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Original Research Article

NON LINEAR PROGRAMMING MODEL FOR DIET OF SAHIWAL COWS FROM CONTROLLED RANDOM SEARCH

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Abstract: A nonlinear formulation of optimum livestock diets, though very practical, has seen a limited research since classical techniques like Kuhn Tucker theory used by some researchers has its own limitations due to the rigidity of mathematical characteristics that should hold good to apply this technique. The present study deals with the importance of linear livestock ration formulation for sahiwal cows of second to fifth lactation number to maximize the milk yield. Its solution is found using heuristic approaches viz Controlled Random Search Technique (RST2).
We observe that the results obtained are well acceptable with slight deviations, takes less time due to computer usage, gives more flexibility to the decision maker. The techniques do not guarantee optimal solution but at least gives a solution which is best amongst the many solutions generated during the simulation process. The performance of both the techniques indicates that they can be well implemented for nonlinear livestock ration formulation problem.

Keywords: Animal diet problem, Controlled Random Search Technique (RST2), Non-linear Programming (NLP), Sahiwal Cow.

Introduction*:* Animal diet composition is concerned with the distribution of individual ingredients for ensure the greatest piece of the animal in provisions of yield and weight increase. The purpose of diet composition is to supply that put of nutrient ingredient to the animal that finest fulfill its nutrient supplies[1-4].
When formulate the diet of an animal, various feed ingredient are combinations so as to supply the essential nourishment to the animal at diverse stage of production. Animal diet formulation model have been developed for profitable purpose as well as for farm animals enlargement, using diverse form of numerical program for several decades[5-9].
To attain the object of optimal and objective diet for maximization of milk yield or weight gain of animal, a number of arithmetical

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program approach have been use for more than 100 years[10-12]. In the preliminary phase of diet formulation, linear programming's (LP) were used; which combine nutrient ingredient for the rationale of devise least-cost ration. It was employ to determine the mainly resourceful way of provide nearby obtainable ingredients[13-14]. A model was solved by LP in which fundamentals of the tableau are stochastic by Rahman and Bender[15].Weintraub and Romero have compare problem types, problem-solving approaches and their application. A mixed-integer non-linear programming (NLP) technique has been developed for the synthesis of a model[16].

Introduction of nonlinear programming to optimize yield and minimize feed cost in broiler feed formulation may lead to better approximation as compared to those of linear cases[17]. A general optimization problem is to select n decision variables from a given feasible region in such a way as to optimize (minimize or maximize) a given objective function of the decision variables. The problem is called a nonlinear programming problem (NLPP) if the objective function is nonlinear and/or the feasible region is determined by nonlinear constraints[18].

Every linear programming problem can be solved by simplex method, but there is no single technique which can be claimed to efficiently solve each and every non-linear optimization problem. In fact, a technique which is efficient for one non-linear optimization problem may be highly inefficient for solving another NLPP. A variety of computational techniques for solving NLPP are available. However, an efficient method for the solution of general NLPP is still a subject of research[19].

The present study deals with the importance of linear livestock ration formulation for sahiwal cows of second to fifth lactation number to maximize the milk yield[20].

There are classical techniques like Kuhn Tucker theory used by some researchers to solve certain Non Linear Programming Problems (NLPP), but has its own limitations since one has to take care of a lot of mathematical characteristics to hold good before applying this technique[21].

Materials and Methods: In present study; animal experiment data of the research project done at National Dairy Research Institute, Kolkata [Surendra Mukhargee]. Concisely, the study consists of lactating sahiwal cows of second to fifth lactation number, were selected from the National Dairy Research Institute herd, and divided into four group, which were switched over four times (as the number of treatments) in a Latin-square change over design (Pratiksha *et al.*). Care was taken to minimize the variation within the animals of various groups. Each period was of 40 days duration. The 4 groups A, B, C and D were fed with isonitrogeneous and isocaloric concentrate mixtures, containing ground nut cake, cotton cake, cotton seedcake (undecorticated) and cotton seed cake (decorticated), respectively. In addition to the maintenance requirements, 50 gm DCP requirement, 50 percent was met through the concentrate mixture. A green fodder was given *ad libitum* to provide rest of the DCP and also to meet the dry matter and energy requirements. Table 1 gives composition of concentrate mixtures in respect of DCP and TDN. The various concentrate mixtures containing groundnut cake cotton seed and the two types of cotton seed cakes (undecorticated and decorticated) were analyzed for crude protein, crude fibre, ether extract, organic matter, nitrogen-free extract and total ash.

Table 1 Computation of concentrate mixtures in respect of DCP and TDN.

Ingredients	Control (G.N.Cake)	Cotton seed (whole)	Cooton seed cake (unde)	Cooton seed cake (deco)
Groundnut cake	20	20	10	0
Cotton seed	0	47	0	0
(undecorticated)	0	0	34	0
(decorticated)	0	0	0	27
Wheat bran	77	30	53	70
Common salt	2	2	2	2
Mineral mixture	1	1	1	1

Present study is carried out to maximize the milk yield. The milk yield and the efficiency with which the nutrients are utilized mainly depend on 3 factors, which may be used to maximize it. Accounting all these facts, milk yield of an animal depends upon:

1. Digestible Crude Protein (DCP)
2. Total Digestible Nutrient (TDN)
3. Digestible Dry Matter(DDM)

Objective function is formulated using the appropriate relations of the variables according to their weight age on milk yield of the cows and the constraints are applied according to feeding standards of NRC recommendations (NRC, 1981).

Results and Discussion: The solution set for NLP model of animal diet by Controlled Random Search Technique is given in table 2. And the graphical representation of maximum milk yield is as shown in figure 2.

The wide range of solutions obtained for original bounds as mentioned in (1) is,

X_1 = 608-680, X_2 = 66-68, X_3 = 400-512.

All the values are in gm/kg. Metabolic body weight.

The solution set for NLP model of animal diet by RST2 is as shown in table 2.

$$Y = 4.1792442\ x_2^2 - 4.082239204\ \times 10^{-6} x_3^2 - 0.114836671\ x_1 - 560.0786654\ x_2 + 4.145857585\ \times 10^{-3} x_3 + 19255.68675.$$

such that

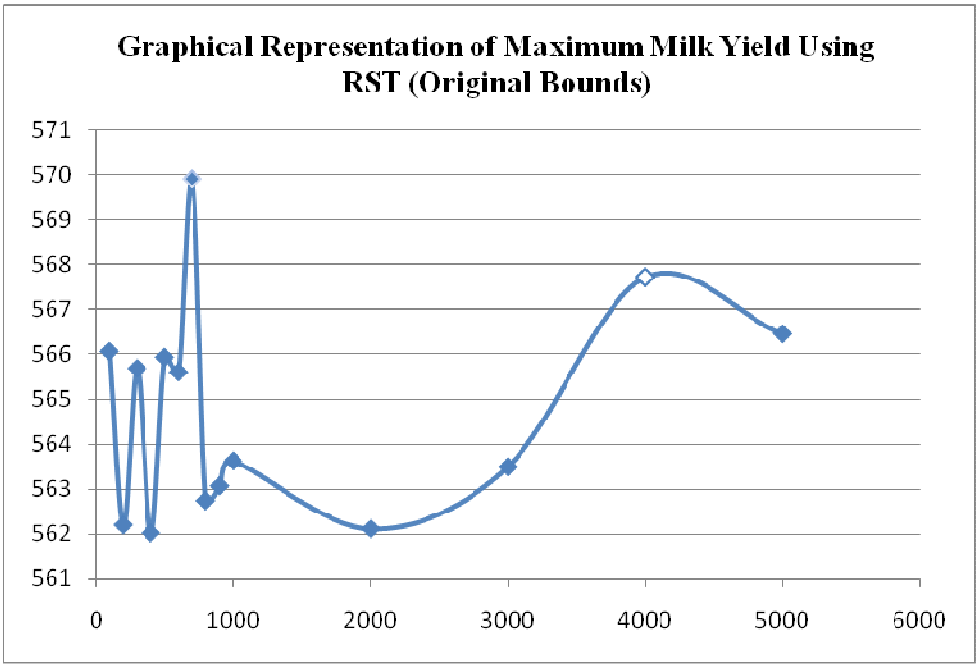
$$608.6718 \le x_1 \le 782.978$$

$$60.641 \le x_2 \le 75.943$$

$$366.0412 \le x_3 \le 508.9343 \qquad (1)$$

Table 2. Solution Set for NLP Model of Animal Diet by Controlled Random Search Technique for Original bounds.

No of iterations.	X^1 in gm/kg.metabolic weight	X^2 in gm/kg.metabolic weight	X^3 ingm/kg.metabolic weight	Value of the function
100	643.75	67	482.73	566.07
200	609.48	66.82	433.62	562.206
300	639.15	66.77	442.47	565.691
400	608.27	66.91	488.97	562.03
500	642.87	66.873	388.55	565.938
600	640.11	66.91	417.47	565.606
700	671.92	66.6	511.13	569.909
800	611.85	66.69	437.28	562.748
900	609.93	67.48	467.53	563.075
1000	623.68	67.012	367.819	563.637
2000	608.67	66.79	390.36	562.121
3000	619.44	66.71	366 563	563.5
4000	657.01	67.19	368.76	567.712
5000	646.22	67.18	479.46	566.456



Conclusions: This study compares the method of linear and non-linear programming of animal diet formulation and shows that linear programming method gives result at corner points of feasible area. This result is at higher side of results as compared to results obtained from Nonlinear programming problem. This comparison shows that linear programming gives higher value of variables to maximize the animal yields than that of nonlinear programming variable values. This comparison shows that nonlinear programming gives better result for maximization of animal yield and weight gain and represents simultaneous effect of all variables altogether. This approach of formulating model using nonlinear programming overcomes the drawback of linearity assumption and represents future prospective of extension of this technique for more variables.

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