

DEVELOPING A FEEDING PROGRAM FOR DAIRY CATTLE IN
MYSORE STATE, INDIA

by

RAJAGHATTA NANJAPPA RAJANNA

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INTRODUCTION

Situation

The state of Mysore is one of the 16 states in India. It is situated in the Peninsula of the Deccan, surrounded by the Arabian Sea to the west, the states of Madras and Kerala to the south, Andhra Pradesh to the east and Bombay to the north. The state of Mysore extends over an area of 74,122 square miles. For administrative conveniences the state has been divided into four divisions and further subdivided into 19 districts. The districts are further divided into smaller units called Taluks, which also form the unit of developmental activities. These areas are called development blocks. The state is situated in the northern hemisphere between latitudes 15° and 20° north and longitude 75° and 80° east. The state varies in elevation from 72 feet above sea level (Mangalore) to 3,021 feet above sea level (Bangalore). The temperature throughout the year is moderate, ranging from 50° to 60°F during January and from 90° to 100°F during May and June (10).

Population

The population of the state as per 1961 (random checking) is 23,547,081 with a density per square mile of 318 (7b). The population is distributed into various social and economic groups. As in any other part of India the majority of the people live in small groups of communities called villages. Based on their main occupation the population of the state can be classified into two groups.

Rural Population. People in this classification live in villages, the population of which ranges from less than 500 to over 10,000. There are 25,875 such villages in Mysore (39). Based on population these villages are grouped into the following categories:

<u>Village population</u>	<u>Number of villages</u>
Over 10,000	5
5,000 to 10,000	180
2,000 to 5,000	972
1,000 to 2,000	2,869
500 to 1,000	5,632
Less than 500	16,320

Urban Population. This class includes towns, the population of which ranges from 5,000 to over 100,000. There are 289 such towns in Mysore (39). Based on the population the towns are grouped into the following categories:

<u>Town population</u>	<u>Number of towns</u>
Over 100,000	5
50,000 to 100,000	8
20,000 to 50,000	20
10,000 to 20,000	59
5,000 to 10,000	137
Less than 5,000	60

Of a total of 3,428,391 households in Mysore 77.9 percent are in rural areas (1961 random checking) (7b). The following are some of the big cities in Mysore State with a population of over 100,000 (39):

Bangalore	1,300,000 (1961 random checking)
Mysore	250,000

Kolar Goldfield	159,000
HUBLI	129,000
Mangalore	117,000

Rainfall

Average rainfall in Mysore is about 36 inches (39). The rainfall is mainly seasonal in distribution:

March to May	5.47 inches
June to September	22.27 inches
October to November	7.54 inches

The rainfall in various parts of the states varies from only about 15 to 25 inches in some parts (Kolar district) to about 129 inches in the Mangalore district. Because of the variation in rainfall and low rainfall very often there are reports of failure of crops in some districts. Failure of crops due to very heavy rainfall and floods, so often reported in many parts of India, is not a feature in Mysore State.

Soils

The soils of Mysore are divided into four main kinds, viz., trap soils, associated red and black soils, red soils, and lateritic soils (37).

Trap Soils. These soils are derived from the Deccan trap and occupy large areas in the Districts of Belgaum, Bijapur, Gulbarga and Bidar. These soils are good for growing jowar, pulses and cotton.

Mixed Red and Black Soils. Soils derived from Gneisses and Schists are from mixed geological parent material. These soils are found in Belgaum, Dharwar and Bellary districts. These soils are good for the crops of peanuts, cotton, and jowar.

Deep Black Soils. Deep black soils are found in the districts of Bijapur, Dharwar, Bellary, Raichur and Chitldurg. These soils are fertile and can grow good crops of cotton, jowar, wheat, etc.

Red Soils. These soils occur in Kolar, Bangalore, Tumkur, Mandya and Mysore districts. Red soils are generally poor in plant nutrients but respond well to irrigation and manuring. Ragi is mainly grown as a rainfed crop. Paddy (rice), sugarcane and other crops are grown chiefly under irrigation.

Red Loams. These soils occur in a long strip in the district of Shimoga, Chikkamagalur, Hassan, Mysore and Coorg. They are richer than red soil and support coffee, areca and cardamum.

Lateritic Soils. These soils occupy the heavy rainfall districts of north and south Kanara, part of Coorg, Hassan, Chikkamagalur and Shimoga districts. They are acidic in nature and deficient in lime and other nutrients. Paddy (rice) is the main crop. Coffee, tea and coccoanut are also grown.

Dark-brownish Clayey Soils. These soils occur in some areas of Coorg and Mysore districts. This area is rich in forests.

Among the above soil groups it may be generally stated that the dark or black colored soils are usually well supplied with plant nutrients such as nitrogen, potash, and phosphoric acid and are also rich in their contents of bases such as lime and magnesium. They also possess a good texture and high colloidal contents which make them highly retentive. However, adverse soil conditions such as salinity and alkalinity are found to occur in these soils. The red and lateritic soils, on the other hand, tend to be comparatively poorer in their plant nutrient contents and also suffer from conditions of deficiency of lime and other bases, leading to soil acidity.

Vegetation

Because of the dense population of the state and the majority of people depend entirely on agriculture the amount of land per capita is only 2.13 acres (39). Since the farmer needs to grow enough grains for himself it is impossible for him to keep a portion of his land for pasture or for growing grains exclusively for his cattle (35). The entire land can be classified as follows (45):

Area under Cultivation; 24,897,000 acres.

Area under Pasture (these are called Gomals); 6,560,000 acres.

In the past each community had an extensive area of land on the outskirts of the village, depending on the number of cattle in the village, left for grazing of cattle. These were called "Gomals", meaning 'Cattle Areas'. It was for the villages to improve these Gomals as a community work, plant shade trees and put up contour bunds to prevent erosion of soil. With the increasing population and greater demand for food grains a good part of these gomals have been given away to farmers for cultivation. For unexplainable reasons the care of the available pasture land also has been very little. As a result, today, the Gomal lands are of absolutely no benefit to the cattle.

Area under Forests. The forest area in the state of Mysore occupies 13,556 square miles. A large proportion of this area, about 4,300 square miles, serves as grazing land (45). This can be improved to become a better source of feed for cattle in Mysore State.

Livestock

As per the livestock Census of 1956 the following was the number of cattle, buffaloes, sheep, goats, etc., in the state of Mysore (39):

Cattle	8,965,700
Water buffaloes	2,668,700
Sheep	4,059,500
Goats	2,584,000
Pigs	185,500
Horses, Ponies, Donkeys	102,000

From the above figures it is evident that there are a little over 50 cattle and buffaloes for every 100 persons besides another 50 domesticated animals and birds (Poultry) for every 100 persons.

Of the above mentioned cattle population the following is the number of cattle and buffaloes, classified according to their performance (39):

I. Cattle population

A. Cattle (Males over 3 years)

	In thousands
Breeding bulls	46.2
Working bullocks	3222.6
Others	151.0
Total	3419.8

B. Cattle (Females over 3 years)

Cows in milk (all breeds)	1183.2
Cows dry and not calved	1724.6
Working cows	267.3
Others	33.7
Total	3208.8

C. Young Stock (3 years and under)

TOTAL CATTLE	8965.6
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II. Buffalo population

A. Buffaloes (Males over 3 years)	
	In thousands
Breeding bulls	17.5
Working bullocks	248.6
Others	14.7
Total	280.8
B. Buffaloes (Females over 3 years)	
Buffalo cows in milk	767.5
Buffalo cows not calved	648.9
Buffalo cows used for work	17.9
Others	25.0
Total	1459.3
C. Young Stock 3 years and under	929.1
TOTAL BUFFALOES	2669.2

In Mysore State, like the rest of India, there are large numbers of domestic animals. But the quality of the livestock is generally poor. In Mysore, where over 70 percent of the people are directly engaged in agricultural pursuits, cattle are essential for agricultural operations. Maintenance of livestock for milk and meat is secondary. So the milk yielding capacity of the cow or buffalo in Mysore is very low. The average milk production of cows in Mysore is the lowest in the world.

Milk Production and Utilization

Considering the dairy industry in the state of Mysore it may be said that the industry is in its lowest ebb (35). It has been estimated that the amount of milk produced in the state is 17,949 thousand mounds annually (39)

(one moud = 80 pounds). This amounts to about 3.4 ounces of milk per person per day (39). This too is not uniform because consumption of milk and milk products has increased considerably in the larger cities. The economic condition of a village farmer forces him to sell all the milk he produces to the city dweller, without keeping anything for himself. Consequently the villager and his dependents do not get even minimum requirement of animal protein. For many persons, milk and milk products form the only source of animal protein, as they do not eat meat.

The 17,949 thousand mounds of milk produced in Mysore State is utilized as follows (39):

	Thousand mounds	Percent
Fluid milk	5905	32.3
Converted into ghee	7682	42.8
Converted into dahi (yogurt)	1525	8.5
Converted into butter	2208	12.3
Converted into khoa (condensed)	467	2.6
Converted into ice cream	72	0.4
Converted into cream	90	0.5

Furthermore, following independence there is a rapid growth of cities. The country is developing industrially; as a result there is a slow mobilization of population from villages to cities to work in factories. The workers in the industrial concerns are in a better position financially than the villagers. They are now learning the importance of animal protein in their diet. They are now slowly developing a liking for milk. Thus, there is a greater demand for milk in the cities. With increased education and better knowledge of health the farmer also has learned the importance of milk in the

diet. The farmer is now willing to sell only a portion of milk produced by him since he wants some for his own family. As a result there is a scarcity of milk both in rural and urban areas.

In an attempt to solve the situation arising out of the increased demand for milk, it has become absolutely essential that various necessary steps be taken. In Mysore there are already too many cattle and therefore it will not be a sound idea to increase the number of cattle. The only other alternative is to take necessary steps to improve the present productive capacity of the cattle.

Any sound program for the improvement of cattle towards better production should include (1) judicious feeding, (2) better breeding practices, (3) good management, and (4) disease control.

The Government of India, the state government and the various associated organizations are taking necessary actions for improvement of livestock. Various breeding programs have been drawn and are in progress. The disease control program is definitely on a more sound footing than it was ever before. There is, therefore, an ever increasing need for developing a better feeding program. The good management usually follows. It is said (45) that by proper feeding alone the milk production capacity of cows in India can be increased by 300 percent.

Of the 11,634,400 cattle and buffaloes (1956 Census) only 1,850,700 (about 16 percent) were producing, and 2,373,000 (about 20 percent) were not calved, thus making 4,223,700 cows and buffaloes of milk producing ability. In Mysore it is estimated that there are 3,428,391 households in rural areas. Taking for granted that all the cows and buffaloes of milk producing ability are located in among these rural households there will be 1.25 cows and

buffaloes per household or 100 cows for every 80 households.

From the above facts it can be seen that improvement of milk production in the state of Mysore is not an impossible task. Any attempt at improvement of milk production must therefore be based on knowledge of

- (1) The number of cattle of milk producing ability upon which the program is to be concentrated.
- (2) Available feeds, roughage and concentrates, their feed values and suitable methods of improvement of the feeds.
- (3) The present milk producing ability of the cattle and desired and expected milk production within a prescribed period for which a plan is to be drawn up.
- (4) How best to make up the deficit of feeds by supplementing with better variety feed stuffs, minerals, vitamins and food additives.
- (5) Means to make the farmer accept these suggestions and make him apply these suggested improvements. This is the most important factor to consider.

A farmer in Mysore, like any of his counterparts elsewhere, does not like to make changes. More so when the suggestions hitherto given to him were more theoretical and sounded so high that he thought that it was impossible to practice any of them. Therefore, it is absolutely necessary that the improved feeding practices so developed are easy to understand and not expensive to practice.

IMPORTANT BREEDS OF DAIRY CATTLE IN MYSORE

The important breeds of cattle in Mysore (not dairy purpose animals) are the Hallikar and Amrith Mahal, which are renowned as the fast walking draft breed (8).

History of an organized dairy department dates back to the 16th century when the rulers of Mysore had established the "Amrith Mahal Department," literally meaning Department of Milk (14). However, the Amrith Mahal and Hallikar breeds became less and less efficient as milkers and more efficient as draft breeds. Even though Amrith Mahal and Hallikar cows are milked, their importance as milk cattle is very small.

Since the demand for milk increased with the growing population, many breeds of cows, primarily milk producing strains, whose homeland is in other parts of India and Pakistan, are being bred and maintained in most cities and towns of Mysore State. The most important of the dairy cows in Mysore are: (1) Red Sindhi, (2) Sahiwal, (3) Gir, and (4) Hariyana.

During preindependence days, Bangalore, the capital city of Mysore, was one of the military stations and also a summer resort for many Europeans living in India. Quite a few Holstein-Friesian cattle, mostly bulls, were imported. As a result of breeding between the native and the foreign breeds a number of quite distinctive dairy cattle can be seen. They are popularly known as "crossbreeds." They are classified according to the body color as, black and white, red and white, or brindle and red (35).

Red Sindhi. Sindhis as a rule are small in size, thus they are very useful for areas where larger animals are not needed and where feed conditions preclude the use of large animals. Sindhis are reported to have a capacity to adapt themselves to varying conditions of soils and climate (9).

The breed has a deep compact frame, with round drooping quarters. The color varies from dark red to dun yellow. Occasionally specks of white are seen in the dewlap and forehead (11). For bulls the color is likely to be dark at the shoulders and thighs.

Mature cows weigh around 650 to 700 pounds and bulls up to 1,000 pounds. The average milk production per lactation is about 3,500 pounds in 274 days. But in some herds the average production is as high as 6,778 pounds. Butterfat content ranges from 4 to 5.7 percent, while solids not fat varies from 8.9 to 9.7 percent (14).

Sahiwal. Sahiwal is a very heavy breed with symmetrical body and loose skin. The animals are usually long, deep, rather fleshy, short of leg, comparatively lethargic and heavily built (11). They are commonly of reddish dun color but many are pale red, while dark brown and almost black colorings splashed with white, are occasionally seen. The forehead is medium sized in females, but broad and massive in males. The neck is short while the dewlap is large and heavy. The mature female weighs 900 pounds on the average and the male 1,000 pounds.

Sahiwals have been used for grading up of low producing scrubs (14). It is interesting to note that in a herd whose average milk yield was 500 pounds per lactation, the grading up program increased milk yield to 2,500 pounds in three generations (14).

The average milk yield per lactation is about 4,500 pounds, but individual records of over 10,000 pounds in normal lactations of 305 days have been recorded (35, 39). The average butterfat content has been recorded as 4.65 percent and solids not fat 9.20 percent.

Hariyana. Animals of the Hariyana breed are well proportioned and compact in build. The neck is moderately long, thin, and fine. The dewlap is small, thin and free from folds. Females have medium sized humps and bulls have large sized humps. The feet are small and hooves are well shaped. The back is long and straight with good depth and breadth in males but slightly sloping forward in cows.

The udder is relatively capacious and extends well forward and behind. The teats are medium size; the fore teats being longer than the hind teats.

Females on the average weigh from 700 to 800 pounds and males 1,100 to 1,200 pounds.

The Hariyana breed is a dual purpose breed (8). Milk production ranges from 1,565 to 6,742 pounds per lactation, averaging about 3,275 pounds of milk in 301 days with 123 days dry period. The average butterfat test varies from 4 to 4.81 percent.

Gir. For purebred Girs, solid red color is sometimes encountered although it is usually mottled and varies from yellowish red to almost black. The popular color is white with dark red or chocolate brown patches distributed all over the body. A well defined patch of either dark or light color, generally found on one or both sides of the body, is typical of the breed (14).

The most noticeable characteristic of Girs is a very prominent and broad forehead. The ears are markedly long and pendulous, opening to the front resembling a curled-up leaf.

Girs are fairly good milkers. Milk yield varies from 2,750 pounds to 4,000 pounds. The fat percentage of milk is five percent and above.

Crossbreeds. Besides the above mentioned purebred cows the most popular milk cows in the state of Mysore are the crossbreeds. They have been developed by an unorthodox breeding method. They are usually classed as to their body color. They are mostly Holstein, Ayrshire or Jersey crosses with native cattle (35).

These crossbred cows may be black and white, brindle, red, or red and white. They differ from other Indian breeds in that they have no hump, the

development is incompletely developed or even absent. They have small sized ears. The body weight varies from 800 pounds to 1,400 pounds. The average milk yield varies a great deal, ranging from 3,500 pounds to as much as 8,000 pounds (35).

Recently, crosses of Jerseys with the local cows, particularly Sindhis, have gained considerable importance. Studies on the Red Sindhi-Jersey crosses reveal that the milk yield has been increased up to 5,500 pounds to as much as 10,700 pounds (14).

Apart from the cows, water buffaloes are next in importance as milk animals. The most important breeds of water buffaloes popular in Mysore State are the Murrah, the Dharwar and the local nondescript breeds (35).

Murrah Buffaloes. These are large bodied animals weighing from 1,000 to 2,000 pounds. They are deep chested and have powerful limbs. They have a very prominent forehead and highly curved horns. A white patch on the forehead is not uncommon. The milk yield varies from 3,000 to 6,000 pounds per lactation. The fat percentage of Murrah buffalo milk is about 7.1 percent and total solids 9.6 percent (44).

Dharwar Buffaloes. These are shorter buffaloes with long narrow faces and flat long curved horns. They are lighter colored than Murrachs. The milk yield is from 2,000 to 2,500 pounds per lactation (35).

Nondescript Breeds. These are small sized with varying color and conformation. The milk yield varies from 1,000 to 2,500 pounds (35). Since they yield comparatively more milk than the local nondescript cows they are more popular than the cows. The fat percentage of this buffalo milk is 7.6 percent and the solids not fat 9.3 percent (44).

AVAILABLE FEEDS FOR DAIRY CATTLE IN MYSORE

Roughages

Permanent Pastures or Gosals. In most of Mysore State permanent pastures form the most important source of feed for cattle. In Mysore there is a permanent pasture area of about 6,560,000 acres (45). These pastures are not fit for grazing throughout the year even though it is in practice in most parts of Mysore. The effective grazing season does not extend for more than four or five months of the year. Even during these months the nutritive value of the herbage at its best is such that it cannot always provide for both maintenance and production for good quality livestock. Besides the varieties of grasses whose nutritive value is known, there are many more indigenous varieties whose actual chemical composition is not known. Some of the known varieties of grasses are very high in nutritive value.

The area of grassland is decreasing owing to the increasing pressure of the agricultural population on land. This process is likely to be accelerated in the future in view of the need for increasing the area for food grains (12). It is, therefore, essential that the best possible use should be made of all available grasslands.

Forests. In Mysore State 13,500 square miles of area is covered by forests, of which an area of 4,300 square miles is under the control of the forest department and open to grazing. It is estimated that 272,320 cattle usually graze in the forests thus providing 10.2 acres per animal (45).

Indigenous Grasses. Dicanthem annulatum (Jarga, bara jergi). This is a perennial tufted grass with a creeping rhizomatous stem (45). It is particularly adapted to the heavy clay soils of the gulf coast prairie where

the rainfall exceeds 30 inches. It does well on loam soils but is best adapted to well drained soils. It has a low nutrient analysis except in the immature stage. Hay yields are two to six tons per acre (1).

Dicanthem caricogum (Kartak, Keel). This species is very similar to Dicanthem annulatum but less common (1). It is found in rather dry areas.

Cynodon dactylon (Bermuda, root grass). This perennial grass spreads by creeping extensively by stoloniferous stems. This is one of the best fodder grasses and is also a good sand binder. This is a good nutritious grass and is very popular in Mysore (1, 6).

Heteropogon contortus - Spear grass (Kumeria, Parva). This is a perennial grass. Culms are densely tufted up to four to five feet, erect or decumbent below, leafy mainly at base. Large tracts, especially those subjected to annual fire, are covered by this grass (45).

Sorghum halepense. This perennial grass has a long creeping, rhizomatous root stock and culms up to six to seven feet. The grass is believed to be good fodder and suitable for haymaking if cut when about three feet high (45).

Aphuda mutica (Bhanjura, tachula). This is a perennial grass with a glaucous appearance. Culms are up to five to eight feet tall. This grass is chopped and added to give bulk with more palatable grasses.

Apart from the above mentioned grasses the following other varieties are found in the pasture lands of the state (1, 6):

Digitaria marginata

Seteria pallide-lutea

Digitaria sanguinalis

Conchus citiaris

Paspalum scrobiculatum

Cynodon barberi

Paspalum dilatatum

Eleusine indica

Echinochloa colonum

The chemical composition of some grasses, both cultivated and indigenous is known (34, 45) and given in Table 1. Some of the others have not been analyzed (45).

Cultivated grasses. Panicum maximum (Guinea grass). This is a perennial densely tufted grass which grows six to 10 feet in height. The grass appears to have been introduced in India by about 1793 and is now becoming very popular (45). The first cutting is generally obtained in two to two and a half months and then every six to eight weeks afterwards. Average yield varies from 15 to 25 tons per acre.

Guinea grass is used mainly as silage although it has been grazed successfully in a few places. It can be grown with advantage along water channels to protect the bunds against erosion.

Guinea grass is palatable to all classes of livestock. It is best utilized if cut when about three feet in height. It does not become coarse even if allowed to grow further but it is apt to lose some of its palatability with age.

Pennisetum purpureum (Napier grass, Elephant grass). This is a robust perennial grass with creeping rhizomes with culms six to 10 feet tall. It is cultivated as a fodder crop in many parts of Mysore. It is propagated by the planting of cuttings. The first cutting is generally obtained about three months after planting and subsequent cuttings every six to eight weeks under proper management. The average yield is 30 to 35 tons in five or six cuttings. The record cutting of 85 to 87 tons in one year has been recorded (45).

The grass is used in India mainly as a cut fodder (34, 45). It is also an excellent crop for silage. The grass is best utilized if cut when

Table 1. Chemical composition of some of the grasses grown in Mysore (34, 45).

Common name	Botanical name	Crude protein: %	Crude fibre: %	Crude nitrogen: %	Ether extract: %	Total digestible nutrients: %	Remarks
Buffalo grass	<i>Brachiaria mutica</i>	11.30	24.10	42.30	2.00	50.80	dry matter basis
Guinea grass	<i>Panicum maximum</i>	1.50	8.70	10.60	0.40	12.30	
Napier grass	<i>Pennisetum purpureum</i>	2.20	6.60	9.70	0.80	13.50	
Para grass	<i>Pennisetum barbinode</i>	2.10	8.80	11.00	0.50	14.70	
Rhodes grass	<i>Chloris gayana</i>	2.30	10.70	11.40	0.60	16.40	
Anjan grass	<i>Pennisetum conchocoides</i>	9.97					dry matter basis
Doob grass	<i>Cynodon dactylon</i>	12.72	31.00	42.42	42.12		dry matter basis

it is four feet high; if allowed to grow taller it becomes fibrous and loses its palatability (45).

Chloris gayana (Rhodes grass). Rhodes grass is a perennial grass which appeared to have been introduced in India about the year 1915 at Bangalore (45). Rhodes grass is adapted to both tropical and subtropical India. The grass becomes ready for the first cutting in about two months after planting. Subsequent cuttings can be obtained more or less regularly at 30 day intervals. It is a fairly heavy yielder giving an average of 15 wet tons per acre. In Mysore, however, an average of five to six tons per cutting is the record. Depending on the management practices, seven to eight cuttings can be had in one year, although many as 12 cuttings have been recorded (45).

Although Rhodes grass is suitable for pasture, hay and silage crops, like all other introduced grasses it is used mainly as a silage crop. For this purpose the grass should be cut before flowering. As a pasture crop it is grazed at the rate of two steers per acre. At Bangalore, Rhodes grass is used as a pasture crop and is grazed until September, the aftermath generally being reserved for hay (45).

The grass is very leafy and palatable. Cattle eat it with relish and although its stems are succulent the grass does not contain an unduly large proportion of moisture even during the rainy season or when grown on irrigated land.

Brachiaria mutica (Buffalo grass). Buffalo or Stapf paragrass is a coarse perennial grass. Like other tropical grasses Stapf paragrass is well suited to a warm and humid climate. Although it makes fairly good growth on dry soils, its best growth is shown on moist, almost water-logged, soils. The average yield is about 13 tons of green fodder per acre per year. With sewage irrigation over 50 tons per acre have been obtained in 12 cuttings (45).

As a silage crop the grass is generally cut when it attains a height of three to four feet, before it gets woody. Although the hay is rather coarse it is considered to be excellent quality hay. It can stand moderately heavy grazing and can carry one or two animals per acre for a period of nine to 10 months. The fact that highly saline soil can be utilized for growing Rhodes grass, as shown by the Indian Council of Agricultural Research, is an additional advantage in utilization of saline soils (45).

In addition to the grasses and forages grown indigenously in pastures and forests and also cultivated by farmers, there are other crops, which serve as the feedstuffs for animals. Most of these are grown for human consumption and the forage part of the plants are fed to animals.

Straws. Sorghum vulgare (Jowar). This is the most extensively grown crop in Mysore. It is grown in both irrigated lands and as a rain fed crop. It is estimated that jowar is grown in an area of 6,717,000 acres in Mysore (39). Jowar seeds are staple food for human beings in a vast area in Mysore State. The straw or stover is fed to cattle. In some areas a variety of jowar is grown where the entire plant is fed to cattle. The yield of grain per acre is estimated to be 366 pounds (39). Jowar yields about 10 tons of stover per acre (34).

The jowar of the variety Andopagon, is nutritious and contains 3.42 percent protein on a dry matter basis (45).

Oryza sativa (Rice). Rice is extensively grown in all parts of Mysore. It is estimated that an area of 2,342,000 acres is under rice cultivation (39). Rice is an important food for human beings. Rice straw, though very poor in its nutritional values, forms one of the most important sources of feed for cattle in India. Rice bran, a byproduct of the rice milling industry, is fed

Table 2. Chemical composition of some of the roughages grown in Mysore (33, 34).

Common name	Botanical name	Crude		Crude		Nitrogen		Ether		Calcium		Phosphorus	
		protein	fibra	free extract	%	%	%	%	%	%	%	%	
Jowar	<i>Sorghum vulgare</i>	4.91	34.17	49.55	1.44	-	-	-	-	-	-	-	-
Ragi straw	<i>Kleusine coracana</i>	3.42	27.23	43.10	1.06	1.11	0.16						
Rice straw	<i>Oryza sativa</i>	2.4-5.6	33.30	45.58	0.86	0.1-0.7	0.20						
Wheat straw	<i>Triticum vulgare</i>	2.4-3.2	42.14	41.66	1.62	0.42	0.15						

as a concentrate, particularly to dairy animals. Rice bran is soaked in water and fed with oil meal and common salt to the milk animals.

Eleusine coracana (Ragi). Ragi is a staple food for a considerable part of Mysore's population and ragi straw is the most staple food for animals in areas where ragi is grown. It is grown in an area of 2,325,000 acres (39). Ragi straw is better than rice straw in its nutritive value and is a good source of calcium and phosphorus (45). Ragi meal is used as a calf feed by many of the dairy farmers (35).

Triticum vulgare (Wheat). Wheat is not very extensively grown in Mysore State. It is expected that wheat is grown in an area of about 744,000 acres (39). Wheat straw is fed to cattle and wheat bran, a byproduct of the wheat milling industry, is fed as a concentrate to dairy animals.

Tree and Vegetable Leaves and Creepers. Besides the roughages mentioned above some of the following leaves and creepers are fed to animals in certain areas where these are available in abundance or during certain seasons when the other feed supplies are not available. Some of these are fairly good in their nutritive values, as shown in Table 3.

Sweet Potato Creepers. Sweet potatoes are grown all over the state of Mysore. The tubers are used as human food. In many places the creepers are fed to cattle.

Castor. Castor is grown extensively in Mysore for oil production. The castor plants are fed to cattle in some parts of Mysore.

Neem Leaves. Neem trees are grown both at roadsides and in forests. The leaves of the neem tree are fed to cattle particularly during the summer when other feedstuffs are scarce. The leaves are rich in protein and other nutrients.

Table 3. Chemical composition of some vegetable leaves and creepers grown in Mysore

Common name	Botanical name	Crude protein : %	Ether extract : %	Nitrogen : free extract : %	Crude fibre : %	Ash : %	Insoluble ash : %	Phosphorus : %	Calcium : %
Sweet potato creepers	<i>Ipomoea batatas</i>	17.2	3.4	43.4	19.3	16.7	2.5	1.23	2.77
Castor	<i>Ricinus communis</i>	24.4	5.7	46.9	10.2	12.7	1.2	1.03	3.77
Banyan leaves	<i>Ficus religiosa</i>	9.7	2.9	50.2	23.2	14.1	5.6	0.42	3.40
Jambo leaves	<i>Eugenia jambos</i>	8.4	4.3	63.4	17.3	6.6	0.5	0.38	1.82
Mango leaves	<i>Mangifera indica</i>	7.8	3.8	54.0	21.1	13.3	6.4	0.38	2.93
Keem leaves	<i>Azadirachta indica</i>	15.6	4.4	55.7	13.4	11.9	1.2	0.54	3.50
Tamarind	<i>Tamarindus indica</i>	13.5	6.8	52.0	18.1	9.5	1.3	0.55	3.18

Tamarind. Tamarind trees are grown extensively all over Mysore. The fruits are used as a source of "Sour". The leaves can be fed to animals. The leaves of tamarind are rich in ether extract (24).

Rayan, Jamboo, Mahuda Pipal and Mango leaves are fairly good sources of certain essential nutrients for dairy cattle. Some of the vegetable leaves and creepers are comparable to some of the good concentrates in their nutrient contents (24).

Concentrates

Feeding of concentrates to cattle is not generally practiced in Mysore. But dairy cattle, calves which may develop into good bulls or bullocks and the draft animals, are fed a very small amount of concentrates. Though the most important concentrate that is fed to the animals is rice or wheat bran; horse gram and ragi meal are also fed. It is not unusual for the animals to be fed one or two pounds of oil meal which has been soaked overnight in water. Apart from the above, the husks of some of the dicotyledonous seeds are fed to the animals.

The following are some of the crops and their byproducts which form a source of concentrates for the dairy cattle in Mysore.

Pulses. Pulses like horse gram (Dolichos uniflorus), red gram (Cajanus indicus) and Bengal gram (Cicer arictinum) are used as human food, but horse gram and the husks of other gram seeds are fed to dairy cattle.

These pulses are grown over an area of 3,000,000 acres of which black gram is grown on nearly 1,000,000 acres (39). It is fed mostly to cattle. The plant of horse gram also is fed to cattle. The horse gram is coarsely ground, soaked for a few hours and fed to cattle. Whole gram is sometimes

soaked and made into paste and fed to milk cows and calves. The yield of horse gram seed is about 200 pounds per acre.

Other grams like green gram, Bengal gram and black gram are utilized as human food. The husk of these grams are fed to animals. The yield of the other grams varies from 400 to 600 pounds per acre (39).

Cotton Seed. Cotton is grown extensively in Mysore in an area of about 2,512,000 acres (39). While cotton fiber is used for making cloth, the cotton seeds are excellent concentrates for cattle. The cotton seeds are highly nutritious and are fed in the form of whole seed soaked in water or in the form of cotton seed meal. An average yield of over 65 pounds of cotton seed can be obtained per acre. About 80,000 tons of cotton seeds are produced annually.

Peanut (Ground nut). Peanuts are grown in an area of over 2,000,000 acres in Mysore. While peanut oil is used for humans, peanut meal is fed to cattle. It is soaked in water and made into a paste and fed to animals. The yield per acre is about 625 pounds and about 350,000 tons of peanut oil meal is produced annually (34).

Peanut plants, after removal of the peanut, are fed to animals either in the form of the green plant or in the form of hay mixed with other forms of hay.

Sesamum. Sesamum is grown in an area of about 175,000 acres in Mysore (39). The sesamum oil cake is fed to cattle as a concentrate. About 200 pounds of sesame oil cake can be obtained from each acre of the crop. About 7,500 tons of sesamum oil meal is produced annually.

Linseed. About 127,000 acres of land is in flax production. Linseed oil meal, a byproduct of the linseed oil industry, is fed to dairy cattle

Table 4. Chemical composition of some of the concentrates fed to cattle in Mysore (21, 33, 34).

Common name	Botanical name	Dry matter %	Digestible nutrients %	Total digestible nutrients %	Nutritive ratio	Ash %	Crude protein %	Crude fibre %	Nitrogen-free extract %	
Cotton seed, whole	<i>Gossypium herbaceum</i>	92.5	10.7	75.8	1:6.1	4.4	17.0	24.5	28.7	17.9
Cotton seed meal		90.5	34.2	79.1	1:1.3	6.7	42.4	6.2	25.2	10.2
Peanut oil meal	<i>Arachis hypogea</i>	90.2	36.7	80.3	1:1.2	5.3	39.1	5.3	34.3	6.2
Linseed oil meal	<i>Linum usitatissimum</i>	92.0	27.5	77.1	1:1.8	5.3	32.4	7.6	35.0	11.7
Cocconut oil meal	<i>Cocos nucifera</i>	86.6	19.6	72.1	1:2.7	6.0	24.2	13.3	35.7	7.4
Rice bran		-	-	-	-	-	9.9	14.8	44.1	9.9
Rice polishing		-	-	-	-	-	11.1	3.8	64.2	5.9
Wheat bran		-	-	-	-	-	16.3	10.0	51.7	5.0

as a concentrate. The yield per acre is about 175 pounds. Approximately 5,000 tons of linseed oil meal is produced annually (34).

Cocoanut. Cocoanuts are grown in some areas of Mysore State, and cocoanut oil meal, a byproduct of the cocoanut oil industry, is a highly nutritious concentrate and is fed to dairy cattle in some areas.

EXISTING FEEDING PRACTICES

The feeding of dairy cattle in Mysore State varies considerably from one area to another. The main factors governing such practices are the availability of grazing facilities, agricultural practices, quality of animals and price for milk and milk products. In general, it may be said that dairy cattle are fed better in the cities and villages close to cities, where there is a good price for milk and milk products. Even in the villages far away from cities, animals of good quality are fed better than the local scrubs. It may be said that the dairy animals are not fed sufficiently and feeding habits are not in accordance with any recommended nutritional standard (35).

Feeding practices of dairy cattle may be considered under the following headings:

Roughages

Grazing in Village Pastures. Each community has a certain area of grazing lands. Cattle are driven into these grazing areas in the morning and are allowed to graze until evening. In most villages there is no definite system of grazing. However, in some villages a system of rotational

grazing is practiced. The cattle are grazed in a particular area for a period of 15 days and then moved to another area for another 15 days.

Most of these grazing lands are in a deplorable condition and are practically unfit for grazing during summer (43). In some villages, however, grazing lands are maintained in a fairly good condition. The villagers have a project for improving the grasslands. During the rainy season they plow up the grazing land, put up some bunds to prevent soil erosion and also plant shade trees. However, with less than one half acre of poor quality grazing land per animal, the animals do not get enough feed from these pastures.

Grazing in Forest Pastures. Forests are under the control of the Department of Forests of the Government of Mysore. Grazing of animals in these forests is allowed only in an area of about 4,300 square miles (45). In some areas of the state these grazing rights are given away to some farmers with large operations. The following systems of forest grazing are in vogue in Mysore (45):

Grazing on Prepaid Permits. Permits are issued by the Department of Forests for a period of one year. Since the area in which a permit holder grazes his cattle is not limited this system is detrimental to forest sods and seedlings.

Kancha System. The rights of grazing are auctioned off. Grazing is confined to blocks and the number of cattle that can be grazed is regulated by the department. This system is the best.

Forest Village System. In this system separate blocks of forests are allowed to different villages or groups of villages. Their size depending on the number of cattle. Grazing is free or at concessional rates fixed

by the forest department.

Lump Sum Grazing System. The village is the unit and a lump sum payment is made to the forest department for grazing all the cattle in the village. This system is next best to the Kancha system. It controls the number of cattle but does not restrict the grazing to specific areas.

Plantation or Kaval System. Kavals are areas of reserved lands in which the rights of grazing are auctioned annually with no restrictions on the number of cattle grazed.

In such forest areas where grazing is considered detrimental only grass cutting is permitted (45).

Feeding Straws. Straw of ragi, rice, wheat and other cereals are stacked by the villagers and are fed to cattle particularly in summer, when other sources of roughages are poor. Some farmers chop these straws and many others do not chop them. Stovers of jowar are also stacked and fed throughout the summer season.

Feeding Hay. Hay made of dhubgrass, paragrass, peanut vine and horse gram plants are usually stacked and fed to dairy cattle during the summer.

Feeding Green Grass. Green grass is fed only during the monsoon season when it is available. In addition to the ordinary indigenous grasses grown in forest village pastures and near the fields, some of the other grasses are cultivated. The common cultivated grasses are: guinea grass, napier grass, buffalo grass, and anjan grass. Irrigated grasses cultivated by using sewage water are becoming popular in many towns, and in most of these towns green grasses are fed to milk cows in small quantities but throughout the year.

Concentrates

Feeding of concentrates to dairy cattle is done only to a limited extent. Dairy cattle in villages are fed small quantities of concentrates mostly consisting of horse gram, rice bran, ragi meal and a small quantity of oil seed meal. These concentrates are soaked overnight and are fed to cows and buffaloes along with an ounce or two of common salt or some jaggery (molasses), just before milking. In cities, concentrates are fed in a larger quantity and are fed both in the morning and evening. Here the concentrates fed consist of peanut oil meal, wheat bran, and rice polishings which are soaked overnight and are fed before milking with some common salt or jaggery. Since many milkmen drive their cows or buffaloes from one house to another for milking, these animals are fed concentrates before each milking with the result they get much more concentrates than those which are fed in the stalls. The following are the most commonly fed concentrates:

Horse gram. The whole grains are either cocked or soaked in water and are fed, but more frequently they are made into a coarse flour and are soaked and fed together with some quantity of peanut oil meal, salt, and jaggery.

Oil seed meal. Peanut oil meal is most commonly fed in all parts of Mysore but sesame oil meal, cotton seed oil meal, and cocoanut oil meal are fed in areas wherever these products are available.

Cotton seed. In areas where cotton is an important crop, cotton seeds are extensively fed to dairy cattle. Cotton seeds are crushed and soaked overnight and are fed together with some common salt.

Gram husk. The husks of Bengal gram, green gram, black gram and red gram are also fed to dairy cattle as a source of concentrate feed.

Bran. Rice bran and wheat bran, or a mixture of wheat bran and coarse flour of wheat (bhoosa) are fed to dairy cattle either alone or in combination with any of the other concentrates.

Whenever concentrates are soaked in water, it is customary to add about two ounces of common salt and some molasses.

SUGGESTIONS FOR THE IMPROVEMENT OF FEEDING OF DAIRY CATTLE

Roughages

Grazing and Management of Pastures. The suggestions made by the Royal Commission on Agriculture in India presided over by Lord Linlithgow, for improvement of grassland still hold good. The following procedures were suggested by the committee (45).

(1) Grazing on the common land should be regulated and rotational grazing established with the consent of the majority of people possessing grazing rights and by means of authority conferred on a group of villagers, e.g., a Panchayat or a Cooperative Society.

(2) A definite area may in some cases be separated for village Cooperative Cattle Improvement Society.

(3) In hilly districts where the grazing facilities were assumed to be better than elsewhere, an attempt might be made to demarcate areas to be assigned at nominal rates to groups of occupiers of village-lands on conditions that the areas shall be grazed in rotation, cattle not owned by the group shall be excluded from grazing and part of the areas shall be reserved for cutting grasses for use in the hot season.

The commission also recommended the cutting and storage of dry grass as an important supplement or substitute for natural grazing.

Some of the methods adopted or suggested by many others, which appear to be very practicable and can be adopted for improving pasture land in villages in Mysore State are discussed below:

Cleaning the land fairly well of existing vegetation and introducing a new grass or mixture is one of the methods.

The outstanding example of such artificial introduction of cultivated pasture is on the lands of the Pattagar of Palayakettai in Coimbatore District, Madras (45). Here Cenchrus ciliaris (known as kolukattai grass) has been in cultivation. The land is plowed during the hot weather rains and grass seed is sown either alone or mixed with jaur, gingelly (Sesamum indicum) or other species. The land is usually manured at sowing time and manure is provided subsequently by the cattle grazing in the area. The pasture lasts for many years and is then plowed or reseeded or broken up for crop production.

Because of the difficulties in reseeding it is necessary to utilize the remarkable capacity of grassland for rapid regeneration after protection from serious misuse. The first prerequisite is the removal of the main factor, the grazing animal. This is, however, a difficult task. The most suitable method suggested by Kumar (1954) (45) is one that can be efficiently adopted.

In this method one tenth of the grazing area should be completely closed to all grazing for one year. The grass may be cut after maturity when the seeds have fallen to the ground. This grass hay or straw may be sold or distributed to the villagers for stall feeding or probably stored for use during hot weather. In the following year another tenth of the grazing area should be added to the first and treated in the same way. After the third year, when three tenths of the area has been reclaimed, the whole may be opened to control grazing. The animals should be allowed to enter the pasture after the commencement of the rains, by which time the grasses will

have made sufficient growth to withstand browsing and trampling. Grazing should end when the hot weather sets in. This procedure may be repeated until the entire grazing area of the village has been reconditioned.

Whenever controlled grazing of the rational type has been practiced, the following advantages have been found (45):

- (a) The vegetation is afforded a chance to make better growth.
- (b) Young and nutritious grass becomes continuously available as feed during the grazing period.
- (c) The grazing season is prolonged.
- (d) The cattle maintain better condition.
- (e) Inferior and coarse grasses gradually give place to superior types.
- (f) Soil erosion is reduced.
- (g) Seedlings and saplings of forest trees are not damaged or browsed by cattle since sufficient feed is available.

Unlimited and uncontrolled grazing requires that grazing should be regulated as regards the time and place and also the number of cattle grazed. The following methods should be adopted in grazing the forest grasslands:

(1) Wherever possible, efforts should be made to introduce rotational grazing, the benefits of which should be explained and demonstrated to farmers.

(2) Grazing should not be allowed in regeneration areas and in young plantations during such periods as the seedlings require for their establishment.

(3) Some recommendations of the Planning Commission (5) should be adopted. They include introduction of exotic types of fodders, development of grassland farming and preservation of surplus fodder.

The best method of proper utilization of forests in cattle feeding is by encouraging grass cutting in forests instead of grazing. Early cut grasses are of better nutritive value than when cut at later stages of maturity. Delay in cutting by 15 days caused significant reduction in milk yield, less gain of body weight and lower intake of hay (38, 43). In the United States certain dates have been recommended for cutting grasses depending on the variety of pasture and geographical situation (25). Early cutting of grasses in forests should be practiced in Mysore.

Hay and Silage Making. If properly organized it is possible to induce farmers to adopt the practice of cutting grasses in the forests before the grasses become unfit for feeding. It has been shown that harvesting and transportation costs of hay to rail heads would vary from Rupees 11/- to Rupees 12/- per ton. This hay could be sold to farmers at a reasonable price.

Preparing of silage from these grasses should be made more popular. It may be necessary in the initial stages that the government make some silo pits, or that the village organizations and cooperatives be encouraged to sink silo pits and make silage from grass and some of the leaves of the trees which can be used as cattle feed.

Trials conducted by Kandaswamy and Ramaswamy (40) with regard to the expenses in making silage are most encouraging. If these data are popularized many farmers and organizations will be encouraged to make silage. According to these authors 320,000 pounds of fodder can be ensiled in a pit 36 × 20 × 8 ft. The expenditure is estimated as follows:

Labor charges on loading, carting, filling and storing silage --	Rs 180.00
Cost of molasses - 300 pounds at Rupees 0.03 per pound --	9.00
Cost of salt - 300 pounds at Rupees 0.03 per pound --	9.00
	Total Rs 198.00

The cost of preparing 100 pounds of silage would be Rupees 0.06 or about 1 1/4 cents.

Introducing Exotic Grasses and Legumes. Work done by the Indian Agricultural Research Station at New Delhi (13) has shown that certain strains of grasses are superior to the common strains both in their botanical characters and in economic importance. This includes such factors as growth and forage production, leafiness and stemminess, palatability, and capacity to show growth in certain seasons in which the other strains of the same species remain dormant. It is therefore advisable to popularize these strains in order to get better supplies of forage throughout the year.

Cenchrus ciliaris (Anjan grass). The common type of this grass grows in the monsoon, otherwise remaining dormant except for a short, hardly significant spring growth. It does not resist the cold and is a moderate forage yielder (about 2,000 lbs. dry matter per acre) annually.

The following strains developed by the Agricultural Research Station (13) New Delhi, are found to be superior:

S 1529. This strain is prostrate in growth habits and forms a dense mat over the ground within two or three months. It holds promise for checking erosion by both wind and water and shows appreciable resistance to grazing and trampling. It produces about 2,200 pounds dry matter per acre annually.

S 1535. This is an erect bunchy type which grows to a height of about four feet. This strain produces fodder of high quality; and yields 5,200

pounds dry matter per acre annually. It puts forth active growth in summer (April to June) and is suitable for hay making. It also shows appreciable resistance to drought and cold.

S 5635. This strain shows a remarkable degree of resistance to drought. It responds to cutting and appears to stand grazing. It also shows active growth throughout the year, yielding about 8,000 to 9,000 pounds of dry matter per acre annually. It is recommended for both cutting and grazing.

S 7382. This is an erect type which grows to a height of about four and one-half feet and yields about 5,000 pounds of dry matter per acre annually. Due to its extensive root system and large production of rhizomes, it holds considerable promise both for soil conservation and improvement.

Cenchrus setigerus (Anjan grass). S 1548. This type seems to be remarkable in remaining green and succulent over the major part of the year, even after seed maturity. Unlike other types of C. setigerus, it continues to grow through all the seasons and produces very thin, tender and numerous succulent, very palatable stems and leaves. It yields about 7,000 pounds of dry matter per acre annually.

Panicum antidotale (Blue panic). This is perhaps the only grass of its kind which puts forth effective and active growth in drier areas and especially during the hotter parts (April to June) of the year. Two strains, one with appreciably tender and finer leaves and stems (S. 1515) and another (S. 1516) with very thick but succulent stems and leaves have been selected. These strains retain the other qualities such as forage yield and growth cycle, which are characteristic of the other types of the species.

Chrysopogon montanus (Dhavalu grass). This grass grows throughout the country on rocky and hilly terrain and forms one of the fine pasture grasses

of the country. This species normally shows active growth during the monsoon only and remains dormant during the rest of the year.

A type (S. 21) shows good growth during spring (February to March) in addition to normal growth during monsoon.

Heteropogon contortus (Surbala). This is commonly known as spear grass. It grows during the monsoon and remains dormant thereafter. It is palatable until it flowers and forms awns. Once awns appear it becomes useless for grazing.

A strain (S. 1) having very few, rather weak awns, has been isolated. In addition to this quality this strain shows appreciable spring growth when common types remain dormant. The forage is more leafy and of better quality and yields about 6,000 pounds of dry matter per acre annually.

Buffel is another good pasture crop which thrives efficiently in loam soil and in areas where rainfall is below 30 inches (31). According to incomplete analysis the average composition of buffel is protein, 2.6 percent; crude fiber, 7.00 percent; and dry matter, 25 percent. Buffel grows luxuriantly during part of the summer and winter. To get a continuous supply of green forage for the greater part of the year, a mixture of buffel, jowar and sweet clover is worth trying. For this purpose jowar and buffel may be sown in July and sweet clover put in after the harvest of jowar in October (31).

Kudzu vines make a luxurious vegetative growth and if given protection for a couple of years, it will establish very well and cover a large area (22). It provides large quantities of leafy growth for grazing along with grasses in the pastures.

Lespedeza and white clover are also known to thrive well in some parts of India (18, 45). It is, therefore, necessary that growing of these legumes should be popularized in Mysore.

Manuring and Fertilizing. Application of manure and other fertilizers to the grasslands, even though it cannot be practiced in Mysore at the present time, should not be overlooked. Whenever availability and economy permits, dairy farmers must be persuaded to practice this technique to increase the quality and quantity of forages.

Nitrogen deficiency is very widespread and it is necessary to take every possible step to insure the return to the soil of anything likely to improve its nitrogen status. Although priority should obviously be given to manures available locally, consideration might also be given to concentrated forms of the nutrients.

It is also indicated that phosphate in combination with nitrogen and potash are required for the improvement of grasslands (45). Application of ammonium sulphate and super phosphate in amounts of 100 pounds and 200 pounds respectively, has increased the yield of from 2,900 to 4,100 pounds on a dry matter basis (45). Crude protein increased from 7.5 to 12.1 percent on a dry matter basis in Kolukattai grass (Ramaiah 1941) (45).

Experiments conducted by the Dharwar Agricultural College (45) reveal that by mere manuring of grassland, yield of fodder can be increased from 2,245 to 4,048 pounds per acre and can be maintained at the level of 4,884 pounds per acre beyond the second year.

The technique of grassland improvement involves some form of complete or partial protection from grazing to allow time for progressive forces of nature to heal the wounds resulting from past years of abuse. The methods that are now adopted for improving grasslands, in Sourashtra (2), should also be followed in Mysore State; namely, (1) to control ever increasing loss of water and soil, contour furrows were made at one foot intervals. These

furrows collect water during rains and also provide a location for planting sods and seeds of desirable grasses. (2) Educating farmers and village leaders regarding the programs is essential. This is the most important part of any developmental activity. Unless the farmers and the village leaders are properly educated and unless they accept the program it is not possible to bring in any improvement.

Better Variety Crops. In areas where jowar is grown and fed to cattle excessively, it is harvested only when the heads are well developed. At this stage of maturity of the plant the chemical composition is altered to the extent of increase in fibre and the fodder or straw is less nutritious. In some varieties of jowar, namely Sundhia and Sholapuri, it is said that the protein content increases with maturity (25). While reports on the other aspects of their efficiency are incomplete, it is necessary that a variety whose protein content increases with maturity will be more suitable for cattle feed and should be developed.

Sugarcane is grown in an area of 138,000 acres in Mysore and the area of sugar cultivation is rapidly increasing. Sugarcane tops have not been a popular cattle feed. Trials conducted (4) show that the milk yield is quite satisfactory even when the amount of oil cake supplement necessary with wheat straw is reduced by 50 percent while feeding sugarcane tops. Nutrient content of sugarcane tops is given as crude protein 2.6 percent; crude fibre 37.2 percent; nitrogen free extract 52.7 percent; and ether extract 1.4 percent (15).

The economy of feeding sugarcane tops has been shown by data that it required 23.4 pounds of linseed cake to produce 100 pounds of milk when fed with sugarcane tops, whereas it required 53.5 pounds of linseed cake when

fed with wheat straw (4). Therefore, feeding of sugarcane tops either fresh or as silage made with other feedstuffs should be advocated in areas where sugarcane is grown.

Utilization of sewage water for growing fodder crops is being practiced in some cities in Mysore. The yield of fodder crops when grown by using sewage water is very high. The yield per acre in Mysore City is as follows (42):

Perennial grass	48,400 pounds per acre
Ragi seed	684 " " "
Jowar fodder	21,744 " " "
Horse gram seed	540 " " "

Efforts should be made to grow cattle feed utilizing sewage water in all towns in Mysore State.

Alkali and Water Treatment of Straw. Feeding of ragi straw and paddy (rice) straw is very common in Mysore. These straws are not very nutritious. Experiments conducted show that alkali treatment of straw which consists of soaking of chopped straw for 16 to 24 hours in one or two percent solution of caustic soda and then washed with clean water three times, dried and fed increased the digestible coefficient of total carbohydrates from about 50 to 75 percent (29). This increased digestibility enhanced the total digestible nutrients in straw up to 45 percent. Further alkali treatment removes 70 to 80 percent of the deleterious potassium oxalate from the straw as a result of which assimilation of calcium from the ration containing treated straw is increased. It was also shown that feeding of treated straw affects greater utilization.

Water treatment of straw consists of soaking the straw for 24 hours, after which it is washed with clean water, dried and fed. In Mysore, where labor is comparatively cheap this can be practiced, particularly in cooperatives.

Where an increase in acreage of fodder crops or cattle feed is practically impossible, it would be a sound idea to utilize some of the products which are available in plenty and which are proved to be good as cattle feed.

Peanut Shell. Utilization of the peanut shell as a roughage for cattle has been tried. The shell is crushed and pounded into pulp. To this some molasses, dissolved in water, can be added to make the pulp soft and palatable. Cattle develop a sufficient liking for it within about a week after it is included in the ration. This should not constitute more than one-fourth to one-third of the roughage portion of the ration. The chemical composition of groundnut shell is estimated to be (15): crude protein, 8.25 percent; crude fibre, 57.44 percent; nitrogen free extract, 29.44 percent; ash, 4.25 percent; calcium oxide, 0.31 percent; and phosphorus oxide, 0.22 percent.

Concentrates

New Variety Horse gram. Cultivation of horse gram (Dolichos biflorus) as a feed for cattle, particularly dairy animals, is a common practice. The local variety of horse gram grown in Mysore is a poor yielder in that the yield is from 400 to 500 pounds per acre.

A new strain of horse gram, Co 1, evolved by the Department of Agriculture, Madras (41), yields from 700 to 800 pounds of seeds besides being a crop of 120 days duration. The introduction of this variety should be more popularized for better yields of grain.

Mangifera indica (Mango seeds). The kernels of the seeds of mango can be a useful feed for cattle. This grain is rich in carbohydrates. In protein value it compares favorably with barley and corn. The dried kernels should be broken into small pieces, pulverized, moistened with water and fed along with other feeds. Starting with a small quantity, it should be gradually increased to make about 25 percent of the concentrate mixture. The animals take about three weeks to acquire a taste for it.

Eugenia jambolana (Jamun). The seed of jamun is rich in protein and calcium. This can be crushed and dried and fed to cattle. This can satisfactorily replace oil cakes in the feed up to 75 percent.

Tamarindus indica (Tamarind). Seeds of tamarind can be used as a part of the concentrate mixture up to 50 percent over a long period without any injurious effect and can form up to 15 to 20 percent of the total feed mixture. The seeds, preserved after drying in the sun, can be pulverized, moistened for about six hours and then mixed with other concentrates for feeding (15).

The chemical composition of tamarind seed is: ether extract, 3.39 percent; crude protein, 15.4 percent; crude fibre, 8.17 percent; nitrogen free extract, 16.25 percent; ash, 3.28 percent; and carbohydrate, 77.4 percent.

Oil Seed Meal. Oil seed meal is one of the major items among concentrate feeds for dairy cattle. At present a rough estimate of oil cake production of edible oil cakes in Mysore can be taken as about 350,000 tons per year (12, 39). A good portion of these oil cakes, almost 50 percent of the annual production, is used as manure in the cultivation of crops and this practice of using edible oil cake for manurial purposes will adversely affect the maximum potentiality for animal production.

The following suggestions made by the Nutritional Advisory Committee should be popularized (12):

(a) The existing practice of using a large quantity of edible oil cakes as manure adversely affects animal production and if oil cakes are to be used at all for manurial purposes, the possibilities of using the cakes from nonedible seeds such as neem and pangonia, should be fully explored.

(b) In view of the acute shortage of edible oils, solvent extraction of oil from the edible cakes can be allowed if the loss of oil due to solvent extraction is made up for animal feeding with grains.

(c) The oil in cottonseed can also be extracted for human consumption provided such deoiling has no adverse effect on milk and butterfat production of buffaloes fed extensively with cottonseed. To safe-guard the latter situation only one-half of the total production of cottonseed may be utilized for oil extraction. The loss of oil sustained thereby should, as in the case of oil cakes, be made up by requisite quantity of grains like corn and roughage including leguminous fodder.

From the present knowledge of animal nutrition it is known that oil or fat is not necessary for the animals. Thus, the oil may be extracted from cotton seed for use of human beings and the byproduct utilized for cattle.

Other Potential Sources of Protein

Sericulture Waste. In some parts of Mysore State, notably in the Kolar and Bangalore districts, some farmers feed their cattle a byproduct of the sericulture industry, consisting of small pieces of mulberry leaves and excreta of the larva of the silk moth. Animals fed with this product put on excess fat and appear to be in much better condition than animals which are not so fed. Since no work has been done regarding its feeding value, it is necessary that trials be conducted regarding the utility of this waste product in the feeding of dairy cattle. Mulberry is grown in an area of 200,000 acres in Mysore and as many as 75,000 families are directly engaged in this operation (39).

Urea. Urea, a non-protein nitrogenous compound, can be manufactured from the nitrogen of air for use in industry and agriculture. Commercial feeding grade urea contains 42 percent nitrogen. Converted to protein equivalent by the usual factor ($N \times 6.25$) this product contains 262 percent protein. When urea is added to a suitable ration for ruminants, the bacteria in the rumen can convert it more or less completely into protein in their cells during fermentation, which occurs normally in rumen digestion. All the urea fed will be converted to ammonia within an hour (26). The conversion of urea into protein is not efficient when the ration does not have a readily available supply of energy for the bacteria or when urea is added to mixtures that are already high in protein (21). Urea can be fed to the extent of one percent of the total ration, three percent of the concentrate ration or as a source of 33 percent of protein in the concentrates. Urea making up as much as five percent and seven percent of the concentrates has been fed to calves, but this higher level adversely affected the rate of gain when compared to calves which had been fed three percent urea in the concentrate (17). It is known that young calves are not able to use urea nitrogen to any practical extent for growth but it is better utilized in older calves (21). In a Scotland trial, urea was found to be superior to blood meal for dairy cows (23). Care must be taken in mixing urea. Small quantities of urea, undiluted by feed and introduced suddenly into the digestive tract may result in rapid onset of toxicosis (27).

Urea can also be used in silage making. Ten pounds of urea for a ton of sweet sorghum speeded up the rate of fermentation, saved carotene and produced silage with a greater titratable acidity (3). Animals fed with urea treated sorghum silage maintained their body weight whereas those fed with untreated silage lost 47 pounds in 78 days (3).

At the present rate of industrial development in India it is possible to produce enough urea to meet the requirements for dairy cattle within a course of 10 years. Trials will have to be conducted under the conditions existing in Mysore and the possibility of utilizing urea with other starchy foodstuffs will have to be worked out.

Fish Meal. Fish meal is very rich in protein, containing 60.9 percent on the average. Protein of good quality fish meal is of higher nutritive value, tending to be more efficient, than protein of tankage or meat scraps as a supplement to grains. In a number of feeding experiments with fish meal for dairy cattle no injurious effect has been produced when good fish meal, not unduly high in fat, was fed in such amounts as were needed to balance the ration (19, 21). Milk produced by dairy cows fed fish meal was apparently normal in odor (19). In the experiments conducted at the Mansfield reformatory in Ohio a grain mixture containing Menhaden meal was not relished by dairy cows particularly where the upper limits of intake was 18 pounds of fish meal grain mixture (47). Fish meal is not palatable to cattle but they usually become accustomed to concentrate mixtures containing 10 to 15 percent (21). If decomposition of fish waste occurs before it is processed, the fish meal may be injurious. Obviously more care must be taken to prevent decomposition in the production of fish meal for stock feeding. Fish meal is also used as a source of protein in calf meals or calf starters for dairy calves being raised on a minimum amount of milk. This has a special value in Mysore because the quantity of milk now spent for nourishment of calves could be reduced, thus saving it for human consumption.

In Mysore State it is estimated that 120,000 tons of fish are caught annually and this may be increased considerably in the future. There are

at present 134 fish meal and oil plants (39). As the fishing industry increases it is possible to have more and more fish meal. The possibility and the extent to which fish meal can be utilized for dairy animals should be worked out and utilized as much as possible for dairy cattle feeding.

Tankage or Meat Scrap. Although these animal byproducts are not commonly used for dairy cows they are satisfactory when they furnish protein at lower cost than other sources. Dairy cows will usually eat concentrate mixtures containing eight to 17 percent of tankage or meat scraps (21). Occasionally some cows do not like such a mixture but later get used to it and eat it readily. Tankage and linseed oil meal mixed in equal parts by weight have proved to be more palatable than tankage fed alone (46). Milk yield has not been increased by feeding these animal proteins. The flavor and odor of milk was not affected even when fed one or two hours before mixing (21). Meat scraps and tankage can be used as a supplement in calf starters but can replace only a part of dried skimmed milk, other dairy products, or soybean oil meal (21).

Blood Meal. Blood meal is the highest in protein of all packing plant byproducts, containing 80 percent. However, this protein is less digestible and of much poorer quality than that in high grade tankage or meat scraps. It is chiefly used in calf starters or calf meals for raising dairy calves on a minimum of milk. A mixture of 6.8 pounds containing 3.2 parts of dried whey and one part blood meal is a satisfactory substitute for 50 pounds of skim milk in feeding dairy calves (7a). The use of dried whey and blood meal can be utilized as a means of diverting milk from calf feeding to human beings. Blood meal is not usually liked by calves at first and if it is used as a chief protein supplement in a calf meal it may be difficult to get them

started on it. In the New Jersey calf feeding system milk is discontinued after the calves have reached 30 days of age and soluble blood flour to the extent of 12.5 percent of the grain mixture is fed. Results were satisfactory (16).

In Mysore State most of the slaughter waste, meat scrap, tankage and blood meal is not utilized for any purpose. Possibilities of utilizing these products will have to be worked out. Sentimental objection on the part of the people against such a feeding practice could be overcome if it is introduced gradually.

A FEEDING PROGRAM WORKABLE FOR DAIRY CATTLE IN MYSORE

The average body weight of the dairy cow in Mysore can be taken as 700 pounds for an adult cow and 1,000 pounds for an adult dairy buffalo. The average milk yield varies a great deal from breed to breed. Whereas the milk yield is as low as two and one-half pounds for a Hallikar, Amrith Mahal (draft animal), or the nondescript scrubs, the milk yield averages about 10 pounds per day for an ordinary dairy cow and may increase up to 40 pounds in a good dairy animal. The milk yield varies from eight to 10 pounds for a local buffalo to 40 pounds for a Murrah water buffalo. Therefore, a ration for a dairy animal may be calculated on the basis of nutrients needed for maintenance based on body weight, plus the nutrients needed for milk production.

According to Morrison a dairy cow weighing 700 pounds requires nutrients for maintenance daily as follows (21):

Digestible protein	0.44 to 0.48 pounds
Total digestible nutrients	5.1 to 5.8 "

In addition for each pound of milk of 4.0 to 5.0 percent fat, the requirements are as follows:

	4.0% milk	4.5% milk	5% milk
Digestible protein	0.045	0.050	0.055
Total digestible nutrients	0.32	0.34	0.36

A mature dairy bull which on the average weighs 800 pounds requires the following amount of nutrients per day:

Digestible protein	1.00 pounds
Total digestible nutrients	10.60 "

On the basis of feeding standards for dairy cattle it is expected that a buffalo cow weighing 1,000 pounds would require the following nutrients per day:

Digestible protein	0.65 pounds
Total digestible nutrients	7.9 "

The production requirement for a buffalo cow can be at the same level as that of a cow producing milk with five percent butterfat.

A mature Murrah buffalo bull which on the average weighs about 1,400 pounds requires a daily ration of:

Digestible protein	1.25 pounds
Total digestible nutrients	12.00 "

The roughages and concentrates available in different parts of Mysore vary. In general the availability of cattle feed can be grouped into two categories. The roughages available in some parts are mainly ragi and rice

straw and pasture for grazing, in another part the commonly available roughages are jowar straw and rice straw and pasture for grazing.

The grazing facilities available for dairy cattle in Mysore are not of any significance. It can be assumed that about one-third of the maintenance ration for dairy cattle is being provided from both village pastures and forest grazing lands during the monsoon season. While this proportion is considerably more during spring and autumn it is less during winter and very poor in summer.

The Nutrition Advisory Committee of the Indian Council of Medical Research and the Animal Nutrition Committee of the Indian Council of Agricultural Research, considering the existing condition of cattle in India and the availability and demand for foodstuffs by human vis a vis animals, have recommended the following ration for cows and buffaloes per head per day (12):

<u>Maintenance</u>	<u>Cow</u>	<u>Buffalo</u>
Cultivated green fodder	30 pounds	40 pounds
Dry roughage	5 "	10 "

In addition to the above requirements for maintenance, the committee has recommended a concentrate mixture of one pound for every two and one-half pounds of milk produced by them.

Oil cake	2 parts
Maise or barley	35 "
Gram or cotton seed	35 "
Bran	1 "

While the above formula is suitable for many parts of India, it is desirable to try some of the other feedstuffs that are suggested in the earlier part of this article since they are available in Mysore. It is

known from results of some trials that there is no injurious effect to the health of the animals by feeding these feedstuffs. Therefore, trials should be conducted extensively at the government dairy farms and elsewhere to test the utility of these feedstuffs and make them more popular so that these feeds which are now being wasted can be better utilized by cattle. What is more important is that there will be less competition for feeds that can be consumed directly by human beings.

First, the preparation of silage from the grasses of forests should be tried. It is urged that in addition to the forest grasses that can be used for silage making, some of the tree and vegetable leaves, such as sweet potato creepers, castors, neem leaves, tamarind leaves, and also leaves of jamboo, Mahuda pipal and mango should be ensiled. It is necessary that in the earlier stages the quantity of these leaves added should be limited to less than one-fourth of the total amount and the proportion may be increased subsequently if proved beneficial. Research is needed along these lines.

Sugarcane tops can be best utilized by ensiling. It may even be advantageous to utilize peanut shells for ensiling. Along with various grasses, sugarcane tops, peanut shells and tree and vegetable leaves and creepers, the possibility of utilizing urea, a nonprotein nitrogenous substance should be explored. At the present rate of industrial development in India it will be possible to produce enough urea for use as cattle feed within the course of ten years. However, one must be very careful in feeding urea to dairy cattle that receive a low energy ration like these in Mysore. It is known that for proper utilization of urea the animals need to be fed some starchy grain, or other source of energy for the rumen.

It is also known that under proper conditions, urea can be fed to the extent of one percent of the total ration, three percent of the concentrate ration or as a source of energy 33 percent of the protein in the concentrate (27). Since the dairy cattle in Mysore do not get enough energy in the ration, it is suggested that urea should be tried at a lower level than this, say about half of the amount suggested above.

Since knowledge of the chemical composition of the various feedstuffs, particularly roughages, is limited, a fair guide that may be suggested to the dairy farmers might be based on the amount of hay that can be consumed daily by each animal. It may be assumed that a cow can consume two and one-half pounds of hay equivalent per 100 pounds of body weight and a buffalo three pounds of hay per 100 pounds body weight. Based on these factors it can be assumed that a cow of average weight requires 15 to 20 pounds of hay equivalent and a buffalo 30 pounds of hay equivalent. Thus, a ration consisting of the following would supply enough nutrients for her maintenance:

Cow	Straw	5 pounds
	Cultivated green fodder	15 "
	Silage	25 "
Buffalo	Straw	10 pounds
	Cultivated green fodder	25 "
	Silage	30 "

Any recommendation for feeding of concentrates to dairy animals in Mysore must be based on the fact that there is an acute shortage of these feedstuffs, and whatever excess is expected to be produced due to improved techniques and facilities will be needed for human consumption. Utilization

of certain grains and their byproducts, not required for human consumption, is one possibility, but it is nevertheless not the only solution. Before any recommendations for using mango seed kernels, jamun seeds, tamarind seeds and many other seeds can be made, careful laboratory and field trials should be conducted. However, a concentrate mixture consisting of the following can be recommended for experimental trial:

Oil cakes	2.5 parts
Seeds of mango, jamun or tamarind	2.5 "
Cotton seed, horse gram or other grains locally available	3.5 "
Bran (rice or wheat)	1.5 "

According to Morrison's standard (21) a dairy cow weighing 700 pounds and producing 25 pounds of milk daily would require:

	Digestible protein (lb)	Total digestible nutrients (lb)
For maintenance	0.45	5.5
For production	1.25	8.5
Total requirement	1.70	14.0

Table 5. A ration that can be fed in Mysore State and the nutrients that are supplied by such a ration.

Name of feed	Amount lb	Nutrient contents		Nutrients supplied to the cow	
		:protein %	:nutrients %	:protein % lb	:nutrients % lb
Roughage					
Straw (ragi, rice or wheat)	5	1.5	35.0	0.075	1.75
Cultivated green fodder	15	1.5	15.0	0.225	2.25
Silage	25	1.5	15.0	0.375	3.75
Concentrates					
Oil cake	2.5	35.0	75.0	0.875	1.870
Seeds of mango, tamarind	2.5	10.0	55.0	0.250	1.375
Cotton seed or horse gram	3.5	10.0	75.0	0.350	2.625
Bran	1.5	10.0	80.0	0.150	1.200
Total nutrients supplemented				2.300	14.82

In formulating the concentrate mixture it is necessary to consider the availability and cost. Depending upon these factors various combinations of the ingredients can be advocated. The following may serve as a guide:

(1) Peanut oil meal	30 parts
Mango kernel	25 "
Horse gram	30 "
Rice bran	15 "

(2) Cocoanut oil meal	30 parts
Tamarind seed	25 "
Cotton seed	30 "
Rice bran	15 "
(3) Sesamum oil meal	30 "
Jamun seed	25 "
Horse gram	30 "
Rice bran	15 "
(4) Cotton seed meal	30 "
Tamarind seed	25 "
Bengal gram or other gram husk	30 "
Wheat bran	15 "

Under the existing conditions in Mysore State, increasing milk production is an immediate necessity. Such an increase in milk production can be brought about by improving the nutrition of dairy cattle. Since it is not possible to increase the area of land in which cattle feeds are grown, the only alternative would be to improve the existing grazing lands, encourage cultivation of better quality forage, and to utilize some of the seeds and other high protein products.

If proper steps are taken to implement the suggestions discussed in this report it is possible that milk production will be increased within a short period.

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DEVELOPING A FEEDING PROGRAM FOR DAIRY CATTLE IN
MYSORE STATE, INDIA

by

RAJAGHATTA NANJAPPA RAJANNA

G. V. Sc. Bengal Veterinary College, Calcutta, India, 1953

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Department of Dairy Science

KANSAS STATE UNIVERSITY
Manhattan, Kansas

Mysore State is one of the 16 states in the Indian Republic. Extending over an area of 74,122 square miles this state has a population of 23.5 million, with a density of 318 persons per square mile. Over 70 percent of the total population live by cultivation of land and the per capita land is 2.1 acres. Due to the limited land area, poor techniques of agricultural operations and seasonal rains, the productive capacity of this land is very poor.

There are over 11 million cattle and water buffaloes in Mysore State. They are mostly nondescript types and Hallikar and Amrith Mahal breeds, which are very poor milk producers. In most towns and some villages some recognized dairy breeds of cattle and buffaloes are maintained. The most common breeds of the dairy cows maintained in Mysore State are Red Sindhi, Sahiwal, Hariyana, Gir, and crossbreeds. Murrah and Dharwar are the two breeds of water buffalo. In spite of such large numbers of cattle in Mysore the production of milk is so poor that the average consumption of milk per person per day is less than 3.5 ounces.

The most important cause of this under production is the low level of nutrition of the cattle. For a great majority of cattle in Mysore, the only source of feed is the pasture lands and forest grazing lands. Even these grazing lands are very poor sources of feed as they are not properly maintained and the grasses grow in them only during the monsoon season. An area of 6,500,000 acres of grazing lands have to provide feed for these 11 million cattle besides an equal number of other animals. The forest grazing lands, which extend over an area of 4,300 square miles, are fit for grazing during monsoons only. Whatever excess grass is available during that season is not being conserved for use during the rest of the year. The only other source of feed for these animals during the rest of the year is the straw of ragi, rice and jowar. Concentrate feeding is practically unknown in

the villages. Concentrates, if any, fed to milking animals will be a small quantity of peanut oil seed meal (one or two pounds) and rice bran (one or two pounds). In cities where dairying is quite profitable, milking animals are fed some quantity of green grasses and some concentrates, mainly oil seed meal, cotton seed, horse gram, gram husk, rice bran and wheat bran. In general, it can be said that these animals are not fed according to any nutritional standard.

With the increasing demand for milk and milk products both in cities and in villages, the necessity for increased milk production has been keenly felt. It is known that quickest results can be obtained in this direction by improving the feeding of animals. This means that more and better feeds must be made available for dairy cattle. With the existing scarcity of land in Mysore it is not possible to increase the area of pastures or forest grazing lands, much less the area where cattle feed grains can be grown. Some methods that are recommended for improving the quality and supply of roughages for dairy animals are as follows:

- (1) Improving the existing pastures by plowing, reseeded and manuring.
- (2) Adopting rotational grazing systems to increase the utility of village and forest pastures.
- (3) Encourage making of hay and silage from grasses available in forests. Cutting of grasses in early stage of maturity should be encouraged.
- (4) Utilizing some of the tree and vegetable leaves, sugarcane tops and peanut shells as a source of roughages.
- (5) Encourage cultivation of such strains of cereals and grains which yield more and better quality fodder.
- (6) Encourage cultivation of exotic strains of grasses particularly in towns by making use of sewage water.

(7) Urge alkali and water treatment of ragi and rice straw to improve their nutritional value.

(8) Promote use of urea in making silage to increase the protein content of roughages.

In respect to concentrate feeding the following recommendations could improve the situation:

(1) Discourage the use of edible oil seed meal as manure and encourage feeding them to dairy cattle.

(2) Use of seeds of mango, tamarind and jamun which are fairly high in protein content as a part of concentrate mixtures.

(3) Encourage cultivation of a new variety horse gram which yields twice as much as the one which is now grown.

(4) Encourage feeding of sericulture waste, slaughter house offal and fish meal as a part of the protein supplement.

(5) Increase production of urea and encourage its use as a source of protein for dairy cattle.

(6) Develop practice of feeding calf starters and milk replacers to conserve milk.

The entire program must be educational. The farmer, on whom the entire success depends, must be unmistakably convinced of the needs and advantages of the change in his attitude. Once the farmer is convinced about such a program, he should be assisted in planning for better feeding practices. He can then be educated in the finer aspects of dairy cattle feeding such as requirements of nutrients and formulating rations for dairy animals.

Adoption of such a program will do much to improve the milk production in Mysore within a reasonably short period.

