Using linear programming model for production of Eggs (designed for reflecting various feedstuff combination) Iraq – Erbiel

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Keywords
Linear programming model, production of eggs, different stages of rearing, Kurdistan region, local feed stuff, minimizing the cost .

Abstract
This study aimed to formulate a linear programming model for production of eggs at different stages of rearing and production periods using local feed ingredients , the main Goal of the study is to reduce the cost . We construct a mathematical model were designed to reflect various feedstuff combination used in the diet formulation by taking into consideration nutrient requirements and the variables of this model is the feed ingredients were used(protean, carbohydrate, fat, minerals, vitamin's, Soya oil, corn, barley, wheat brain, salt, limestone, phosphate, vitamin/mineral complex and calcium) . The objective function of the model was to minimize the total cost production of producing a particular diet after satisfying a set of constraints at market price we used Kurdistan region north of Iraq for this study, the result which found to reduce cost of feeding by as much as between (300 to 500) $/ton than those imposed on the produced by the market.
The variation in the cost is a result of the variation in the nutrient requirements of the laying hens according to the stage of production, each stage required a certain level of combined nutrients' in the feedstuff which it cause different quantities of feedstuff to be used in each ration.

Introduction
Eggs production in layer is the major concern, as it constitutes bulk of total revenues generated, and which is reported by (Chung et al 1983 and Farooqet 2001) that there is a significant and positive association of net profit with number of eggs production in layers production enterprise. generally speaking, the major problem with poultry production can be streamlined to feeds in all its ramifications (David – West 1989) reported that feed costs represent between 60% to 80% of total cost of producing various livestock product.

Feed formulation is the process of quantifying the amounts of feed ingredients that need to be put together to form a single uniform mixture for poultry that supplies all of their nutrient requirements. It is important that returns are maximized through use of adequate mixture. Feed formulation is a central operation in poultry production, ensuring that feed ingredients are economically used for optimum growth of chicken. It requires a good knowledge of poultry and feed ingredients. Most large scale poultry farmers depend on commercial feed mills for their feeds, to obviate the need to do their own formulation or feed preparation. It is therefore essential that formulation are accurate, to ensure a large number of swarms are not adversely affected (Chung et 1983) .

The problem of least cost ration formulation in poultry can be effectively managed through using linear programming model technique. but least cost feed has been defined by (Patrick and Schaible 1980) as the lowest – cost formula that contains all the nutritional elements needed for maximum performance .

Linear programming is a computational method of selecting, allocating and evaluating limited resources with linear, algebraic constraints to obtain an optimal solution for a linear, algebraic objective function. They are used in administrative and economic planning to maximize the linear functions of a large number of variables, subject to certain constraints. (Patrick and Schaible 1980) stated that linear programming is technically a mathematical procedure for obtaining a value - weighting solution to a set of simultaneous equations.

Linear programming was first put into significant use during World War II when it was used to determine the most effective way of deploying troops, ammunitions, machineries which were all scarce

resources. There are hundreds of applications of linear programming to subjects ranging from the familiar cases in industry, military, agriculture, economics ….. etc. even reported that linear programming has been applied to marriage problem and the optimum solution show that monogamy is the best type of marriage (Hamday Taha). (Olorunfemi et 2001) reviewed extensively the use of linear programming in least – cost ration formulation for aquaculture and he applied Linear Programming model into duckweed utilization in least cost feed formulation for broiler starter 2006 .

(Kuester and Mize 1973), reported that linear programming is a technique for optimization of a linear objective function, subject to linear equality and inequality constraints. Linear programming is the one of the most important technique to allocate the available feedstuffs in a least cost broiler ration formulation. The egg production in Kurdistan has been widely founded as a full – scale agribusiness there are more than 900 project for production of broiler in the region .

This study aimed at using the linear programming technique to formulate least cost balance ration for eggs layers at different stages of life period using local feed ingredients to minimize the total cost of production in Kurdistan.

Sources and Analysis of data collection

Egg production in Kurdistan region is approaching the rate of (700) million eggs per year, the Ministry of Agriculture and Water Resources Regional Government of Kurdistan said the ministry has allocated nearly 3 billion ID to support the poultry projects in the region, which has a number of (983) projects poultry, some projects for the production of chicken meat and (28) projects for hatching and others, the preparation of these projects continues to increase and that of egg production, a rat more than the citizens of the region needs .

This study is concerned with feed formulation (Data collection for this study was based on raw material (feedstuffs) specification, constraints imposed on the selected raw materials and the dietary nutrient requirements in each stage of life of eggs laying flocks. The main sources for these data was the National Research Council, Nutrient Requirement of Poultry became available in March 1994. The objective of this publication is to provide a reference point for nutrient requirement of the various class of poultry and to provide authoritative information on nutrient content of feed ingredient. Cost of raw materials used in the diet formulation were obtained from the prevailing market prices of feedstuffs in Kurdistan through survey, and some data sources to achieve the study objectives from the Ministry of Agriculture and Water Resources Regional Government of Kurdistan (department of statistics). Proximate constituents, limiting amino acids, calcium and phosphorus contents, minimum and maximum dietary inclusion levels of various feedstuffs used in diet formulation were obtained from standard tables and sources Aletor, 1986; Aduku, 1993; Tacon, 1993; NRC 1994 .

The recommended nutritional and restriction levels of the Metabolizable Energy (ME), of feed stuffs for diets were calculated by converting the gross energy using the following equation as described by Miller and Payne 1959.

$$ME = (GE\ g^{-1} \times 0.95) - (N\% \times 0.075)$$

Where : GE, gross energy

N% , Dietary Nitrogen Percent

We used linear programming model and techniques to analyze the data in this study. The objective function of this study was to minimize the cost ration of eggs, and the model designed to reflect various feedstuff combination used in the diet formulation at current price and range of inclusion to obtain a least cost ration for eggs layers according to the available raw material in Kurdistan Iraq, the model were constructed according to the stage of hens life period.

Feedstuff and Nutrient Requirement

Chicks require a diet that can provide the nutrient needed for rapid growth and feather development. Chicks are given relatively high levels of energy, protein, and Vitamins and Minerals for the starter period. Once the Chicks are fully feathered their energy requirement are reduced. Feeding management for layer pullets aim to maintain a growth rate that will lead to the pullet reaching sexual

maturity at the desired age while avoiding obesity . The stage at which a pullet will start laying eggs is affected by age, bodyweight and day length .

The aim of layer diet is to optimize egg production, provide the nutrient required to safeguard health and maintain the desired bodyweight. This can be in term of egg number, egg size, or egg mass. As with layer pullet, different breeders recommend different feeding strategies for their birds, including the number of different diet fed during the laying stage. Calcium is increased in the ration for egg shell formation .

Feedstuffs is divided to two types :

1- Feed material source of energy: such as grain and the grain industry and waste fats and oils.

2- Feed material source of protein: such as plant - sources of animal protein - and yeast as well as minerals and vitamins.

Poultry feed consists

Poultry feed consists of (Protein, carbohydrates, fats, minerals, vitamins, water. Where different ratios of these elements in poultry feed depending on a variety of factors :-

1- Carbohydrates.

Carbohydrates found in yellow or white corn, sorghum, or in the remnants of racquets and grinders are very important for chickens to get them on energy and composition of the fat in the egg yolk and the worms movement of the intestines.

2- Mineral salts.

Important ingredients in poultry feed, especially laying hens, accounting for 3.4% of the weight of the bird and about 10% of the weight of the egg, as they represent 40% of the bone consisting mainly of calcium and phosphorus, and referred to the proportion of salt in the diet ashes.

3- yellow corn.

Major component in the diets of poultry and up to 75% in diets containing 7.7 - 9% protein, the fat around 3.1%, fiber 2% and has prefixes vitamin A beta-carotene, which turns into vitamin A in the body and in recent times have been developed strains of corn content of high-fat 6-7% and lysine and protein due to the large size of embryo corn.

Analyzing the model

To analysis the linear programming model, The objective of the models was to minimize cost production for a particular diet by satisfying a set of constraints, the variables in this model were the ingredients while the cost of each ingredient and the nutrient value of each ingredient was parameter.

Feed stuff used in ration formulation for local farms and feed factories and the following feedstuff (variables) which is used in this study are (wheat bran, cotton seeds, yellow corn, barley, soy bean, vitamin, mineral complex, concentrate, salt, limestone, methionine, di calcium, phosphate) the model which is designed to reflect the feedstuff as follow :-

Objective function is to minimize the cost.

Subject to feedstuff as a constraints .

$$\text{Minimum } Z = \sum_j CjXj$$

Subject to :

$$\sum aijXj \leq = \geq Bi$$

$$X_1, X_2, \ldots, X_n \geq 0$$

Where :

Xj , j =1,2….13 (ingredient quantities)

aij = technical coefficient of nutrient components in feed stuff

bi = the ration raw material availability (nutrient)

Cij= ingredient cost

Zj = total cost of Ration

(a_{ij}, b_i and C_j are given constants and X_j are the decision variable). From the above format (Kuester and Mize, 1973), we are seeking the values of the X_j which will optimize (maximize or minimize) the objective function, Z.

The number of unknowns is usually greater than number of equations (n> m). Taha . H 1987

Stated that by setting (n- m) variables to zero the unique solution are called basic solution, if a basic solution satisfies the nonnegative restrictions, it is called feasible basic solution . He also stated that variables set equal to zero are called non basic variables while the remaining ones are called basic variables. Each basic solution is usually associated with an iteration.

The following tables summarized the data on typical nutrient levels for layer diets for the growing and laying periods. As well the cost implications of raw material level of feed ingredients restrictions imposed on selected feed stuff by linear programming model for laying diets for growing and laying period (the weight is 1000 gk).

Age in weeks Weight Nutrient consumed gm/day	Unit	0 to 6 Weeks; 450 g[a]2,850[b]	6 to 12 Weeks; 980 g[a]2,850[b]	12 to 18 Weeks; 1,375 g[a]2,900[b]	18 Weeks to First Egg; 1,475 g[a]2,900[b]
Crude protein	%	18.00	16.00	15.00	17.00
Lysine	%	0.85	0.60	0.45	0.52
Methionine	%	0.30	0.25	0.20	0.22
Methionine + cysteine	%	0.62	0.52	0.42	0.47
Valine	%	0.62	0.52	0.41	0.46
Linoleic acid	%	1.00	*1.00*	*1.00*	*1.00*
Calcium	%	0.90	0.80	0.80	2.00
Nonphytate phosphorus	%	0.40	0.35	0.30	0.32
Potassium	%	*0.25*	*0.25*	*0.25*	*0.25*
Sodium	%	0.15	0.15	0.15	0.15
Crude Fiber	%	4.000	5.000	5.500	4.500
Fat	%	*4.0*	*3.5*	*3.5*	*3.0*
NaCl	%	0.18	0.18	0.18	0.18

Table 1: Layer Nutrient Requirements for the growing and laying periods :- Sources : NRC 1994

Nutrient	Unit	80[a,b]	100[a,b]	120[a,b]
Crude protein	%	18.8	15.0	12.5
Lucien	%	*1.03*	*0.82*	*0.68*
Lysine	%	0.86	0.69	0.58
Methionine	%	0.38	0.30	0.25
Methionine + cysteine	%	0.73	0.58	0.48
Phenylalanine	%	*0.59*	*0.47*	*0.39*
Phenylalanine + tyrosine	%	*1.04*	*0.83*	*0.69*
Threonine	%	*0.59*	*0.47*	*0.39*
Valine	%	*0.88*	*0.70*	*0.58*
Linoleic acid	%	1.25	1.0	0.83
Calcium	%	4.06	3.25	2.71
Potassium	%	0.19	0.15	0.13
Sodium	%	0.19	0.15	0.13
Crude fiber	%	4.5	4.5	5.5
Fat	%	3,750	3,000	2,500
Na Cl	%	0.18	0.18	0.18

Table 2: Nutrient Requirements of Laying Hens as Percentages or Units per Kilogram of Diet (80, 100, 120) gms/day sources : NRC 1994

Ingredient %	Cost ID	Cp	fat	crude Fiber	Ca	P	lysine	Methionine	Linoleic acid	Me
Yellow corn	660	8.8	4.0	2.0	0.01	0.09	0.25	0.09	0 .022	343
Soybean	820	44.0	3.5	6.5	0.20	0.20	2.5	0.6	0.40	273
Wheat bran	375	15.9	0	10.5	0.04	1.15	0.6	0.24	1.74	186
Cotton seeds	300	45.0	6.0	2.0	0.2	0.16	0.90	0.2		277
Fisher meal	1200	65.	4.5	1.0	6.1	3.0	4.5	1.8		2860
Concentrate	600	65	4.5	1	5.5	3.0	4.5	1.5		1680
Premix(vit/miner	2500						0.5	0.7		
al) Lysine	1500	60					1.0			
Limestone	1000				38					
Soy oil	1400		98							3430
Methionine	6000	60						1.0		
Calcium	1600				21	19				
phosphor	250									
Salt										

Table 3: cost of raw materials and nutrient levels of feed ingredients for growing laying period 1 US$ = 1220 ID

Nutrient	Maximum	Minimum
Crude protein	185	125
Fat	40	30
Crud Fiber	50	30
Calcium (kg)	9.5	3.5
Phosphor (kg)	4.0	3.5
Lysine	8.5	4.5
Methionine +	4.5	2.5
Cysteine	8.5	5.5
Linoleic acid	15	8.5
Mineral (kg)	2.5	2.5
Na Cl (kg)	3	3

Table 4: Constraints imposed on the selection of feedstuffs by computerized linear programming(maximum and minim um) for growing and laying periods and consumption : Sources :NRC 1994 : weights = 1000 kg

1 kg of premix contains ; 600,000 IU vitamin A 100,000 Iu , vitamin D3 1850 mg, vitamin E 160 mg ,vitamin B1 480 mg , ,vitamin B2 500 mg , ,vitamin B6 2000 mg ,vitamin B12 200 mg , ,vitamin K3 , 2800 mg , nicotinic acid 1000 mg Ca pantothenic. 60 mg folic acid , 10000 mg biotin,80000 mg cholinchlorid ,

The variables in these models were ingredients staff while the cost of each ingredient and the nutrient value of each ingredient was the parameter.

We define the variables as follows: X1= yellow corn, X2 = soybean, X3 = wheat bran, X4 =cottonseeds, X5 = fish meal, X6 = concentrate, X7 = premix (vitamin, X8 = lysine, X9 = Limestone, X10 = soy oil, X11 = Methionine, X12= Calcium Phosphor, X13 = salt

The mathematical model construction for birds in deferent stage (0-6, 6-12, 12-18, 18-) and feed consumption (80 gm/day, 100 gm/day, 120 gm/day) as follow :

Min Z = 600X1 + 820X2 + 375X3 + 300X4 + 1200X5 + 600X6 + 2500X7 + 1500X8 + 1000X9 + 1400X10 + 6000X11 + 1600X12 + 250X13

Subject to :

X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 + X10 + X11 + X12 + X13 = 1000

0.088X1 + 0.44X2 + 0.159 X3+ 0.045X4 + 0.065X5+ 0.65X6 + 0.60X8 + 0.60X11 ≥ 185 cp

0 .04X1 + 0.035X2 + 0.06X6 + 0.980X10 ≤ 40 fat

0.02X1 + 0.065X2 +0.105X3 + 0.2X4 + 0.001X5 ≤ 50 c f
0.0001X1 + 0.002X2 + 0.0004X3 + 0.002X4 + 0.061X5 + 0.055X6 + 0.38X9 + 0.21X12 ≥ 9.5 ca
0.0009X1 + 0.002 X2 + 0.0115 X3 + 0.0014X4 + 0.03 X5 + 0.03X6 + 0.21X12 ≥ 4.0 phosphor
0.0025X1 + 0.025 X2 + 0.006X3 + 0.009X4 + 0.045X5 + 0.045X6 + 0.005 X7 ≥ 8.5 lysine
0.0009X1 + 0.006 X2 + 0.024X3 + 0.002X4 + 0.018 X5 + 0.07 X7 + X8 ≥ 4.5 methionine
0.0022X1 + 0.004X2 + 0.0174X3 + X11 ≥ 9.5
3.43X1 + 2.73 X2 + 1.86X3 + 1.97X4 + 2.86X5 + 3.43 X11 ≥2850 ME
X7 = 2.5 minerals
X13 = 3 salt

X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X13 >= 0

The same model is been used for birds of age 6-12 , 12-18 , 18- pre lay with deferent right hand side a cording to the availability of the ingredient, and with the deferent consumption level (80 , 100 , 120) gm which it mean we will repeat the model with deferent (R.H.S) six time again the results which is calculated by using linear programing technique as in the following table .

Results and Discussion

The following table 5 shows the result of the optimal solution obtained by using linear programming model for all growing and laying periods and the total cost for each period with their chemical composition. and table 6 shows the optimal solution for consumed feed gm./ day (80 100 120) with their chemical composition .

Feed stuff	0-6	6-12	12-18	18- pre lay	80 gm	100 gm	120 gm
yellow corn	532.368	550.38	560.56	601.31	560	691.8	750
soy bean	240.17	233.7.	216	171.6	119	66.5	0
wheat bran	192.1	178.5	187	166.1	136	112.3	142.6
fish meal	0	0	0	26.6	37.6	47.77	21.73
premix	2.5	2.5	2.5	2.5	2.5	2.5	2.5
lysine	4.7	5.5	6	3.47	52.6	73.15	58.17
limestone	19.3	19.8	20.6	3.58	0.67	0	16.239
soy oil	2.2	4.2	3	4	6.5	6.5	7
methionine	3.23	3	3.2	3	3.2	3.5	3.5
ca	7.36	8.62	6.16	10.07	2.8	2.94	5.69
salt	3	3	3	3	3	3	3
Total cost	637874	630129	618489	652233	672254	690507	649197

Table 5: ingredient composition of least cost ration formulation produced by computerized linear programming for growing and laying periods of eggs laying hens and for consumed feed gram/day for production of eggs ..

Nutrient	0-6	6-12	12-18	18- pre lay	80gm	100gm	120gm
Crude protein %	18.3	18.3	16.7	15.2	133.3	134.7	123.7
ME(Kcal kg)	2788	2788	2862	2900	2827	2829	2963
Fat %	29.8	29.1	30.6	29.0	29.6	29.3	28.7
Ca %	3.2	3.2	2.	4.3	3.2	3.7	6.8
P %	3.1	3.1	3.2	4.6	3.4.	3.9	2.9
Crude Fiber %	46.3	46.5	36.25	39.2	33.7	19.7	16.5
Lysine %	8.6	8.6	8.3	8.2	5.9	7.9	6.1
Methionine %	6.6	6.6	6.4	6.06	5.4	4.7	4.6

Table 6: calculated chemical composition for age per week until laying production and calculated composition of basic ration us consumed feed (80 , 100 , 120 gm /day) and their nutrient Kg

Conclusion

The optimum solution for producing eggs layers at different stages for rearing and production periods by using the local feedstuff to get the minimum cost. we found that the linear programming techniques was the good model and method to be used in Iraq specially in Kurdistan, the results of least

cost diet formulation starter ration consists of 65% yellow corn, 24.01 % soy bean, 20 % wheat bran, 01% cotton seeds, 0.8% fish meal, 0.8% Ca DE phosphate, 0 .1% lysine, 0.33% methionine, 0.3 limestone, 0.5 ready premix, 0.4 soy oil and 0.01 vitamin and mineral mix. the least cost ration for starter broilers according to local feedstuff availability and meets all the nutritional requirement needs the cost in US $ according to the stage of rearing and production period (637 , 630 , 618 ,652) and for consumed feed per grams (672, 690 , 649) the ration meets all the requirement needs these cost lowered by 300 to 400 $ per ton than imposed on producers by the market price .

Problems and obstacles

Some problems they must conceder

1- A lot of poultry products enters thoughtful and illegal and is not in conformity with the specifications and global health at his opponent, thus affecting the supply and demand and thus the inability of the domestic product of price competition and the local product losses incurred great.

2 - The lack of balance between imported and domestic production as the importer exceeds significantly the actual need.

3 - Non-application of Law No. 4 of 2008, on the protection of domestic production issued by the Kurdistan Parliament.

Proposals

1 - Controls for imports and coordination with the Ministry of Agriculture and representatives of the poultry industry in all provinces to determine the quantities imported per month and involve representatives of the poultry industry in all of the committees and the decisions that concern the industry with force all traders market rate of not less than 30% of the national product and inventory granting import licenses ministries agriculture and trade.

2- Financial support for the poultry industry and increasing agricultural loan granted to enable companies and that implement the integrated system in poultry production in Kurdistan, more broadly, in order to improve production quality and lower prices.

3 -The distribution of large quantities of wheat and barley stocks by the state working on projects and promotional prices as the federal government is working to distribute local maize and wheat bran on poultry projects .

4- By government departments such as the Ministry of Health and the Ministry of Interior and the army and other purchase and provide local chicken meals and force contractors to it .

5- By the Ministry of Agriculture to conduct a comprehensive field survey of endemic diseases in the region based on the technical expertise and resources of local and international hiring of foreigners and the introduction of modern technologies in the diagnosis of diseases .

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