Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Engineering
7(1), 2019, 06-08

ISSN 2347 – 7393

Original Research Article

NONLINEAR PROGRAMMING FOR ANIMAL NUTRIATIONS: AN INTRODUCTION FOR MAXIMIZE MILK GAIN BY BUFFALO

Bhupendra Sharma, Subhash Chandra Sikdar

Department of Mathematics, University Teaching Department, Sri SatyaSai University of Techgnology& Medical Sciences, Sehore-466001

Abstract: In this paper, nonlinear effects of nutrient ingredients are introduced as an approach closer to the true effects of nutrient ingredients. A nonlinear model is developed to take consideration of nutrient ingredients more effectively. The nonlinear model is introduced in order to maximize the weight gain in buffalo by the optimal use of feed ingredients. Data from a variable caloric density study for buffalo is fitted to nonlinear objective function expression for weight gain of the animal in terms of feed ingredients. National Research Council requirements are introduced as constraints for mathematical model. Proposed model with nonlinear programming measures its performance and gives a comparative result with linear programming models. Thus the study is an attempt to develop a nonlinear programming model for optimal planning and best use of nutrient ingredients.

Keywords: Nonlinear Programming, Nutrient Ingredients, Weight Gain, Feed Formulation, Feeding Standards.

Introduction*:* Algebraic procedures such as pivoting are so powerful for manipulating linear equalities and inequalities thatmany nonlinear-programming algorithms replace the given problem by an approximating linear problem[1-4].Separable programming is a prime example, and also one of the most useful, of these procedures. As inseparable programming, these nonlinear algorithms usually solve several linear approximations by letting thesolution of the last approximation suggest a new one[5-8].

By using different approximation schemes, this strategy can be implemented in several ways. This sectionintroduces three of these methods, all structured to exploit the extraordinary computational capabilities of thesimplex method and the wide-spread availability of its computer implementation.There are two general schemes for approximating nonlinear programs[9-12].

For Correspondence:
om11agra85@gmail.com
Received on: January 2019
Accepted after revision: March 2019

DOI: 10.30876/JOHR.7.1.2019.06-08

The last section used linear approximationfor separable problems by weighting selected values of each function. This method is frequentlyreferred to as *inner linearization* when applied to a convex programming problem(i.e., constraints $g_i(x)\geq 0$ with $g_i$concave, or $gi(x) \leq 0$ with $g_i$convex), the feasible region for theapproximating problem lies inside that of the original problem[13].

In contrast, other approximation schemes useslopes to approximate each function. These methods are commonly referred to as *outer linearization's*since,for convex-programming problems, the feasible region for the approximating problem encompasses that ofthe original problem[15-18].

In this present study, it is envisaged to develop a mathematical model using non-linear programming to take simultaneous effects of all nutrient ingredients and the diet is optimized by using Kuhn- Tucker conditions. This result is also compared to than that of linear programming formulation of the model.

Material and Methods: The present study is based on the secondary data of animal experiment of Elangovan (1990). Briefly, the study consists of male buffalo calves of about 6-9 months of age, which were procured locally at Bareilly. Animals were dewormed and vaccinated against common contagious diseases. The animals were kept in a shed having cemented floor with individual feeding arrangement during the feeding trial but transferred to metabolic cages during metabolism trial. Drinking water was provided to all calves ad libitum. Three different feed treatments used in the experiment are given to animal which are shown in Table 1.

Table 1. Dietary treatment given to animals

Feed	Control Group	Experimental Group	
	I	**II**	**III**
Block 1	---	400 gm	---
Block 2	---	----	----
Deoiled rice bran	2 kg	2 kg	2 kg
Wheat bhoosa	*ad lib*	*ad lib*	*ad lib*

The animals were kept under these feeding regimens for 166 days. The calves were first fed on a standard farm ration for about two month's period to make them healthier in order to avoid experimental error. The calves were offered feed, once in a day between 8.30 to 9.00 AM. Ad libitum drinking water was provided to all the calves twice a day. Animals were weighed on two consecutive days at fortnightly inter-vals before feeding and watering.

The study parameters included digestibility of different nutrients as well as bal-ances of nitrogen, calcium and phosphorus besides serum urea. The present study is carried out to maximize the weight gain of the animal. The weight gain and the efficiency with which the nutrients are utilized mainly depend on several factors related to nutrient utilization (Maynard and Loosli, 1956), however weight gain of an animal mainly depends upon digestible crude protein (DCP), total digestible nutrient (TDN) and digestible dry matter (DM). Metabolic body weight is used as a base for all the calculations (Elliot and Toops, 1964). Input data for this work is represented in terms of three nutrient ingredients DCP, TDN and DM.\

Result and Discussion

Weightage of Variables: First of all, linear relationship for dependent and independent variables is formulated to decide the weightage of the variables. Assuming a linear relationship between weight gain of buffaloes and intake of DM, CP and TDN, the weightage of these variables was decided. Using least square method, the relationship is depicted in the following equation which describes the weightage of the variables x_1, x_2 and x_3.

$$y = 2.00542\times 10^{-1}x_1+3.648748\times x_2-7.691844\times 10^{-2}x_3+ 2.671533$$

Problem Defined: The main problem is formulated to maximize weight gain of the animal:

$$Y= -17.77778869 + 0.131615729x_1+0.077184052x2+ 5.627355208\times 10^{-3}x_3 - 1.725868661\times 10^{-4} x_1^2$$

Subject to:

$$56.9 \leq x1 \leq 396.311$$
$$7.6816 \leq x2 \leq 37.708$$
$$220.4792 \leq x3 \leq 368.1687036$$

Solution of the Problem: Introducing Kuhn-Tucker conditions, the weight gain of the buffalo calves could be maximized as:

$$L= -17.77778869 + 0.1316155729x_1 + 0.077184052x_2 + 5.627355208 \times 10^{-3} x_3 – 1.725868661 \times 10^{-4}x_1^2- \lambda_1 (x_1-396.311)-\lambda_2(x_2-37.708)-\lambda_3(x_3-368.1687036)$$

Using Kuhn-Tucker conditions, the following set of equations were obtained for optimal solutions:

1. $0.70752862-1.855555531\times 10^{-3}x_1-\lambda_1=0$
2. $0.393301399-\lambda_2 =0$
3. $0.027548012-\lambda_3 = 0$
4. $\lambda_1 (x_1– 396.311) = 0$
5. $\lambda_2 (x_2– 37.708) = 0$
6. $\lambda_3 (x_3– 368.168706) = 0$
7. $X_1\leq 396.311$
8. $X_2 \leq 37.708$
9. $X_3 \leq 368.1687036$
10. $\lambda_1, \lambda_2, \lambda_3\geq 0$

Solving these equations the optimum values of the three nutrients is found out to maximize the body weight gain. Accordingly we have:

$$x_1 = 381.3028,\ x_2 = 7.708,\ x_3 = 368.1687036 \text{ g/kg } W^{0.75}$$

It also gives, $\lambda_1 = 0.393301399$, $\lambda_2 = 0.027548012$ which satisfied all the conditions.

Conclusion: Comparison of the present nonlinear method with linear programming represents that nonlinear programming gives maximum weight gain with optimum use of nutrients. The effect of these nutrients on body weight gain was considered and individual relations as obtained in equations present the linear and nonlinear effects of different ingredient on body weight gain.

References:

1. C. Van de Panne, W. Popp. “Minimum-Cost Cattle Feed Under Probabilistic Protein Constarints”. Management Science. Vol. 9, Issue 3, pp. 405-430, 1963.
2. Robert Townsley (1968). Derivation of optimal livestock rations using quadratic programming. Journal of Agricultural Economics. 19(3): 347-354.
3. David L. Olson and Scott R. Swenseth (1987).A Linear Approximation for Chance-Constrained Programming. J Opera-tional Research Society. 38(3): 261-267.
4. Bill R. Miller, Ronaldo A. Arraes, Gene M. Pesti (1986). Formulation of Broiler Rations by Quadratic Programming. Southern J Agricultural Economics. 141-151.
5. Roush, W. B., Purswell J. and Branton, S. L. “Adjustable nutrient margin of safety comparison using linear and stochastic programming in an Excel spreadsheet”, Journal of Applied Poultry Research, Vol. 16, pp. 514-520, 2007.
6. Weintraub, A. and Romeo, Operations research models and the management of agricultural and forestry resources: A review and comparison”. Interfaces, Vol. 36, pp. 446-457, 2006.
7. Grossmann, I. E. “J. Breckling, Ed. “Mixed-integer nonlinear programming techniques for the synthesis of engineering systems” Research in Engineering Design, Vol.1, pp. 205-228, 1990.
8. Elangovan, A.V. “Nutrient Utilization and Growth Perfor-mance in Buffalo Calves Fed on Wheat Bhoosa and Oil Ex-tracted Rice Bran Supplemented with Urea-molasses Cake”. MVSc Thesis, Indian Veterinary Research Institute, Izzatnagar, India, 1990.
9. Elliot, R. C. and Toops. “Studies of Protein requirements of ruminants”. British Journal of Nutrition, Vol. 18, pp. 245-249, 1964.
10. Maynard L. A. and Loosli, J. K. Animal Nutrition, Tata McGraw Hill, pp. 138-145, 1956.
11. NRC, Report of Commission on Natural Resources, National Research Council, National Academy Press, Washington, DC, 1981.