Research Article

Animal feed formulation by using linear programming technique

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Abstract

The secondary data were obtained from Network Project on Pandharpuri buffalo, Zonal Agricultural Research Station, Shendapark, Kolhapur on farm animals and different types of feeds and fodder offered daily to animalsin the year 2011. It is concluded that, the least cost ration plan formulated by linear programming technique for daily feeding of milking Pandharpuri buffalo included hybrid napier, groundnut leaves, hay, and cotton cake. The least cost ration only used the 4 ingredients as compared with 14 in the original feeding plan and alsoper dayfeeding cost was reduced.

Keywords: Pandharpuri buffalo, Linear Programming Technique, Least cost, feed formulation.

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Received Date: 03/12/2014 Accepted Date: 13/12/2014

Access this article online

Quick Response Code:

Website: www.statperson.com

DOI: 14 December 2014

INTRODUCTION

Linear programming is a mathematical technique widely used in practice with noticeable success for formulating optimum livestock diets. Diet formulated by linear programming is based on the assumption of linearity between animal milk yield and nutrient ingredients included in the diet. It has formed as the basis for livestock feed formulation since Waugh (1951) defined the feeding problemin the mathematical form. It has been widely used in modeling the least cost ration problem (Tozer 2000; Chakeredza *et al.* 2008). The recent livestock census of Department of Animal Husbandry and dairy, Govt. of India (2007) indicates a rise in both cattle (199 million) as well as buffalo (105 million) population contributing to about 121.8 million tons of milk annually (2011), with major contribution greater than 51 per cent coming from buffaloes. The per capita availability of milk has increased from 260 g/d in 2007-08 to 281 g/d in 2010-11. The share of milk production in buffaloes was 51.2 per cent of total milk production. The proportion of animals in milk to the total milch animals has increased from 70.6 to 73.3 per cent for buffaloes. Enhancing the productivity of animals is a major concern to our country, which can be addressed by developing proper feeding systems to adequate and balanced nutrients to fulfill their requirements. Nutrients to livestock are essentially provided through feed and the requirements expressed in terms of energy, protein, minerals and vitamins. The linear programming technique was applied to the feed formulation for Pandharpuri buffalo with the objective of minimizing feeding cost in relation to fulfill nutrient requirement of animal. Pandharpuri buffalo is one of the important breed of Maharashtra State. The Pandharpuri is originated from the town of Pandharpur of Solapur district. The demand of buffalo milk is higher than cattle milk due to its high fat percent in milk. Maximization of profit is the main goal of any dairy system. The milk production depends on the quality and quantity of the feed and fodder fed to animals. It is very necessary to provide balanced diet to livestock so

How to site this article: Anju A Bhagat, V H Bajaj. Animal feed formulation by using linear programming technique. *International Journal of Statistika and Mathemtika* Nov 2014 to Jan 2015; 12(2): 101-104. http://www.statperson.com (accessed 15 December 2014).

as to obtain an optimum level of production. Very rare work has been done on Pandharpuri buffalo. In point of view, the present study was undertaken.

MATERIALS AND METHODS

The data were obtained from Network project on Pandharpuri buffalo situated at Kolhapur on milking animals and different types of feeds and fodder offered daily to milking animals for the year of 2011. The nutrient requirement of buffalo was estimated by the thumb rule was given by Banerjee (1978) with a fair degree of precision on the basis of dry matter and digestible nutrients (DCP and TDN). The animals producing different milk yield with varying fat percent. In this case, buffalo needed ration not only for maintenance but also for milk. The average animal weight of Pandharpuri buffalo was taken as 400 kg having 8 % fat in per kg milk. The specified nutrients viz. Dry matter, TDN, Ca and P available in different feeds and fodders were taken from recommended level of standards suggested by ICAR, New Delhi. The optimal plan for feeding Pandharpuri buffalo were developed. The cost minimization problem were formulated by using the simplex method of linear programming (Anderson *et al.* 2000). The TORA software was used for data analysis. The 14 decision variables and 10constraints were taken for the studyas follows: Objective function is

$$Minimize\ z = \sum_{j=1}^{n} C_j x_j$$

Subjected to the linear constraints such as

$$\sum_{j=1}^{n} a_{ij} X_j \geq B_i, i = 1,2,---,10.$$

Non negativity $x_j \geq 0$,

Where,

Z= total cost of feed in Rs.,

X_j = Qty. of j^{th}feed material in the feed in kg,

C_j = Unit cost of feed material X_j in rupees per kg,

C_j wasper kg cost (green and dry fodder) taken from prices fixedby purchase and selling rate committee of MPKV, Rahuri and for concentrates market prices was taken.

a_{ij} = Amount ofi^{th}nutrient available in one kg of X_j feed material,

B_1, B_2, B_3, B_4 B_5, B_6, B_7, $B_8$$B_9$ and B_{10} are required level of nutrients such as :

B_1 = Digestible Crude Protein (DCP), B_2 = Total Digestible nutrients (TDN),

B_3 = Total Dry matter (DM), B_4 = Calcium (Ca) (%),

B_5 = Phosphorus (P) (%), B_6 = Requirement of Leguminous fodder

B_7 = Requirement of Non – Leguminous B_8 = Dry matter supplied by Green roughages, fodder,

B_9 = Dry matter supplied by Dry roughages, B_{10} =Dry matter supplied by Concentrates,

Table 1: Optimal plan compared with existing plan for Pandharpuri Buffalo 2011

Sr. No.	Source of Nutrients	Existing plan		Optimum Plan*	
		Qty.(Kg)	Cost (Rs.)	Qty.(Kg)	Cost (Rs.)
1	green grass	4.82	1.93	-	-
2	green maize	4.77	4.77	-	-
3	groundnut leaves	0.56	0.25	13.33	3.00
4	jaywant napier	2.48	1.12	6.66	6.00
5	Lucerne	0.06	0.10	-	-
6	Sugarcane	5.49	8.24	-	-
7	Bhos grass	1.94	0.77	-	-
8	Hay	0.93	0.28	4.72	1.42
9	Kadbakutti	0.23	0.50	-	-
10	soyabean straw	0.04	0.02	-	-
11	Staylo grass	0.29	0.13	-	-
12	cotton cake	0.04	0.44	3.14	31.40
13	mahalaxmi conc.	1.33	26.50	-	-
14	Mineral Mix.	0.05	7.21	-	-
	Total		52.26		41.82

Table 2: Level of slack / surplus activity and dual price for Pandharpuri Buffalo dietnutrients

Sr. No.	Particulars	Level of slack-/Surplus+ activity*	Dual Price * (Rs./day)
1	Digestible Crude Protein	0.62^{+}	0.00
2	Total Digestible Nutrients	5.68^{+}	0.00
3	Total Dry Matter	1.90^{+}	0.00
4	Calcium	28.38^{+}	0.00
5	Phosphorus	3.54^{+}	0.00
6	Requirement of Leguminous fodder	0.00	0.45
7	Requirement of Non - Leguminous fodder	0.00	0.45
8	Dry matter supplied by green roughages	13.70^{+}	0.00
9	Dry matter supplied by dry roughages	0.00	0.30
10	Dry matter supplied by concentrates	0.00	10.00

*The TORA software Windows version 2.2, Feb. 2006 is used for evaluating these values.

RESULT AND DISCUSSION

The least cost feeding plan reduced the ration cost for Pandharpuri buffalo from Rs.52.26 to Rs. 41.82 (Table 1). The least cost ration only used 4 ingredients compared with 14 in the original feed plan. The principle component of the least cost ration was groundnut leaves and hybrid napier, compared with sugarcane, green grass, lucerne and green maize in original diet. Groundnut leaves and hybrid napier were the principal components of energy. For hybrid napier, similar findings were reported by Goswami *et al.* (2013). The dual price under the given set of conditions indicates the potentiality of nutrients (Table 2). It was observed that, the activities in the solution at non - zero values have zero dual prices. The supply of DCP, TDN, total dry matter and dry matter supplied by green roughages are surplus, amounting to 0.62, 5.68, 1.90 and 13.70 kg respectively with zero dual price. For DCP and TDN similar results were reported by *Radha Gupta et al.*(2013). The supply of Ca and P are also in surplus quantity amounting to 28.38 and 3.54 per cent with zero dual price. The dual prices of DCP, TDN, total dry matter and dry matter supplied by green roughages, Ca and P revealed that, the least cost combination of feeds and fodder after meeting all the requirements also exceed the DCP, TDN, total dry matter and dry matter supplied by green roughages and Ca, P requirement by 0.62, 5.68, 1.90, 13.70 kg and 28.38 and 3.54 per cent respectively without any cost implication. For P similar findings were reported by Goswami *et al.* (2013) and *RadhaGuptaet al*. (2013). In the case of requirement of leguminous fodder, Non - Leguminous fodder,Dry matter supplied by dry roughages and dry matter supplied by concentrates observed that their slack activities at zero level it means that how much the cost of ration would be reduced when the constraint relaxed by one unit. A decrease in one unit (kg) of requirement of leguminous fodder and non - leguminous fodder constraints reduced the cost of each in optimal plan by Rs. 0.45 respectively. The dual price of Dry matter supplied by dry roughages and Dry matter supplied by concentrates were Rs. 0.30 and Rs. 10.00 respectively indicated that for every decrease in one unit restrictions, cost will reduce by Rs. 0.30 and Rs. 10.00 respectively and vice versa.

CONCLUSION

It is concluded that the least cost ration plan formulated by linear programming technique for daily feeding for milking animals of Pandharpuri buffalo included 13.33 kg Groundnut leaves, 6.66 kg Hybrid Napier, 4.72 kg hay, and 3.14 kg cotton cake, costing 19.99% less than the routine feeding plan. The least cost feeding plan reduced the ration cost for Pandharpuri buffalo from Rs. 52.26 to Rs. 41.82. The least cost ration only used the 4 ingredients as compared with 14 in the original feeding plan. The per day feeding cost was reduced by Rs. 10.44 for milk animal of Pandharpuri buffalo.

ACKNOWLEDGMENT

Authors sincerely thank to Hon'ble Vice Chancellor, Dr. T. A. More, MPKV, Rahuri for allowing me to pursue research work for getting higher degree, Dr. R.S. Patil, Director of Research, MPKV, Rahuri was given the permission to use data of research station of University, and also Dr. A.P. Fernandes, Associate Professor, Zonal Agril. Research Station, Shenda Park, Kolhapur for providing the same data for research purpose.

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Source of Support: None Declared
Conflict of Interest: None Declared