Original Research Article

Value chain analysis of cattle feed market in Banaskantha district, India

ABSTRACT

India has vast resources of livestock and poultry, which play a vital role in improving the socio-economic conditions of rural masses. Livestock sector contributed 4.90 per cent of total GVA in 2020-21. Birthal and Jha (2005) has found feed scarcity as the main limiting factor to improving livestock productivity. Therefore, to increase the productivity potential of milch animals the use of commercial compound feed is inevitable as supply of feed & fodder is shortening due to shrinking pasture land in the country. The Indian feed industry is about 57 years old. India is deficient in fodder and its availability is shrinking day by day due to decrease in cultivable area and increased share in food crop production so more thrust should be directed towards compound feeds by identifying the constraints and removing them.This study focused on the effectiveness of the feed industry and the performance of the value chain when mapping the cattle feed value chain in the Banaskantha district of Gujarat state. Total of ten feed manufacturing units and 120 farmers were selected for the study. The study was based on primary data and secondary data, the primary data were collected through personal interviews with the help of a structured survey schedule. Secondary data on livestock population were collected through the livestock census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India. A multi stage random sampling method was adopted as an appropriate sampling procedure for the study. Banaskantha district was purposely selected for the study as Banaskantha district has highest livestock population in overall Gujarat State. Four talukas from Banaskantha district were selected randomly and feed manufacturing units were selected by snowball sampling method. From each taluka, five villages were selected randomly. From each village, six farmers were selected randomly. The study focused on buying behavior of farmers regarding cattle feed purchase and to estimate demand for concentrated feed requirements for the future in Banaskantha district. The study found that among the eight explanatory (independent) variables, five variables viz., livestock population, farm size, feed price, income from livestock, total feed fed per day were found to be significantly associated with expenditure of cattle feed price per animal per month and other variables such as average age of the animal, technology adoption and distance from buying location were statistically non-significant. The required feed demand for future livestock populations in Banaskantha district are 3651480 metric tonnes, 4487461 metric tonnes, 5514543 metric tonnes, 6774097 metric tonnes and 8315523 metric tonnes for the year 2024, 2029,2034, 2039 and 2044 respectively.

Keywords: (Cattle feed, Value chain, Livestock census, Multistage random sampling, Concentrates feed, independent variables)

1. INTRODUCTION

Livestock sector is an important sub sector of agriculture in the Indian economy. It grew at a CAGR of 7.93 per cent during 2014-15 to 2020-21 (at constant prices). The contribution of livestock in total agriculture and allied sector GVA (at constant prices) has increased from 24.32 per cent (2014-15) to 30.13 per cent (2020-21). Livestock sector

contributed 4.90 per cent of total GVA in 2020-21 (PIB, 2023). India has vast resources of livestock and poultry, which play a vital role in improving the socio-economic conditions of rural masses. There are about 303.76 million bovines (cattle, buffalo, mithun and yak), 74.26 million sheep, 148.88 million goats, 9.06 million pigs and about 851.81 million poultry as per 20th Livestock Census in the country.

"Dairy is the single largest agricultural commodity contributing 5.00 per cent of the national economy and employing more than 8 crore farmers directly. India is ranked 1st in milk production contributing 23 percent of global milk production. Milk production has increased by 51.05 per cent over the past 8 years from 146.3 million tons during 2014-15 to 221.06 million tonnes during 2021-22. Increasing population, rising income, rapid urbanization and greater economic liberalization makes it imperative to increase the production of animal food substantially to cope up with the expected rise in its demand which is about to increase 44 per cent by 2030. Increasing population, rising income, rapid urbanization and greater economic liberalization makes it imperative to increase the production of animal food substantially to cope up with the expected rise in its demand which is about to increase 44.00 per cent by 2030. The role of feed in increasing production of animal food needs no emphasis. India is deficient in fodder and its availability is shrinking day by day due to decrease in cultivable area and increased share in food crop production, necessitating greater emphasis on compound feeds. At present the estimated annual availability of total concentrate feed is only 61 million tonnes against a demand of 96 million tonnes, indicating a deficit of 36.00 per cent at national level" (Anonymous, 2018) indicating the need for development of livestock feed industry by improvising the feed value chain.

"Value chains encompass the full range of activities and services required to bring a product or service from its conception to sale in its final markets whether local, national, regional or global" (Campbell, 2008). Value chains include input suppliers, producers, processors and buyers. They are supported by a range of technical, business and financial service providers. A value chain is designed to capture value for all actors by carrying out activities to meet the demand of consumers. The factors influencing the buying behavior of farmers and their relative significance needs to ascertain for the meaningful formulation of marketing strategies for cattle feed products.

➢ **Objectives of the study**

- To find buying behavior of farmers regarding cattle feed purchase
- To estimate demand of concentrated feed requirement for the future

2. METHODOLOGY

The present study was carried out during the year 2023-24 in Banaskantha district of Gujarat state.The data were collected on the basis of information given by 120 farmers and 10 feed firms on selected research study, which might not represent the whole Banaskantha district of North Gujarat, hence limited area was covered for the study. The limited time was available within which survey had to be completed, hence time duration was also a limitation. The data were collected solely on the basis of information given by sample respondents.

The multistage sampling technique was adopted as per the objective of the study. In the first stage, Banaskantha district was purposely selected for the study as Banaskantha district has highest livestock population Gujarat State. At the second stage, four talukas from Banaskantha district were selected randomly and feed manufacturing units were selected by snowball sampling method. At the third stage from each taluka, five villages were selected randomly. From each village, six farmers were selected randomly. A sample size of 10 feed manufacturing units and a sample size of 120 farmers from 20 villages of four talukas from Banaskantha district namely Dantiwada, Deesa, Palanpur and Dhanera were selected for the research study.

To study the buying behavior of farmers regarding cattle feed, multiple regression methods were used. From the selected farmers, relevant data were collected so as to achieve the objective of the study.

Multiple linear regression analysis:

The collected data were analyzed by using multiple linear regression functions of the following form to study the relationship between expenditure of cattle feed price per animal per month (dependent variable) and independent variables (Table 1).

$$Y = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\mu$$

Where, Y= Expenditure on cattle feed price per animal (in rupees)

β_0 is the intercept and β_1, β_2,…, β_8 are coefficients of the variables X_1, X_2,…, X_8 are variables and μ is the error term.

Table 1: Description of variables used in multiple linear regression analysis for factors influencing expenditure on cattle feed price per animal per month in rupees.

X1	Livestock population (number of animals)
X2	Feed price (kg)
X3	Farm size (bigha)
X4	Average age of the animal (years)
X5	Income from livestock (rupees)
X6	Technological adoption (no technology-1, any one technology-2, any two technology-3, any three technology-4, any four technology-5, more than four technology-6)
X7	Distance from buying location (km)
X8	Total feed fed for animals per day (kg)

For the variable, technology adoption, the following technologies were considered for the study and accordingly score was given.

Table 2: Description of technologies adopted by farmer

S. No	Type of technology	Technology adopted
1.	No technology adoption	
2.	Automatic water	
3.	Automatic feed	
4.	Pakka shed	
5.	Milking machine	
6.	Mineral mixture	

The estimation of demand for feed was worked out through different standards as estimated by the FAO, NATP and our own primary data with the help of livestock population data and their per day consumption in different stages of life, species, age and sex of the animal. The methodology is explained in detail as follows:

Firstly, the projected future population of livestock census is calculated by using formulae compound annual growth rate (CAGR) and exponential growth based on historical data of livestock census of Banaskantha district.

The CAGR formula is:

$$\text{CAGR} = (\text{ending value}/\ \text{beginning value})^{1/n} - 1$$

Where n is number of years

Exponential growth formula is:

$$Y_t = Y_o \times (1+ r)^t$$

Where,

Y_t = the future population year

Y_o = the current population

r = compound annual growth rate of livestock population

t = numbers of years under projection

Table 3: Feeding allowances for dairy cattle and buffalo

Type of cattle	Stage of the cattle	Green fodder (kg/day/animal)	Dry fodder (kg/day/animal)	Concentrates (kg/day/animal)
Cow (Average weight 250 kg)	Milk yield 5 litres/day	15	5.0	2.0
	Milk yield 5 to 10 litres/day	17.5	5.5	3.0
	Milk yield 10 to 15 litres/day	20.0	6.0	4.0
Cow in gestation	-	15.0	5.0	1.5
Buffalo (Average weight 400 kg)	Milk yield 5 litres/day	15.0	5.0	2.5
	Milk yield 5 to 10 litres/day	20.0	6.0	4.0
	Milk yield more than 10 litres/day	25.0	7.0	5.0
Bull (Average weight 300 kg)	During days of work	20.0	7.0	2.0
	During days of no work	15.0	5.5	1.0

(Source: Anonymous (2024)

The estimation of feed requirement for the livestock was worked out only for a major ruminant species such as cattle and buffalo as they consume a major share of feed resources available. The body size and their feed requirement of cattle and buffalo have been worked out based on data of feeding allowance of cattle and buffalo (Table 3) given by TNAU.

From the Table 3 the milking cow at the stage of milk yield 5 to 10 liters per day consumes about 3 kg concentrate feed and at the time of gestation it consumes 1.5 kg of

concentrates feed per day is considered to calculate the annual concentrates feed requirement. Similarly the milking buffalo at the stage of milk yield 5 to 10 liters per day consumes about 4 kg concentrate feed and at the time of bull it consumes 2 kg of concentrated feed per day is considered.

The total requirement of concentrated feed was calculated by using the data of feeding allowance of cattle and buffalo as provided in Table 3. The animals' category-wise data was calculated by assuming a forty per cent of dry animals and a sixty per cent of milking animals from the given population. The requirement of concentrated feed was calculated individually and the aggregate demand was calculated by summing up all categories. Further, an attempt was also made to estimate the demand of concentrated feed for the projected future population.

3. RESULTS AND DISCUSSION

3.1 Buying behavior of farmers regarding cattle feed purchase

Multiple linear regression was carried out to predict the contribution of independent variables on the expenditure of cattle feed price per animal per month and the results were furnished in (Table 4).

Table 4: Factors influencing the expenditure of cattle feed price per animal per month (In rupees)

S. No	Variables	Regression coefficients	Standard error	Probability level
1	Intercept	-71.319	1186.731	0.952
2	Livestock population (no. of animals)	-676.959	99.765	0.000**
3	Feed price (per kg)	243.250	33.650	0.000**
4	Farm size (in bigha)	-35.977	12.639	0.005*
5	Income from livestock (in rupees)	-0.0048	0.0016	0.003*
6	Average age of animal (in years)	-187.341^{NS}	95.462	0.089
7	Technological adoption	197.818^{NS}	115.564	0.052
8	Distance from buying location (in kilometers)	40.394^{NS}	113.841	0.723
9	Total feed fed for animals per day (in kilometers)	100.224	7.583	0.000**

Dependable variable Y = expenditure of cattle feed price per animal per month (in rupees)
N = 120
F value = 44.193**
R^2 = 0.76
Adjusted R^2 = 0.74
P* < 0.05, P** < 0.01

On perusal of the table, it could be noted that the computed F-value of the function was 44.19 and it is statistically significant at 1 percent level ($P < 0.01$), indicating that a definite statistical relationship exists between the dependent variable and the independent variables. The coefficient determination (adjusted R^2) was 0.74 which indicates that all the explanatory variables explained 74 per cent of the variation in dependent variable. The independent variables were livestock population, feed price, farm size, average age of the animal, income from livestock, technology adoption, distance from buying location, total feed fed per day.

Among the eight explanatory (independent) variables, five variables *viz.,*livestock population, farm size, feed price, income from livestock, total feed fed per day were found to be significantly associated with expenditure of cattle feed price per animal per month and other variables such as average age of the animal, technology adoption and distance from buying location were statistically non-significant.

The variable of livestock population is a negative coefficient and is statistically significant ($p < 0.001$). It suggests that an increase in the number of animals is associated with a decrease in expenditure. This might seem counterintuitive, but it could indicate economies of scale where larger farms spend less per animal. The variable of farm size is also a negative coefficient and statistically significant ($p = 0.005$). This suggests that as farm size increases, expenditure decreases. This might indicate that larger farms manage to reduce costs through more efficient resource utilization.

The variable of feed price per kilogram is positive coefficient and is statistically significant ($p < 0.001$). Higher feed prices lead to increased expenditure, as expected, since more costly feed directly raises overall costs. The variable of income from livestock is negative coefficient is statistically significant ($p = 0.004$). It suggests that higher income from livestock is associated with lower expenditure. This could indicate that more profitable farms manage their costs better or reinvest income in cost-saving technologies or practices.The variable of technological adoption is positive coefficient but not statistically significant ($p = 0.090$), suggesting that investments in technology can increase expenditure. This could be due to the cost of acquiring and maintaining technological equipment. The variable of average age of animal shows negative coefficient is marginally significant ($p = 0.052$). It suggests that older animals are associated with lower expenditures, possibly due to reduced costs associated with maintaining older animals versus younger ones.

The variable of feed fed to animals per day is positive coefficient and highly significant ($p < 0.001$). It indicates that more feed fed to animals per day increases expenditure, as expected, since feeding animals incurs higher costs. Similar findings were found in the Senthilkumar (2002).

3.2 Estimation of demand for concentrated feed requirement for the future in Banaskantha district.

There is a direct relation between the nutritional status of the animals and the type of feed fed. For getting the best results, feeding of animals needs a planned scientific, practical as well as economical approach. Livestock feeds are generally classified as roughages and concentrates. Roughages are further classified into green fodder and dry fodder. Green fodder are cultivated and harvested for feeding the animals in the form of forage (cut green and fed fresh), silage (preserved under anaerobic condition) and hay (dehydrated green fodder). Fodder production and its utilization depend on various factors like cropping pattern followed, climatic condition of the area as well as the socio-economic conditions of the household and type of livestock reared.

Table 5: Livestock census of Banaskantha district

Year	Cattle population	Buffalo population
1992	437200	452000
1997	359300	538000
2003	494841	715000
2007	660113	955000
2012	654167	945346
2019	1390357	1501537

(Source: 15th, 16th, 17th, 18th, 19th and 20th livestock census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India.)

The cattle and buffaloes are normally fed on the fodder available from cultivated areas, supplemented to a small extent by harvested grasses. The major sources of fodder supply are crop residues, cultivated fodder and fodder from common property resources like forests, permanent pastures and grazing lands.

By Calculating Compound Annual Growth Rate (CAGR) based on historical data, the CAGR for cattle is **4.2 per cent** and CAGR for buffalo is **4.5 percent**

3.2.1 Projected Future Livestock Populations

By using the calculated CAGR of cattle and buffalo, the projected future population of livestock census for the years 2023, 2028, 2033, 2038, and 2043 is calculated by using formula

$$\text{Future Population}_{\text{year}} = \text{Current Population} \times (1+\text{CAGR})^{(\text{year}-2019)}$$

Table 6: Projected future livestock populations estimates

Year	Projected Cattle Population	Projected Buffalo Population
2023	1700570	1850840
2028	2079140	2282649
2033	2541527	2815210
2038	3105358	3470722
2043	3791708	4275674

(Assumption: 60 percent is considered as milking animal and 40 per cent as dry animal)

Notes: *estimates based on past livestock censuses published by the Directorate of Economics and Statistics and Department of Animal Husbandry and Dairying

To estimate the demand of concentrated feed for milking and dry animals based on the projected future livestock populations, the specific feed requirements for milking animals and dry animals was considered. From the Table 3 as mentioned in methodology, feeding allowances for dairy cattle and buffalo, the milking cow at the stage of milk yield 5 to 10 liters per day consumes about 3.0 kg concentrates feed and at the time of gestation it consumes 1.5 kg of concentrates feed per day is considered to calculate the annual concentrates feed requirement. Similarly the milking buffalo at the stage of milk yield 5 to 10 liters per day consumes about 4.0 kg concentrate feed and at the time of bull it consumes 2.0 kg of concentrates feed per day is considered. The annual concentrated feed requirement per animal is as shown in Table 7.

Table 7: Annual concentrated feed requirement per animal (kg/year)

Particulars	Cows (average body weight 250 kg)	Buffaloes (average body weight 400 kg)
Milking stage	1095 kg	1460 kg
Dry stage	547.5 kg	730 kg

3.2.2 Feed demand for future livestock populations in Banaskantha district

Table 8: Estimate demand of concentrates feed requirement for future livestock population in Banaskantha district

	Estimates of concentrates feed in Banaskantha district						
Year	Population		Concentrates feed for cattle (in MT)		Concentrates feed for buffalo (in MT)		Total feed required (MT)
	Cattle	Buffalo	In milking	Dry	In milking	Dry	
2023	1700570	1850840	1117274	372424.8	1621336	540445.3	3651480
2028	2079140	2282649	1365995	455331.7	1999601	666533.5	4487461
2033	2541527	2815210	16697783	55654.4	2466124	822041.3	5514543
2038	3105358	3470722	2040220	680073.4	3040352	1013451	6774097
2043	3791708	4275674	2491152	830384.1	3745490	1248497	8315523

Source: estimated using information from Table 6 & 7

On multiplying the estimated feed consumption rates for cattle and buffalo (reported in Table 7) by their respective projected livestock populations we arrived the required feed demand for future livestock populations in Banaskantha district are 3651480 MT, 4487461 MT, 5514543 MT, 6774097 MT and 8315523 MT for the year 2023, 2028,2033, 2038 and 2043 respectively. Similar findings were found in the Earagariyanna *et al*., (2017)

4. CONCLUSION

The result showed that among the eight explanatory (independent) variables, six variables viz.,livestock population, farm size, feed price, income from livestock, average age of the animal, total feed fed per day were found to be significantly associated with expenditure of cattle feed price per animal per month and other variables such as technology adoption and distance from buying location were statistically non-significant.The required concentrates feed demand for future livestock populations in Banaskantha district are 3651480 MT, 4487461 MT, 5514543 MT, 6774097 MT and 8315523 MT for the year 2023, 2028, 2033, 2038 and 2043 respectively.

5. SUGGESTIONS

- As per Livestock Census 2019, Banaskantha district shares 9.40 per cent of livestock of Gujarat. About 80–83 percent of farmers practice dairy farming in Banaskantha district. This implies that increased public investment in the livestock industry is necessary to support smallholder livestock producers, who primarily rely on the livestock industry for their income.
- The supply and demand of cattle feed for livestock in the research region are imbalanced. Increased productivity in the existing units and with the establishment of additional production units can help to overcome this issue. Government has to be given special focus on feed and fodder production to bridge the gap in the demand and supply of feed and fodder.
- Previous research has found a variety of impairments in dairy animals, resulting in low productivity and significant reproductive issues. Feed producers should be educated on balanced rations, mineral deficits, and target rationing. As stated in the primary findings, training feed producers and other stakeholders will have a long-term impact on overall dairy production in the country.

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