Advances In Multidisciplinary & Scientific Research
A Multidisciplinary & Interdisciplinary Journal

Vol. 11 No. 2, 2025

Optimizing Broiler Nutrition with Cassava Starch Residue Leaf Meal: Effects on Economic Efficiency in Nigerian Poultry Production

***Olowoyeye, Janet Chinwe & Ojo, Olaniyi Oluwatosin**
Department of Agricultural Science and Technology,
Bamidele Olumilua University of Education, Science, and Technology
Ikere, Ekiti State, Nigeria
*Corresponding author email: olowoyeye.janet@bouesti.edu.ng

ABSTRACT

The rising cost of maize, a primary ingredient in poultry feed, has necessitated the search for alternative feed sources in Nigeria. This study evaluates the economic implications of replacing maize with Cassava Starch Residue Leaf Meal (CSRLM) in broiler diets at varying inclusion levels (9:1 and 9.5:0.5 mixes). The study analyzes feed costs, production costs, gross income, and profitability to determine the viability of CSRLM as a cost-effective alternative to maize. Results indicate that feed costs decreased with increased CSRLM inclusion, leading to reduced total production costs. However, a decline in gross income and profitability was observed at higher CSRLM levels due to reduced bird weights. Despite this, moderate inclusion levels (10-20%) demonstrated favorable economic returns, highlighting the potential of CSRLM in reducing feed costs without significantly compromising profitability. The study recommends strategic incorporation of CSRLM into broiler diets to balance cost savings and performance sustainability in poultry farming.

Keywords: Optimising, Economic Efficiency, Cassava Starch Residue, Broiler Production
Aims Research Journal Reference Format:
Olowoyeye, Janet Chinwe & Ojo, Olaniyi Oluwatosin (2025): Optimizing Broiler Nutrition with Cassava Starch Residue Leaf Meal: Effects on Economic Efficiency in Nigerian Poultry Production. Advances in Multidisciplinary Research Journal. Vol. 11 No. 2, Pp 17-26. www.isteams.net/aimsjournal. dx.doi.org/10.22624/AIMS/V11N2P2

1. INTRODUCTION

The Nigerian poultry industry is crucial to the country's food security and economic development. However, the rising cost of maize, which constitutes a significant proportion of poultry feed, has increasingly threatened the profitability of broiler production (Akinola et al., 2017). As a result, alternative feed ingredients, such as cassava by-products, have been explored to reduce feed costs while maintaining optimal bird performance (Dairo et al., 2020). Research has shown that broiler producers can achieve significant cost savings and increased gross margins by substituting maize with cassava starch residues (Olowoyeye, 2016). A study analyzing cassava production in Irepodun local government area reported an average gross margin per hectare for cassava of ₦24,749.2, suggesting that the crop has a viable economic return for farmers engaged in its production. This profitability can extend to the poultry sector, where using cassava residues can lower feed costs.

In terms of input costs, farmers have reported varying returns on investment when utilizing cassava products. For example, a study indicated that farmers employing modern agricultural techniques and cassava-based feeds recorded net incomes significantly higher than those relying solely on traditional feeds. The gross margin analysis revealed that farmers using advanced methods achieved a gross margin of N129,014.75 compared to N76,502.77 for their counterparts, suggesting that improved input usage in both cassava and poultry production enhances overall economic returns. Technical efficiency also plays a crucial role in the economic analysis of cassava-based feeding systems.

Estimates from various studies indicate that factors such as farm size, fertilizer application, and labor inputs significantly influence production output. For instance, an estimated mean technical efficiency of 0.69 highlights the potential for improving resource allocation in cassava farming, which could also benefit broiler production by ensuring consistent feed quality and availability.

Cassava Starch Residue (CSR) has gained attention due to its availability, cost-effectiveness, and potential nutritional benefits (Obika et al., 2019). However, concerns remain regarding its economic viability as a replacement for maize in broiler diets. This study evaluates the cost and return implications of using CSRLM (9:1 and 9.5:0.5 mixes) as a partial replacement for maize in broiler feed. The findings provide insights into feed cost savings, gross income trends, and profitability estimates to guide poultry farmers in making informed feed formulation decisions (Adebayo et al., 2022).

2. METHODOLOGY

The experiment was carried out at the Teaching and Research Farm of the Federal University of Technology, Akure. A total of 300 day–old broiler chicks of Marshall Breed were used for the trial. All the chicks were electrically brooded at the Teaching and Research Farm of the Federal University of Technology Akure, where they were fed with a commercial (CP: 23%; ME:3200kcal/kg) diet for the first week pre-experimental period. At the end of the pre-experimental period, the chicks were weighed, and 50 chicks were randomly assigned to each of the 6 diets in 5 replications of 10 chicks per replicate in a Completely Randomized Design (CRD). The mean group weights per diet were identical (137.5 g ± 4.2). The chicks were fed with their respective experimental diets *ad libitum* from day 8 to day 21(starter feed) and from day 22 to day 42 (Finisher feed). Water was provided adequately and records of daily feed consumption were taken and also group weight changes were taken every 7 days. The general objective of this activity was to assess the economics of using cassava starch residue leaf meal mix in the diets of broilers. Tables 1-4 show the experimental diets given to the birds

Table 1: Gross Composition of Experimental Diet (g/100g) for Broiler-starterfed diets in which maize was replaced with CSRLM (9:1) mix

	Level of maize replaced by CSRLM (9:1) mix					
Ingredients	0	10	20	30	40	50
Maize	51.19	46.07	40.95	35.83	30.71	25.60
CSRLM	0.00	5.12	10.24	15.36	20.48	25.60
SBM	30.00	28.00	25.00	22.00	21.00	20.00
GNC	9.00	11.00	14.00	17.00	18.00	19.00
FM	4.00	4.00	4.00	4.00	4.00	4.00
B/Meal	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.13	0.13	0.13	0.13	0.13	0.13
Methionine	0.13	0.13	0.13	0.13	0.13	0.13
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vegetable Oil	2.50	2.50	2.50	2.50	2.50	2.50
Total %	100	100	100	100	100	100.01
Calculated Analysis						
Crude Protein	23.23	23.18	23.17	23.16	23.09	23.01
M.E (Kcal/Kg)	3092.8	3042.98	2942.54	2942.10	2852.86	2843.95
Calcium %	1.54	1.44	1.36	1.34	1.34	1.32
Av. Phosphorus%	0.61	0.59	0.58	0.56	0.55	0.55

Table 2: Composition of Experimental Diet for Broiler Finisher fed diets in which maize was replaced with CSRLM (9:1) mix

	Level of maize replaced by CSRLM (9:1) mix					
Ingredient	0	10	20	30	40	50
Maize	58.23	52.41	46.58	40.76	34.94	29.12
CSRLM	0.00	5.82	11.65	17.47	23.29	29.12
SBM	24.00	24.00	24.00	24.00	24.00	24.00
GNC	9.00	9.00	9.00	9.00	9.00	9.00
FM	3.50	3.50	3.50	3.50	3.50	3.50
B/Meal	2.00	2.00	2.00	2.00	2.00	2.00
Oyster	0.50	0.50	0.50	0.50	0.50	0.50
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.11	0.11	0.11	0.11	0.11	0.11
Methionine	0.11	0.11	0.11	0.11	0.11	0.11
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vegetable Oil	2.00	2.00	2.00	2.00	2.00	2.00
Total %	**100**	**100**	**100**	**100**	**100**	**100.1**
Calculated Analysis						
Crude Protein%	20.21	20.09	19.98	19.86	19.74	19.63
M.E (Kcal/Kg)	3109.20	3053.88	2928.49	2913.20	2847.90	2832.86
Calcium %	1.44	1.42	1.32	1.32	1.24	1.24
Av.Phosphorus%	0.57	0.56	0.56	0.55	0.55	0.54

Table 3. Gross Composition of Experimental Diet (g/100g) for Broiler Starter fed diets in which maize was replaced with CSRLM (9.5:0.5) mix

	Level of maize replaced by CSRLM meal mix (9.5:0.5)					
Ingredient	**0**	**10**	**20**	**30**	**40**	**50**
Maize	51.19	46.07	40.95	35.83	30.71	25.60
CSRLM	0.00	5.12	10.24	15.36	20.48	25.60
SBM	30.00	28.00	26.00	22.00	19.00	20.00
GNC	9.00	11.00	13.00	17.00	20.00	19.00
FM	4.00	4.00	4.00	4.00	4.00	4.00
B/Meal	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.13	0.13	0.13	0.13	0.13	0.13
Methionine	0.13	0.13	0.13	0.13	0.13	0.13
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vegetable Oil	2.50	2.50	2.50	2.50	2.50	2.50
Total %	**100**	**100**	**100**	**100**	**100**	**100.01**
Calculated Analysis						
Crude Protein	23.23	23.13	23.04	23.00	22.94	22.76
M.E (Kcal/Kg)	3092.80	3042.98	2933.14	2924.10	2861.70	2843.95
Calcium %	1.54	1.42	1.34	1.24	1.24	1.20
Avail.Phosphorus %	0.61	0.59	0.58	0.56	0.55	0.55

Table 4: Gross Composition of Experimental diet (g/100g) for broiler finisher fed diets in which maize was replaced with CSRLM (9.5:0.5) mix

Ingredient	Level of maize replaced by CSRLM (9.5:0.5) mix					
	0	10	20	30	40	50
Maize	58.23	52.41	46.58	40.76	34.94	29.12
CSRLM	0.00	5.82	11.65	17.47	23.29	29.12
SBM	24.00	24.00	24.00	24.00	24.00	16.00
GNC	9.00	9.00	9.00	9.00	9.00	17.00
FM	3.50	3.50	3.50	3.50	3.50	3.50
B/Meal	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Premix *	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.11	0.11	0.11	0.11	0.11	0.11
Methionine	0.11	0.11	0.11	0.11	0.11	0.11
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vegetable Oil	2.00	2.00	2.00	2.00	2.00	2.00
Total %	**100**	**100**	**100**	**100**	**100**	**100.01**
Calculated Analysis						
Crude Protein %	20.21	20.03	19.86	19.68	19.51	19.50
M.E (Kcal/Kg)	3109.20	3053.88	2898.49	2843.20	2787.90	2728.06
Calcium	1.44	1.40	1.24	1.22	1.22	1.20
Phosphorus	0.57	0.56	0.56	0.55	0.55	0.51

3. DATA COLLECTION AND ANALYSIS

The study involved feeding broilers with diets containing varying levels of CSRLM (9:1 and 9.5:0.5 mixes) as a replacement for maize. The data used for this study were the broiler production data collected from the above experiment carried out at the Teaching and Research Farm of the Federal University of Technology, Akure.

The economic analysis was conducted based on the following key parameters (Ogunleye et al., 2021):

- Feed cost per diet
- Total Variable Cost (TVC) – includes feed, veterinary, labor, and utility costs
- Total Fixed Cost (TFC) – depreciation of equipment and housing
- Total Cost (TC) – sum of TVC and TFC
- Gross Income (GI) – calculated from bird sales based on final body weight
- Gross Margin (GM) – GI minus TVC
- Net Profit (NP) – GI minus TC
- Profit per Naira invested (PNI) – NP divided by TC

The profitability level of each activity i.e. broiler chicken enterprise using cassava by-products as alternative feed resources for livestock feed formulation, was compared with that fed with conventional feedstuffs. The profitability levels were compared between the different feedstuffs. This was used to determine the impact of the feedstuffs on the level of profits of participants. Also, return per naira invested was used to explain the extent to which a naira invested into broiler production contributes to gross margin

4. RESULTS

4.1 Cost and Returns Analysis of CSRLM (9:1) Mix

Table 5: Cost and Return Analysis in Broiler Production per Bird fed varying levels of CSRLM (9:1) mix as a replacement **for maize**

	Diet 1 0%	Diet 2 10%	Diet 3 20%	Diet 4 30%	Diet 5 40%	Diet 6 50%
A. Variable Cost (₦)						
Cost of Stock	1520	1520	1520	1520	1520	1520
Veterinary Cost	228.64	228.64	228.64	228.64	228.64	228.64
Cost of Feed	2680.08	2607.84	2495.20	2389.44	2290.32	2190.88
Labour Cost	2284.64	2284.64	2284.64	2284.64	2284.64	2284.64
Utilities	297.20	297.20	297.20	297.20	297.20	297.20
Total Variable Cost (₦)	7010.56	6938.32	6825.68	6719.92	6620.80	6521.36
B. Fixed Cost (₦)						
Depreciation Cost	182.88	182.88	182.88	182.88	182.88	182.88
Total Fixed Cost	182.88	182.88	182.88	182.88	182.88	182.88
Total Production Cost (₦)	7193.44	7121.20	7008.56	6902.80	6803.68	6704.24
C. Weight (kg)	1.97	1.75	1.74	1.64	1.57	1.53
D. Gross Income (₦)	11820	10500	10440	9840	9420	9180
E. Net Profit (₦)	4626.56	3378.80	3431.44	2937.20	2616.32	2475.76
F. Profit per Naira invested (₦)	0.64	0.47	0.49	0.43	0.38	0.37
G. Gross Margin (₦)	4809.44	3561.68	3614.32	3120.08	2799.20	2658.64
H. Gross Margin per Naira invested (₦)	0.69	0.51	0.53	0.46	0.42	0.41

Table 4.36 presents the cost and return analysis for broilers fed varying levels of CSRLM (9:1). The cost of feed decreased progressively from ₦2680.08 per bird in Diet 1 (0% CSRLM) to ₦2190.88 in Diet 6 (50% CSRLM). Consequently, total production costs were reduced from ₦7193.44 to ₦6704.24 across diets. Gross income declined with increasing CSRLM inclusion, with Diet 1 (0% CSRLM) yielding ₦11820 per bird and Diet 6 (50% CSRLM) yielding ₦9180. The gross margin followed a similar trend, reducing from ₦4809.44 in Diet 1 to ₦2658.64 in Diet 6. Net profit also declined, ranging from ₦4626.56 in Diet 1 to ₦2658.64 in Diet 6. The profit per naira invested decreased from ₦0.64 in Diet 1 to ₦0.37 in Diet 6.

4.2 Cost and Returns Analysis of CSRLM (9.5:0.5) Mix

Table 6: Cost and Return Analysis in Broiler Production per Bird fed varying levels of CSRLM (9.5:0.5) mix as a replacement for maize

	Diet 1 0%	Diet 2 10%	Diet 3 20%	Diet 4 30%	Diet 5 40%	Diet 6 50%
A. Variable Cost (₦)						
Cost of Stock	1520	1520	1520	1520	1520	1520
Veterinary Cost	228.64	228.64	228.64	228.64	228.64	228.64
Cost of Feed	2680.08	2489.36	2373.36	2198.88	2073.6	1878.00
Labour Cost	2284.64	2284.64	2284.64	2284.64	2284.64	2284.64
Utilities	297.20	297.20	297.20	297.20	297.20	297.20
Total Variable Cost (₦)	7010.56	6819.84	6703.84	6529.36	6404.08	6208.48
B. Fixed Cost (₦)						
Depreciation Cost	182.88	182.88	182.88	182.88	182.88	182.88
Total Fixed Cost	182.88	182.88	182.88	182.88	182.88	182.88
Total Production Cost (₦)	7193.44	7002.72	6886.72	6712.24	6586.96	6391.36
C. Weight (kg)	1.97	1.66	1.56	1.54	1.44	1.42
D. Gross Income (₦)	11820	9960	9360	9240	8640	8520
E. Net Profit (₦)	4626.56	2957.28	2473.28	2527.76	2053.04	2128.64
F. Profit per Naira invested (₦)	0.64	0.42	0.40	0.38	0.31	0.33
G. Gross Margin (₦)	4809.44	3140.16	2656.16	2710.64	2235.92	2311.52
H. Gross Margin per Naira invested (₦)	0.69	0.46	0.40	0.42	0.35	0.37

The cost and return analysis for broilers fed CSRLM (9.5:0.) mix is shown in Table 4.37. Similar to the 9:1 mix, feed costs decreased from ₦2680.08 in Diet 1 (0% CSRLM) to ₦1878.00 in Diet 6 (50% CSRLM), reducing total production costs. Gross income declined from ₦11820 in Diet 1 to ₦8520 in Diet 6, while net profit decreased from ₦4626.56 to ₦2128.64. The gross margin showed a downward trend from ₦4809.44 in Diet 1 to ₦2128.64 in Diet 6. The profit per naira invested ranged from ₦0.64 in Diet 1 to ₦0.33 in Diet 6.

4.3 Comparison of CSRLM (9:1) and CSRLM (9.5:0.5) Mixes

Comparing both mixes, the 9.5:0.5 CSRLM formulation yielded slightly lower feed costs than the 9:1 mix. However, its birds had lower final weights, resulting in reduced gross income and profitability as can be seen in Figures 1and 2,. The 9:1 mix offered relatively better returns per naira invested, suggesting that it is a more viable alternative than the 9.5:0.5 formulation.

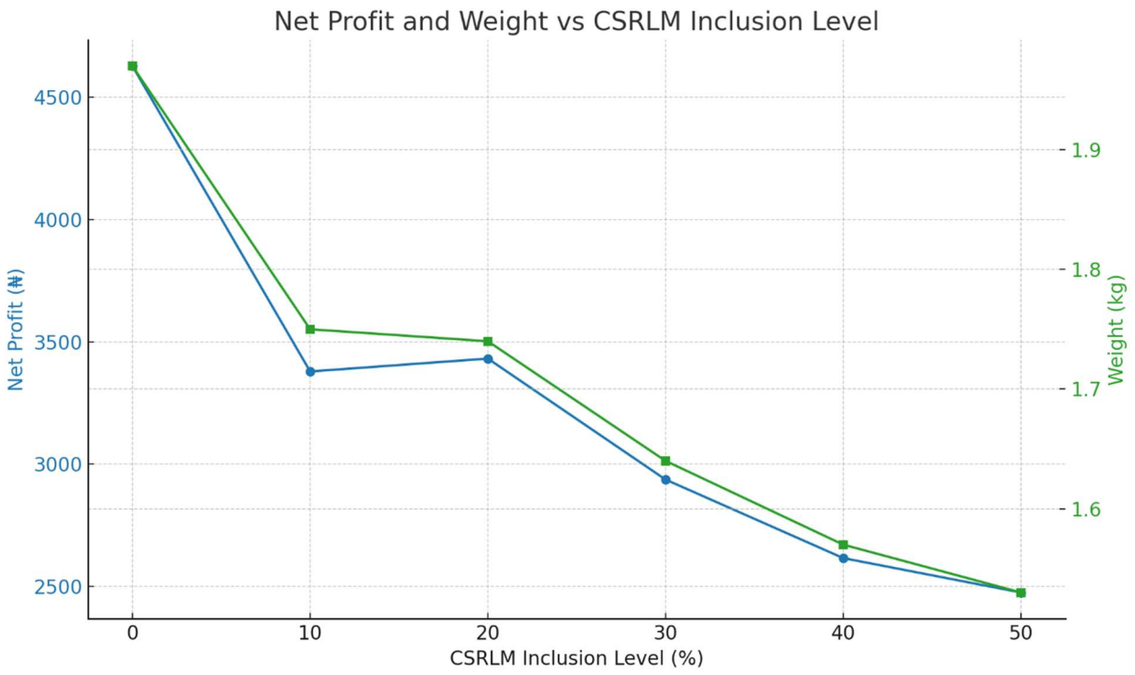

Fig.1: Net Profit and Weight vs CSRLM (90:10) Inclusion Level

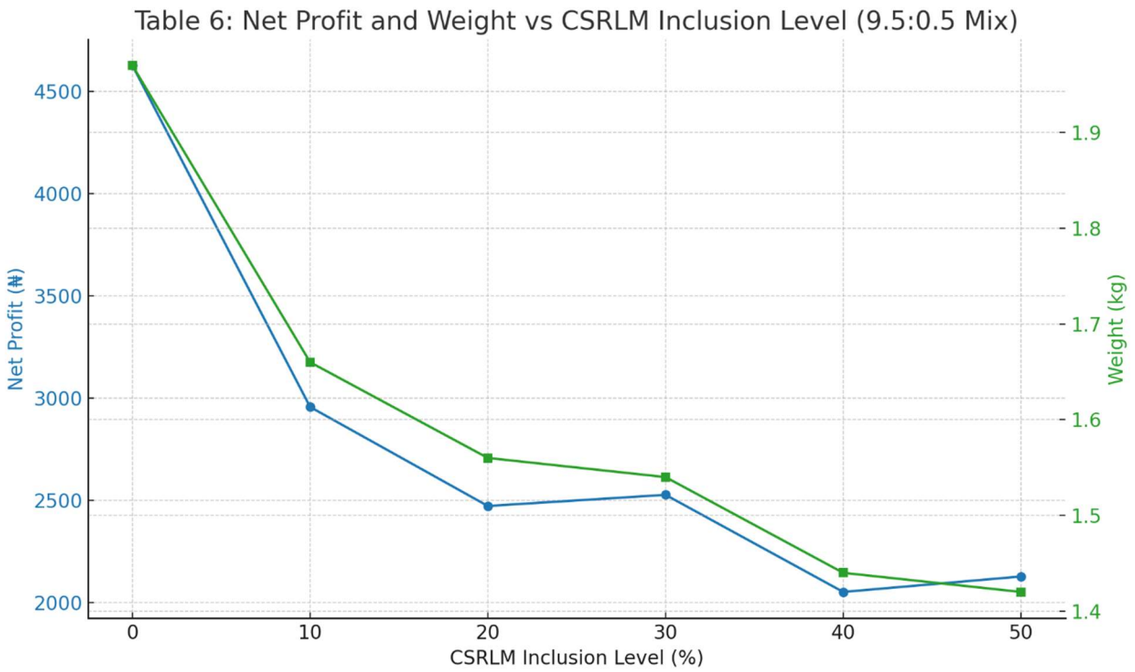

Fig.2: Net Profit and Weight vs CSRLM (95:05) Inclusion Level

5. DISCUSSION

Table 5 provided a close look at how replacing maize with a 9:1 mix of Cassava Starch Residue and Cassava Leaf Meal (CSRLM) affects the economics of broiler production. The replacement was done at six different levels: 0%, 10%, 20%, 30%, 40%, and 50%, respectively. One of the first things to note is that some expenses like the cost of stock (₦1520), veterinary services (₦228.64), labour (₦2284.64), and utilities (₦297.20) stayed constant across all feed levels. However, feed cost—which forms a huge part of poultry production expenses—showed a noticeable decline as CSRLM inclusion increased. Feed cost dropped from ₦2680.08 at 0% inclusion to ₦2190.88 at 50%. This suggests that CSRLM is a cheaper alternative to maize, making the diet more economical (Esonu et al., 2006). Because of the decline in feed cost, the total variable cost also reduced—from ₦7010.56 for birds on 0% CSRLM to ₦6521.36 for those on 50%. This trend supports findings by Tewe and Egbunike (1992), who highlighted the cost-saving benefits of incorporating agro-industrial by-products like cassava waste into poultry diets.

Fixed costs, which include depreciation of equipment and other long-term investments, remained unchanged at ₦182.88. Since these costs are not directly tied to feed formulation, they didn't vary with the levels of CSRLM used (Oladimeji & Abdulsalam, 2014). With the steady drop in feed expenses, it's no surprise that total production cost also decreased—from ₦7193.44 at 0% CSRLM to ₦6704.24 at 50%. That's almost ₦500 in savings per bird, which can make a significant difference in large-scale production (Olomu, 2011). Now here's where the trade-off starts to appear. While cost went down, so did bird weight. Birds on the standard maize diet (0% CSRLM) weighed an average of 1.97 kg, while those on the highest CSRLM diet (50%) averaged just 1.53 kg. This suggests that while CSRLM reduces cost, high levels may compromise growth—likely due to lower digestibility or energy content of the cassava leaf meal (Udedibie & Carlini, 1998).

Gross income followed the weight trend. It declined from ₦11,820 (0% CSRLM) to ₦9180 (50% CSRLM). Since income is often linked to the final live weight of the birds, this drop reflects the impact of reduced body weight at higher CSRLM levels (Adenuga et al., 2020). Despite lower feed costs, net profit was still highest at 0% CSRLM (₦4626.56). It dropped to ₦2475.76 at 50%. However, a slight rise was seen at 20% inclusion (₦3431.44), hinting that moderate use of CSRLM may balance cost-saving and growth performance. The profit per Naira invested dropped steadily from 0.64 to 0.37, while gross margin also declined from ₦4809.44 to ₦2658.64. These profitability indicators show that although higher CSRLM levels cut costs, they don't necessarily result in better returns.

Table 6 evaluates a different formulation ratio (9.5:0.5) of **Cassava Starch Residue and Cassava Leaf Meal**. As in Table 5, this mix is also used to replace maize at varying levels, from 0% to 50%. Costs such as stock, veterinary care, labour, and utilities remained unchanged. However, feed cost dropped more sharply compared to Table 5—from ₦2680.08 at 0% inclusion to ₦1878.00 at 50%. This sharper drop reflects the adjusted feed formulation and suggests greater cost efficiency due to the higher proportion of cassava starch residue (Esonu et al., 2006). Fixed costs remained the same at ₦182.88. Total production cost decreased significantly from ₦7193.44 at 0% to ₦6391.36 at 50% inclusion, saving over ₦800 per bird—more than Table 5's ₦489 savings (Olomu, 2011). Weight dropped from 1.97 kg to 1.42 kg, and gross income declined accordingly from ₦11,820 to ₦8520. The decline was more pronounced than in Table 5, reflecting a greater loss in growth performance possibly due to reduced energy and protein density in the adjusted mix (Udedibie & Carlini, 1998).

Despite lower production costs, net profit declined from ₦4626.56 to ₦2128.64. Interestingly, 20% inclusion had the lowest net profit (₦2473.28), unlike Table 5 where 20% gave a peak. The profit per Naira invested ranged from 0.64 (0%) to 0.33 (50%) (Adenuga et al., 2020). While the 9.5:0.5 mix reduced costs more aggressively, it also resulted in lower weight gains and profits than the 9:1 mix, suggesting a steeper performance trade-off at higher inclusion levels (Tewe & Egbunike, 1992; Oladimeji & Abdulsalam, 2014) These findings reinforce that increasing CSRLM inclusion lowers feed costs and total production costs, but adversely affects broiler final weight and overall profitability (Obika et al., 2019; Eze et al., 2019). A moderate inclusion level, like 20%, seems to offer the best of both worlds—economic feed and decent returns.

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