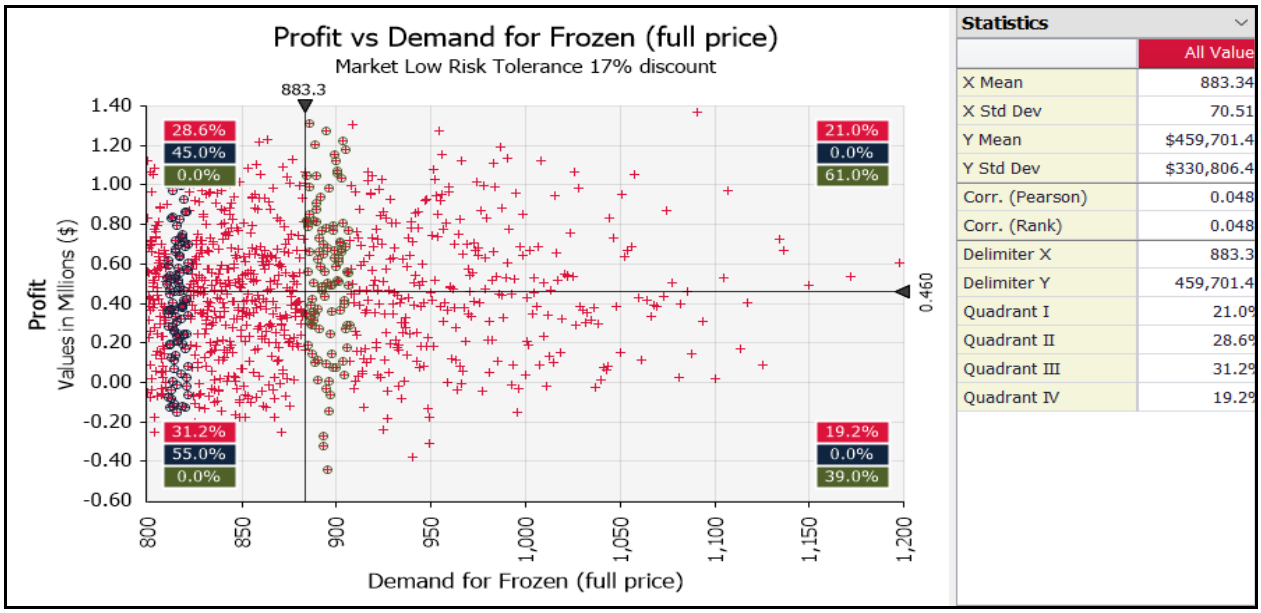


Figure 4: Broiler Products Marketing Share and Growth and Profit Scatter Plot Quadrant Analysis

Scatter Plot stress analysis showed that marketing strategy scenarios depending on unit cost reduction will increase market demand share more than net profit growth. The marketing strategies should monitor and observe sale revenue of frozen and fresh products and control contract expenses such as refrigerated transportation cost, supermarket shelf rent cost, products expiry return cost and review product cash flow to prevent unexpected overrun and negative affect on organization financial health. The production team should monitor unit cost saving plans for fresh and frozen products to extend market demand and market shares and achieve sustainable business growth rate.

The broiler product market demand uncertainty can be divided into two categories, fresh products with high operation and marketing risk, recognized with high return realization and market volatility. Frozen broiler products are recognized as low return and market volatility with one year shelf live duration. The products identified as low stable market products with stability income and low return. Understanding the elements and characters of each broiler products and combination will enhance decision makers process and achieve organization objectives. Understanding investor and stakeholders risk tolerance approaches are essential in determining broiler business strategies with business objectives. The fresh products exposed to unstable potential larger return risk despite the possibility of substantial and significant losses. The risk management decision making process can lead to significant stress and challenges during market downturns. The strategies for fresh meat, high risk and uncertain challenges should include market diversification to avoid high loss of single customers due to stopping orders suddenly. While low risk tolerance frozen market strategy should balance market stability and market growth.

Effective risk management is crucial for mitigating uncertainties and protecting broiler business investments and operation across both high-risk and low-risk products categories matrix. Fresh product are high market shares and grow slowly and are a leader in the marketplace. It is cash generation and should spread risk and diversify products to increase market growth activities, whereas frozen products have a low market demand share and dominate by import products. Frozen products have low market shares and show slow market growth and less cash generation to sustain financial health. The market strategy for frozen should balance between steady market share and business growth to achieve financial stability and sustainability. Both operation and market risk measures and quantification enabled organization to address new marketing strategies and fresh product repositioning, as per Figure (4).

e) *Net Profit Frequency Distribution and Downside Risk Management*

The net profit frequency distribution shape is one of important tool to assess and manage broiler farming risk. As farmers like good uncertainty products because they increase the potential of gain and increase net profit and dislike bad uncertainty products as it increases likelihoods 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 products. 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 results from a net

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profit decrease due to products unit cost change and market demand 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 due to unit product cost and market share and growth conditions.

Simulation analysis was performed to obtain net profit frequency distribution and calculated distribution measures skewness and kurtosis. Skewness measures the degree of variability of a frequency distribution of net profit and in all three production scenarios positive net profit skewed distribution were obtained and range between (0.0368 – 0.0383). Kurtosis test was obtained and record a figure between (2.5926 – 2.6019). 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 positive for all production scenarios and represent flatter peaks and thinner light-tail distributions. The simulation analysis of broiler business performance under market uncertainty shows that increase production from 6,557 tons to 6,800 tons and 7,650 tons increased risk and stander deviation SD from 345,552 to 352,798 and 426,521 respectively. The value at risk VaR also increased from (100,000) to (171,000) and (364,000) respectively. The probability distribution function PDF of broiler farming results showed at Figure No (2) and Table (4).

f) Technical and Market Risk Quantification and Cumulated Distribution Function Analysis

Broiler market uncertainty described by cumulated distribution function (CDF). The entire change of CDFs is quantified in terms of the net profit difference between two CDFs. Net profit of each market strategy measure developed in this study reflects the relative impact of distributional changes of inputs (market demand production volume) on the change of output distribution (net profit). The study tested sustainability of three broiler production levels and products mix and two scenarios i.e. Basic Model (Broiler SD1) and model with uncertain marketing strategies (Broiler UND1) were used. Each scenario represented and included three market alternatives models. This study constructed the cumulated distribution function (CDF) graph to quantify market risk and indicates the range and probabilities of net profit value for six different production volume and marketing alternatives, Figure (5). Due to cumulated distribution function (CDF) lines crossing in the graph, we could not be able to rank operation and market alternatives risk accord with their economic sustainability by using the first and second stochastic dominance with respect function (SDRF). Accordingly, stochastic efficiency with respect to function (SERF) analysis has been used for a better risk ranking analysis. The analysis showed Baseline models are better alternatives and uncertain market conditions need to be monitored and controlled to form dynamic market strategies and risk efficient alternatives as shown in Figure (5).

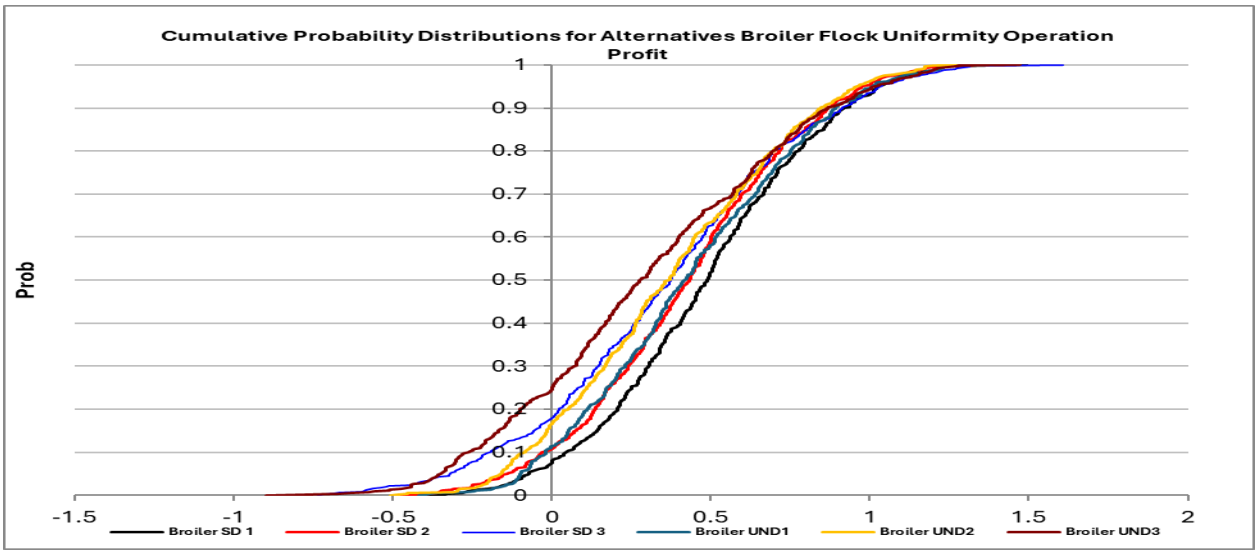


Figure 5: Comparison of 7 CDF of NPs of Broiler Production and marketing Alternatives Strategies

g) Certainly Equivalent Coefficient and Market Risk Premium Analysis

The study calculated stochastic efficiency with respect to a function (SERF) by using SIMETAR program developed by Richarson et al. (2008), to evaluate risk-efficient of broiler product mix, production volume level and market demand instabilities. The analysis compared Certainty Equivalent (CE) of uncertain potential future return of broiler farm performance with current farming practices and

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marketing demand volatility. Three different production groups examined with different product sale discount given to customers to sale balance small whole chicken product. Net profit alternatives options for three different production levels and market demand compared by using multiple simulation model and construction SERF and CE analysis. The CE is guaranteed low net profit that corporate decision makers would accept now rather than taking risk on a higher uncertain profit in the future. The corporate decision maker's risk tolerance level recognized and considered both sides of the equation the willingness and financial ability that stakeholders are ready to lose and take the risk. The study investigates broiler business risk and assesses operation and market risk that safeguards financial stability and achieves growth objective. Broiler business risk tolerance level influenced by financial position such as revenue, expenses, debit obligation and cash reserves. A company with strong financial positions and sufficient cash may have a higher risk tolerance to pursue growth opportunities. The corporate strategic objective in terms of market expansion, developing products and managing risk would have a higher ambition to gain opportunity out of risk tolerance. Moreover, business market dynamics characterized by rapid technology and market dynamic need a high-risk tolerance investor to adapt to market changes and competition. The SERF recognize the most risk efficient alternative of production and market demand level for a range of risk preferences by ranking alternatives in terms of (CE) figures. financial sustainability for different product unit cost and marketing parameters performed to evaluate risk efferent alternative option for a range of risk preference for all absolute risk aversion coefficient (ARAC). SIMETAR program calculated certainty equivalent value and constructed graphs to rank net profit of different production and market demand scenarios and unit cost of production level across the specified range of ARAC values. Across two or several alternatives, a higher CE, with the same level of ARAC is considered as the best risk management alternative, Figure No (6).

Company-specific risk premium is distinct from other risk premiums, such as the market risk premium. The market risk analysis showed that production and market demand Certainty Equivalent (CE) value decline with production volume increase from 6,557 to 7,650 tons and increasing frozen whole chicken volume by 269 tons and frozen parts products by 405 tons, Table No (6). The new marketing plan for increasing market share of fresh products by 419 ton and frozen products by 674 tons provide the Company extra return earning over current risk free operation and market risk premium of RO 120,181, Whereas, uncertain market conditions return compared to current risk free plan provides equity risk premium of RO 131,875 which represents the additional return investors expect to earn for bearing the systematic risks associated with the overall market, Figure No (6). Market risk premium is a difference between high risk market plan characterized by potential substantial returns paired with significant volatility and low-risk market plan with stability lower returns. This comparative analysis explores these differences to aid investors in choosing the best path for their financial goals. By accounting for the unique risks associated with a specific company market plan, investors can better estimate the value of the company's market shares and make more informed decisions about their investments.

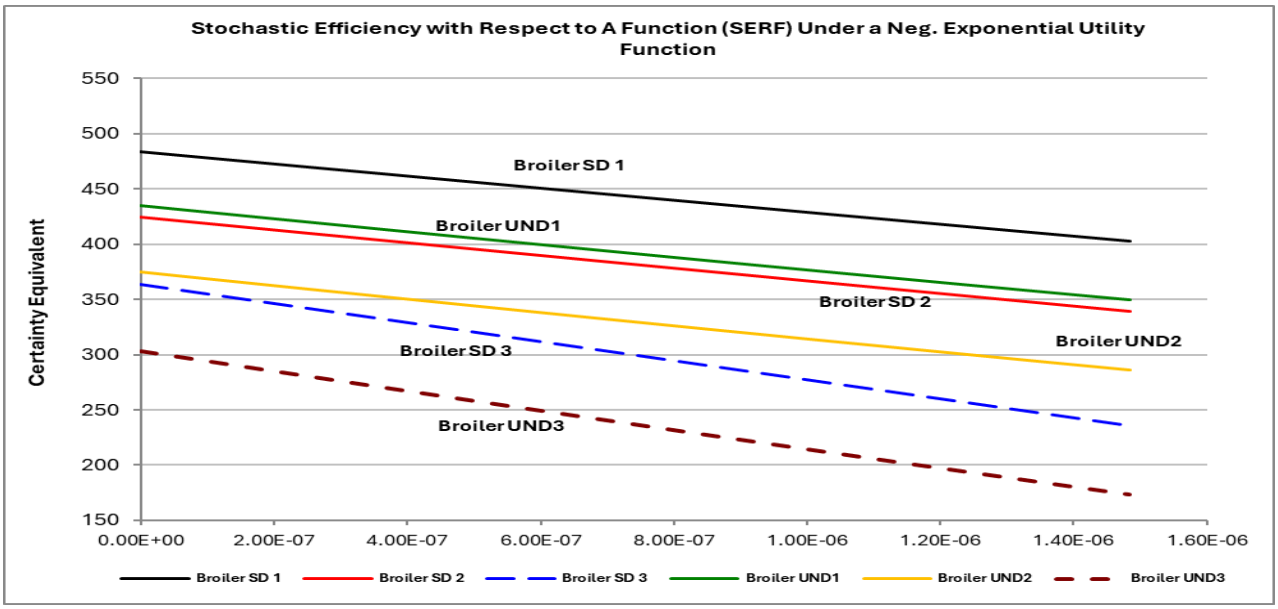


Figure 6: Stochastic Efficiency with Respect to a Function (SERF) and Certainty Equivalent for all ARAC

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However, the new risk management policy could not mitigate fresh products operation and marketing risk. High competition of cheap import of frozen broiler products needs government support policy and small whole chicken size problem needs operation team to control flock uniformity to support product market share and sustainable growth policy. The study measure market plan in terms of volume and product mix for all risk averse alternative to test products market volatility risk for all absolute risk aversion coefficient (ARAC). The risk aversion coefficient (ARAC) ranged from 0.00000 which represents risk neutral to 0.00000148 which present strongly risk averse level. The sale revenue reduction by 17% discount rate given to customers lower CE value for all (ARAC) and are not risk averse alternatives compared to potential uncertain alternatives. The market risk tolerance depends on Management willingness to lose return in exchange for greater potential uncertain returns and their financial ability to pay for risks. Operation team need to control unit costs of parts and fresh products to mitigate risk at stress situation and evolve fresh products market segmentation policy and target high income consumers to reduce fresh products expiry cost. Cost of RO 0.209 per one kg is offsetting cost of business difficulty by developing business in other directions.

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 0.00000148 were used in the (SERF) analysis to calculate CE values for each of the product marketing variables, sale revenue level and broiler product cost level. Table (6) indicates that scenario (1) for uncertain potential future profit models (Broiler SD1, SD2, SD3) whereas scenario (2) for current risk free cash and profit models (Broiler UND1, UND2, UND3). Six models were calculated under different levels of risk averse coefficient and presented in Figure (6). The multiple simulation analysis also shows an increasing farm's production volume for scenario (1) and (2) will increase business loss and risk premium value for all ARAC.

Table 6: Ranking Net Profit's Certainty Equivalent and Risk Premium for all Absolute Risk Aversion Coefficient

Variables	No.	CE			Risk Premium (Production Scenarios)		
		Neutral (0.00000)	Moderate (0.00000074)	Strong (0.00000148)	Neutral (0.00000)	Moderate (0.00000074)	Strong (0.00000148)
Broiler SD1	1 Option (1)	483,416	442,853	402,787	-	-	-
Broiler UND1	2 Option (2)	435,160	391,760	350,077	48,256	51,093	52,710
Broiler SD2	3 Option (1)	424,381	381,798	339,636	-	-	-
Broiler UND2	4 Option (2)	375,107	329,834	286,339	49,274	51,964	53,297
Broiler SD3	5 Option (1)	363,235	299,474	235,785	-	-	-
Broiler UND3	6 Option (2)	303,283	236,899	173,417	59,952	62,575	62,368

The net profit risk premiums were calculated for each production level (Broiler SD1, Broiler SD2 and Broiler SD3) by subtracting CE values of risk free cash flow model (Broiler UND1) from the highest CE (Broiler SD1) potential uncertain value for each production level at any given ARAC values. Risk premium is a measure of excess return that is required by decision makers to compensate for being subjected to uncertain marketing and operation risk. The analysis showed broiler market risk premium increased with uncertain market parameters and market instabilities at all ARAC values for all models. The CE value and market risk premium for each model is summarized at table (6).

The study measure risk aversion for three levels of absolute risk aversion coefficient (ARAC). At risk neutral level, the investor is willing to pay RO 48.258 K to avoid market risk within the production level of Broiler SD1. The market risk tolerance is amount of CE investors can tolerate of a production return between RO (483,416- 435,160). The risk premium represents payment to investors for tolerating the extra risk in given investment over risk free operation and marketing level (Broiler UND1). Risk premium of RO 49,274 is an

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amount that investment willing to pay to avoid market risk for the production level of model Broiler SD2. The market risk tolerance is amount of CE Mangment can tolerate of a production level return between RO (424,381- 375,107). RO 59,952 Amount willing to pay to avoid market risk production level of model Broiler SD3. The market risk tolerance is amount of CE Mangment can tolerate of a production level return between RO (363,235- 303,283)

Fresh broiler products have a short shelf-life during of 7 days and are sensitive to hygiene and long tribe duration to UAE and considered as high risk broiler products. The investor is ready to pay more risk attention to a possible better unknown return. The frozen broiler products have long shelf-life duration of about one year and are recognized as low risk broiler products for investment seeking conservative investment with granted return.

IV. Conclusions

This study presents an evaluation of three broiler production level and products mix under different marketing uncertain parameters and marketing strategies. Simulation risk analyses were performed to test operation performance sustainability of alternative marketing demand, sale revenue, unit cost of products and salable meat production level parameters. The analysis identifies factors that affect broiler farming continuity and measure market risk premium to control risk and avoid opportunity loss in future. The study stimulated net profit for different alternative product mix and marketing strategy by using @Risk 8.2 program to investigate operation and marketing risk assessment. Stochastic Efficiency with Respect to a Function (SERF) constructed and used to estimate Certainty Equivalent (CE) and market risk premium (RP) values. The market risk premium represents the additional return investors expect to earn for bearing the systematic risks associated with the overall market uncertainty and volatility.

Descriptive analysis showed Broiler SD1 model with 6,557 tons production volume achieved net profit mean of RO 460,219 and 8.8% profit breakeven point. Option No (2) Broiler SD2 generated RO 400,964 net profit and 13.3% profit breakeven point and option No (3) Broiler SD3 model recorded the lowest net profit RO 334,557 and breakeven 22.7%. The net profits probability distribution functions (PDF) are performed to evaluate risk volatility and economic sustainability. The analysis showed that option (1) reduces performance variability and focuses on effective use of resources and reduces waste and undesirable chicken meat products. The Value at Risk (VaR) test introduced as an objective quantitative measure of downside risk and recorded a loss of RO (100,000) of option (1) compared to RO (364,000) with confidence level 95% and (0.0382) skewness and (2.6019) kurtosis for Option No (3). Poor flock uniformity and discount given to sale small whole chicken product were the main operation problems behind this dilemma.

The sensitivity and tornado analysis showed that unit cost of fresh and frozen parts have a higher impact on target net profit of RO 460K, followed by market demand of whole fresh and whole frozen chicken and frozen parts. The operating team should work out a plan to reduce unit costs and improve flock uniformity through increasing bird size up to the market demand level range 900-1200 grams.

The Boston Consulting Group (BCG) Matrix tool performed to test market performance of alternative production and marketing strategies and identify broiler products market share and products competitiveness marketing strength. The scatter plot quadrant analysis showed fresh products have high market demand shares and profit growth with higher potential for profit growth than market demand shares. On the other hand, frozen products showed low market share and low growth, and the market strategy should work for potential growth to sustain net profit growth and improve financial health. The whole chicken frozen products serve only 15.7% of the total Company market share and might be repositioned to serve niche markets such as hotels, restaurants and catering services (HORECA) channels.

The study constructed Cumulated Distribution Function (CDF) analysis to quantify broiler market demand uncertainty and indicated the range and probabilities of net profit value for six different production volume and marketing alternatives. Net profit of each market strategy developed to measure reflects the relative impact of distributional changes of inputs (market demand production volume) on the change of output distribution (net profit). The study tested sustainability of three broiler production levels and products mix and two scenarios i.e. Baseline Models (Broiler SD1, Broiler SD2, Broiler SD3) against uncertain marketing strategies models (Broiler UND1, Broiler UND2, Broiler UND3) and fined Baseline model (Broiler SD1) is the most profitable and sustainable alternative. Due to CDF lines crossing 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 better ranking alternatives. The analysis showed Baseline models i.e. (Broiler SD1, SD2, SD3) are better alternatives if organization could control technical and marketing uncertain future conditions and challenges.

Broiler business risk efficiency is performed by comparing Certainty Equivalent (CE) of uncertain potential future return of broiler farm performance with current farming practices and marketing demand

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volatility. Three different production groups examined with different product sale discounted given to customers to sell whole chicken small size. Net profit alternatives options for three different production levels and market demand compared by using multiple simulation model and construction SERF and CE analysis. The CE guarantees low net profit that organization decision makers would accept now i.e. RO 435,160 rather than taking risk on a higher uncertain net profit i.e. RO 483,416 in the future. Broiler business risk tolerance level influenced by financial position such as revenue, expenses, debit obligation and cash reserves. A company with strong financial positions and sufficient cash may have a higher risk tolerance to pursue growth opportunities.

According to CE value and market risk premium measures, the Broiler (SD1) Model group are the best production level and products mix and risk efficient alternative for all ARAC followed by two other Broiler (SD2) and Broiler (SD3) production level and products mix. Market demand uncertainty and discounts given for small-size whole-chicken products were the main uncertain parameters differentiated between the two group models, i.e. Broiler SD1 and Broiler UND1. The market risk premium for alternative production level of 6,557 tons is RO 48,256 and for production level of 6,800 tons is RO 49,275 and production of 7,650 tons is RO 59,952. CE values were obtained for risk neutral, moderate and strong absolute risk aversion coefficient (ARAC). The marketing team should monitor market volatility and corporate product demand to avoid sale revenue reduction caused by the situation of market uncertainties. The operation team should maintain technicality and good flock uniformity and produce marketable bird size between 900 - 1,200 Grams for whole chicken products as per market prevenances. Risk premium of RO 48,256 is a risk for poor flock uniformity and market challenges face the organization to sale small size birds. The cost of RO 0.209 per one kg is compensation between current broiler farming practices and uncertain future unseen risk and cost of offsetting broiler business difficulty by developing business in other informed directions.

The marketing team should monitor and observe sale revenue and control contract expenses such as transportation cost, supermarket shelf rent cost, products expiry returns cost and review cash flow to prevent unexpected overrun and negative financial impacts. The production team should concentrate on and monitor unit cost saving plan and improve flock uniformity to extend market demand and achieve business sustainability and improve growth rate. Moreover, controlling market share enables the company to measure its competitiveness and its ability to attract and retain customers compared to its competitors. The Management and operation team should work closely to reduce cost of production and optimize product mix, whereas the marketing team should understand product market share and growth to mitigate risk as shown by study result. Marketing promotion and market risk premium should also be monitored and calculated carefully to control risk and obtain higher gain under high dynamic market challenges.

Market simulation analysis help Company to identify their market standing, track their performance over time, and benchmark themselves against competitors. Study results and information helps the Company gauge their market penetration and identify opportunities for growth and areas that require improvement. More study are needed to analyzing market demand to identify market trends, anticipate customer needs, and tailor their offerings to meet consumer demands effectively. Study results and recommendation help businesses make informed decisions regarding production levels, pricing strategies, marketing campaigns, and resource allocation. Increasing products market share may not necessarily increase market demand as significant discount and lowering frozen price may reduce total market demand if customers perceive the product as less valuable and blow market standard. The study investigated this question by using simulation analysis and refiled lowering frozen price did not increase market demand but liquidated whole chicken frozen stock only.

Conflict of Interest

The author declared 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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Research on the Power Consumed by Drives of Machines for Working with Greenhouse Soil

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Abstract- The quality of soil preparation for greenhouses is a key factor influencing crop yields in organic farming. Several machines perform various operations for working with greenhouse soil: a soil removal machine, a loader-mixer for soil components, and a machine for laying soil components. Theoretical research has established that the greatest influence on the power of the component laying machine comes from: the speed of the conveyor chain, the angular velocity of the dosing drum, the number of conveyor scrapers, and the number of drum slats. For the power of the soil removal machine, the influencing factors are: the size of the cut soil layer, the speed of the machine itself, and the angle of the bucket surface.

Keywords: power, regression equation, graphical dependency, combined layer, machine for removing and loading greenhouse soil.

GJSFR-D Classification: LCC: S631.5



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Research on the Power Consumed by Drives of Machines for Working with Greenhouse Soil

P.I. Pavlov [α] & A.O. Vezirov [σ]

Abstract- The quality of soil preparation for greenhouses is a key factor influencing crop yields in organic farming. Several machines perform various operations for working with greenhouse soil: a soil removal machine, a loader-mixer for soil components, and a machine for laying soil components. Theoretical research has established that the greatest influence on the power of the component laying machine comes from: the speed of the conveyor chain, the angular velocity of the dosing drum, the number of conveyor scrapers, and the number of drum slats. For the power of the soil removal machine, the influencing factors are: the size of the cut soil layer, the speed of the machine itself, and the angle of the bucket surface. Experimental research confirmed the results of theoretical studies and established the parameter values of the combined layer that minimize power consumption: conveyor chain speed 0.33-0.37 m/s, number of conveyor scrapers 7-8, angular velocity 6.0-6.5 rad/s, and the number of dosing drum slats 6. For the soil removal machine, these parameters are: bucket angle 25-27 degrees, forward speed 0.2-0.25 m/s, and the size of the cut soil layer 0.18 m. The presented results confirm the effectiveness of the machinery complex for greenhouse soil preparation.

Keywords: power, regression equation, graphical dependency, combined layer, machine for removing and loading greenhouse soil.

I. Introduction

The preparation and use of greenhouse soil is one of the most energy- and labor-intensive operations in growing plants in protected soil. The quality of the prepared soil directly affects the yield of the crops grown, and consequently, the cost of the final product. Previously, a technological scheme for the preparation, use, and removal of greenhouse soil was proposed [1,2]. This technology is based on the use of a comprehensive set of machines for working with greenhouse soil: a combined layer, a loader-mixer, and a soil removal machine [3-5].

One of the key indicators of the efficiency of these machines is the power required to drive their working elements or to move the machine while performing technological operations. The power value is influenced by both structural factors–related to the design and geometric parameters of the working elements and operational factors–related to their movement parameters.

The aim of this study is to determine the specific structural and operational parameters that have the greatest impact on the power of the considered machines; to establish the nature of this dependency; and to justify the parameter values at which the power value is minimized.

The research conducted jointly with Ph.D. in Technical Sciences Mukhin D.V. and Ph.D. in Technical Sciences Levchenko A.V. allowed us to establish analytical and experimental dependencies of power on structural and operational parameters for each machine [6-7].

The main working elements of the combined layer are the chain conveyor and the dosing drums. Therefore, the total drive power of the machine P_y (W) will be equal to the sum of the power consumed by the drive (power on the shaft) of the chain conveyor $P_{тр}$ (W) and each of the two dosing drums $P_б$ (W):

$$P_y = P_{тр} + P_{б1} + P_{б2}. \quad (1)$$

By previously finding expressions for determining each term and performing the corresponding mathematical operations, equation (1) will take the form:

$$P_y = \left\{\left(K_{сд} l_{ск} b_{ск} \tau_{сд} + g\rho_{кт} l_{ск} b_{ск} h_к f_{вн} + g\rho_{кт} l_{ск} b_{ск} h_{кп} f_н + m_{ск}\frac{v_c}{t}\right)\frac{l_{тр}}{l_{ск}} + \sigma_к b_{ск} h_{ок}\right\} v_c + 0{,}5 z_{п1} D_{н1} \omega_{б1}\left(m_1 \frac{\omega_{б1} R_{б1}}{t} + f_{вн1} m_{кб1} g - m_1 g \cos\beta\right) + 0{,}5 z_{п2} D_{н2} \omega_{б2}\left(m_2 \frac{\omega_б R_б}{t} + f_{вн2} m_{кб2} g - m_2 g \cos\beta\right), \quad (2)$$

Where, $K_{сд}$ – coefficient of increase in the shear area, accounting for the deviation of the actual shear surface shape from the theoretical for the chain conveyor; $b_{ск}$ – width of the conveyor scraper, m; $h_{ск}$ – height of the conveyor scraper, m; $\rho_{кт}$ – density of the component transported by the conveyor, kg/m³; v_c – conveyor chain (scraper) speed, m/s; $\rho_к$ – average density of the component in the dosing drum hopper, kg/m³; $\alpha_п$ – central angle between the drum slats, degrees; $D_в$– diameter of the dosing drums along the generating line of the cylinder, m; $D_н$ – diameter of the dosing drums along the outer edges of the longitudinal slats, m; $\omega_б$ - angular speed of the dosing drum, rad/s; $\alpha_п$ – angle between the blades, degrees; $B_п$ – width of the longitudinal slat of the drum, m; $z_п$ – number of

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longitudinal slats on the drum; $n_к$ – rotational speed of the dosing drum, s^{-1}; $\tau_{сд}$ – ultimate shear stress of the material component in the chain conveyor, Pa; $h_{кп}$ – total height of the component layer in the front hopper, m; $f_н$ – coefficient of friction of the component on the surface of the front hopper deck; $f_{вн}$– coefficient of internal friction of the component in the first hopper; $h_к$ – height of the component layer in the front hopper, m; $\sigma_к$ - crushing stress of the component, Pa; $h_{ок}$ – height of the separated component layer before the damper in the first hopper, m; $m_{ск}$ – mass of the separated component by the chain conveyor scraper, kg; m– mass of the separated component by the dosing drum slat, kg; $m_{кб}$– mass of the main component in the middle and rear hoppers, kg [8]. The index «1» refers to the first dosing drum, the index «2» to the second.

The power of the soil removal machine $P_{уд}$ (W) is the sum of the following terms: the power consumed for horizontal soil movement P_{ox} (W), the power required to lift the soil along the surface of the bucket (vertically) to the unloading conveyor P_{ox} (W), and the power necessary for moving the machine and driving the unloading conveyor P_0 (W):

$$P_{уд} = P_0 + P_{ox} + P_{oy}. \quad (3)$$

Substituting the previously found expressions for determining each term into equation (3), we get:

$$P_{уд} = P_0 + v \cdot \left\{\tau_р \cdot B \cdot \delta + 2 \cdot \sigma_д \cdot b \cdot h + \frac{\rho\left(B \cdot h \cdot v^2 + b_k \cdot h_k \cdot v \cdot t \cdot g \cdot f_к\right)}{cos\gamma} + 2 \cdot \tau_о \cdot l_{бпо} \cdot s + \frac{2 \cdot \rho \cdot b \cdot h_0 \cdot v_0 \cdot g \cdot f_о \cdot cos\theta}{cos\gamma}\right\} + v \cdot sin\gamma \cdot \left(\rho \cdot B \cdot h \cdot v \cdot t \cdot g + \frac{\rho\left(B \cdot h \cdot v^2 + b_k \cdot h_k \cdot v \cdot t \cdot g \cdot f_к\right)}{sin\gamma} + \frac{2 \cdot \rho \cdot b \cdot h_0 \cdot v_0 \cdot g \cdot f_о \cdot \sin\theta}{sin\gamma}\right), \quad (4)$$

Where, P_0 – is the power required to move the machine itself during operation, in watts; $\tau_р$ – is the soil cutting stress, in N/m; B– is the bucket width (cutting edge width), in meters; δ – is the thickness of the cutting edge of the blade, in meters; $\sigma_к$ – is the soil rupture stress, in N/m^2; b – is the width of the soil layer, in meters; h– is the height of the soil layer, in meters; ρ – is the density of the removed soil, in kg/m^3; v – is the translational working speed of the machine, in m/s; $b_к$ – is the width of the lateral surface of the blade, in meters; $f_к$ – is the coefficient of friction of the soil on the bucket surface; τ_0 – is the shear stress of the soil on the blade, in N/m^2; s – is the height of the soil layer on the blade, in meters; h_0 – is the height of the soil layer on the blade, in meters; v_0 – is the speed of the soil movement on the blade, in m/s; f_0 – is the coefficient of friction of the soil on the blade surface; γ – is the angle of inclination of the bucket surface, in degrees; θ – is the average angle of the blade surface, in degrees [9].

Analysis of equations (2) and (4) shows that significant factors influencing the total power of the drive system of the combined layer include parameters such as chain speed, number of chain conveyor scrapers, angular speed of the drums, and the number of slats installed on them. The power required for the movement of the soil removal machine is influenced by the height of the removed soil layer, translational speed of the machine, and the angle of inclination of the bucket surface. These parameters can be identified as key factors affecting power optimization during the experimental phase of research.

II. Research Methodology

For the experiment, two prototypes were fabricated: a combined layer (with a scraper conveyor length of 2.5 meters) and a soil removal machine. The research was conducted in the production conditions of a greenhouse complex. The methodology involved a series of two-factor experiments for each machine. Structural parameters (such as the number of scrapers and slats) were adjusted by installing the required quantity on the working elements, while the chain conveyor speed and drum rotational frequency were regulated by changing the sprockets on the drive shafts. The data were processed using regression analysis methods with the «Statistica» software package. Regression equations and corresponding three-dimensional graphical dependencies were derived. The adequacy of the regression equations in describing the experimental data was assessed using the Fisher's criterion.

III. Results and Discussions

Experimental research enabled the construction of a graphical dependency and determination of the influence of angular speed and the number of slats on the power of the drive system of the combined layer (Figure 1).

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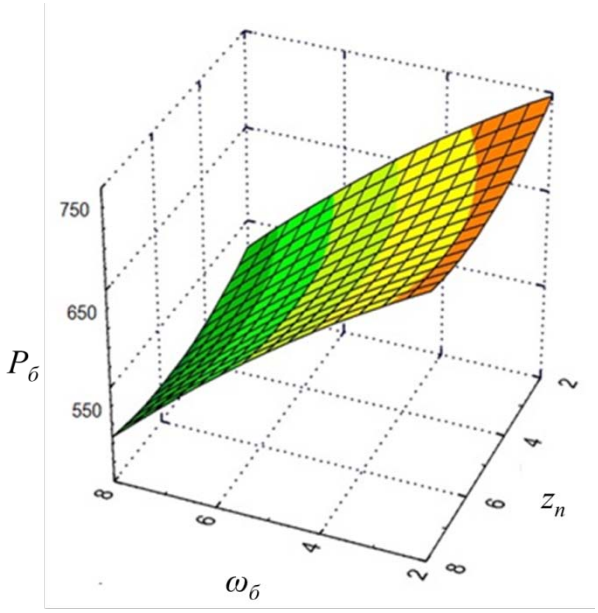


Figure 1: Dependence of the Power on the Drive Shaft of the Dosing Drum of the Combined Layer $P_б$ (W) on the Angular Speed $\omega_б$ (rad/s) and the Number of Slats z_n(pcs)

With increasing angular speed, the power on the drive shaft increases across the entire investigated range. Minimum power corresponds to high angular speeds. At low angular speeds, the power increases due to material buildup in the drum from the hopper. As angular speed increases, the mass of incoming material decreases, torque decreases, and required power drops.

The influence of the number of slats on power is less significant: maximum power is observed at z_n =2, then it slightly decreases and stabilizes around z_n =6-8. This is because the number of slats has little impact on the mass of material fed from the hopper, and the filling of the space between the slats remains relatively constant, resulting in almost unchanged power.

The analysis of experimental data allowed for the construction of a graphical dependency describing the power dependence on the drive of the scraper conveyor, based on the chain's translational speed and the number of scrapers (Figure 2).

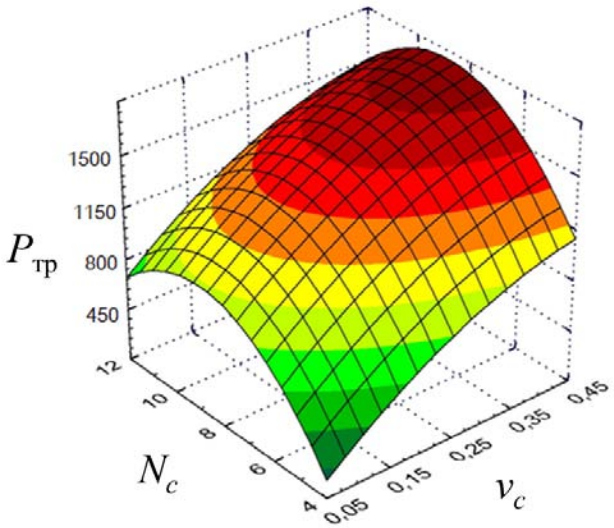


Figure 2: Dependency of the Power Consumed by the Scraper Conveyor Drive of the Combined Layer $P_{тр}$ (W) on the Chain Speed v_c (m/s) and the Number of Scrapers N_c (pcs)

The obtained dependencies show that the change in power due to these parameters is similar to the change in torque but with greater intensity. As the chain speedv_c with scrapers increases, the required power increases across the entire investigated range. For instance, with N_c =4, increasing v_c from 0.1 to 0.3 m/s leads to a rise in power from 1347 to 2975 W.

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However, when $v_c > 0.35$ m/s, the rate of power increase slows down.

The influence of the number of scrapers on power follows a quadratic pattern: as the number of scrapers N_c increases, power initially increases, reaches a maximum around $N_c = 6$, and then decreases. Increasing N_c from 4 to 6 at a chain speed $v_c = 0.21$ m/s results in an increase in power from 1927 to 3532 W. This dependency is explained by changes in torque. With increased chain speed, the mass of moved components increases. However, at high speeds, components may not fully fill the space between the scrapers, leading to a reduced rate of power increase. Increasing N_c from 2 to 8 also increases the mass of moved components, requiring additional power. If $N_c > 8$, the useful volume of the space between scrapers decreases, reducing the mass of components and consequently the required power.

The processing of experimental data has revealed the influence of the soil layer height and translational speed on the power expended for the movement of the soil removing machine. The obtained values form the basis of regression equation (5).

$$P = 6443{,}37 - 479{,}61 \cdot v - 84{,}651 \cdot h + 17413{,}2 \cdot v^2 + 162{,}321 \cdot v \cdot h + 0{,}377 \cdot h^2 \quad (5)$$

The analysis of the dependency (Figure 3) shows that the power expended for the machine movement increases with the speed. The change in power occurs linearly, with the growth intensity increasing as the height of the removed layer increases. For instance, at $h = 60$ mm, increasing the speed from 0.11 to 0.17 m/s results in a power increase from 4045 to 4792 W, which is an 18% rise.

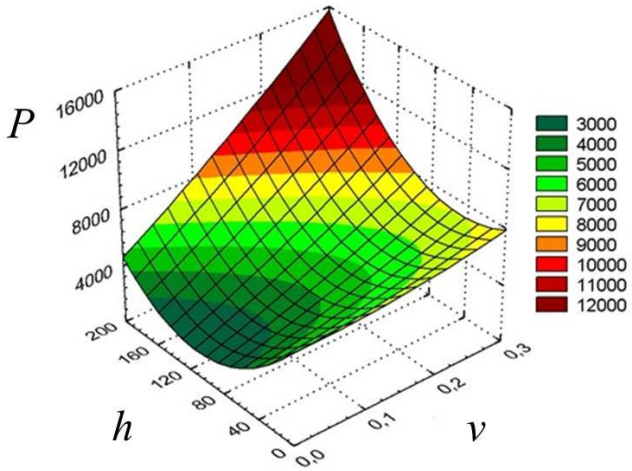


Figure 3: Dependency of Power Expended for the Movement of the Soil Removing Machine P (W) on the Machine's Speed v (m/s) and layer height h (mm)

At $h = 100$ mm, increasing the speed within the same range results in an increase in power from 3980 to 4925 watts, or 23.5%. Similar behavior is observed at other values of the investigated parameters. Increasing both speed and layer height leads to an increase in the mass requiring movement, thereby increasing the required power. However, the influence of layer height on power is not linear: at low heights, the layer has almost no effect on power, but when $h > 80-100$mm, power begins to significantly increase. Regression analysis and its graphical representation show that there is no optimum – power increases with parameter increases.

Additionally, the influence of the slope angle of the dumping surface and the machine's speed on the power expended for moving the soil removing machine was determined, and regression equation (6) was developed:

$$P = 5740{,}316 + 18869{,}3 \cdot \upsilon - 291{,}654 \cdot \gamma - 13732{,}64 \cdot \upsilon^2 + 85{,}833 \cdot \upsilon \cdot \gamma + 5{,}438 \cdot \gamma^2 \quad (6)$$

The power expended for moving the machine increases almost directly proportional across the entire range with increasing speed (Figure 4). This is due to the increase in the separated and moved mass of soil with increasing speed. At $\gamma = 20$ degrees, increasing the speed from 0.11 to 0.17 m/s results in a power increase from 4189 to 4950 watts. At $\gamma = 30$ degrees, increasing the speed leads to a power increase from 4160 to 5010 watts, or by 20%.

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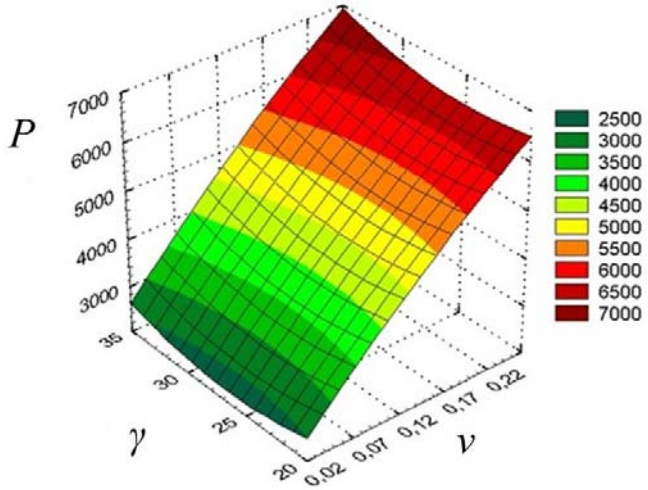


Figure 4: Dependence of power expended for the movement of the soil removing machine *P* (W) on the machine's movement speed *v* (m/s) and the inclination angle of the surface of the ejector γ (degrees)

The influence of the surface slope angle is expressed in a more nonlinear manner. Power increases at smaller or larger slope angles. This change in power is explained by variations in traction force due to the slope angle. For $\gamma <$ 25 degrees, the length of the working surface of the ejector increases, elongating the soil path and increasing resistance forces to the machine's movement. For $\gamma >$ 27 degrees, the interaction between the ejector and the soil changes: soil accumulates in front of the ejector, creating additional resistance. Increasing the slope angle from 30 to 35 degrees at v = 0.17 m/s leads to an increase in power from 5007 to 5549 W. The lowest power is achieved at γ = 25-27 degrees; deviation from these values increases power due to changes in traction force and interaction between the ejector and the soil.

IV. Conclusions

The analysis of experimental results allowed us to establish optimal values for the operational parameters of the machines, where the power consumption for driving their mechanisms reaches its minimum.

For the combined paver, these parameters are: chain conveyor speed v_u = 0.33-0.37 m/s and number of scrapers N_c = 7-8; angular velocity of dosing drums ω = 6.0-6.5 rad/s and number of blades z_n = 6.

For the soil remover machine, the optimal parameters are: bucket tilt angle γ = 25-27 degrees, translational speed v = 0.2-0.25 m/s, and depth of removed soil layer h = 0.18 m.

Thus, through the conducted experimental studies, we identified the influence of design and operational parameters on the power consumption of machines involved in the greenhouse soil preparation process. Furthermore, we determined rational values for these parameters that exert the greatest influence on the power required to drive the mechanisms of these machines.

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Innovative and Affordable Feed Solutions for Enhancing Cattle Finishing in Tanzania

By Zabron Nziku, Valentino Urassa, Jonas Kizima, Hamis Lugundi, Walter Mangesho, Salum Kafuku, Angela Majoya, Hossiana Mgonja, Zeno Massawe, Barick Masakia, Samuel Munguru, Said Mbelwa, Rose Loina, Ayoub Kambadu, Angelo Mwilwa & Lovince Asimwe

Abstract- In Tanzania, livestock significantly contributes to the national economy, with the beef sub-sector accounting for 2.2% of the GDP. However, unfinished cattle at slaughterhouses result in suboptimal beef quality. Proper finishing is crucial because it adds value to the quality of beef meat. Apart from genetics, applying the right feed technology and feeding strategies on beef cattle before slaughter can increase output by 70% and perhaps coequal with health. The current study developed two feed diet formulas using local feed materials given the high quality and affordable cost for the Zebu cattle finishing business.

Keywords: *cattle, finishing, fattening, feed formula, diet.*

GJSFR-D Classification: *LCC: SF94.5*



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Innovative and Affordable Feed Solutions for Enhancing Cattle Finishing in Tanzania

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Abstract- In Tanzania, livestock significantly contributes to the national economy, with the beef sub-sector accounting for 2.2% of the GDP. However, unfinished cattle at slaughterhouses result in suboptimal beef quality. Proper finishing is crucial because it adds value to the quality of beef meat. Apart from genetics, applying the right feed technology and feeding strategies on beef cattle before slaughter can increase output by 70% and perhaps coequal with health. The current study developed two feed diet formulas using local feed materials given the high quality and affordable cost for the Zebu cattle finishing business. The study involved 60 Tanzanian Short Horn Zebu (SHZ) cattle, divided into three age categories and randomly assigned to three treatments. Two diet formulas using local feed materials were developed and tested over an 11-week period. Also, the experiment has Phase I trial and Phase II for validation. The diet comprised Maize meal, Cassava root meal, and Rice Polish as energy sources while Leucaena Leaf meal, Soya bean meal, and Sunflower seed cake were protein sources in both diet formulas with varying energy amounts. The mineral mixture (Josera for beef) and Molasses powder were included. Quality evaluation of the feed resources and formulated diets was conducted, and the least cost feeds analysis with Win Feed 2.8 a computer software program was used toquantify feed quality and quantity required to meet the requirements of Zebu cattle for finishing and their cost implications. Cattle's initialweight data was registered followed by weekly weights captured by a digital weighbridge scale. The general linear model procedure using SAS software was used to obtain the means. Results revealed that both tested feed rations performed well, with slightly significant differences between the two formulas on weight gain per day, conforming in phases I & II. The average DMI (dry matter intake) was 4.67kg and 7.3kg, for control and formulated diets, respectively. The composition of the formulated diets bywin Feed 2.8 programs was19.01 protein, and 12MEMJ/kg. The average cost per kg of the diets was TSHs 498. Results indicated significant improvements in weight gain for cattle fed the formulated diets compared to the control group, with daily live weight gains of 0.86kg and 0.25kg, respectively. In conclusion, the formula prototype is worthwhile and can be applied for commercial purposes in finishing the SHZ cattle genotype in Tanzania. However, more research on seasonal variation and further research for other cattle breeds/strains is recommended.

Keywords: cattle, finishing, fattening, feed formula, diet.

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I. Introduction

In Tanzania, livestock plays an important role in building a national economy as considered the first and second livelihood drivers. Tanzania has approximately 33.9 million cattle, predominantly indigenous breeds, making it the second-largest cattle population in Africa after Ethiopia (MLF, 2023).". The beef sub-sector contributes about 2.2% to the GDP compared to other livestock species and products (Ministry of Livestock and Fisheries (MLF), 2023). Several initiatives and platforms for the improved beef industry in the country are evident this include; the presence of 50-improved abattoirs, 532-markets (506-primary, 14 second aries, and 12-borders), 15 national ranches, and 5 livestock multiplications units of which some have been newly constructed between 2015-2021 (MLF, 2023).

Despite the initiatives, less effort has been made to improve the quality of beef meat. Today most cattle are brought at slaughterhouses without a special diet. Proper feeding cattle before slaughters crucial because it adds value to the quality of beef meat and as are sult more income for improved livelihood and a sustainable market. To achieve that appropriate knowledge, technology, and capacity building on cattle feeds for beef cattle finishing are key. Apart from genetics, the application of the right feed technology and feeding strategies can increase its output by 70% and perhaps be coequal with health. Several studies recommended the importance of cattle finishing practice (FAO, 2022, Muzzo and Provenza, 2018 Asimwe, 2016). The application of cattle finishing technique is not new in Tanzania, however; the questions lie in what quality of feeds is used as supplements and its associated costs per unit kilogram.

To answer that, the current project was dedicated to developing Innovative and Affordable Feed Solutions for Enhanced beef quality in the market, employment, and livelihood and hence increased contributions to the national economy on a sustainable basis.

a) General Objective

Develop and enhance the availability of quality and cost-effective beef cattle feeds for increased beef meat quality in Tanzania.

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b) Specific Objectives

- DevelopedInnovative and Affordable Feed Solutionsby considering locally available feed resourcesfor cattle finishing in Tanga region
- Enhanced participation of stakeholders by genderin developing Innovative and Affordable Feed Solutionsfor cattle finishingin Tanga region

II. Materials and Methods

a) Study Location and Stakeholders

This research work was conducted on-stations at TALIRI Tanga. TALIRI Tanga was chosen because of the available resources and infrastructures necessary for the experiment which included animal scientists, a feed mixing machine, and an experimental building for individual feed cattle testing. The majority (90%) of stakeholders involved in the study were from the Tanga region.

b) Experimental Design

Infrastructures, feed materials, and beef animals necessary for developing the innovative and affordable feed solutions and testing experiments were locally outsourced from within the Tanga region. A total of 60 beef cattle were involved in the feeding experiment. 40 indigenous cattle (Tanzanian Short-horned Zebu-TSHZ) and 20 crossbred cattle (mainly Boran and Holsten Friesian) were used in the first experiment. The Complete Randomized Block Design (CRBD) in a 3 x 2 x 3 x 2 factorial arrangement was used given every experimental unit to have the same probability of receiving any treatment. Four factors were considered: dietary treatment, Sex, Age, and Row pen with three levels (D_1, D_2, and D_3), two levels (male and female), three levels of age categories (<3, 3-4, >4 years) and two levels of pen (Row1 and Row2), respectively. The experimental animals were randomly assigned to individual pens with specific treatment as per protocol for 11 weeks.

Phase II for validation considered the same feed formulas and feeding protocols as in Phase I. However, based on the recommendations of phase I, in phase II only Diet 1 and TSHZ cattle were considered. At all stages of the experiment, the private sector on feed manufacturing and gender engagement were considered and given priority.

c) Dietary Treatments

The four dietary treatments were D_1 (contained maize meal, Leucaena, cassava leaves, and sunflower seed cakes' meal) D_2 (contained processed cassava roots as an energy source mixed with *leucaena,* cassava leaf, and sunflower seed cakes' meals), and D_3 (Control-Hay). The diet composition and balancing as per animal requirements were done by using *Win Feed* a computer software.

d) Animal Management

i. *Housing*

An experiment was done in an open side and roofed house made of poles with two rows (30x2) of individual pens and a concrete floor facing North-South set in an are a where Mosoon wind is common. In addition, good ventilation, shading, drainage, hygiene, and water were prerequisites maintained.

ii. *Feeding*

Beef cattle assigned to diet$_1$ (D_1) and diet2(D_2) were supplied with basal diet in ad-lib and supplemented with 2kg of formulated diet every morning. The group assigned to the control diet (D_3)(hay and corn silage) was not supplemented with concentrate in the formulated diets. The mixed grass hay with corn silage and ad-lib water was the main basal diet and was given across all animals under the experiment.

e) Health Management

Two weeks before the experiment all health aspects such as deworming individual identification, and animal acclimatization processes were conducted. Acclimatization was necessary because animals were purchased from local markets by different pastoralists with different environments and management before being brought to TALIRI with new environments and feed types.

f) Data Collection

Data collection covered a period of 11 weeks and only 8 weeks (Week 3 to Week 10 of the experiment) of its data were considered in the current analysis report. Because in the first two and last weeks of the experiment, Walter became a major challenge.

Data collected included the quantity and quality of feed materials and formulated diets, the initiallive weight of cattle for the experiment, and subsequent weekly live weight data measured using a digital weighbridge scale. Apart from live weight gain information, the health and eating habits of individual animals were monitored. Optimal feed required for maintenance and live weight gain of Zebu cattle given the cost for producing one kg of potential formula for cattle finishing diet by a Win Feed a computer software. The general linear model procedure using SAS software was used to obtain the means.

III. Results and Discussion

a) Stakeholder Participation by Gender

The smallholders included smallholder farmers (agro-pastoralists), private sectors mainly animal feed processors, beef business people, researchers, and policymakers who participated in the current study as part of awareness creation and capacity building. They were engaged during project inception, research works

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and data collection, training on the project outcome, selection and purchase of cattle for the experiment, and mobilization and processing of local feed resources (cassava, leucaena, maize, hay, and silage). Overall women constituted 50.41% of the participants who participated in different project activities (Table 1).The feed resource mobilization and processing activity engaged more women than men by 86%, since equal opportunity was provided to men and women, the observed results possibly because the feed materials (Leucaena and cassava leaves) were easily accessible and light to carry. Also, suggests that the engagement opportunities are beneficial and gender-sensitive (Obosha, 2021). On the other hand, training fetched the least women participation, which can be explained by the time limit for women to travel for the meeting as they were occupied with various home activities. Participated stakeholders benefited abundantly both economically and socially (Peña and Valls, 2023).

Table 1: Stakeholders by gender engagement during the development of innovative and affordable feed solutions for cattle finishing in Tanga region

Activity description	Men	Female	%Female
Project Inception meeting	5	7	58
Research and data collection	10	5	33
Purchase of beef animals from markets	5	2	29
Hay and Silage preparation for finishing cattle	30	34	53
Labor contract	1	2	67
Mobilization and processing of local feed resources	10	60	86
Training workshop, project outcome	60	13	17
Total	121	123	50.41

b) Feed Ingredients, Chemical Composition of Feeds, and Cost of Formulated Diet Used

The analysis of feed ingredients, chemical composition, and diet costs used in developing feed solutions are presented in Table 2. Eight feed ingredients were locally sourced for diet formulation based on percentages. Also, the composition was measured in particular energy in MJ/kg DM and the cost was per kilogram.

i. *Feed Ingredients*

Nine (9) feed ingredients were used to formulate two diets for the cattle finishing feed solution experiment (Table 2). Besides the basal diet, corn, rice polish, and cassava roots were the main energy sources, while leucaena leaf, sunflower seed cake, and soya beans for protein. These feed ingredients are all sourced locally and seem available in the Tang a Region abundantly.

ii. *Chemical Composition*

Both diets (one and two) were of high quality in terms of crude protein (CP%, DM) of 16.2% and 14.60; and metabolizable energy (ME)of 11.16 and 10.36 MJ/kg DM (Table 2). The results are of high quality compared to values reported in the work by Gebremariam and Belay, 2021 and Mrema et al. (2022) reported CP% DM of 2.76 to 10.9, and 6.08 to 11.60 MJ/kg DM from local feed materials in Tanzania, respectively. The current analysis results suggest that feed materials obtained from the Tanga region are of high-quality potential for formulating cattle finishing diets.

c) Costs Per Kilogram of Formulated Diets for Cattle Finishing

The cost analysis associated results associated with producing one Kilogram of the formulated feed diet is presented in Table 2. Without adding a profit margin, Diet One cost was about TSHs 498 and TSHs—490 for Diet two per kilogram, respectively. The reported costs were considered cheap for Tanga region, such that the average price of one Kilogram for concentrates with a similar ingredient composition was about TSHs 500 to 1000 (Mlote et al., 2012) as a field survey in 2011/2022. Equally, the requirement of finishing cattle and feeding at optimal was considered as per recommendation in the nutritional requirement for beef cattle (NRC, 1996).At this point, these obtained results on diet quality and cost evaluation given the locally sourced feed materials were considered a feasible feed solution for cattle finishing in Tang a region. Therefore, given a room to select quality high-quality ingredients

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Table 2: Feed ingredients, chemical composition, and cost of formulated diets used

Feed Ingredients	Diet 1 %	Diet 2 %	Control%
Hay & silage (Basal diet)	45	56.6	100
Maize meal	11.92	9.6	0
Rice polish	6.92	2.62	0
Cassava root meal	1.92	4.62	0
Leucaena leaf meal	18	4.62	0
Sunflower seed cake	1.9	12.66	0
Soya bean meal	6.44	8.24	0
Minerals Conc	2.9	0.94	0
Chemical composition			
ME (MJ/kg DM)	11.16	10.36	6.95
CP	16.20	14.60	4.90
Ca	1.66	0.5	0.37
P	1.24	0.72	0.19
Cost per kilogram			
Price/kg (TSH)	498.69	495.76	225.22

d) Effects of Diets on Performance of Finishing Cattle

Table 3 shows Phase I results tested at P≥ 0.5; whereby age category, sex, and penning were not significant. Crosses responded better significantly to the diets than the TSHZ cattle for weekly and total weight gain, respectively. The mean comparison on diets 1 & 2 was all significant to diet control with diet 1ranking first for both weekly and total weight gain, respectively.

The higher gain from crossbred cattle could be a result of better adaptation to the finishing experiment as reported by (Bertipaglia et al., 2010), genetic characteristics and environment (Sakowsk et al.2022),and diet quality and dry matter intake per body weight(DMI/BWT)(Marshall et al 2009)compared to TSHZ that are originally raised and adopted in free grazing. However, Diet 1 seemed to perform better for TSHZ than Diet 2, which can be explained by the possible differences in diet energy density (Bertipagli a *et al.,* 2010).

Table 3: Effects of diet, genotype, Age, sex, and pen on weight gain of finishing cattle

Factors	Parameters		
Dietary	Weekly gain	Total gainP≥ 0.5	
D1	8.04[a]	88.50[a]	***
D2	7.58[a]	83.41[a]	***
D3	3.87[b]	42.58b***	
Genotype			
Crossbred	6.82[a]	75.00[a]	
TSHZ	6.23[b]	68.60[b]	
Age category			
<3 years	6.61[a]	72.20[a]	
3 - 4 years	6.53[a]	71.82[a]	
> 4 years	6.29[a]	69.16[a]	
Sex			
Female	6.52[a]	71.67[a]	
Male	6.43[a]	70.69[a]	
Row pen			
1	6.50[a]	71.52[a]	
2	6.44[a]	70.80[a]	

Key: D = Diet, the similar superscript in the column means no significant difference

Table 4 shows the interaction effects of genotype and diet. TSHZ responded better to Diet 1and crossbred for Diet 2. Suggesting that diets1 and 2 its economically efficient and are genotype dependent (Mollel *et al.,* 2014;Neto et al.2023)un improved cattlege no type attained higher gain per small amount of feeds

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due to lower Feed Conversion Ratio (FCR) and a short period in weight change.

Table 4: Interaction effects of genotype and dieton finishing cattle weight gain

Parameters	TSHZ			Crossbred		
	Diet1	Diet2	Control	Diet1	Diet2	Control
Weekly gain (Kg/week)	7.82	7.23	3.84	8.22	8.72	3.92
Total gain (Kg/11 weeks)	86.00	76.54	42.20	90.44	96.00	43.14

e) Validation

Table 5 shows the Phase II results that were inconsistent with Phase I and performed significantly better than the control. The recorded average daily live weight gain of 0.62kg/dayin 11 weeks for the best-ranked formulated diet against 0.02/kg/day for the control is significant studies reported by Kimirei et al., 2022 and Asimwe et al., 2015 for TSHZ supports the current findings.

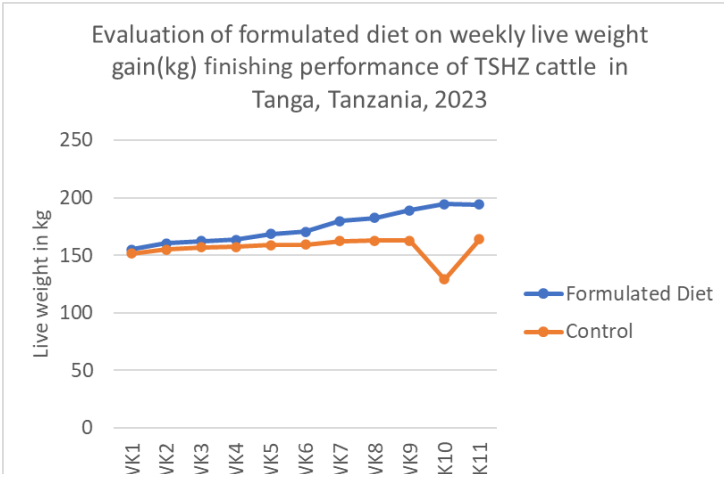


Figure 1: Evaluation of formulated diet on weekly live weight gain (kg) finishing performance of TSHZ cattle in Tanga, Tanzania

IV. Conclusion

This study demonstrated that developing local feed formulas for cattle finishing can significantly enhance the quality of beef, leading to increased profitability for producers and contributing to the national economy, job creation, and the potential for commercial application. The locally developed feed formula prototype by TALIRI not only reduces costs but also creates job opportunities for youth, the private sector, and scientists in Tanzania. Engagement of the private sector, coupled with research expertise, was crucial in the successful development and potential commercialization of the feed formula. Further research should focus on developing feed formulas for other livestock species such as chickens, fish, and dairy cattle. This expansion is essential for diversifying and strengthening the livestock industry in Tanzania.

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Impact of Farm Mechanization on the Psychological Health of the Farmers: A holistic Study in West Bengal, India

By Anannya Chakraborty & Jesmin Abedin

Seacom Skills University

Abstract- *Context:* The present study is based on the impact of farm mechanization on psychological health of the farmers. The physical drudgeries of the farmers caused by daily farm works leave a long term impact on their mental wellbeing. The farm mechanization not only helps in reducing the physical strain, but also it creates a significant impact on the farmers' psychological state.

Objectives: To find out the factors which are improved by the mechanization of farming and how those are impacting the psychological health of the farmers.

Methods: The study has been conducted in the Raipur Gram Panchayet and village, Sriniketan block, Birbhum district of West Bengal. Total 150 farm families were selected for the study with a class interval of 3(2.75 to be precise).

Keywords: *farm mechanization, psychological health, communication, wellbeing.*

GJSFR-D Classification: *LCC S494.5.M42*



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Impact of Farm Mechanization on the Psychological Health of the Farmers: A Holistic Study in West Bengal, India

Anannya Chakraborty [α] & Jesmin Abedin [σ]

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Results and Discussion: It was found in the study that, improved and mechanized way of farming has a significant impact on the psychological health and wellbeing of the farmers.

Significance: The policy makers, extension functionaries and other state holders can get useful references from the study and the study can further be replicated in locales with similar kinds of socio-economic and techno-managerial situations.

Keywords: farm mechanization, psychological health, communication, wellbeing.

I. Introduction

The modernization of agriculture is driven by various factors, including population growth, urbanization, changing dietary patterns, globalization, climate change, and advancements in science and technology. It aims to address the challenges of feeding a growing population sustainably, enhancing food security, reducing poverty, promoting rural development, and mitigating environmental degradation. While agricultural modernization offers opportunities for increasing productivity, profitability, and competitiveness, it also poses challenges related to access to technology, knowledge, resources, and environmental sustainability. Therefore, achieving sustainable 15 agricultural modernization requires a balanced approach that considers social, economic, environmental, and ethical dimensions to ensure inclusive and equitable development while safeguarding natural resources and ecosystem integrity. The modernization of agriculture represents a transformative process aimed at enhancing productivity, efficiency, and sustainability in the agricultural sector. In response to changing socio-economic, environmental, and technological dynamics, countries worldwide are embracing modern agricultural practices and technologies to meet the growing demand for food, ensure food security, and promote rural development. Before the emergence of the modern agricultural tools and techniques, the farmers were suffering so much from the drudgeries of agricultural works. These suffering of theirs were include not only physical, but also psychological stress. Bentley et al. (2019) found in their study that the psycho-social risks, such as high demands, role conflict, lack of managerial or co-worker support, stress, bullying and discrimination in the work environment, are detrimental to both health and well-being of older workers and can also increase the probability of early retirement. This is one of the reasons why many of the farmers don't want to be in agriculture and their mass shifting towards the urban and semi urban areas.

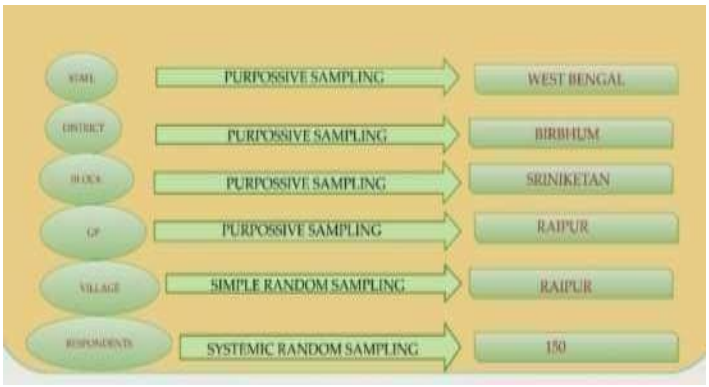
In this paper we will discuss how the farm mechanization has impacted on psychological health of the farmers positively and has reduced their occupational stress to a significant extent.

II. Methodology

This study was conducted in Raipur Gram Panchayet and village, Sriniketan block, Birbhum district of West Bengal. Total 150 farm families were selected for the study with a class interval of 3 (2.75 to be precise). The sampling method used for the study is as follows-

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Pilot Study: A pilot study, pilot project, pilot test, or pilot experiment is a small-scale preliminary study conducted to evaluate feasibility, duration, cost, adverse events, and improve upon the study design prior to performance of a full-scale research project. We have done a pilot study with 10% samples of the total respondents to see whether the questionnaires are applicable and capable for extracting the required information from the tribal women of the area under study.

a) Methods of Data Collection

Preparation of Interview Schedule: On the basis of the findings of pilot study interview schedule was prepared with the help of review literature and by the assistance of chairman of Advisory Committee. The schedule consists of Agro-economic, Socio- personal and Techno managerial.

Pre Testing of Interview Schedule: Main objective of this performance is to detect the discrepancies that have emerged and to eliminate them after necessary modification in the schedule. The individuals who responded in pretesting have been excluded in the final sample for the study.

Techniques of Field Data Collection: The respondents were personally interviewed during summer vacation. Local language (Bengali) was used to retrieve the information from the respondent. The entries were done by the student investigator himself at the time of interview.

b) Statistical Tools

The statistical tools used for the study are coefficient of correlation and step down regression.

Coefficient of correlation: The correlation coefficient is a statistical measure of the strength of the relationship between the relative movements of two variables. The values range between -1 and +1. If the calculated number greater than +1 or less than - 1 means that there was an error in the correlation measurement. A correlation of -1 shows a perfect negative correlation, while a correlation of 1.0 shows a perfect positive correlation. A correlation of 0 shows no linear relationship between the movements of the two variables.

Correlation Coefficient Equation:

Where,

rxy – The correlation coefficient of the linear relationship between the variables x and y

xi – The values of the x-variable in a sample $\bar{x}$ – the mean of the values of the x-variable yi– the values of the y-variable in a sample $\bar{y}$ – the mean of the values of the y-variable

Stepwise Multiple Regressions: Regression analysis is a widely used statistical approach that seeks to identify relationships between variables. The idea is to pool relevant data to make better informed decisions and is a common practice in the world of investing. Stepwise regression is the step-by-step iterative construction of a regression model that involves automatic selection of independent variables. The availability of statistical software packages makes stepwise regression possible, even in models with hundreds of variables.

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III. Results

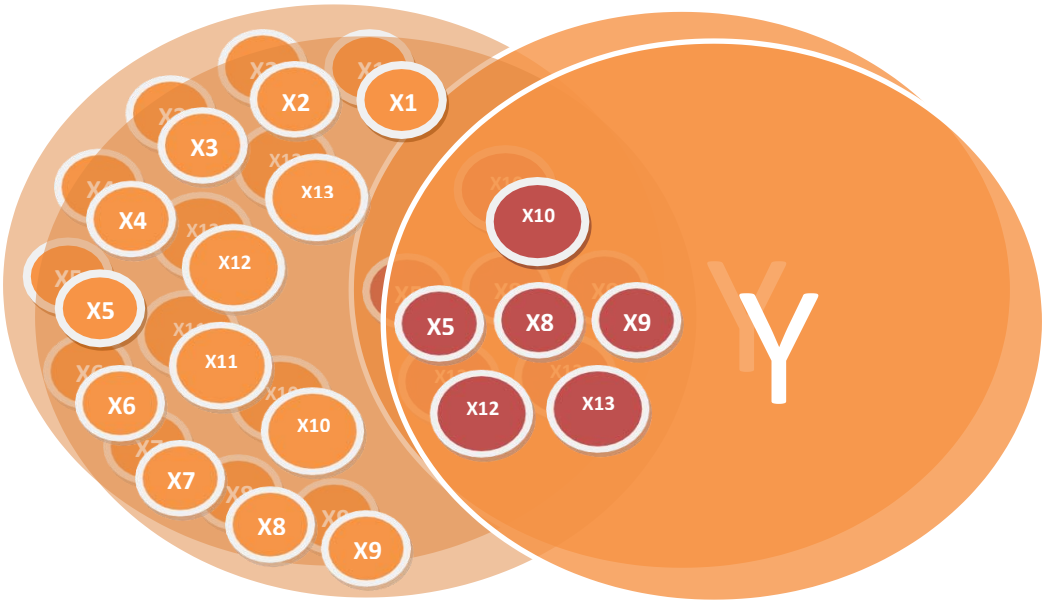
The correlation of coefficient between dependent variable Improvement ofPsychological health (Y) and the 13 independent variables (X1……X13)

Sl No.	Variables	Correlation Coefficient	Remark
1	Age (X1)	0.0328	
2	Educational Qualification (X2)	-0.02186	
3	Total Monthly Income (X3)	-0.0228	
4	Monthly Expenditure on Health Issues (X4)	-0.02225	
5	Family Size (X5)	-0.153005	*
6	Cultivated Crops (X6)	-0.04155	
7	Available Land (X7)	-0.00495	
8	Presence of Health Centre (X8)	0.090	*
9	Usage of Modern Equipment(X9)	0.0615	*
10	Health Consciousness (X10)	0.092047	*
11	Relation with Relatives and Neighbors (X11)	-0.018	
12	Physical Drudgeries Caused byFarming (X12)	0.1749	*
13	Psychological Drudgeries Caused by Farming (X13)	0.1416	*

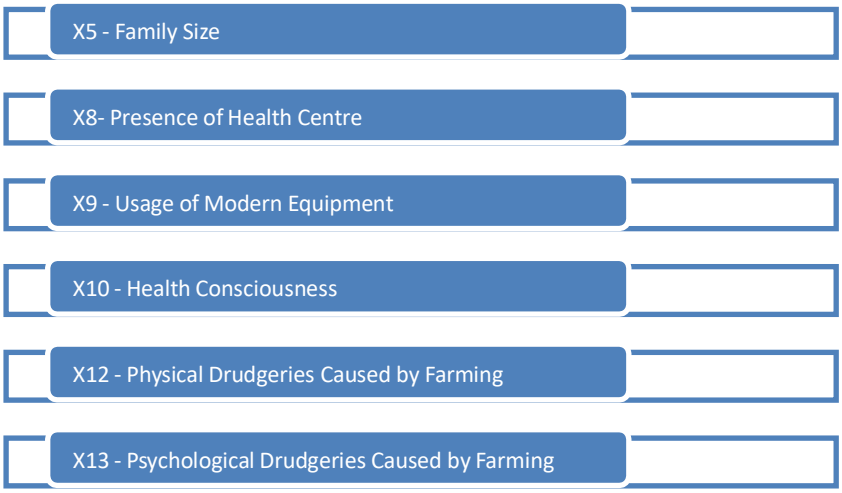
This is clearly visible Family Size (X5), Presence of Health Centre (X8), Usage of Modern Equipment (X9), Health Consciousness (X10), Physical Drudgeries Caused byFarming (X12) and Psychological Drudgeries Caused by Farming (X13) have significant correlation with the dependent variable Improvement of Psychological health (Y3).

Family size is a two way serrated saw. In the one hand it would give the strength to walk in the farming field but on the other hand it would surely give more burden to feed empty stomach. If the survival expenditure of the family is more than there would be a very small amount of resource left to be spend on the mental health issues presence of health center and health consciousness would create a significant positive impact on the mental health status of the respondents. Usage of the modern equipment will lessen the physical and psychological drudgery of the respondents, which would be very helpful to improve their mental health.

The Model of the correlation of coefficient between dependent variable Improvement of Psychological health (Y) and the 13 independent variables (X1……X13)



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Step down regression of 13 independent variables vs dependentvariables Improvement of Psychological health (Y)

Name of the Variables	B	Beta	t
Age (X1)	0.017	0.064	0.455
Educational Qualification(X2)	0.335	0.504	3.222
Total Monthly Income (X3)	-0.001	-0.482	-1.208
Monthly Expenditure on Health Issues (X4)	-0.144	-0.062	-0.167
Family Size (X5)	-0.233	-0.220	-1.056
Cultivated Crops (X6)	0.002	0.383	1.109
Available Land (X7)	0.749	0.330	1.751
Presence of Health Centre(X8)	0.016	0.006	0.020
Usage of Modern Equipment (X9)	1.016	0.349	2.355
Health Consciousness (X10)	0.200	0.306	0.773
Relation with Relatives andNeighbors (X11)	0.062	0.208	0.930
Physical Drudgeries Causedby Farming (X12)	0.540	0.178	0.781
Psychological DrudgeriesCaused by Farming (X13)	0.125	0.179	0.546

$R^2 = 0.5878$

The result depicted in the above table revealed that step down regression analysis between exogenous variable Improvement of Psychological Health (Y) Vs 13 Causalvariables.

It has been found that the R^2 value is 0.5878. It is to infer that 58.78% of variance in the consequent variable have been explain by the combination of these 13 causal variables.

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Step down regression 9th step for Improvement of Psychological health (Y)

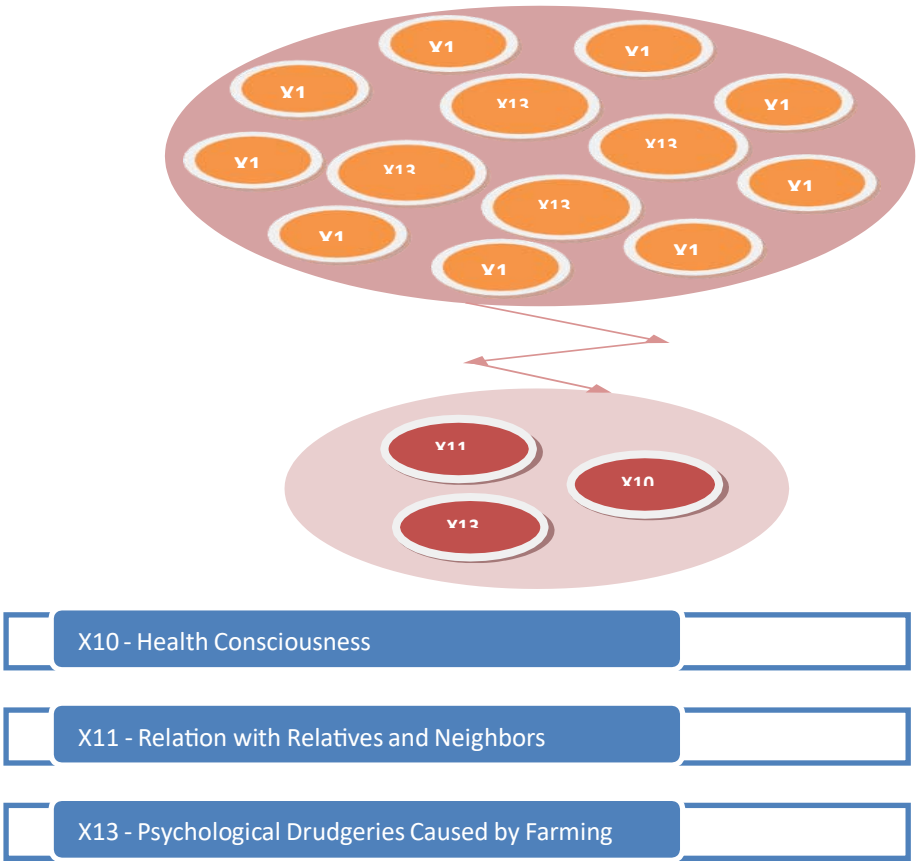
Name of the Variables	B	Beta	t
Health Consciousness (X10)	0.306	0.460	3.783
Relation with Relatives andNeighbors (X11)	0.599	0.264	2.047
Psychological DrudgeriesCaused by Farming (X13)	0.890	0.306	2.344

R^2=0.8138

The above table presents the stepwise regression and it has been depicted that 3 casual variable), Health Consciousness (X10), Relation with Relatives and Neighbors (X11), Psychological Drudgeries Caused by Farming (X13) has been retained in the last step. The R^2 value being 0.8138 shows that 81.38% of variance in the consequent variableshas been explained by the combination of only these 3 casual variables.

Health consciousness is a key factor to detect mental health. Communication can improve the mental health status of an individual. If people are more health conscious more communicative and less stressed then it would surely improve their psychologicalhealth.

Step down regression of 13 independent variables vs dependentvariables Improvement of Psychological health (Y)



IV. Discussion

In case of Exogenous Improvement of Psychological health (Y3) after doing research study we can easily say that the coefficient of correlation is visible Family Size (X5), Presence of Health Centre (X8), Usage of Modern Equipment (X9), Health Consciousness (X10), Physical Drudgeries Caused by Farming (X12) and Psychological Drudgeries Caused by Farming (X13) have significant correlation. And in case of step down regression the result revealed that the analysis between mentioned exogenous variable vs 13 causal variables. it has been found that the R^2 value being 0.5878 shows that 58.78% of variance in the consequent variable have been explain by the combination of these 13 casual variable. And in the 9th step or final of step down regression it has been depicted that 3 casual variables has been retained in the last step. The R^2 value being 0.8138 shows that 81.38% of variance in the consequent variables has been Health Consciousness (X10),

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Relation with Relatives and Neighbours (X11)and Psychological Drudgeries Caused by Farming (X13) explained by the combination of only these 3 casual variables.

The recommendation which we can give to the policy makers:-

- The women should be encourage to have more localized and cosmopolite information to change their present scenario. The government's schemes and programmes which are beneficiary and useful for purchasing latest agricultural equipment should be known by the tribal women. For this a proper bridge should be made in between the government agencies and the tribal women. Opinion leaders who can get the firsthand information from the government agencies and to communicate these information to the other stake holder, should be identified and trained properly.
- As we have found that, this particular village is quite remote and backward. It is very much late to adopt new technology or implements. So, the main problem we can say there is a communication gap, if a contact person or opinion leaders would be there it will be easy for them to adopt things easily and if the contact person is women it will be more comfortable for them to communicate.

V. Conclusion

Saju et. al. (2023) has found in their study that the quantifiable variables associated with farmers's well being are attachment family, friends and peer groups, belongingness and other social engagements. In this study also we have found out that farm mechanization effectively increases the health consciousness of the farmers and establishes better communication and relationship with relatives and neigh bors. It was also evident from the study that mechanized way of farming significantly reduces not only the physical but also the psychological drudgeries of the farmers. The number of the members of the family is negatively significant with the psychological health of the farmer. It indicates that lesser the family size better would be the psychological health of the members. Henceforth, we can conclude from the study that, usage of modern equipment in the farming is pretty much helpful in maintaining a good psychological health of the farmers and their subsequent mental, physical and social well being.

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Declaration of competing interest: The authors have no conflicts of interest.

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Authors Contribution: Both the first and second authors have contributed in problem identification, ideation, data collection and formulation of conclusion.

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We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

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1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

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Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

A

Acclimatization · 23

B

Broiler · 1, 2, 3, 4

C

Crucial · 4, 11, 22

D

Drudgeries · 16, 17, 21

J

Jeopardize · 1

P

Prerequisites · 23

S

Slaughter · 1

T

Tolerance · 1, 2, 8, 10
Tornado · 8, 15



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