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Analytical Assessment of Poultry Feed Production in Animal Husbandry

Ekwonwune Emmanuel N[1],Edebatu Dominic C..[2] , Obikwere Fortune[3]

[1,3]Department of Computer Science, Imo State University, Owerri Nigeria
[2]Department of Computer Science, Nnamdi Azikiwe University, Awka, Nigeria.

Abstract
The cost of Poultry feed represents over 70% of the total cost of poultry production in Nigeria and elsewhere in the globe. This has however not reduced interest shown in poultry agriculture in recent times as contributions from this sector have impacted positively on national economy. Efficient formulation regime devoid of inefficient feed production practices is required for poultry husbandry sustainability. This paper aims to make an analytical assessment of poultry feed production in animal husbandry in Nigeria with a view to finding out how each of the examined methods has helped the growth of this all important industry. The objective is to recommend a software that can solve mixing or blending problem facing a poultry farmer while using locally available feed ingredients at his disposal. It is hoped that the choice method shall minimize cost of producing a particular feed without compromising its adequacy as a balanced diet, which will in turn reduce the cost of overall production of poultry birds. The methodology employed in this paper is Structured System Analysis and Design Methodology (SSADM). A top down Software design approach was followed. The expected result included affordable and acceptable poultry feed production modelling system that grants a high return on investment (ROI) to the poultry farmer. The research work shall be useful to the present and upcoming poultry farmers, who would want to take poultry agriculture as an entrepreneur. It would also encourage further research in this area of study.

Key Words: *Modeling, Feed Formulation, Simulation, Returns On Investment, Blending Problem, Ingredients*

1.0 Introduction

There is no gain-saying the fact that poultry as one of the animal husbandry practices in Nigeria provides a good source of income and food of protein origin. This contribution has helped to sustain many families and the poultry agriculture itself as a business. Different farming systems exist under this practice. While some undergo subsistence husbandry, others practice commercial farming. The kind of agricultural practice adopted, sometimes determines how individual farmer chooses to feed his poultry. While some adopt producing own feeds through available local feed ingredients, others buy from the market at a cost.
According to report, feeding cost of poultry bird alone takes about seventy per cent (70%) of the total production cost, which is of major concern to the local farmer (Ghananian Poultry and Products Report, (GPPR), 2011). This calls for concern as it might definitely reduce the supply of poultry meat or increase its cost, inter alia. So there is need for some thinking by way of assessing the feed production methods that could help reduce cost of production, while maintaining standards. From the foregoing, the research notes two major ways of poultry feed production, namely: the manual method associated with the rule of thumb / intuition and the mechanical method associated with the use of computer models.
Thus, the objective of this paper is to make an analytical assessment of the poultry feed mix with a view to developing a software modelling system for blending the poultry feed mix so as to minimize the feeding cost in poultry husbandry in this part of the globe. So, to meet these requirements, this work employs mathematical techniques and computer program to model and analyze the best combination of

locally available feed ingredients that meet the optimum feed requirements for the proper growth of poultry birds.

According to Hooge and Rowland (1978), the availability of quality ingredient at a reasonable cost was the key to successful poultry operations. Dantzing (1951), opined that Linear Programming concept implemented in a computer understandable form constitutes one of the important techniques used in allocating available feed ingredients in lowest-cost broiler feed formulation. However, N.W. Taylor (1965) posits that the development of linear programming and the use of the electronic computer have made a considerable impact on agricultural research in recent years. One important use is in the determination of least-cost feed compounds for livestock.

Therefore, a very good measure must be taken in formulating ration for poultry birds like broiler starter, broiler finisher, chicks, growers and layers, among others so as to ensure optimum use of resources, which can in turn ensure reduction in the total cost of production of a standard ration.

2. Assessing Poultry Feed Formulation Using Manual Methods

So many literatures on this exist. According to poultrymanual.com, there are factors to consider when formulating poultry feed manually. Understanding these factors, it adds, could help one make right decisions for one's poultry birds as poultry feed formulation is a critical aspect in running a sustainable and profitable poultry business. The factors include:

- the nutritional requirements for each particular class of birds (layers, breeders, broilers, etc.)
- the kind of ingredients in the feed,
- the ingredients' nutrient composition and how easy the birds can process it;
- the cost of the ingredients; and
- the availability of the ingredients

the poultry website advised poultry farmers to be accurate in making own feeds as mistakes or inaccuracies after the feed was made be extremely costly, adding that poultry feed formulation is a science, that requires empirical measurements and exact proportions of each ingredient. At the same time, it's also an art in that the person formulating the food has to have an in-depth knowledge about the various ingredients that can be used, and an understanding of the poultry themselves and their feeding requirements.

Thus, some farmers do formulate a food on a "Reduced Cost" basis, which is a formulation process that considers the nutritional needs of flock while also taking into account the raw materials available and their cost. In other words, the reduced cost formulation method will find a way to formulate a feed that fits bird's needs at the lowest price point possible. A mathematical formula is used to derive the amount of ingredients used as part of poultry feed formulation. Poultry feed formulation is a process that requires accuracy at every level of production. However, it can get more complex when multiple ingredients to the formulation is needed.

According to Peter Kamau (2015) of www.nation.co.ke in: "The A-Z of making your own quality chicken feed at home to cut costs," making poultry feeds on the farm is one of the best ways to maintain quality and cut the cost of production as poor quality feeds lead to a slow growth in chickens, low egg production, diseases or even death. He listed the common ingredients to include whole maize, maize germ, cotton seed cake, soya beans, and sunflower or fish meal. In addition, farmers need to add several feed additives (micronutrients, minerals and vitamins) to make sure their chicken have a balanced feed that meets their daily nutrient requirements. This agric farmer believes that depending on the cost of raw material, farmers who make their own feeds at home save between 30 to 50 per cent for every 70kg bag of chicken feed, depending on the source of their raw materials.

2.1 Manual Method Of Formulating Feeds - Pearson Square Method.

In this method, the Digestible Crude Protein (DCP) is the basic nutritional requirement for any feed preparation for all animals and birds. The following are the DCP values for each of the common ingredients used in feed making:

- Whole maize — 8.23%
- Soya bean — 45%
- Fishmeal — 55%
- Maize bran — 7%
- Sunflower /Lime — 35%

Each category of chicken has its nutritional requirement. For example, to make feed for layers, the feed should have at least 18 per cent crude protein, then calculate the percentage of DCP in each of the ingredients to be used to ensure that the total crude protein content is at least 18 per cent.

Thus, making a 70kg bag of feed for layers, a farmer would require the following ingredients:

- 34kg of whole maize
- 12kg of soya
- 8kg of fishmeal
- 10kg of maize bran
- 6kg of lime (as a source of calcium)

To find out if all the above ingredients meet this standard of 18% crude protein, a farmer does a simple calculation as follows:

- Whole maize — 34kg x 8.23 ÷100 = 2.80 %
- Soya — 12kg x 45kg ÷ 100 = 5.40 %
- Fish Meal — 8 kg x 55kg ÷ 100 = 4.40 %
- Lime — 6 kg x 0 kg ÷ 100 = 0.00%
- Total % of crude protein = 13.30%

To get the Total Crude Protein percentage of all these ingredients in a 70kg bag of feed, the farmer should take this crude protein content of the combined ingredients, divide by 70kg and multiply by 100, thus — 13.30 ÷70 ×100 = 19%; this shows that the crude protein content of the above feed formulation is 19%, which is quite adequate for layers.

The table below summarizes the preparation:

Table 1: Manual Feed Formulation of Poultry Birds

Ingredients	Required % DCP	DCP Restrictions for Layers	Requirements for Making a 70Kg of feed for LAYERS	% Calculation of the DCP in each of the ingredients to achieve total DCP of at least 18%
Whole maize	8.23%	18% to 20%	34kg	34kg x 8.23 ÷100 = 2.80 %
Soya bean	45%		12Kg	12kg x 45kg ÷ 100 = 5.40 %
Fish meal	55%		8Kg	8 kg x 55kg ÷ 100 = 4.40 %
Maize bran	7%		10Kg	10 kg x 7kg ÷ 100 = 0.70 %
Lime	35%		6Kg	6 kg x 0 kg ÷ 100 = 0.00%

Total			70Kg	13.3%
Total Digestible Crude Protein (DCP)			13.30% ÷70 ×100 = 19%;	

To ensure the chicken get all they needed nutrients such as vitamins, minerals and amino acids, add necessary additives in their standard quantities.

2.2 MANUAL METHOD OF FORMULATING POULTRY FEED FOR BROILER

Amao (2018) in: www.practicalbusinessideas.com/poultry-feed-formulation-methods-for/ suggested the way to formulate a Poultry Feed For Broiler. He listed the following as major ingredients for the formulation

- Yellow maize: provides vitamin A and carbohydrate.
- White maize provides carbohydrate.
- Rice bran: provides carbohydrate and acts as midlings.
- Wheat offal: provide carbohydrate and act as midlings.
- Guinea corn: provides carbohydrate
- Palm kernel cake: provides lipids, vitamin, proteins
- Coconut cake: provides lipids, vitamins, proteins.
- Bean meal: provides proteins, carbohydrate, lipids.
- Groundnut cake: provides protein, lipids, and vitamins.
- Pigeon pea: provides protein, lipids, and vitamins.
- Bone meal: Provides minerals like calcium and phosphorus.
- Oyster shell and grot: Minerals like calcium and phosphorus.
- Blood meal: Provides protein, minerals like iron and copper.
- Cotton seed meal: Provides protein, carbohydrate, vitamins and lipids.
- Linseed meal: Provides protein, carbohydrate, vitamins and lipids.
- Fish meal: Provides proteins, lipids and vitamins.
- Common salt or salt lick: Provides mineral salts like sodium, iodine, chlorine and so many others.

He emphasized the need for poultry famers to make own feed as 'factory processed or ready made feeds' are too costly. An alternative, more cost effective approach is for one to make own feed for ones chickens. This is done by assembling the various feed ingredients in their right proportions and processing them at a miller's plant. He noted that producing a feed equal in quality to factory processed feeds requires knowledge of the Compounded feed plan indicating the various feed ingredients and their formulation ratio(correct nutritional proportions) for the different stages of development in the chickens. The objective here is to make more profits and spend much less on feeding the birds if one makes own feed.

He further stated various categories of chicken the farmer must take note of while making the feeds as follows:

Layers

- Starter Mash 0-8 weeks
- Grower Mash 9-20 weeks
- Layer mash 20 weeks to end of laying period

Broilers

- Starter Mash 0-5 weeks
- Finisher Mash 6-12 weeks

2.3 Pearson Square Method For Making Broiler Starter Feed – Another Manual Method

- The Pearson Square method as earlier stated relies on the Digestible Crude Protein (DCP) as the basic nutritional Whole maize = 40 kg x 8.23 ÷ 100 = 3.20 kg
- Fish Meal = 12 kg x 55 ÷ 100 = 6.60 kg
- Soya beans = 14 kg x 45 ÷ 100 = 6.30 kg
- Lime = 4 kg x 0 ÷ 100 = 0.00 kg
- (Total crude protein 16.10 kg)

requirement for feed. The most common ingredients used are whole maize, maize germ, cotton seed cake, soya beans, sunflower or fishmeal.

Chickens meant for meat production require feed with a higher content of DCP. From the first to the fourth week, the chicks require feed with a DCP content of between 22 to 24 per cent. From the fourth to the eighth week, the chicks require feed with a protein content of 21 to 22 per cent crude protein. To attain this requirement, farmers can formulate feed using the same method given above.

Thus, to make a 70 kg bags of feed, the right ingredients in the proportions are given below:

To determine if a 70 kg bag of feed has adequate crude protein content for birds meant for meat production, the same method is used: (16. 10 ÷ 70) x 100 = 23 %. The feed given in this example has a total crude protein content of 23% which is adequate to feed chicken in this category. In every 70 kg bag of feed, add 250g of table salt. This is an animal feed formulation method that can be used as a model for other livestock and poultry species.

2.4 Other Manual Method Of Preparing Poultry Feed.

- **Dairyman's Square Method**

According to poultryone.com in "A Guide to Formulating Rations and Making Chicken Feed," Although many people buy their chicken feed, some hobbyists prefer to have control over what goes into the mixture by making their own chicken feed at home. 'Formulating own feed doesn't just give you control, it can also be cheaper.' It said and added that one should understand the nutritional basics required by your backyard chickens needed at a Chicken's Different Stages of Growth.

For example, chicks from 28 days of age and up are fed a "starter ration," which contains high levels of protein (approximately 22 percent) to give the chicks the energy they need to grow and develop properly. From eight weeks of age and up to when they start laying (usually around six months of age), the pullets are fed a grower ration containing about 17 percent protein. Once laying commences, layer ration is fed to them.

It suggested "Dairyman's Square as a a solution for manual formulating own backyard chicken feed, which will help one determine the amount of energy and protein ingredients needed in the feed. The procedure is as follows:

i. Draw a square

ii. In the center of the square, write the protein content desired in the final mixture (such as 20%

iii. At the upper LEFT hand corner write "corn" and its protein content (9%)

iv. At the lower LEFT hand corner, write "supplement" and its protein content (40%)

v. Subtract diagonally across the square (the smaller from the larger) and enter (in the corners) the results on the RIGHT hand side (20-9=11; 40-20=20)

vi. The number at the upper RIGHT hand corner gives the parts of corn, and in the lower RIGHT hand corner you have the parts of supplement needed to make a mixture with 20 percent protein. Thus, 20 parts of corn mixed with 11 parts of supplement gives 31 parts of feed with 20 percent protein.

vii. To convert this to a percentage basis, divide 20 by 31 and multiply the result by 100. The ending result, 64.5 percent, indicated the amount of corn that will be used. The supplement is represented by the remaining percent (35.5). And so…in a 100 pound 20 percent mix, there would be 64.5 pounds of corn and 35.5 pounds of supplement.

The above is one of the simpler ways to compute and balance a poultry ration to figure out how much that is needed of each ingredient. This is show in the figure below.

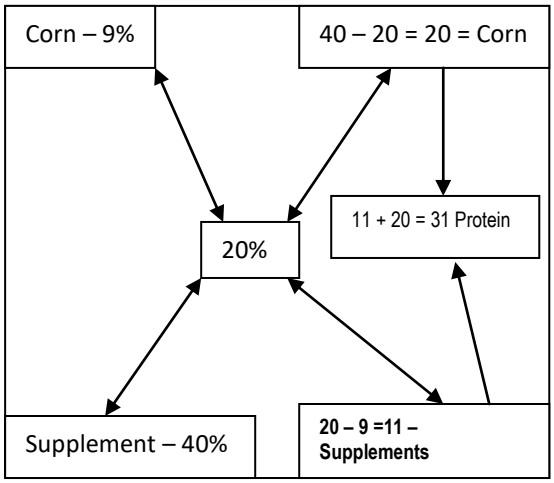

Figure 1 : Dairyman's Square of formulating Poultry Feed Manually

Arcuri (2018) in: "thespruce.com", observed that it takes some equipment and some trial and error to make own feed manually but attributed the interest to greater self-sufficiency and quest for one to know the composition and proportions of the feed fed to own birds. Lauren advised own feed makers to always strike a balance between all the macronutrients (fats, carbohydrates, and protein) and micronutrients (vitamins and enzymes). Some trial and error might come into play.

Arcuri (2018) listed some Equipment Needed to Make Chicken Feed or flour mill or Pulverizer (Grinding Machine) to freshly grind the purchased grains; Sieving Machine; Mixing Machine; Weighing Scale; storage bin; among others.

2.5 Steps For Making Poultry Feed

i. Grind all the materials to a particular mash size

ii. Mix in a rotator mixing machine

iii. Add vitamins and minerals

iv. Mix well, sieve and pack into suitable bags.

Inference

The above scenario describes a situation where an average Nigerian poultry farmer uses intuition, imagination and crude method to mix and produce own poultry feed without recourse to the consequences of his actions or inactions. This has, in most cases, led to losses in revenue, Returns on Investment, high mortality rate of birds, higher product prices, and lower sales leading to lower profits. Age of birds, nutritional adequacy, digestibility and other constraints are usually neglected somehow in this method though this may be a non commercial venture.

3.0 **Weaknesses of The Present System**:

- There is a problem of optimizing cost factor, which depends on constraints associated with the ingredients of the feed, though could be solved by Deterministic Linear Programming Model to be developed in the proposed system,
- Production cost, is normally affected by marginal cost, labour cost, inventory cost, transportation cost, cost of drugs, housing and electricity, feeding cost, etc. An average feed producing farmer has to battle with all these.
- Feedipedia (2018) notes that in developing countries, feed resources available locally are often under-utilized due to lack of information and suggested that providing global knowledge on feed resources, including unconventional and lesser known ones that could contribute to the development and use of innovative and appropriate feeding options and strategies.
- Cisse (2017) observed that using locally produced feedstuffs for poultry production in developing countries can greatly lower production costs but for *increase in corn prices on the world's market due to ethanol production.* However, identifying alternative grains that can replace corn in poultry diets can also make local poultry production more economical.
- Tables of composition and nutritive value are sometimes neglected on some occasions with potential constraints such as presence of anti-nutritional and toxic factors not taken into consideration.

The purpose of this paper therefore is to do quantitative analysis of the poultry feed mix and thus develop a mathematical model for blending the poultry feed mix to minimize the feeding cost in the poultry feed production

4.0 Assessing The Usage Of Computer Software In Feed Formulation (Mechanical Means)

Feed formulation software, like that of Brill in "www.formatsolution.com" is basically a piece of program that helps a poultry farmer with the chemical analysis and finances of poultry feed formulation. Feed mills generally, apply various quality control measures (restrictions) before producing large amounts of feed and distributing it to the market. A poultry feed formulation may be tested in the lab or used in feeding trials to ensure its diet adequacy for the type of chickens it is meant for.

To ensure that poultry feed formulation is both accurate and cost-effective; there is need to measure the chemical composition of each ingredient. A feed formulation package will help give all the data in an easy-to-digest form so that one can make the right decisions for one's flock.

4.1 Data Collection And Analysis

Secondary data were collected from the recommended nutrient requirements' schedule from Nigerian Poultry Farming Regulatory Authority for the study. Feedstuffs used in feed formulation came sampled poultry farms in Nigeria and include maize (x_1), soya bean (x_2), wheat bran (x_3), fish meal (x_4), lysine (x_5), concentrate (x_6), premix (x_7), cotton (x_8), oyster shell (x_9) and methionine (x_{10}).

The Cost implications of feedstuffs and nutrient levels of feed ingredients, constraints imposed on the selection of feedstuffs for broiler feeds and least-cost formulation restrictions on nutrients were also collated. Ten (10) decision variables and eight (8) constraints were identified and used for the modelling for reduced cost rations for broilers as shown in the tables below.

Table 2 shows some feed stuffs, nutrient levels and cost of ingredients from one of the farms – Mike 'M' Farms Nigeria Ltd.

Table 2 : Nutrient Levels of some Feed Ingredients and Cost Implications

Nutrients Ingredients	**Symbol**	**M.E (kcal/kg)**	**Crude Protein (%)**	**Fat (%)**	**Crude Fibre (%)**	**Calcium (%)**	**Phosphorus (%)**	**Lysine (%)**	**Methionine (%)**	**Cost N /Kg**
Maize	X1	3432	8.8	4.0	2.0	0.1	0.34	0.4	0.18	0.70
Soya bean	X2	2557	48	3.5	6.5	0.2	0,37	3.2	0.59	1.40
Wheat bran	X3	3153	13	0	5.1	0.05	1.20	0.5	0.42	2.00
Fish meal	X4	2950	60	4.5	1.0	6.5	3.5	4.5	1.8	1.80
Lysine	X5	0	95	0	0	0	0	100	0	7.0
Concentrate	X6	1260	12	0.25	4.75	1.50	1.50	0.2	0.15	2.60
Premix	X7	0	0	0	0	0	0	0	0	3.00
Cotton	X8	2350	39.6	0	00	0.15	0.48	62.8	71.9	1.40
Oyster shell	X9	0	0	0	0	38	0	0	0	0.24
Methionine	X10	0	0	0	0	0	0	0	10	5.00

Table 3: **Broiler Feeds Formulation Constraints**

Nutrients	**Variables**	**Broiler Starter**		**Broiler Finisher**		**Cost formulation restrictions**	
		Minimum level	**Maximum level**	**Minimum level**	**Maximum level**	**Starter /1000kg**	**Finisher /1000kg**
Crude Protein **(%)**	X1	23	-	18	-	≤ 23	≤ 21
ME (Kcal/kg)	X2	2800	3200	3200	3400	$\leq$ 2800	$\leq$ 3200
Calcium **(%)**	X3	10	15	10	25	≥ 1.5	$\leq$ 1.5
Phosphorus **(%)**	X4	45	-	55	-	≤ 0.45	$\leq$ 0.45
Fat **(%)**	X5	-	50	-	60	$\geq$ 5.0	≥ 6.0
Crude fibre **(%)**	X6	-	50	-	50	$\geq$ 5.0	$\geq$5.0
Lysine **(%)**	X7	11	-	11	-	$\leq$ 1.15	$\leq$ 1.15
Methionine	X8	5	-	5	-	≤ 0.5	$\leq$ 0. 5

(%)							

4.2 Modelling Of Poultry Feed Production Based On Field Data on A Reduced Cost Basis

Based on the collected field data Table 4, where prices of feed nutrients and ingredients were gather for analysis and model farm statistics (tables 2 and 3), the research implements the cost reduction software in poultry feed production.

Table 4 : Cost Of Feed Nutrients For Ten Sampled Poultry Feed Farms In Nigeria

Feedstufffs	**Coy 1**	**Coy 2**	**Coy 3**	**Coy 4**	**Coy 5**	**Coy 6**	**Coy 7**	**Coy 8**	**Coy 9**	**Coy 10**
Maize	0.70	0.50	0.70	1.00	0.80	0.40	2.00	0.60	0.90	1.90
Soy Bean	1.40	2.00	2.10	1.90	2.10	1.50	2.10	0.90	1.80	1.70
Wheat bran	2.00	2.20	2.90	2.30	2.20	6.30	3.90	1.80	4.30	4.20
Fish meal	1.80	1.90	1.80	1.60	1.80	1.20	0.90	0.50	1.60	1.80
Lysine	7.00	8.10	7.90	6.50	7.70	3.20	2.60	2.30	3.10	3.40
Concentrate	2.60	3.00	2.80	2.50	2.30	1.60	1.50	1.60	1.80	1.90
Premix	3.00	2.90	2.40	2.80	2.90	7.00	6.40	5.90	7.10	6.90
Cotton	1.40	2.10	1.80	1.20	1.90	2.60	2.40	2.50	2.60	2.20
Oyster shell	0.24	0.50	0.40	0.30	0.26	3.40	2.90	2.90	3.00	2.90
Methionine	5.00	6.00	6.50	5.20	5.30	0.80	0.50	1.00	0.80	0.70
Bone meal	6.80	2.40	1.50	2.60	3.10	1.40	6.20	2.40	1.80	3.60
Stock lime	2.00	1.10	4.60	3.10	2.40	2.20	3.00	1.50	2.90	3.20

Based on the field work and the data table above, we obtain standard cost named: "**Beta Data Coefficient**" using **SPSS** techniques. It is this Beta Data that is used for the Modeling.

Table 5 : Standardized Data Coefficients (Standard Data) using SPSS*

		Unstandardized Coefficients		**Standardized Coefficients**	t	Sig.
Model		B	Std. Error	**Beta**	B	Std. Error
1	(Constant)	9.134	1.186		7.703	.082
	Coy1	4.262	.378	**2.660**	11.283	.056
	Coy2	-8.322	1.923	**-5.125**	-4.328	.145
	Coy3	1.540	1.243	**.974**	1.239	.432
	Coy4	-.142	1.550	**-.069**	-.092	.942
	Coy5	3.332	2.042	**1.845**	1.632	.350
	Coy6	2.428	.881	**1.405**	2.756	.222
	Coy7	-3.540	.975	**-1.817**	-3.631	.171
	Coy8	5.844	.827	**2.363**	7.070	.089
	Coy9	-1.079	1.085	**-.515**	-.994	.502
	Coy10	-3.600	.805	**-1.607**	-4.474	.140

Note: Nutrients are the Dependent Variables here.

It is the Beta Data that the researcher used to model the prices to produce a software called **"Poultry Feed Formulation Modelling System (PolySoft)."** Modellings were done for:

i. Chicks grower feed ration (Broiler Finisher)

ii. Chicks layer feed ration (Layer)

iii. Chicks broiler feed ration (Broiler Starter)

iv. Broiler feed production cost reduction

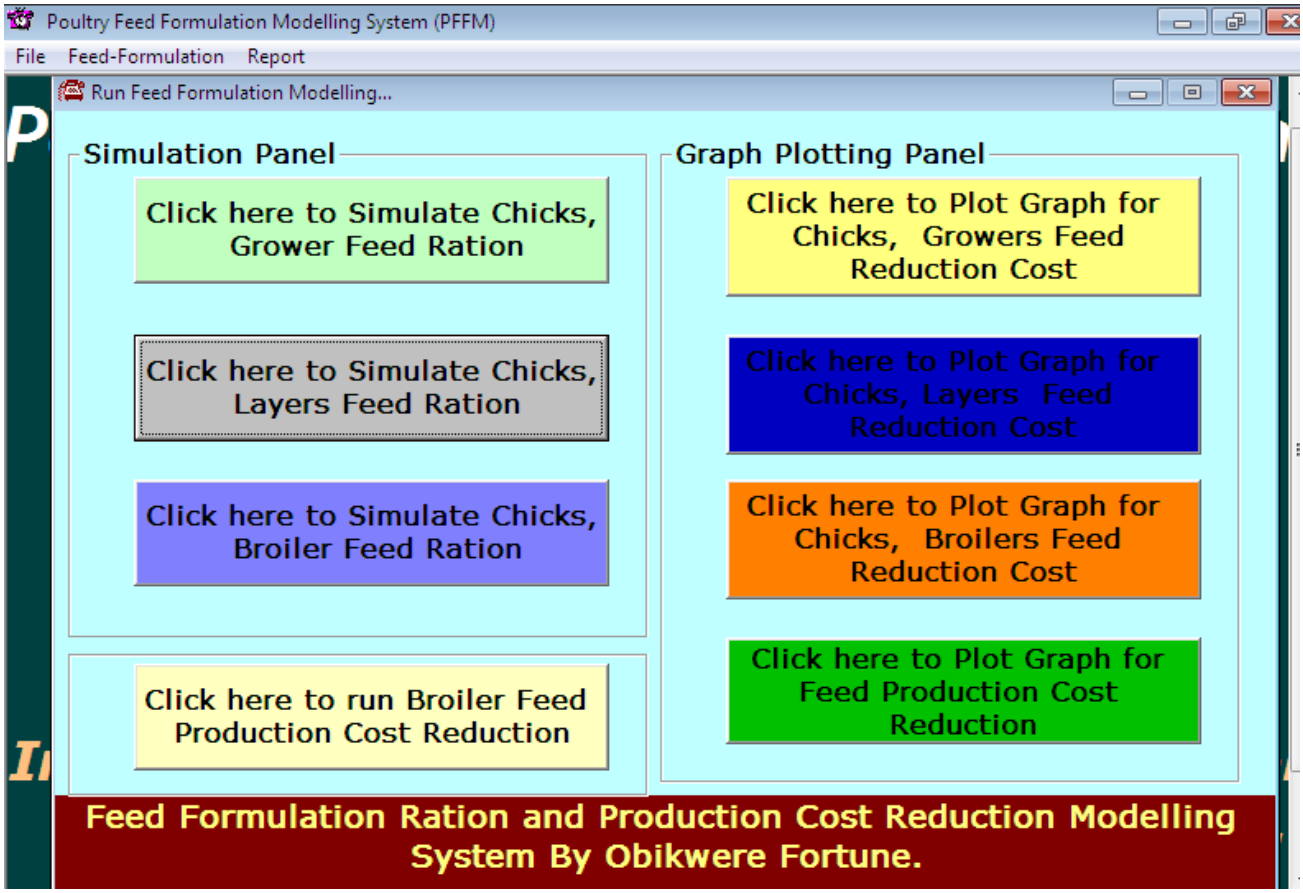

Figure 2 : Poultry Feed Formulation Modelling System

Table 6 : Growers' Feed Formulation Modelling

Growers Feed Formulation Modelling:

Feed Ration Modelling from (X1 - X10).

Nutr	Cost	Crudp%	Fat%	CrudeF%	Calc%	Phosp%	Lysine%	Methi%	Me%
X1	0.26	1.4	1.72	1.17	0.68	0.41	1.17	1.77	5819
X2	18.18	0.17	1.63	0.06	1.85	1.74	0.16	0.09	488
X3	11.26	2.67	0.92	1.03	1.32	1.39	0.71	1.03	7660
X4	18.26	0.44	1.6	0.85	1.58	1.74	1.68	0.05	5678
X5	12.06	1.03	1.71	2.46	1.14	1.3	0.88	0.02	845
X6	7.1	1.33	0.57	1.92	1.48	0.76	1.29	0.86	4302
X7	10.36	1.33	0.15	1.31	1.78	1.48	1.2	0.03	9285
X8	13.27	2.29	0.27	1.63	0.88	0.15	0.69	1.75	9426
X9	19.38	1.43	0.19	1.74	1.59	0.58	2.16	1.82	9069
X10	2.63	0.07	0.53	0.85	1.43	1.21	1.58	2	1582

Table 7 : Growers' Feed Formulation Modelling – Cost Reduction Table

Feed Cost Reduction.

VQTY	UCost	iTCost	IvQty	TCost	Reduction Cost
1.4	0.26	0.37	4.29	0.11	-0.26
0.17	18.18	3.11	1.87	31.64	28.53
2.67	11.26	30.02	4.61	15.63	-14.39
0.44	18.26	8.1	2.9	31.7	23.6
1.03	12.06	12.39	5.2	15.74	3.34
1.33	7.1	9.46	3.82	5.43	-4.03
1.33	10.36	13.82	2.8	15.31	1.49
2.29	13.27	30.38	4.19	1.97	-28.41
1.43	19.38	27.79	3.36	11.33	-16.46
0.07	2.63	0.18	1.45	3.18	3

Total Grower Feed Reduction Cost: 3.59

Statistical Grower Feed Ration Indices.

X1 = Yellow Corn / Maize Quantity
X2 = Soya Bean Quantity
X3 = Fish Meal Quantity
X4 = Bone Meal Quantity
X5 = Wheat Offal Quantity
X6 = Palm Kernal Cake Quantity
X7 = Methionine Quantity
X8 = Lime Stone Quantity
X9 = Lysine Quantity
X10 = Premix Quantity

Table 8 : Broilers' Feed Formulation Modelling

Broilers Feed Formulation Modelling:

Broilers Feed Ration Modelling from (X1 - X10).

Nutr	Cost	Crudp%	Fat%	CrudeF%	Calc%	Phosp%	Lysine%	Methi%	Me%
X1	10.15	1.42	1.22	0.99	1.43	0.92	0.28	1.74	8379
X2	4	0.07	0.27	2.24	0.28	1.96	1.36	0.97	2841
X3	4.67	0.5	1.77	1.23	1.96	0.09	1.84	1.93	8643
X4	10.34	1.39	1.46	0.97	1.72	1.23	0.26	2	8263
X5	4.67	2.32	0.92	1.72	1.27	0.14	1.59	1.58	5800
X6	17.62	1.85	0.82	2.45	1.1	1.44	0.74	0.9	3220
X7	10.34	0.96	1.5	0.59	0.8	1.77	2.07	0.49	3957
X8	6.54	0.04	0.51	2.22	0.57	0.19	1.34	1.23	2725
X9	5.34	1.86	1.19	1.34	0.34	0.69	2.01	1.92	1493
X10	4.14	0.97	1.87	0.47	0.12	1.18	0.46	0.81	262

Table 9 : Broilers' Feed Formulation Modelling – Cost Reduction Table

Feed Cost Reduction.

VQTY	UCost	iTCost	lvQty	TCost	Redu
1.42	10.15	14.43	3.64	9.32	-5.11
0.07	4	0.29	2.59	7.84	7.55
0.5	4.67	2.34	3.49	0.44	-1.9
1.39	10.34	14.41	3.82	12.71	-1.7
2.32	4.67	10.83	4.95	0.66	-10.1
1.85	17.62	32.6	5.12	25.44	-7.16
0.96	10.34	9.94	3.05	18.33	8.39
0.04	6.54	0.29	2.77	1.24	0.95
1.86	5.34	9.91	4.39	3.66	-6.25
0.97	4.14	4	3.3	4.89	0.89

Total Broilers Feed Reduction Cost: 14.49

From Table 6 to 9, it was discovered that the Poultry Feed Formulation Software was able to adjust various quantities of the feed ingredients and their nutrients to a balanced proportion. In addition, this model reduces the feed cost by almost N31.03.the program also to various amounts N3.59 for Grower and N14.49 for Broiler.

4.4 Comparing The Model With Existing/Old Practice

The existing practices for both Grower and Broiler Feeds were compared with the New model for both starter types of birds to see which one is more cost effective. The results were recorded in tables 10 and 11 below.

Table 10 : Growers' Feed Formulation Modelling – Cost Reduction Table

Feed Cost Reduction.

VQTY	UCost	iTCost	IvQty	TCost	Reduction Cost
1.4	0.26	0.37	4.29	0.11	-0.26
0.17	18.18	3.11	1.87	31.64	28.53
2.67	11.26	30.02	4.61	15.63	-14.39
0.44	18.26	8.1	2.9	31.7	23.6
1.03	12.06	12.39	5.2	15.74	3.34
1.33	7.1	9.46	3.82	5.43	-4.03
1.33	10.36	13.82	2.8	15.31	1.49
2.29	13.27	30.38	4.19	1.97	-28.41
1.43	19.38	27.79	3.36	11.33	-16.46
0.07	2.63	0.18	1.45	3.18	3
Total		**N135.61**		**N132.04**	**N3.57**

In Table 10 above, it was observed that the cost of producing Grower feed was N135.61/Kg using the existing or old practice of the farm compared with the N132.04, if feed formulation was based on the proposed model, giving a total reduction of N3.57. This gives a substantial savings of about 2.64%. Obviously feed formulation is more cost effective when based on valid Feed Production or formulation model.

Table 11 : Broilers' Feed Formulation Modelling – Cost Reduction Table

Feed Cost Reduction.

VQTY	UCost	iTCost	IvQty	TCost	Redu
1.42	10.15	14.43	3.64	9.32	-5.11
0.07	4	0.29	2.59	7.84	7.55
0.5	4.67	2.34	3.49	0.44	-1.9
1.39	10.34	14.41	3.82	12.71	-1.7
2.32	4.67	10.83	4.95	0.66	-10.1
1.85	17.62	32.6	5.12	25.44	-7.16
0.96	10.34	9.94	3.05	18.33	8.39
0.04	6.54	0.29	2.77	1.24	0.95
1.86	5.34	9.91	4.39	3.66	-6.25
0.97	4.14	4	3.3	4.89	0.89
Total		**N99.04**		**N84.53**	**N10.51**

Similarly, Table 11 shows that the cost of producing broiler feed is N99.04 using the existing or old practice of the farm compared with the N84.53, if feed formulation is based on the proposed model, giving a total reduction of N10.51. This results in substantial savings of about 1.47%. Thus, Feed formulation is more cost-effective than the existing farm practice.

Furthermore, the formulation system produced by the software model showed that the feeds meet all the nutritional requirements needed for the specified poultry birds. This is in addition to the reduced cost of production per Kg.

5.0 High Level Model Of The Proposed System

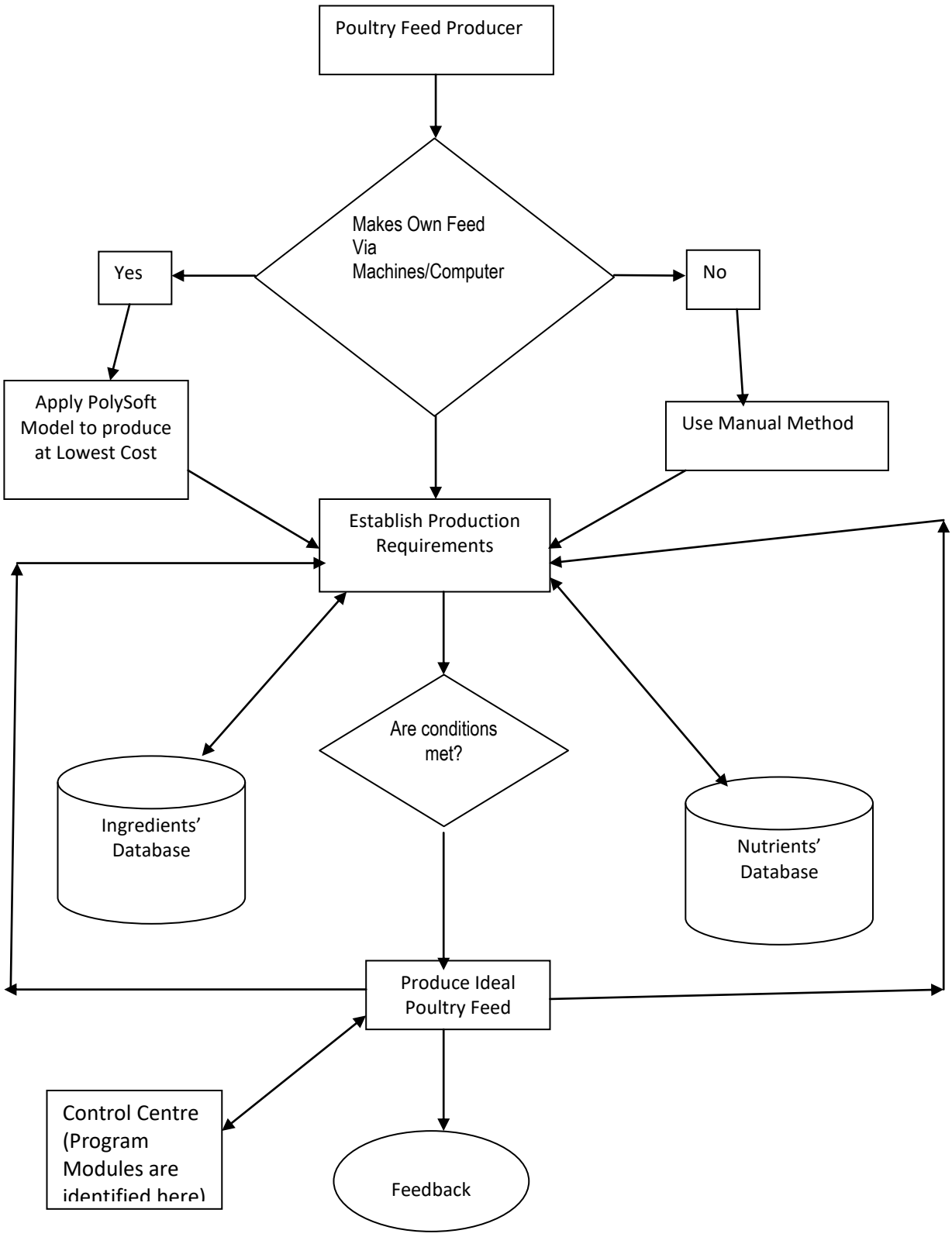

Fig. 3.1 High Level Model of the new System

6.0 Overall Data Flow Chart Of The Proposed System

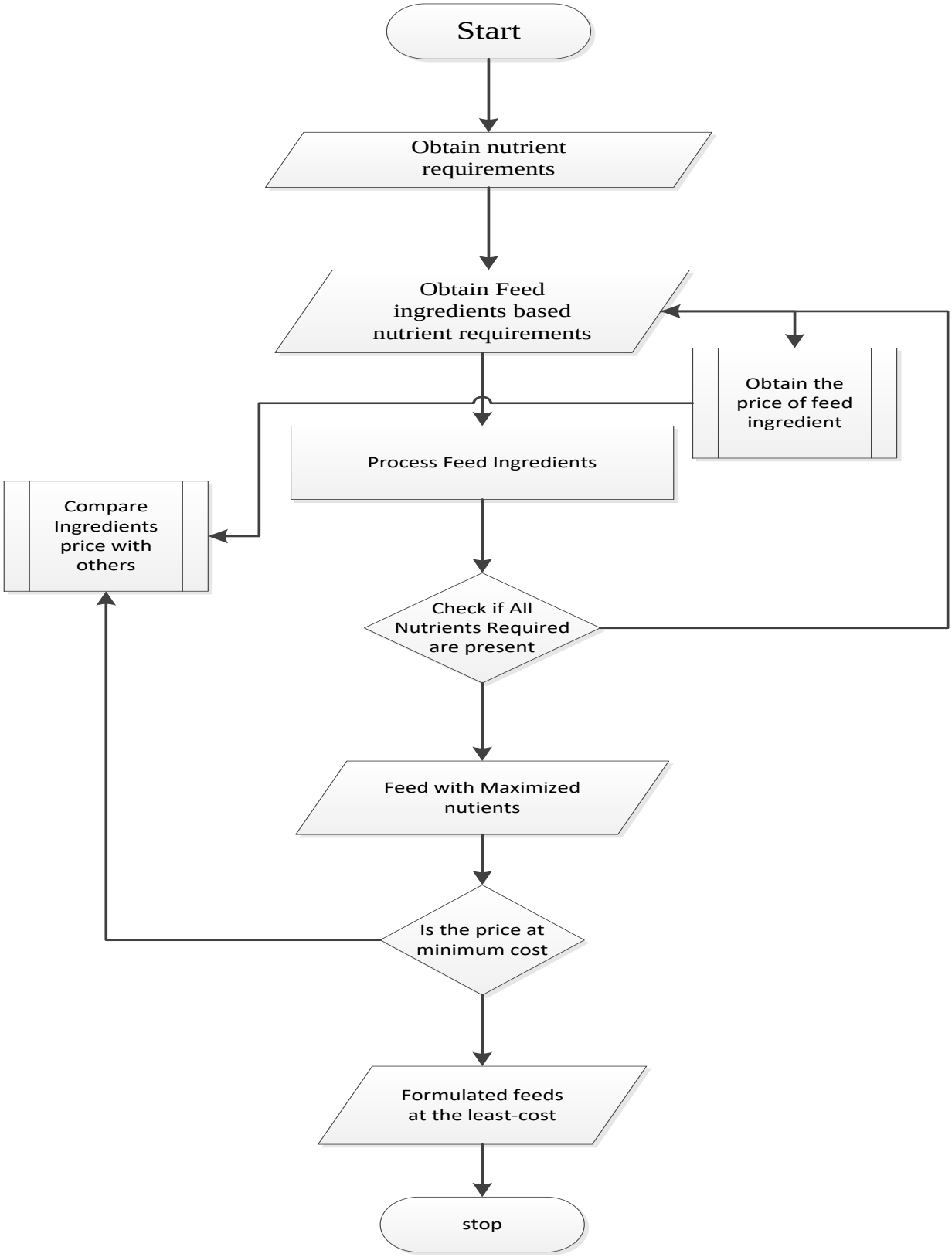

Figure 3.2: Overall Structure of the Present System

6.0 Conclusion

Chicken diets are primarily made up of macro ingredients such as cereal grains (e.g. wheat, barley and sorghum); oilseed meals (such as soya bean or canola meal) and animal by-product meals, among others. Cereal grains make up between 60-70% of the diet and are the major source of energy in the feed. When in a balanced state, it becomes the amount of feed that will supply the proper amount and proportions of nutrients needed for the birds to perform a specific purpose such as growth, maintenance, and reproduction.

In formulating poultry feeds, one engages in the process through which the ingredients in the feed come together in order to form a complete diet. Here, the farmer ensures that the diet the poultry eats meets all of the nutritional requirements to keep them alive and well – and to ensure the highest possible quality of the poultry products made (poultrymanual.com).

In developing software as done in this work, a balance was sought to make cost-effective mixtures (at a reduced cost). The developed program called ***"Poultry Formulation Modelling System"*** was able to do just that. It is hoped that agric entrepreneurs, especially poultry feed manufacturing farms would find it useful. In addition, an average poultry farmer can also find the software beneficial in making own feeds at a reduced cost, which invariably would impact positively on the prices of poultry by-products in the market.

Finally, the work made a detailed analysis of methods adopted in poultry feed production and discovered that using a poultry modelling system was better compared with the existing or old practice. This is because developed software was able to combine poultry feeds in a balanced proportion of the ingredients and nutrients involved - at a reduced cost. It is therefore recommended that it be used by average poultry farmer in making feeds.

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