FEED RESOURCES AND MAIN ASPECTS OF NUTRITION AND FEEDING OF LIVESTOCK IN INDIA

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The Republic of India has a human population of 684 million according to the 1981 census. There are 181 million cattle, 63 million buffaloes, 159 million poultry and 86 million other livestock (Table 1). Unlike the West, where dairying has been evolved as a more specialised and commercial enterprise, animal husbandry in India is subsidiary to crop production. The pattern of livestock kept on landholdings is dominated by draught animals and milch cattle.

Table 1. Livestock population of India (millions)

No.	Item	1977	1972	1966
1.	Cattle			
	a. Males	74.76	74.46	73.38
	b. Females			
	i. In milk	23.21	22.03	20.97
	ii. Dry	26.51	26.33	25.80
	iii. Others	8.11	8.03	7.60
	c. Young stock	47.39	47.48	48.07
	Total	179.98	178.33	175.82
2.	Buffaloes			
	a. Males	8.4	8.11	8.20
	b. Females			
	i. In milk	17.00	15.07	12.92
	ii Dry	14.80	14.13	13.24
	c. Young stock	21.70	20.11	18.59
	Total	61.90	57.42	52.95
3.	Sheep	40.87	39.99	42.01
4.	Goats	75.36	67.52	64.59
5.	Horses & ponies	0.89	0.94	1.15
6.	Pigs	7.70	6.90	5.04
7.	Camels	1.10	1.10	1.10
8.	Mules	0.06	0.08	0.08
9.	Donkeys	1.00	0.99	1.05
10.	Yaks	0.04	0.03	0.03
11.	Others	0.09	0.02	N.A.
12.	Poultry	159.22	138.54	115.44

Source: Twelfth all India livestock census—1977.

India has a land mass of 3.28 million $(km)^2$ stretching 2977 km between its East-west points and 3219 km from North to South. This land mass comprises 2.4 percent of the world's land mass area but has 15.5 percent of the World's human population. According to the 1981-82 Fertilizer Association Economic Survey, the total geographical area for land utilization is 329, million ha, out of which the net area sown is 14.3 million ha. The utilisation of the land for major crop cultivation is rice 23 percent, wheat 12.5 percent, *jowar* 9.4 percent *bajra* 6.4 percent and groundnut 3.4 percent (Tables 2 and 3).

The 1981 census indicated that 76 percent of the population live in rural areas. Out of these, 30 percent are landless agricultural labourers and 19 percent have non-agricultural occupations.

Indian agriculture is dominated by the influence of the Himalayas to the North, from which the major rivers originate and the seasonality of monsoon rains which come from the South-west in the middle of the year followed by a second monsoon from the North-east (Nov.—Jan.). Al-

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Table 2. Land utilization pattern and production (1980-81)

	('000' ha)	('000' tonnes)
Geographical area*	328,778	
Net area sown*	142,606	
Gross area sown*	172,306	
Cereals	103,160	118,700
Rice	39,770	53,230
Wheat	22,100	36,460
Jowar	15,610	10,500
Pulses	22,630	11,170
Sugarcane	2,650	15,400**
Net area irrigated*	36,665	
Gross area irrigated*	45,910	

* *1977-78*

** *In terms of Gur*

Source: Fertilizer statistics, 1979-80. Fertilizer association of India and economic survey (1981-82) Govt. of India.

though a majority of the people are vegetarians there are still large number of people who eat meat and eggs. Milk is the main source of animal protein for the vegetarians. The per capita consumption of milk is 131 g per day. Despite the large cattle population, there is a religious ban on cow slaughter. However, buffalo meat is popularly used.

PRODUCTION OF CEREALS AND OTHER CROPS

The yields and cropping pattern of cereals and other crops are given in Table 3. During the year 1980-81, production of rice was 53.2, wheat 36.4, jowar 10.5, pulses 11.2 and sugarcane 15.4 million tonnes. The national average yields (kg/ha) were 1,088, 1,387, 667, 554, 11,600 and 747 for rice, wheat, *jowar*, *bajra*, potato and groundnut respectively.

In general, the agricultural crops are divided into four categories i.e., food crops, oil seeds, fodder and non-fodder crops (Fig. 1).

CROP BY-PRODUCTS AND AGRO-INDUSTRIAL BY-PRODUCTS AVAILABLE FOR LIVESTOCK

The food and export crops leave residues (straws) and by-products (oil cakes and brans). Straws, forage crops and natural herbages and tree leaves comprise the roughage portion of the livestock feed whereas oil cakes, other by-products (from cotton and cereals) and non-conventional feeds constitute the concentrate component. The predicted availability of the different feed resources for livestock for the year 1985 is given in Table 4. A report of the committee on Livestock Feeds and Fodder (1974) showed that there was a deficit of 8.5 million tonnes of concentrates, 40 million tonnes of dry fodder and 29 million tonnes of green fodder. The requirements of feeds and fodder were calculated as per the different feeding standards. The national awareness for increasing milk production in India urged the animal nutritionists to explore the possibilities of identifying non-conventional feed stuffs for livestock. The various centres of the Indian Council of Agricultural Research at Bhubaneswar, Trichur, Bangalore,

Table 3. Yields and cropping patterns — regional examples and national averages

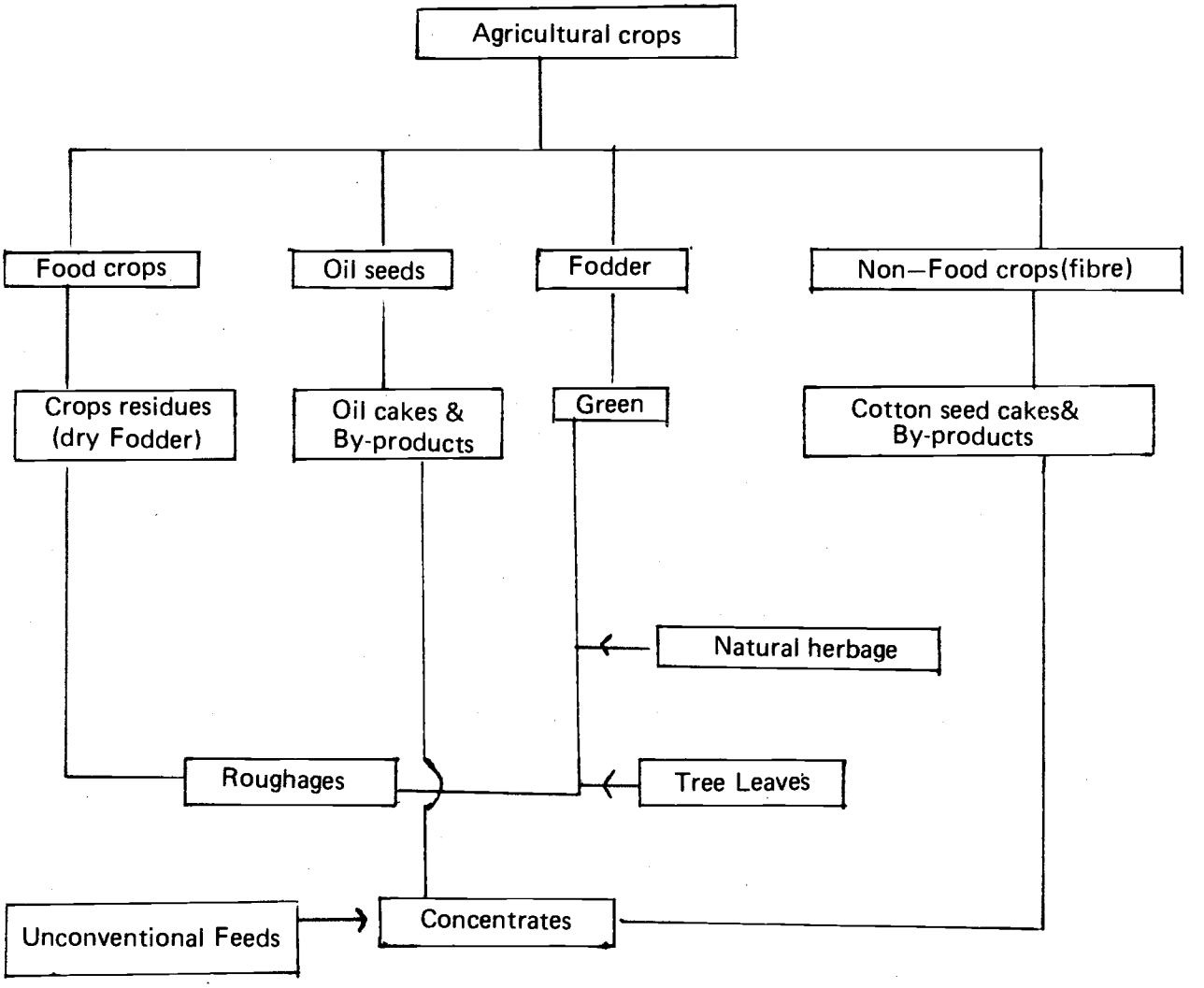
Region	Rice	Wheat	Jowar	Bajra	Potato	Groundnut
			(kg/ha)			
North	2,583	2,432	NA*	924	21,481	915
South	1,846	NA	942	1,010	11,839	882
East-west	1,143	2,040	NA	NA	14,410	—
West	1,218	1,475	556	808	30,382	1,006
National	1,088	1,387	667	554	11,573	747
Average	(23.0)**	(12.5)	(9.4)	(6.4)	(NA)	(4.2)

* *NA : Not available.*

** *Figures in paranthesis is % of cultivated land used for crop.*

Source: Estimates of area and production of principal crops in India 1978-79, Ministry of Agriculture, 1980.

Fig:1 Model of resources



Anand etc. and also the Indian Veterinary Research Institute, have identified more than 100 non-conventional items for feeding livestock. Anti-metabolites and toxic principles have been found in many of them. The major anti-metabolites plants are incorporating 60 to 70 percent agro-industrial by-products and unconventional feeds, thus minimising the utilisation of expensive oil cakes. Apart from these plants, there are 134 other feed plants in public and private sectors.

Table 4. Estimated availability of feeds and fodder (1985) (million tonnes)

No.	Item	Total quantity	Protein	By-pass protein	Met. energy
		..... (10^6 tonnes).			(10^6 MJ)
1.	Concentrates				
	i. Oil cakes	15.3	6.12	2.40	198900
	ii. Soybean meal	1.4	0.70	0.56	25480
	iii. Brans and churis	9.7	1.70	–	87300
	iv. Pulse by-products	2.5	0.50	–	27500
	v. Unconventional feeds	7.7	1.90	–	731500
	vi. Coarse grain	7.0	0.70	–	91000
	vii. Molasses	3.0	–	–	28500
	Total	46.6			
2.	Green Fodder				
	i. Cultivated green	351	8.41	–	631800
	ii. Natural herbage and tree leaves	430	5.16	–	688000
3.	Dry Fodder	316	12.64	–	1580000
	Total		37.83	2.96	4089980

are tannins, trypsin inhibitors, hydrocyanic acid, nimbidin, saponin and crysophenic acid. The names, nutritive value, the levels of incorporation in live-stock feeds and the anti-metabolites present are given in Table 5.

FEED INDUSTRY

The prospects for the livestock feed industry in the country are considered bright although the industry is still in its infancy. In 1978, the production of compounded cattle and poultry feeds was 0.66 million tonnes. In 1981, it rose to 1.7 million tonnes. The feed mill industry provides a nutritionally balanced feed which is less expensive than the oil cakes and meals. Under the Operation Flood Programme in India, a total of 34 plants have been envisaged to produce around 4,000 tonnes balanced cattle feed in a day. These feed

BALANCED LIVESTOCK FEED

The animal nutritionists definition of a balanced livestock feed, is a correct mixture of protein, energy, minerals and vitamins. However, the food mill industry defines it as one which is balanced in different aspects of feed milling technology such as nutrition purchase and production. This is a practical approach to produce nutritionally balanced feed at the least cost. Many times the formulation may not take care of the availability constraints of raw material and the production constraints of feed milling. The quality control specifies the standards for the nutrition value of the feed, raw material specifications, production specifications and also checks the various operations. This will enable the feed miller to produce and distribute balanced feeds at a reasonable price to the farmers (Fig. 2).

Fig. 2. Balanced livestock feed

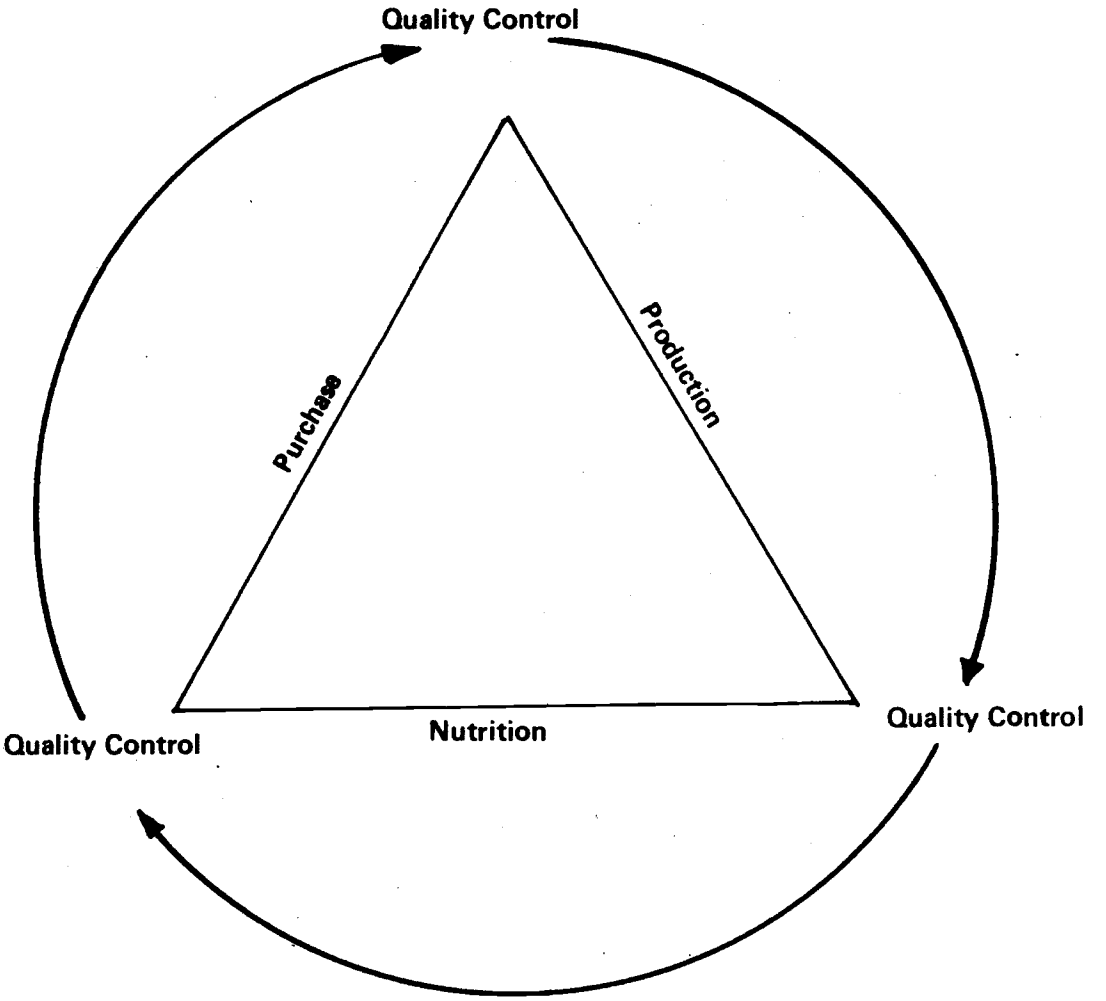


Table 5. Industrial wastes

No.	Unconventional seed/cake	Chemical composition & nutritive value (% on dry matter basis)						Level of incorporation (%)		Antimetabolite present, if any
		CP	EE	CF	TA	DCP	TDN	Cattle feed	Poultry feed	
	Fruit and Vegetable Canning Industry									
1.	Mango seed kernels	8.5	8.5	2.8	5.3	6.1	70.0	10	—	Tannin 5-10%
2.	Cashew apple waste	9.5	—	—	—	7.5	68.5	—	—	—
3.	Tomato pomace and citrus peel	26.7	21.0	21.4	5.8	14.3	41.0	—	—	—
	Sugar Industry									
4.	Molasses	2.4	5.3	—	3.0	—	55.0	10	—	—
	Meat Processing Industry									
5.	Fish meal	60.0	—	—	—	—	—	5 (Young calves)	5	—
6.	Meat meal. Offals Carcasses	—	—	—	—	—	—	-do-	5	—
7.	Blood meal	80.0	0.8	—	2.7	—	—	-do-	3	—
8.	Frog meal/waste	60.0	6.0	3.5	3.3	—	—	-do-	10	—
9.	Silk worm pupae meal	60.65	—	—	—	—	—	-do-	5	—
	Miscellaneous									
10.	Warai bran *(panicam milliaceum)*	8.0	3.5	25.0	15.0	4.5	55.0	20.30	—	—
11.	Guar meal	44.0	5.8	7.13	6.8	38.0	75.0	10.20	10	Residual guar-gum trypsin inhibitor
12.	Tappioca starch waste	5.0	1.0	19.0	5.6	2.0	60.0	20.25	—	—
13.	Cashew bran *(Anacardium accaidentale)*	16.9	29.0	6.5	3.7	—	—	—	—	Tannic acid 29.3% unpalatable
	Agricultural By-products									
14.	Cereals and other dry roughages	—	—	—	—	0.4	42.50	—	—	Silica & oxalates
15.	Rice husk	2.4	1.0	40.0	15.20	—	30.35	—	—	-do-
16.	Bagasse	3.5	1.8	36.0	10.7	0	43.0	—	—	—
17.	Sugarcane tops	3.5	1.7	29.0	8.5	2.0	41.0	—	—	—
18.	Tapiocca *(Manihot utilissima)*	15.2	3.7	9.8	7.9	—	—	—	—	Hyprocyanic acid
19.	Tapiocca leaf meal	15.4	12.2	22.0	8.5	8.3	45.5	10.20	—	Hydrocyanic acid 17.5mg/100mg.
20.	Coffee husk	7.7	2.5	25.5	5.4	3.0	50.0	10	—	Tannic acid 2.8%

No.	Unconventional seed/cake	Chemical composition & nutritive value (% on dry matter basis						Level of incorporation (%)		Antimetabolite present, if any
		CP	EE	CF	TA	DCP	TDN	Cattle feed	Poultry feed	
21.	Tea waste	28.0	3.0	18.0	6.0	9.5	43.0	20	—	Tannic acid 1.9%
22.	Coconut pith *(Cocos nucifera)*	1.8	2.4	19.3	5.4	—	—	—	—	Unpalatable
	Availability and Utilization of Agro-Industrial By-Products in Cattle Feed									
23.	Salseed *(Shorea robusta)*	6.5–9.0	1.0	2.35	3.63	—	41.0	10	5	Tannin–8.10%
24.	Neem seed *(Azadirachta Indica)*	11.0–25.0	—	—	—	8.4	60.0	—	—	Nimbidin Tannic acid-1-1.5% Unpalatable
	Availability and Utilization of Agro-Industrial By-Products in Cattle Feed									
23.	Salseed (Shorea robusta)	6.5–9.0	1.0	2.35	3.63	—	41.0	10	5	Tannin–8.10%
24.	Neem seed (Azadirachta Indica)	11.0–25.0	—	—	—	8.4	60.0	—	—	Nimbidin Tannic acid-1-1.5% Unpalatable
25.	Mahua seed (Madhu-calndica)	19.0	12.0	—	6.42	8.0	60.0	10.25	—	Saponin (Morwine)
26.	Babul seed	10.0–14.0	1.0	13.8	5.70	6.0–10.5	62.0–73.5	5–10	—	—
27.	Rain tree pods (Entero-lobium samon)	15.9	1.5	11.8	3.76	9.0	63.0	20% in goat	—	—
28.	Powad seed (Cassia tora)	21.0	7.7	—	—	16.6	59.4	5.10	—	Crysophenicacid.
29.	Tamarind seed	15.4	3.89	—	—	5.3	60.0	5	—	Tannins
30.	Date stones	5.99	6.89	10.5	2.65	0.8	62.0	—	—	—
31.	Sunhemp seeds (Crotolaria guncea)	35.0	3.7	10.0	5.3	30.8	70.3	—	—	—
32.	Sheria (Ambadi cake)	30.0	7.0	18.0	—	22.0	60.0	5-10	—	—
33.	Dhupa seed (Vateria indica)	6.3	9.8	7.0	4.4	—	—	—	—	Unpalatable
34.	Rubber seed (Hevea Brasiliensis)	25.0	11.0	4.0	8.5	17.0	70.0	10.20	—	Hydrocyanic acid 9 ml/100 gm
35.	Tobacco seed/cake (Nicotiana tabacum)	29.9	10.3	22.3	12.7	26.3	69.4	3.5	—	—
36.	Safflower seed/cake									
	Seed	19.0	27.5	30.0	7.8	—	—	—	—	—
	Cake	38.0	20.0	12.0	4.6	—	—	—	—	—
37.	Silk cotton seed cake	24.0	10.0	17.0	7.8	20.0	60.0	10.0	—	—
38.	Raple seed (Sataria etalica)		10.0	2.5	8.5	3.5	6.5	70.0	5.10	

No.	Unconventional seed/cake	Chemical composition & nutritive value (% on dry matter basis						Level of incorporation (%)		Antimetabolite present, if any
		CP	EE	CF	TA	DCP	TDN	Cattle feed	Poultry feed	
39.	Kokam cake (Garainia indica)	13.0	2.7	4.2	10.8	—	—	—	—	—
40.	Raramira cake (Eruca sativa)	32.0		9.0	7.0	7.5	—	—	—	—
41.	Prosopis juli flora seed/pods	14.3	4.1	15.8	4.8	—	—	10.20	—	—
42.	Karanj cake	27.2	9.0	4.9	3.0	—	—	2.4	—	Unpalatable

FEED FORMULATION

The important step in feed formulation is to decide on the product specification (Fig. 3). According to the nutrient requirement of the livestock, the nutritional composition of different feeds have been worked out (Tables 6 and 7). The feeds are manufactured in different forms such as; mash, pellets, cubes and blocks. Different raw materials are selected to produce a particular feed with the specified nutritional composition. These raw materials vary in their nutritional composition, and this determines the quality specifications. These specifications should be genuine and practicable. It may help the buyer to know what is being purchased and the supplier to know what should be supplied. Any dispute regarding the quality of the material can be solved once the specifications are available. The Indian Standards Institute has worked out specifications for various raw materials available in the country. Along with the quality specifications, processing specifications such as degree of grinding of the ingredients, molasses percentage, steaming, percentage of "fines" in pellets and also the moisture content and density of the final product, are also worked out. For cattle feed formulations linear programming is used to derive the least cost formula. The data sheet generally used is shown in Table 8.

PURCHASE OF RAW MATERIALS

The purchase of raw materials is based on quality specifications. Since large quantities of different by-products are being purchased, there is a possibility of variation in the chemical composition. Generally, the specifications laid down are for moisture, protein, ether extract, fibre, total ash, silica and various minerals. The toxic elements such as fluorine, aflatoxin and ergotoxin are also controlled by specifications. If the raw material is found to be unadulterated and free from harmful elements to livestock this could be accepted with certain rebate conditions. The rebates are being worked out for different nutritional motives for their excess on maximum limit as well as deficiency on minimum limit in between the rejection limits. However, the quality standards on the final product are not sacrified for short-term economic gain.

PRODUCTION

The processes involved in feed milling are cleaning, grinding, mixing, molassing, pelleting, cooling and packaging. Strict plant production control is exercised to maintain the quality of the finished product, to increase production and decrease the cost. Idle operations are discouraged. Weighing and conveying is done under strict supervision.

QUALITY CONTROL

The most important function in a feed plant is the quality control operation. The quality

Fig. 3: Specification and quality control in feedmill operations

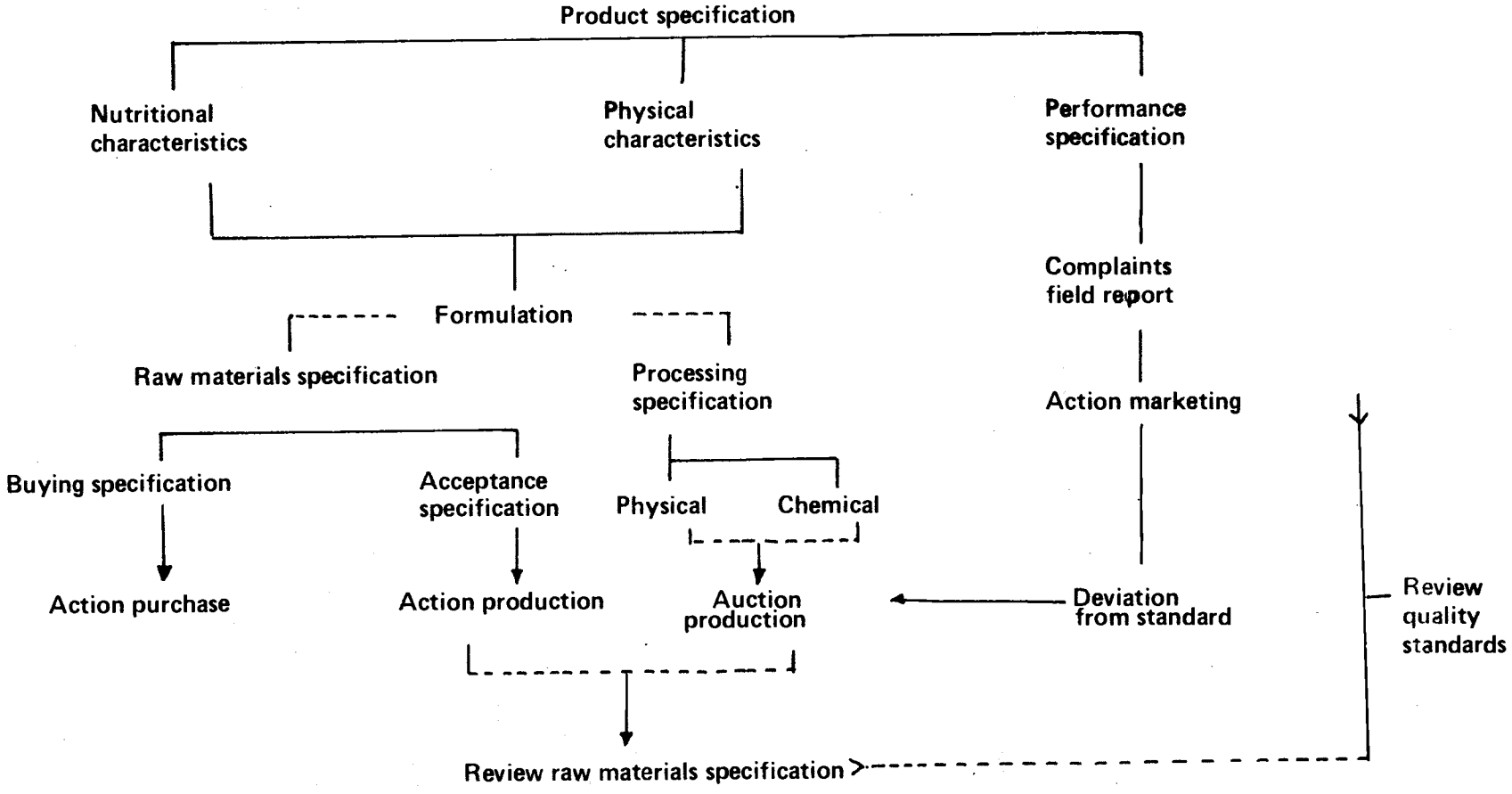


Table 6. Nutritive value of different types of feeds manufactured in India

No.	Analysis	Cattle feed-I	Cattle feed-II	Calf starter*	Poultry feeds					
					Layer	Grower	Broiler Starter	Broiler Finisher	Chick feed	Breeders
1.	Moisture	10	10	10	10	10	10	10	10	10
2.	Crude protein	22	20	22	18	16	22	19	22	18
3.	Ether extract	3.5	2.5	4.5	—	—	—	—	—	—
4.	Crude fibre	7	12	6.0	8	8	6	6	7	8
5.	Acid insoluble ash	3.0	4.0	2.5	4.0	4.0	3.0	3.0	4.0	4.0
6.	Calcium	0.5	0.5	1.0	2.75	1.0	1.0	1.0	1.0	2.74
7.	Phosphorus	0.5	0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.5
8.	Urea	1	1	—	—	—	—	—	—	—
9.	Vitamin A+D3 IU/kg	5000	5000	8000	8000	4000	6000	6000	4000	8000
10.	Common salt	2	2	2	0.6	0.6	0.6	0.6	0.6	0.6

** Kaira district cooperative milk producers union Ltd. (by author)*

Source: Indian Standards IS : 2052, 1979; IS : 1374—1979.

Table 7. Requirements for chicken feeds to be declared

No.	Items	Broiler starter	Broiler finisher	Chick	Growing chicken	Layers	Breeders
1.	Lysine (percent)	0.9	0.9	1.0	0.7	0.5	0.5
2.	Methionine (percent)	0.35	0.35	0.35	0.25	0.25	0.25
3.	Metabolisable energy Kcal/kg	2900	3000	2700	2700	2700	2800
4.	Manganese, mg/kg	60	60	55	55	55	55
5.	Iodine, mg/kg	1	1	1	1	1	1
6.	Iron, mg/kg	40	40	20	20	20	20
7.	Copper, mg/kg	4	4	2	2	2	2
8.	Zinc, mg/kg	50	50	—	—	—	—
9.	Vitamin D, AOAC chick units/kg	600	600	600	600	1200	1200
10.	Thiamine, mg/kg	2	2	6	6	6	6
11.	Riboflavin, mg/kg	5	5	5	5	5	8
12.	Pantothenic acid, mg/kg	12	12	10	10	15	15
13.	Nicotinic acid mg/kg	40	40	30	20	20	20
14.	Vitamin B_{12} mg/kg	8	8	15	15	15	30
15.	Biotin mg/kg	0.1	0.1	0.1	0.1	0.15	0.15
16.	Alpha tocopherol	20	20	10	10	10	20
17.	Linoleic acid, g/100g	1.0	1.0	1.0	1.0	1.0	1.00
19.	Sulpher amino acids g/100g	0.75	0.75	0.75	0.5	0.5	0.5
19.	Choline chloride	1400	1400	1300	—	—	1300

Source: Indian Standard IS : 1374 — 1979.

Table 8. Data sheet for least cost formulation

No.	Item	CP	DCP	TDN	Fat	Fibre	Silica	Cost	Individual constrain
1.	Maize	10	6	80	3	2	–	1400	–
2.	Jowar	9	5	79	3	2	–	1200	–
3.	Bajra	11	6	74	3	2	–	1300	–
4.	Tapioca chips	2	–	75	1	2	–	1000	UB 7
5.	Coconut cake ext.	27	18	75	1.2	9	2	1200	–
6.	Guar meal	56	50	75	7	3	–	1200	UB 14
7.	Salseed ext.	10	–	40	1	2	2	500	UB 5
8.	Groundnut ext.	45	42	75	1	10	2	1300	–
9.	Soybean ext.	54	50	75	2	7	1	1700	–
10.	Groundnut cake	37	35	75	7	12	2	1400	–
11.	Sunflower cake	32	21	51	1	18	2	1000	UB 7
12.	Safflower cake	20	15	51	1	36	2	700	UB 7
13.	Rice bran ext.	16	10	55	1	14	6	560	UB 40
14.	Wheat bran	15	12	65	3	7	–	1000	UB 12
15.	Maize bran	12	10	55	2	10	–	750	UB 16
16.	Rice polish	13	10	80	16	7	5	1200	UB 16
17.	Cotton seed ext.	40	38	75	1	10	2	1600	UB 10
18.	Cotton seed bran	4	–	45	–	36	2	400	UB 7
19.	Groundnut shells	5	–	40	–	55	4	250	UB 5
20.	Molasses	–	–	59	–	–	–	150	UB 11 LB 11
21.	Calcite powder	–	–	–	–	–	–	200	UB 2
22.	Mineral mixture	–	–	–	–	–	–	2000	LB/UB 1
23.	Salt	–	–	–	–	–	–	200	UB 1 UB 2

Formula Specification:

CP = 20 percent minimum
DCP = 14 percent minimum
FAT = 3 percent minimum
Fibre = 10 percent maximum
Silica = 3 percent maximum
TDN = 65 percent minimum

Group Constraints

1. *Grains 7 percent minimum*
2. *Brans 40 percent maximum*
3. *Grinding 60 percent maximum*
4. *Unpalatable 25 percent maximum*

control helps in the purchase of good quality raw materials, provides the required nutrients in the feed, controls the production cost and maintains the quality of the stored products (Fig. 2).

Purchase

The raw materials are samples properly analysed before acceptance. The materials with tolerable limit are accepted with rebate but sub-standard materials are rejected outright.

Production

The variation in the usage of different raw materials is controlled. Timely advice regarding the quality of the finished product helps to avoid re-processing. The finished products are analysed to check the quality.

Storage

To prevent spoilage of the stored materials, different measures have been taken such as cleaning, proper stacking, insecticide spray, fumigation and rodent control. Occasional checking of raw materials for moisture, rancidity and infestation will avoid possible spoilage and losses.

In any case the quality control guarantees the

Table 9. Indian Standard Institute specification for raw materials and livestock feeds

1.	Oil Cake	
i)	IS : 1712 – 1970	Specification for cotton seed oil cake as livestock feed.
ii)	IS : 1713 – 1970	Specification for decorticated groundnut oil cakes as livestock feed.
iii)	IS : 1932 – 1972	Specification for mustard and rape oil cakes as livestock feed.
iv)	IS : 1934 – 1961	Specification for sesamum (Til) oil cake as livestock feed.
v)	IS : 1935 – 1961	Specification for linseed oil cake as livestock feed.
vi)	IS : 2151 – 1962	Specification for maize germ oil cake.
vii)	IS : 2154 – 1972	Specification for coconut oil cake as livestock feed.
viii)	IS : 2503 – 1963	Specification for decorticated Safflower oil cakes as livestock feed.
ix)	IS : 3440 – 1966	Specification for solvent extracted linseed oil cake as livestock feed.
x)	IS : 3441 – 1966	Specification for solvent extracted groundnut cake as livestock feed.
xi)	IS : 3591 – 1968	Specification for solvent extracted coconut oil cake as livestock feed.
xii)	IS : 3592 – 1968	Specification for solvent extracted cotton seed oil cake as livestock feed.
xiii)	IS : 3593 – 1968	Specification for solvent extracted rice bran as livestock feed.
xiv)	IS : 5862 – 1970	Specification for solvent extracted niger seed oil cake as livestock feed.
xv)	IS : 6242 – 1971	Specification for solvent extracted safflower oil cake as livestock feed.
xvi)	IS : 7061 – 1973	Sovlent extracted sal seed meal.
xvii)	IS : 1714 – 1960	Methods of sampling and test for oil cakes as livestock feed.
2.	Grain By-Products	
xviii)	IS : 2152 – 1972	Specification for maize glutten feed.
xix)	IS : 2153 – 1962	Specification for maize bran.
xx)	IS : 2239 – 1971	Specification for wheat bran.
xxi)	IS : 3160 – 1965	Specification for tur chuni.
xxii)	IS : 3161 – 1965	Specification for gram chuni.
xxiii)	IS : 3162 – 1965	Specification for gram husk.
xxiv)	IS : 3163 – 1965	Specification for rice polish.
xxv)	IS : 3648 – 1966	Specification for rice bran.
xxvi)	IS : 4193 – 1967	Specification for guar meal as livestock feed.
xxvii)	IS : 5063 – 1969	Specification for tur husk.
3.	Animal Waste and Other Agricultural/ Industrial By-Products	
xxviii)	IS : 1162 – 1958	Specification for cane molasses.
xxix)	IS : 1509 – 1972	Specification for tapioca as livestock feed.
xxx)	IS : 4307 – 1967	Specification for fish meal as livestock feed.
xxxi)	IS : 3336 – 1965	Specification for shark liver oil for veterinary use.
xxxii)	IS : 5064 – 1969	Specification for tapioca spent pulp.
xxxiii)	IS : 5005 – 1969	Specification for meat meal and meat cum bone meal as livestock feed.
xxxiv)	IS : 6107 – 1971	Specification for dried silk worm pupae as livestock feed.
xxxv)	IS : 7060 – 1973	Specification for blood meal.
xxxvi)	IS : 3198 – 1965	Specification for fodder yeast.

Source : Indian Standard Institute, New Delhi.

performance of the product.

In India the feed control laws are not enforced. However, the Indian Standards for different raw materials and finished products are available. The Indian Standards Institute (ISI) has formed Animal Feed Sub-committee, comprising scientists, practitioners, technologists, feed manufacturers and farmers. Generally, the products sold in the market with the certification of ISI are

trusted for quality. The different ISI standards are given in Table 9.

EXPORT OF FOOD AND FEEDS

The export of oilseeds, oil cakes and food materials for the period April, 1978 – March, 1979, is given in Table 10. 18,000 tonnes of oilseeds, 14 million tonnes of oil cakes and 7,000 tonnes of food materials were exported during 1978-79. India does not import feed stuffs from other countries. However, there are imports of oilseeds, rice and wheat.

MAIN FEEDING SYSTEMS

The need for draught power is a pivotal element in the farming operations and determines priorities in feeding. During the seventies, alongwith the "Operation Flood" programme, the milch stock were also given priorities. The co-operative infrastructure created by the project in the rural milkshed area gave a new hope for the milk producers, especially the landless and small farmers. India's non-descript cows *(Bos indicus)* which are randomly bred can survive on a low plane of nutrition and can produce calves (and limited quantity of milk), while consuming mainly coarse roughages of high fibre content such as straw/ stover.

The Indian buffaloes can make better use of roughages than cattle and produce more milk fat. The disadvantages are that even if fed scientifically the non-descript cow uses 44 percent of intake, and the buffalo 60 percent of intake, for milk production whereas an exotic cow utilises 65 to 70 percent of the intake for milk production.

The feeding of Bovines in India is directly dependent on the economic return. Various scientific feeding regimens. have been suggested. e.g. the Sen and Ray Feeding Standard of India, which is similar to the Morrison standards Mullick and Kehar (1952) and Mudgal (1969) suggested that Indian cattle require 20 percent less nutrients than other breeds, but this is not valid. Recent results (Ranjhan et al. 1975, Katiyar 1971; Patle and Mudgal 1976) indicated that lactating cows require the same amount of ME, or even more than what is recommended by NRC.

Feeding requirements (theoretical approach)

Animal	Maintenance		Milk production	
	Energy (ME) Kcal/ $W^{0.75}$ kg/day	DCP g/W $(kg)^{0.75}$	Energy (ME) Kcal/ kg FCM*	Dig.N per 100g milk N
Cow	131	2.31	1170	150
Buffalo	158	2.81	1170	150

*1 kg FCM=750 Kcal

It is observed that when the nutritional requirements of body maintenance are satisfied, the additional nutrients are converted into milk yield. It is theoretical to believe that the increase of milk production is linear to the incremental feeding. In fact, the response of milk production increases till it reaches the genetic potential. It is clear from Fig. 4 that the increase of milk production after 9 litres is not as steep as below 9 litres. Hence the maximum profit return for the farmer could be that point.

ECONOMIC FEEDING REGIMEN (FUTURE APPROACH)

About 55 to 60 percent of the cost of milk production is for feed. The most expensive component is the concentrate. The economics of milk production depends on the degree to which the quantity of concentrates can be reduced without affecting the milk yield. Fig. 4 represents the economic feeding rate. AB represents the conventional feeding rate as per the scientific principles and CD the response by reducing 40 percent of the concentrates increasing the crop residue intake. The net profit in the case of CD is much greater. In India, where a majority of the milch animals are low producers and the economy of milk production depends on the crop residue feeding, a new approach which maximises the crop residue utilisation will be desirable. The ideal way for that is by manipulation of rumen fermentation.

MANIPULATION OF RUMEN FERMENTATION

Leng (1981) proposed that the nutritional

Fig. 4: Milk production response

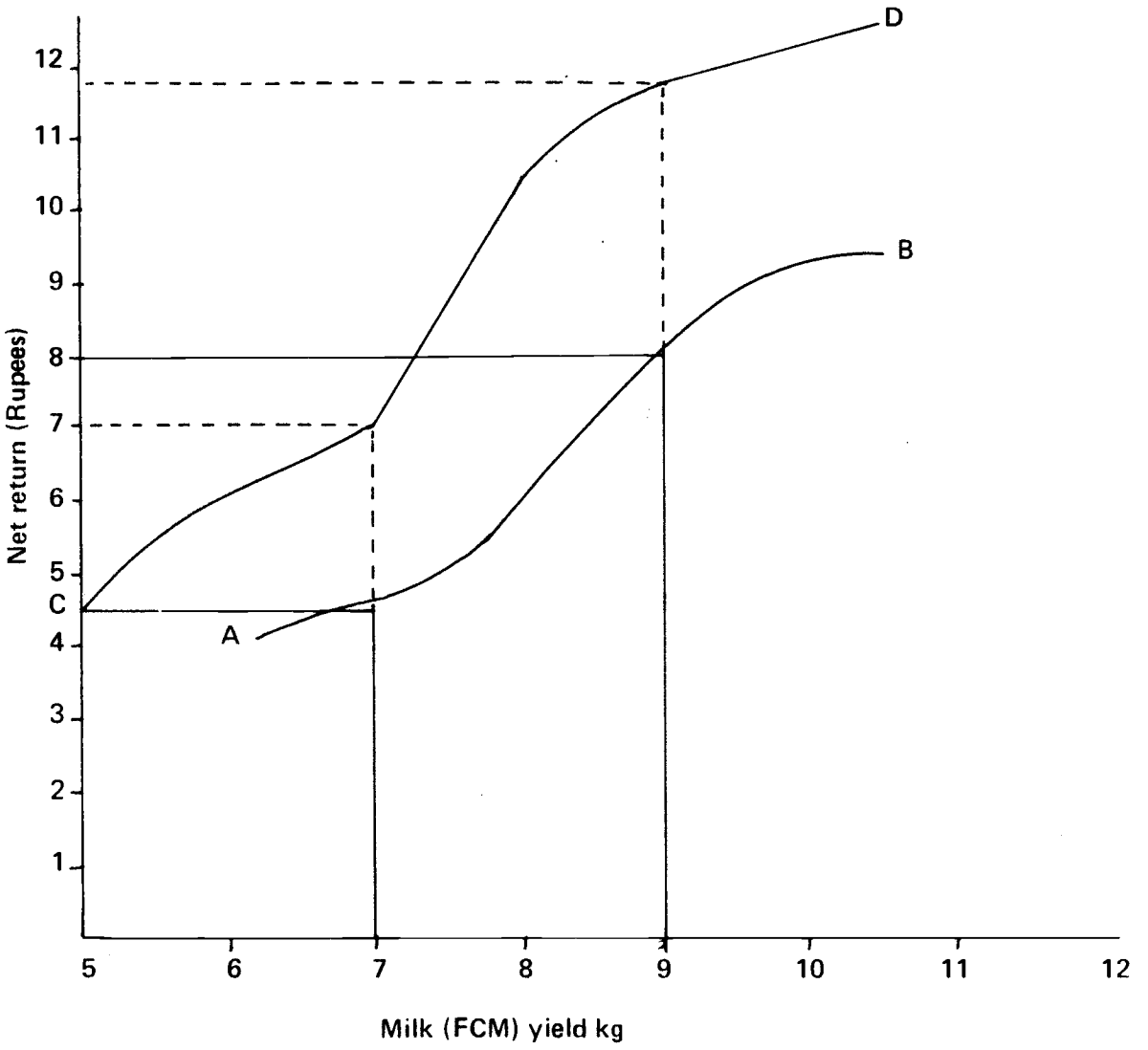


Table 10. Exports of oil seeds and oil cakes from India (April 1978–March 1979)

No.	Item	Quantity (Tonnes)	Value (Rupees Million)
Oil Seeds			
1.	Copra	566	1.73
2.	Groundnut kernel H.P.S.	4,055	26.4
3.	Groundnut shell H.P.S.	4,445	28.8
4.	Cotton seed	312	0.27
5.	Mustard seed	2	0.002
6.	Sesame seed	2,725	18.4
7.	Niger seed	5,915	61.8
8.	Safflower seed	1.5	0.0002
		18,021.5	
Oil Cakes			
1.	Soybean extraction	52,500	87.1
2.	Groundnut extraction	538,493	740.9
3.	Decorticated cotton seed expeller	55,038	66.4
4.	Decorticated cotton seed extraction	115,077	180.4
5.	Linseed oilcake expeller	1,696	0.24
6.	Linseed oil cake extraction	25,111	36.38
7.	Sunflower seed extraction	973	0.70
8.	Rape mustard extraction	11,192	11.10
9.	Copra oilcake expeller	301	0.24
10.	Copra oilcake extraction	4,856	0.38
11.	Mowza oilcake expeller	396	0.22
12.	Kardi oilcake extraction	14,106	8.75
13.	Sesame seed extraction	5,541	7.97
14.	Sesame seed expeller	674	0.99
15.	Mango kernel extraction	3,979	1.79
16.	Sal oil cake extraction	13,473	0.84
17.	Other oilcake expeller	755	0.26
18.	Other oilcake extraction	315	84.99
19.	Compounded animal feed	61,363	
20.	Rice bran extraction	478,826	196.16
		13.84 million	
Food			
1.	Fish	78	2282.6
2.	Cashew kernal	27	802.3
3.	Sugar	7.3	1319.2
4.	Coffee	6,630	1440.6
5.	Tea	172	3404.5
6.	Spices	97	1480.5
		70,11.3	

Oils oilseeds J. Feb–March 1981 P 29/Food Digest Vol. No. 4 October–December, 1981

Source: Directorate General of Commercial Intelligence and Statistics Ministry of Commerce, Civil Supplies and Cooperation.

requirements of ruminents in India are best understood by considering first the need for an efficient rumen fermentation which may increase the efficiency of low cost feed utilisation to increase the productivity of the animal. A highly efficient rumen fermentation can be achieved by:

* Increasing the feed intake.
* Increasing the microbial population.

Intake

The intake of feed is controlled by (a) distension of rumen (b) VFA concentration (c) regulation of energy balance (d) amino acid absorption apart from the factors such as palatability, climatic effects and the physiological status of the animal. The low rate of fermentation of straw may not provide enough substrate for cellulolytic organisms. Addition of readily and totally fermentable energy sources to the diet may possibly increase the availability of substrate for the colonisation by cellulolytic organisms. This may increase the rumen turn-over reducing the distension and increasing the intake. Feeding of urea along with bypass protein has increased the feed intake (Kempton and Leng 1979; Orskov et al., 1973).

Increasing Microbial Population

The major factors that affect microbial protein synthesis in the rumen on straw-based diets are:

a) availability of potentially fermentable feed.
b) availability of precursors of microbes such as glucose, amino acids, ammonia and minerals.
c) Maintenance of ATP requirements of the micro-organisms.
d) Microbial turnover and lysis

When the objective of the feeding strategy is the production of meat, milk and wool then any manipulation of rumen fermentation must be aimed at maximising microbial protein output. Any manipulation which maintains a large pool of organisms in the rumen will increase the rate of colonisation and degradation of straw particles (Nielson 1983).

For maximum cell production, rumen ammo-

nia level, should not be less than 5–8 mg/100 (Sattar and Slyter 1974). A number of studies have emphasized the need for a continuous supply of NH_3 in the rumen in order to maintain higher intake and digestibility of fibrous diets (Romero et al., 1970; Campling et al., 1962).

When the fermentation of roughages is maximised, the degradation of dietary protein has to be minimised. If 100 g dietary amino acid is fermented in the rumen, the availability of microbial protein is about 9 g only, out of which the productive protein is only 4 g (Leng, 1981) which is a waste as far as the feeding economics is concerned. However, the nitrogen requirement of the microbes has to be fulfilled. The empirical evaluation of dietary nitrogen as DCP does not take full account of the effect of ruminal fermentation, nor of the close relationship between energy availability and N requirements and cannot predict with sufficient accuracy the true availability of protein for production in the body (Veritie *et al* 1979: ARC 1981). In India, where concentrates (oil cakes, meals and cereals) are quite expensive, supplying soluble N from cheap sources such as NPN and unconventional feeds; energy from roughages after efficient fermentation in rumen; and the extra productive protein from bypass protein is quite imperative. This can be done on a straw based diet by supplying fermentable N and fermentable energy constantly using a urea = molasses animal lick, and also concentrates with certain amount of bypass protein.

FEEDING OF POULTRY

Rearing of poultry on Kitchen wastes in the backyard has been practised for generations in India. Recently, improved poultry husbandry methods have been started. In practice, birds are fed *ad libitum* and, therefore, the necessity for having a requirement for energy and protein is probably an academic exercise. On *ad libitum* feeding, birds will normally tend to adjust intake voluntarily to their individual requirements for nutrients which can vary with factors such as environment, breed, liveweight, balance of nutrients in the diet, and for layers, on the rate of egg production. The requirement of energy is expressed in terms of Metabolisable Energy (ME). The protein requirements are assured by amino acid analysis of rapid growing chickens at say, weekly intervals determining by difference in composition of new tissue added, during growth. The protein level in starting rations for chickens is about 20 percent, but it is lowered as the chickens increase in weight.

For layers it has been worked out according to the nutrient content of the egg. An egg weighing two ounces will contain about 7.5 g protein, 2 g calcium and about 95 calories of gross energy. The basal heat production of an adult hen is about 2.75 calories/kg BW per hour. The requirement of energy and protein of hens is worked out after calculating their basal heat production, activity requirements and nutrients stored in eggs.

In general, when lower feed intake is noticed then the concentration in nutrients is increased.

FEEDING OTHER LIVESTOCK

Goats: There are different breeds of goats in India and their milk production varies from 60 to 250 litres for 120 days of lactation. A majority of goats prefer browsing rather than grazing. Goats can well utilise the coarse fibrous feed but for efficient production the energy losses in heat production and digestion process have to be minimised to get a maximum return in the form of edible products.

Sheep: Sheep prefer pastures and ranges as their natural habitat. In India the maximum concentration of wool-yielding sheep is in the arid region of the northern plains comprising Rajasthan, Kutch, Saurastoa and North Gujrat. The sheep in India generally live on grazing wild grasses, herbs and farm waste products.

Pigs: Commercial hog industry has not yet been developed like wool and poultry industry because (1) pork is not eaten by a majority of meat eaters in India (2) pigs compete directly with humans for the cereals. Therefore the common village hog in India is a scrub animal and lives on kitchen waste and night soil. However, in recent times a number of piggeries have been established where hogs are reared on scientific principles.

SUMMARY

India has a large livestock population. Feeding the draught animals as well as milch animals is the priority for rationing the available feed stuffs. The available feed stuffs are mainly crop residues, agro-industrial by-products and unconventional feed stuffs. The compound feed industry is still in its infancy. However, a rapid increase in the near future is expected. Feed formulation, compounding and quality control are done on scientific principles. There is an export of oilseeds, oil cakes and food material from India. The import of feed materials is negligible. The feeding of bovines is not practised on scientific principles. An approach to the utilisation of crop residues for better conversion efficiency is proposed. The net return could be increased by giving urea-molasses licks and by-pass protein from crop residues. The feeding of poultry and other livestock is also discussed.

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