

AGRICULTURAL DEPT. MADRAS

BULLETIN No. 79

SOME ASPECTS OF DAIRYING
AT COIMBATORE

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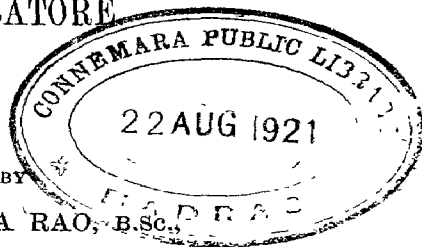
Department of Agriculture, Madras.

Bulletin No. 79.

SOME ASPECTS OF DAIRYING

AT

THE MADRAS AGRICULTURAL COLLEGE,
COIMBATORE



BY
D. ANANDA RAO, B.Sc.
Acting Professor of Agriculture.

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THE COLLEGE DAIRY.



PREFACE

THE bulletin was intended at first to be written both by Mr. Allan Carruth, lately of the Madras Agricultural Department, and by me, but owing to Mr. Carruth's departure the major portion of the work devolved on me. I am therefore responsible for the present form, but must express my indebtedness to Mr. Carruth generally for his suggestions and in particular to the portion relating to the details of the cost of production of milk discussed in Part IV (a). It is hoped that the bulletin will serve the purpose of stimulating interest in Dairy questions and of benefiting the Dairy student.

AGRICULTURAL COLLEGE,
COIMBATORE,
July 1920.

D. ANANDA RAO.

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SOME ASPECTS OF DAIRYING AT THE MADRAS AGRICULTURAL COLLEGE, COIMBATORE.

INTRODUCTION.

These are days of high prices : everywhere living is becoming expensive. These are also, for this very reason, days of intensive farming. Farmers everywhere are obtaining high prices for their produce. There may, therefore, be a desire on the part of some people to embark on agriculture as a speculation to see if farming will not pay. We are, however, concerned in this bulletin with Dairying which is after all a part of Agriculture. Although as an industry it has not attracted much attention, the interest evinced in Dairying in general of recent years has been on the increase, if inquiries are any indication ; there have been in Madras in the past some spasmodic efforts in this line, and although some have been prosperous, there are others which have not stood the test of practical experience. Endeavour is made to describe as faithfully as possible conditions prevailing at the College which has maintained a dairy herd and run a creamery for several years, and to point out the pitfalls into which prospective dairy farmers are likely to fall and to explain, though in a general way, the circumstances which will make dairying in this Presidency successful. It should be at the outset mentioned that the College Dairy is run primarily for educational purposes, namely, teaching students the methods of dairy farming from the production of milk to manufacture of butter and its by-products, and questions of

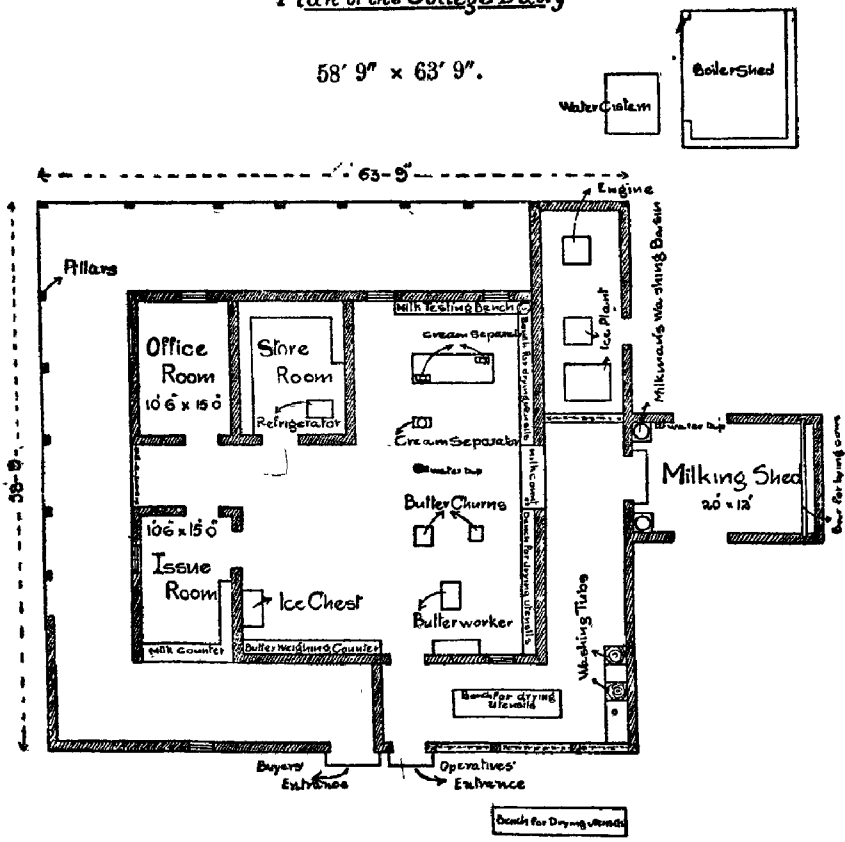
profits are only secondary. Dairying as an art is taught to the student first, while at the same time he is given opportunities to learn what profits he can make out of it. It should also be noticed that, owing to the expensive equipment for purposes of teaching, it is not possible to work the Dairy at a profit, and it will be shown in what directions economies can be effected, thus demonstrating that dairying as a business proposition is also possible under certain conditions.

References are made in the bulletin about the details of dairying in order to enable a novice to start this industry. Such details will, it is hoped, be much more useful than mere generalities.

In the first part, the Dairy Farm, buildings and its working will be described; in the second, the College herd and its management will be considered; in the third, the way how the College creamery is run is shown; and in part four will be discussed the business aspects of the Dairy and Creamery industries as existing in Coimbatore.

Plan of the College Dairy

58' 9" x 63' 9"





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STUDENTS AT WORK IN THE DAIRY



PART

DAIRY FARM.

(A) *Buildings.*—The Dairy consists of a fairly large building—a building larger than would be needed for a business concern—with (a) a main room in which the major portion of work consisting of butter making, cream separation and milk testing is performed, (b) an issue room from which milk is issued to customers, and where buffalo milk brought from neighbouring villages is purchased, weighed and filtered, (c) an office and packing room where registers are kept and butter parcels for the mufassal are packed and (d) a store room. The Dairy has verandahs on all sides which help to keep it cool. At its one end, hot and cold water tubs are provided for washing, and a steam jet for sterilizing. The necessary steam is obtained from a boiler which is also intended to run an ice plant. Attached to the main building is the milking shed, where cows and buffalos of the College herd are brought and milked in the presence of one of the officers of the Dairy. The Dairy is provided with fly proof arrangements and care has also been bestowed on proper ventilation. All doors are provided with self-closing hinges. The Dairy compound in which special fodder crops are grown under irrigation, is enclosed with a wire fence all round. A plan of the Dairy enclosed indicates the internal arrangements.

It may be of interest if the general daily programme of the Dairy is indicated. The hours are long and full. The Dairy is open from 4-30 a.m. to 6 p.m. during all parts of the year, with a break of three hours in the middle of the day. Milking commences at 4-30 a.m. and is supervised by one of the Dairy staff. The milk

of each cow as it is drawn is weighed, filtered and the weight recorded in a milk memorandum sheet as indicated below. At 6 a.m. this milk is sold to customers at the issue room. Except on rare occasions, e.g., when the students are not in session, milk is consumed as such. At 6-30 a.m. butter making starts and goes on till 9-30 a.m. In the meantime, outside milk is purchased, and separated by a machine into cream and skim milk and by the time the latter is sold, vessels cleaned and floors scrubbed and washed, the Dairy staff will have done six hours of strenuous work, when they go home for midday rest. On arrival in the afternoon the records are posted, and butter parcels are despatched to the mufassal. Milking takes place again at 4 p.m. and issued at 5 p.m. and the miscellaneous jobs of washing and cleaning are once again gone through. The Dairy sends into Coimbatore fairly large consignments of butter, three times a week by cart.

Milk Yield Memorandum.

Date

Time of despatch

Names of cows.	lb.	oz.

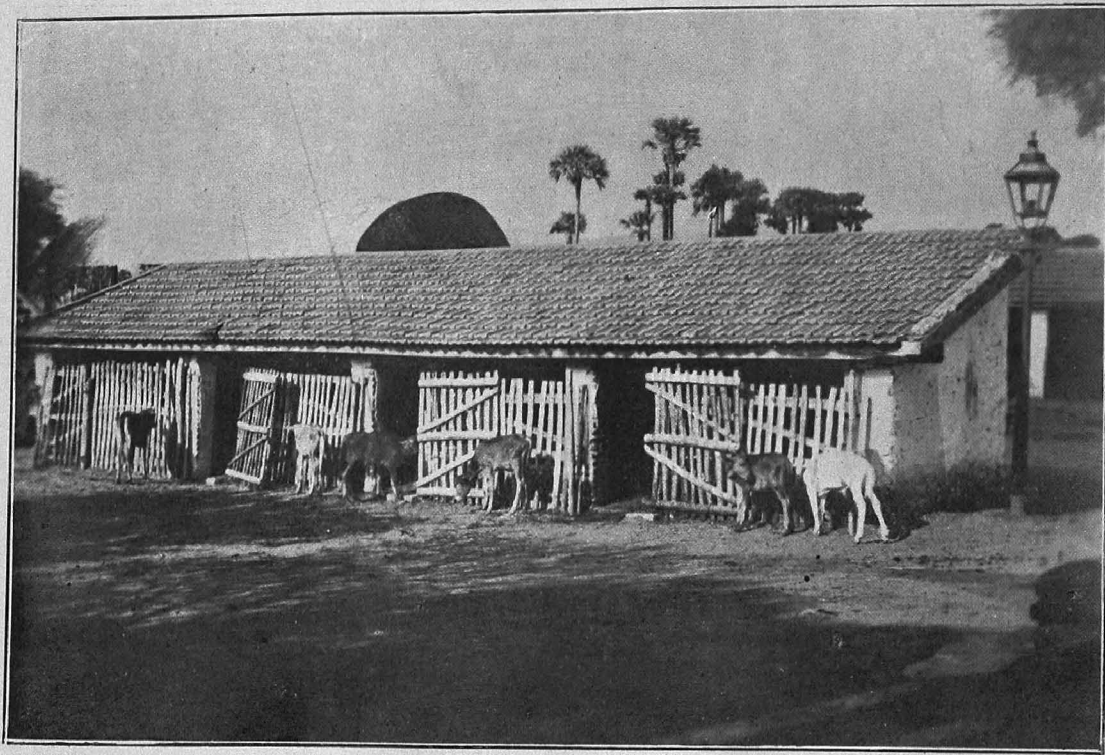
Total yield

Dairy Manager.



THE CATTLE STALLS. NOTE THE FEEDING TROUGHES

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LIBRARY



CALF SHED FOR SUCKLING CALVES. DIVIDED INTO FOUR COMPARTMENTS EACH ACCOMMODATING SIX CALVES.

17165-1892

For efficient working, the Dairy is now equipped with a superior staff consisting of a Dairy Manager on Rs. 50, an Assistant Manager on Rs. 35, a Clerk on Rs. 25, and a packer on Rs. 12 a month. During term time, most of the actual work detailed above is done by students, and in their absence during the vacations paid-hands take their place. Four students work in the morning between 4-30 and 10 a.m. and another batch of three works from 3 to 6 p.m. During the period of training students of the short course take a full course in Dairying which, besides the works described above, consists of pasteurisation,* preparation of starters, cream ripening, milk testing and posting milk records. In addition, students take part in work connected with cattle feeding, which makes them conversant with the rations fed to various classes of animals. During the second year of their course, the students, besides the practical work, attend a course of lectures on the theory and practice of Dairying and Live-stock management. Thus the Dairy fulfils a very important and useful purpose.

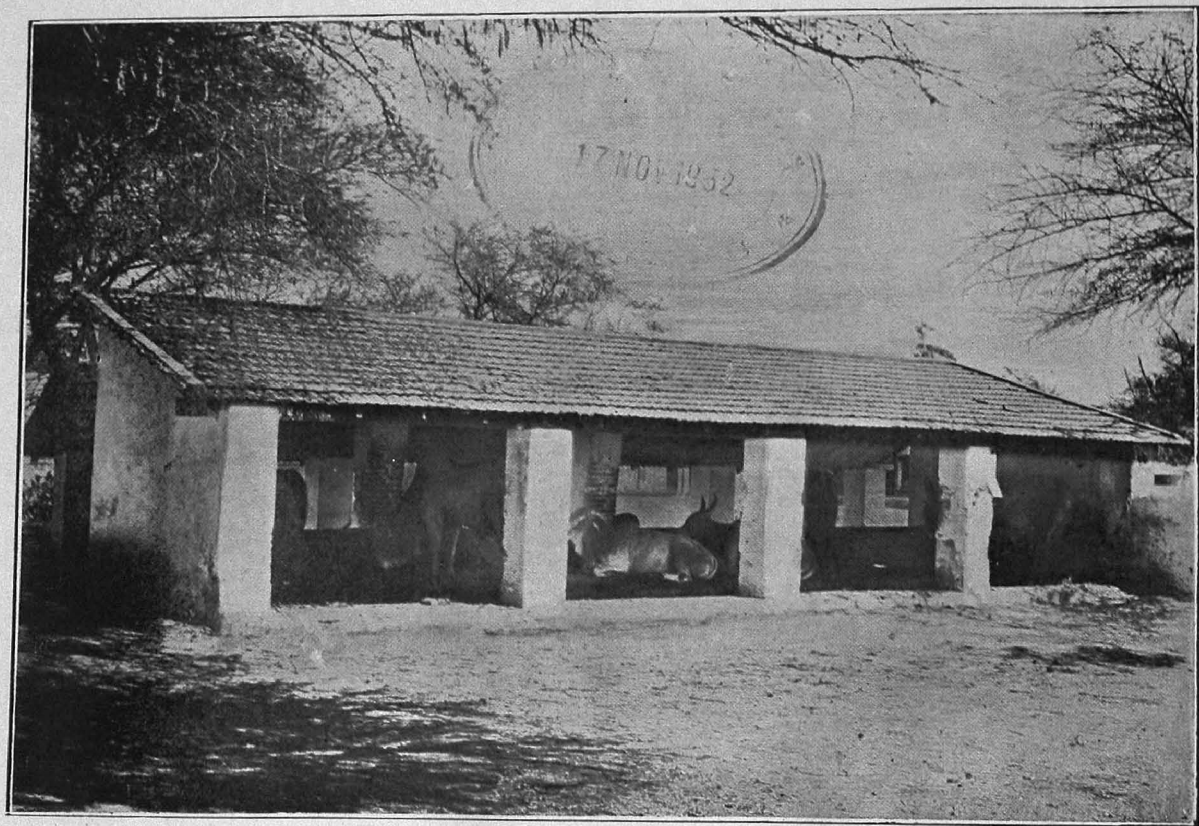
Situated in the proximity of the Dairy building are the stalls in which the College herd is accommodated. The accompanying photographs and plans show their lay out and construction. Stalls for cows, suckling calves, young stock and for breeding bulls are built close to one another, while care is taken to provide the necessary equipment for feeding; a trough is close by with an abundant supply of water. A store room for concentrated food adjoins the cow stalls. Brief descriptions of the various stalls are recorded against each.

* By pasteurisation is meant the boiling, say of milk, to 170° F. and maintaining it at that temperature for a short time in order to destroy mostly the adult forms of micro-organisms.

(B) *Farm*.—The farm, though extensive, has only a limited area reserved purely for fodder purposes for the cattle. The bulky fodder crops are grown under irrigation and an attempt is made to secure a steady supply of green fodder throughout the year. When green fodder is not available or cannot be cut and carted owing to a rainy day intervening, dry paddy (*Oriza sativa*), Sorghum or Ragi (*Eleusine coracana*) straw is substituted. In such cases the milk yield is generally reduced and to test the effect of different fodders, dry *versus* green, on the milk yields, an experiment was instituted and is recorded in the Year Book of the Madras Agricultural Department for 1918 under the title “A preliminary experiment on the influence of different fodders on the quality and quantity of milk.” (Vide Appendix C.)

Fodder sorghum and Guinea grass are grown on garden lands. These are irrigable from wells either by an engine or by mhots. The sorghum fields are generally manured at 15 cartloads of cattle manure per acre per crop and are always irrigated. The crop is often mixed with Lablab (*Dolichos lablab*) or cowpea (*Vigna catiang*), which being a leguminous fodder adds to its quality. The cost of production per year per acre is about Rs. 120. From such a field an average yield of 25,000 lb. of green fodder is obtained per year. The fodder is cut at the flowering stage. Green fodder is given to the cattle at the rate of 40 or 45 lb. a day per head.

Guinea grass is propagated from slips and is planted in rows about 2 feet apart either way and is kept on the same land for about three years. It is very succulent and tillers profusely which makes up for its height. The first cutting is taken when the crop is about six months old, and four more cuttings are obtained during the remaining six months. The cuttings on the whole



BULL SHED TO ACCOMMODATE SIX BREEDING BULLS. IT HAS A VERANDAH IN FRONT TO OFFER SHELTER.

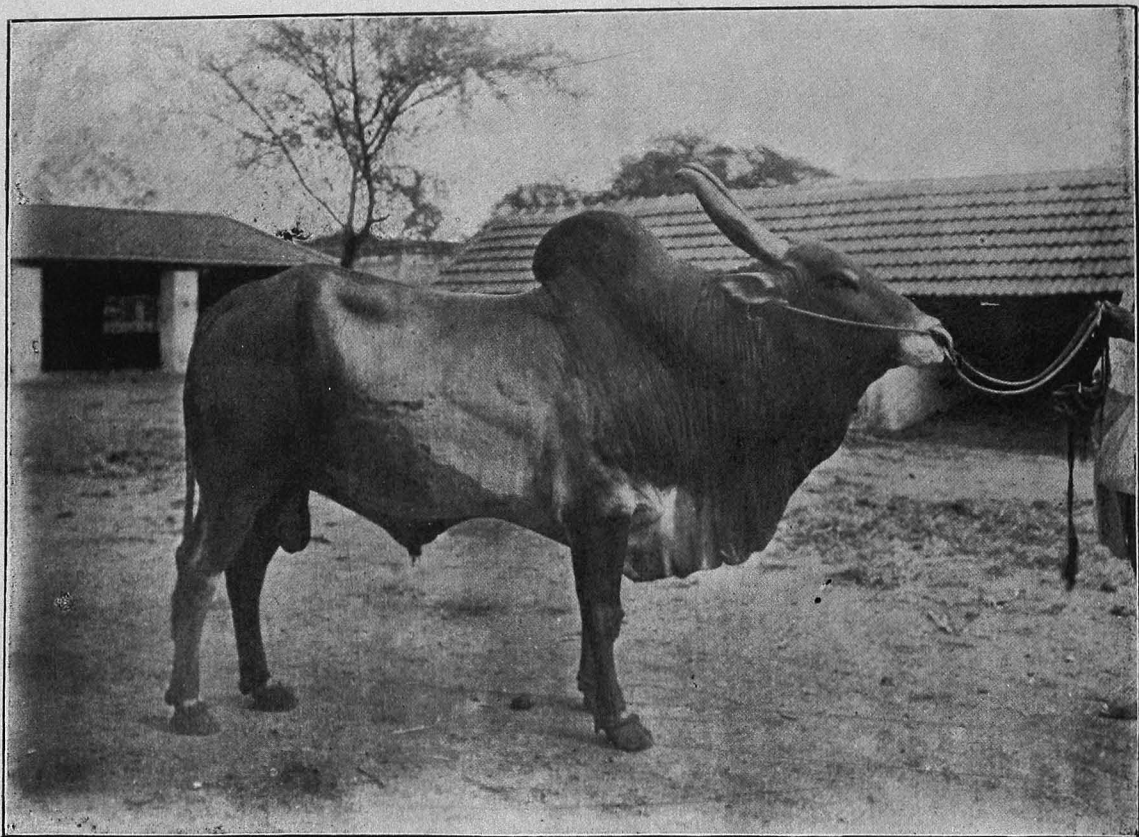
do not average to more than six or eight per year, and 30,000 lb. green fodder may be considered an average acre yield. The average cost of production is about Rs. 70 per acre per annum. Maize is an excellent succulent fodder and its larger extension as a fodder crop is recommended. Dry cows receive dry fodder consisting of sorghum, paddy, Italian millet (*Setaria italica*) or ragi which are primarily grown for grain. These along with green fodder crops are chaffed by a power-driven chaff cutter. About thirty acres of grazing land is available for the cows and calves which serves more as exercise ground. In addition to this, they get as grazing from fields what they can after the removal of fodder and grain crops.

PART II.

THE DAIRY HERD.

The supply of milk for the estate is an important matter and it is not necessary to dwell on the beneficial effects of a reliable milk supply on the health of the students and the staff. The students, and the staff with their families at the Agricultural College respectively number about 120 and 300. In the circumstances, it would not be possible to meet the demand for milk without some organization, and when all is taken into account, the present arrangement would be difficult to improve upon. The mere fact that the students and the staff have been kept free from milk borne diseases is itself an eloquent testimony to the efficiency of the management. The herd is therefore not maintained for profit in any sense of the term, but solely to supply a real want. It also exists for the very important purpose of training students in livestock management. The College herd which is a mixed one consisting of 13 Kangayam cows, 14 Nellore cows, 5 cross-bred cows, 7 local cows and 5 buffalos is maintained partly by rearing and partly by purchase, the latter being necessary to meet the continual demands of an ever-growing population. The above figures are the averages from 1913—17. Animals which are past breeding or are otherwise unprofitable are sold off. Even in such cases it is found that some profit is at times made when they are sold dry. The possession of a calf adds to the profits in the concern.

Intimately associated with the cows are breeding bulls. On the farm there are 13—a number which is far more than necessary. For the above herd consisting on the whole of 44 animals, two breeding bulls ought to be ample. These bulls, however, render good



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SIVAMALAI, A KANGAYAM BULL.

service in serving the Dairy herd as well as satisfy the innumerable calls made on them by farmers and others who come long distances for improving their breeds. This is an important aspect of the dairy farm. A nominal fee is charged for such service and the bulls for all practical purposes are self-supporting. They are also put to light carting work to keep them in condition. A short description of the various breeds will not be without interest. Once a pastoral country, there are indications of parts of this district still being so, with its grazing areas and breeding tracts. The Kangayam cattle are an important breed of the district remarkable for draught. Garden cultivation under wells is a distinctive feature of the district and the Kangayam cattle are famous also for drawing water from these wells. They are compact animals, quick on the road and generally useful for cultivation. The chief drawback lies, however, in their being poor milkers. But they are kept in the farm to maintain an improved draught breed. They calve regularly throughout their economic life dropping the first calf when they are about 3 years old. At the pail, their performance is poor, yielding about 5 lb. per day. Some cows, however, have given up to 2,900 lb. during their lactation period. Six calves have been recorded to have been dropped by some cows of this breed either before they died or were sold.

The Ongole cows are from Guntūr and Nellore districts originally, and are an imported breed in this district. These are much larger than the Kangayams and are rather better milkers. They are docile in temperament and the male stock being heavy are slow at work. Some of the cows of the College herd have in them a trace of Kerry and Ađen blood, but for all practical purposes they come under this breed. They are rather late breeders, dropping their first calf

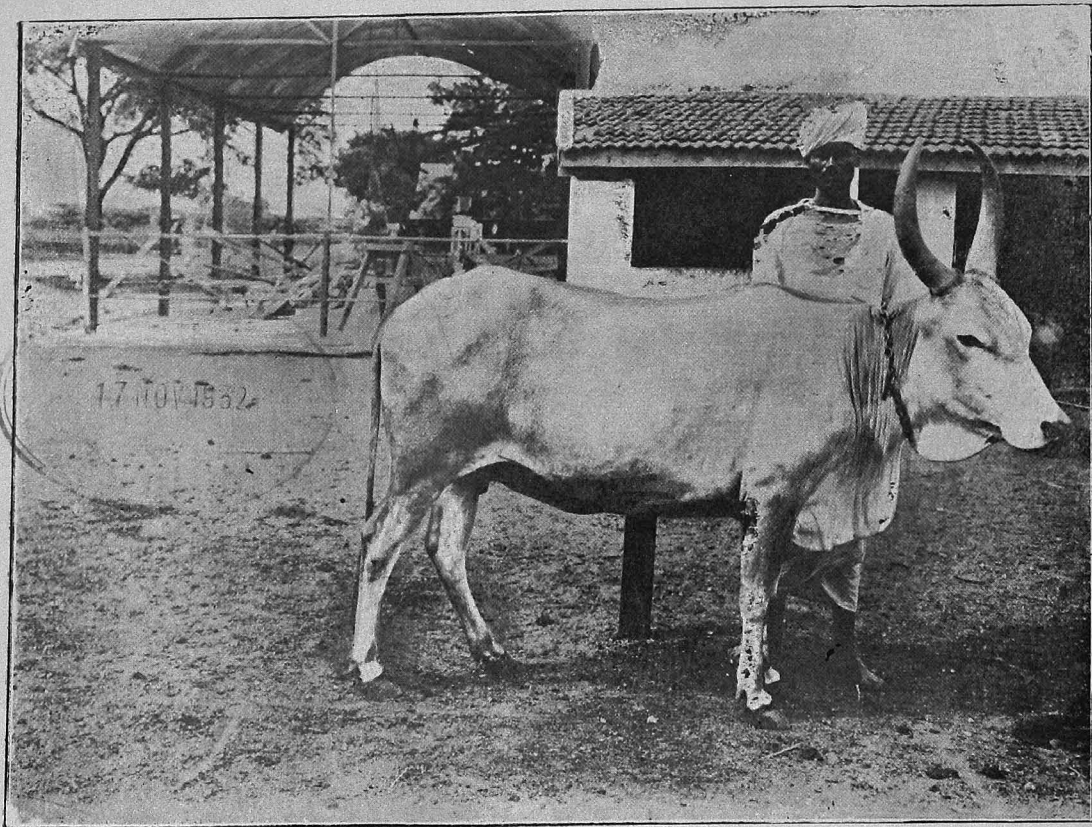
when they are four years of age and do not in this climate calve regularly. Some have calved only four calves in six years, while others, three in four years. During their economic life, a few cows of this breed in the herd are known to have borne as many as nine calves. The average amount of milk of this breed is $8\frac{1}{2}$ lb. per day. Good milkers have yielded up to 3,600 lb. during their lactation period.

The cross-bred cows are principally made up of Ongole, Jersey, Ayrshire and Australian crosses. They are the best in the herd in respect of their milking capacity. They are, however, easily susceptible to contagious diseases, and recently most of the herd succumbed to a severe attack of rinderpest. Their average yield of milk per day is 10 lb. Some cows are known to have yielded 5,600 lb. of milk during a lactation period.

The local cows are non-descript and belong to no particular breed. They resemble the Kangayams in many respects but are of small build. They are purchased comparatively cheap and sold off when not required.

The buffalos are mainly of local country type, small in build, and cheap in price. The College herd has in recent years been strengthened by the addition of some pure Delhi buffalos. They calve for the first time when they are about 3 years old and calve thereafter nearly every year during their economic life. They are better milkers than Kangayam and country cows yielding about 7 lb. per day during their lactation period. Some good local buffalos have yielded 2,800 lb. while the Delhi buffalos have given 2,900 lb. during a lactation.

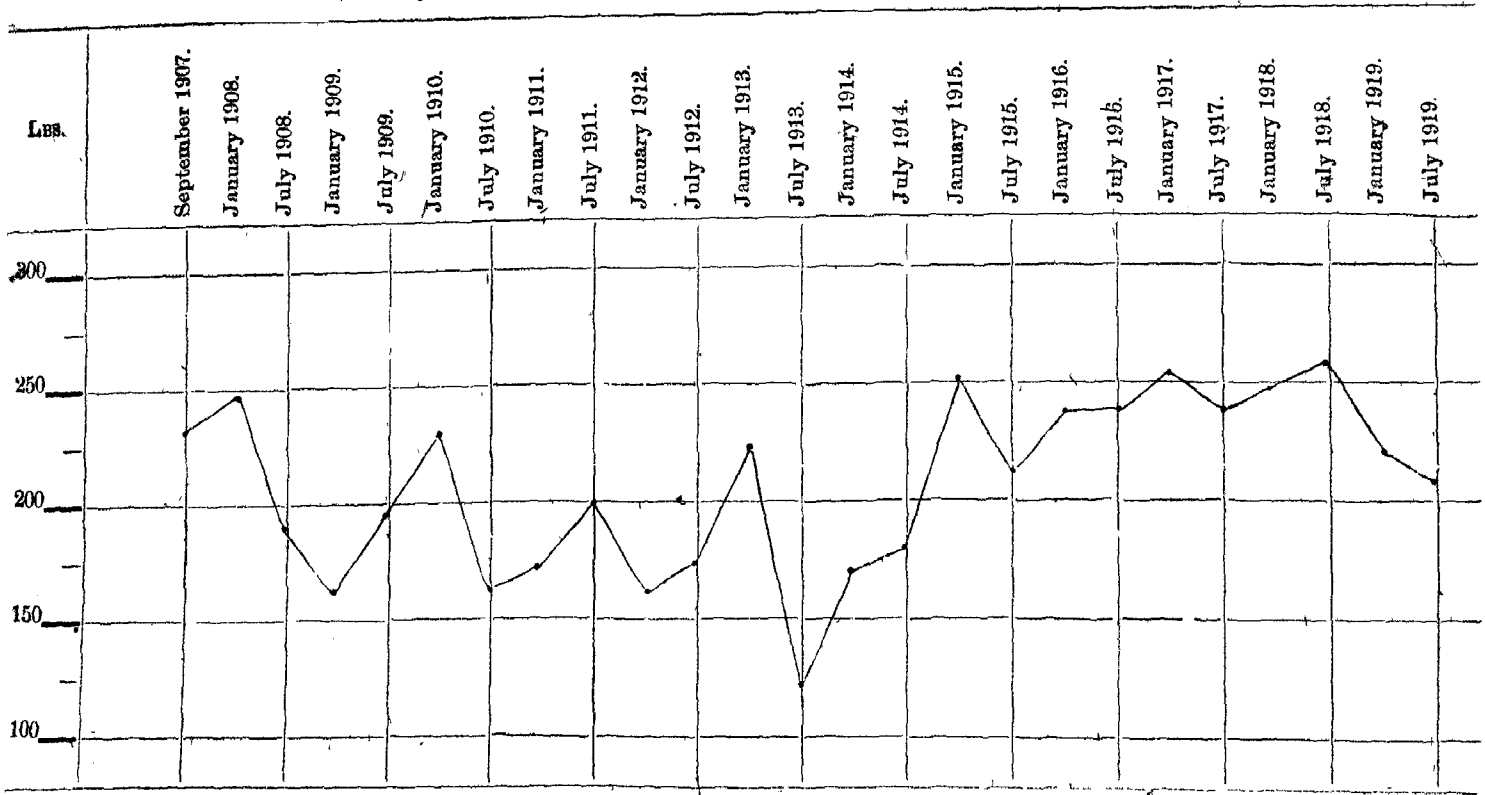
The aim of the farm in breeding is twofold, namely, to obtain good draught bullocks for the farm and to produce a good milking strain of cattle. Reference

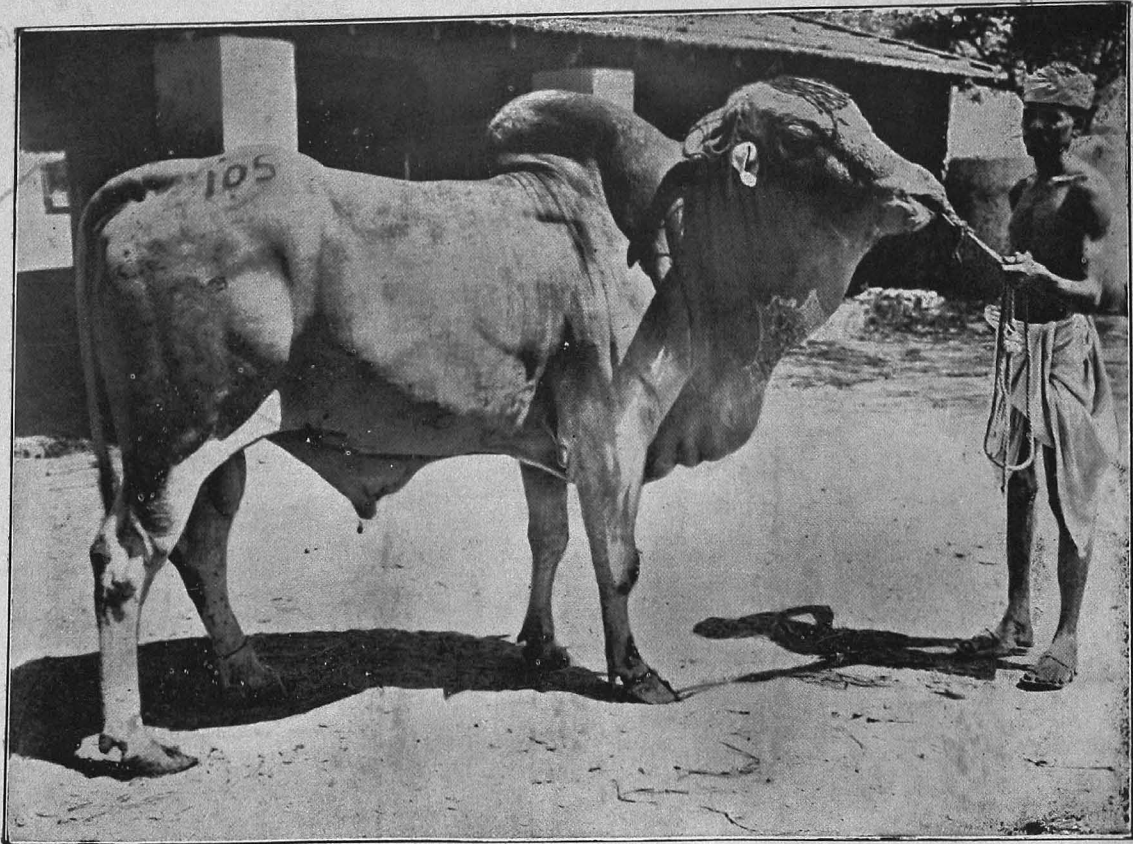


LOCHA, A KANGAYAM COW BORN TO MAPPILLAI.

THE COLLEGE DAIRY.

(Average monthly yield per cow, for cows in milk, for the last 12 years.)





KALYANAM, A NELLORE BULL.

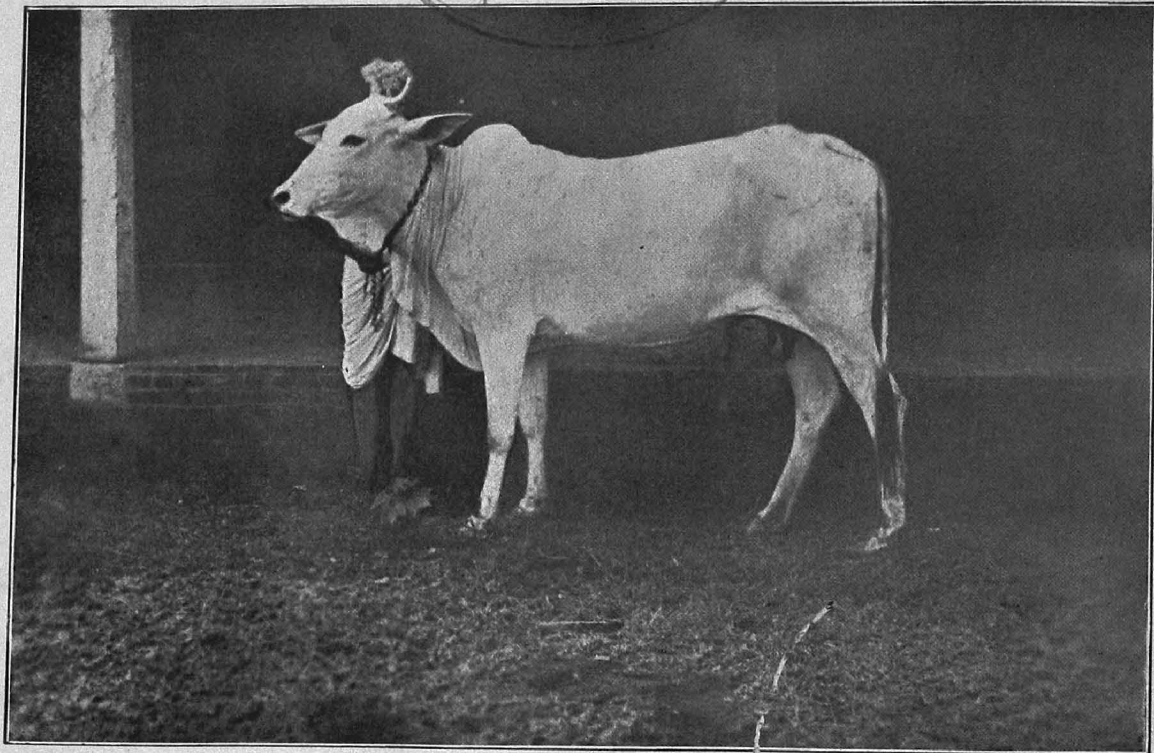
has elsewhere been made to the part the farm has so far played in introducing improved blood into the cattle of the neighbourhood. Breeding is indeed a slow business and one has to wait patiently for years before any results are expected. The farm has existed for more than ten years, and yet the progress in; for example, improved milk production has not been marked, as will be seen from the statement below :—

Average milk yield of the Coimbatore College Dairy Herd.

Year	Month,	Average number of cows in milk,	Total yield per month in lb.	Average yield per month in lb.
1907	September	3	708	236
1908	January	3	736	245
	July	8.3	1,588	190
1909	January	10.9	1,808	166
	July	14.3	2,836	198
1910	January	16.6	3,820	236
	July	18	2,960	164
1911	January	11	1,984	175
	July	17.6	3,524	200
1912	January	19.6	3,196	163
	July	25.3	4,348	172
1913	January	23.5	5,311	226
	July	35	4,349	124
1914	January	21.6	3,616	174
	July	24	4,516	188
1915	January	21	5,321	253
	July	25	5,338	213
1916	January	23	5,524	240
	July	21	5,068	241
1917	January	19.3	4,879	253
	July	24.3	5,330	239
1918	January	30.3	7,613	251
	July	26.0	7,011	262
1919	January	35.0	7,842	224
	July	29.5	6,116	207

The curve representing the above figures, demonstrates clearly the slow but steady improvement that has taken place during the last 12 years. The reduction after July 1918 is due to the attack of rinderpest

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A NELLORE COW.

Herd Register.

Name and Register number of buffalo—No. 1.
Purchased on 16th June 1909 for Rs. 50 with calf at foot.
Description—Country breed. Colour—Light black.

Born in 1905.

Date of service.	Name and Register number of service bull.	Date of calving and number and sex of calf.	Date of going dry.	Number of days in milk.	Yield of milk in lactation period.	Average per cent of fat in milk.	Number of days dry.	Name and brand number of the heifer or bull calf.	Annual valuation as determined each year with remarks.
...	...	June 1909, heifer.	17th Aug. 1910.	427	LB. OZ. 2,611 0	...	236	25/25	
3rd Jan. 1910.	Monigarpalaiyam buffalo bull.	9th Apr. 1911, heifer.	1st Sep. 1912.	506	3,597 8	...	148	57.7	
31st May 1910.	Pallipalaiyam buffalo bull.	26th Jan. 1913, heifer.	8th Feb. 1914.	372	1,955 12	...	164	127/83	
24th Oct. 1911.	Monigarpalaiyam buffalo bull.	23rd July 1914, bull.	24th Apr. 1915.	271	1,315 4	...	325	187.14	
20th Sep. 1913.	Meeran	14th Mar. 1916, bull.	11th Feb. 1917.	330	2,411 0	...	229	256/69	
6th May 1915.	Do.	23rd Sep. 1917, heifer.	30th Oct. 1918.	390	2,296 4	...	...	316/82	
22nd Nov. 1916.	Budha								

Herd Register.

Name and Register number of cow—Kangayam Meenakshi. No. 9/10.
Parentage—Purchased with heifer calf, 40 days old (for Rs. 177-8-0)
on 27th August 1908.
Description—Kangayam breed. Colour—Light iron grey.

Born in 1904.
Sold in auction on 11th
February 1915 for
Rs. 35.

Date of service.	Name and Register number of service bull.	Date of calving and number and sex of calf.	Date of going dry.	Number of days in milk.	Yield of milk in lactation period.	Average per cent of fat in milk.	Number of days dry.	Name and brand number of the heifer or bull calf.	Annual valuation as determined each year with remarks.
...	...	July 1908, heifer.	28th Mar. 1909.	205	LB. OZ. 632 8	...	196	Mvra, 33/31.	
25th Dec. 1903.	Mappillai.	10th Oct. 1909, heifer.	25th Apr. 1910.	175	1,036 12	...	206	Muni.54/51	
9th Dec. 1903.	Do.	29th Oct. 1910, heifer.	23rd May 1911.	187	884 4	...	256	Meena, 78/13.	
15th Jan. 1910.									
10th Jan. 1911.	Do.	20th Jan. 1912, heifer.	3rd Sep. 1912.	221	1,282 4	...	180	Marakatham, 99/25.	
8th Feb. 1911.									
3rd Apr. 1911.	Do.	3rd Mar. 1913, heifer.	18th Oct. 1913.	216	1,031 0	...	127	Manikam, 110/16.	
29th Mar. 1912.									
26th May 1912.	Tamar								
25th Apr. 1913.	Mappillai.	22nd Feb. 1914, bull.	15th Oct. 1914.	230	1,502 8	...	...	Bullock No. 185/28	
15th May 1913.									

Besides this, a pedigree register is maintained in, which the ancestral history of each bull or cow is

recorded. This indicates the parentage of each animal kept in the herd, whose individual qualities are known. One can expect good results by mating animals of known good qualities. To make clear what this advantage really means to the breeder, a geneological chart is included of a good dairy cow, Bhagiam, which produced a large number of very good higher calves which, in turn, when mated to known good bulls from a good milking strain, contributed largely to the improvement of the milking qualities of their progeny.

This gives an indication of how the College herd has been built up from small beginnings. There are in the herd some very promising young stock which ought to be good both for draught and for yield of milk. Improvement of a dairy herd by careful selection and breeding is a sure though a slow process taxing patience but nothing better could be done when the available material is poor. Quicker methods are, of course, possible if one is prepared for risks. This point will be developed more fully later.

For convenience in feeding and supervising, it is desirable to separate the dairy herd into sexes, sizes, and classes. The method adopted here is as follows:—
(a) cows in milk ; (b) dry cows ; (c) cows nearing the period of calving ; (d) suckling calves ; (e) weaned heifer calves and (f) weaned bull calves. At present the whole herd is stall-fed with the result that the cows, whether dry or in milk are housed together. It is desirable, however, to keep the weaned calves and dry cows in separate areas with facilities for grazing and exercise. Land away from urban areas, would be cheaper, and if such could be purchased or hired at reasonable rates, it is desirable to keep these cattle in such places. This, it is believed, would keep not only the cost of upkeep low but would tend to keep the cattle in health.

CROSSBRED KERRY COW × A NELLORE BULL.

Bhagiam (born at Saidapel in 1898 and died on 9 March 1911).

By a Nellore bull.	By a Nellore bull.	By a Nellore bull.	By a Nellore bull.	By a Nellore bull.	By a Nellore bull.	By Mappillai.	By Mappillai.
Heifer. Born on 25 Nov. 1902. Died on 31 Jan. 1903.	Bhagirathi. Born on 21 Feb. 1904. Died on 13 May 1918.	Balamani. Born on 5 Apr. 1905. Died on 27 May 1918.	Bull. Born on 8 Mar. 1906. Sold at Saidapel.	Bull Badsha. Born on 18 June 1907. Sold on 19 Jan. 1918.	Bhavani. Born on 8 June 1908. Sold on 9 June 1913.	Bull. Born on 24 July 1909. Sold on 3 Jan. 1913.	Badami. Born on 19 Sep. 1910.

By Mappillai.	By Mappillai.	By Badsha.	By Badsha.	By Badsha.	By Kallianam.	By Kallianam.	By Mappillai.	By Mappillai.	By Badsha.	By Badsha.	By Badsha.	By Badsha.	By Rajam.	By Looper.	By Badsha.	By Badsha.	By Rajam.	By Rajam.	By Rajam.	By Kallianam.		
Bull. Born on 4 Feb. 1910. Sold on 23 May 1912.	Heifer. Born on 25 Apr. 1910. Died on 7 May 1910.	Bull. Born on 24 Mar. 1911. Sold on 6 Mar. 1914.	Aborted. 1 Feb. 1912.	Bhagavathi. Born on 1 Feb. 1913. Died on 23 Apr. 1918.	Heifer. Born on 5 Dec. 1914. Died on 8 May 1918.	Bull. Born on 8 Feb. 1916. Sold on 19 Jan. 1918.	Bull. Born on 4 Mar. 1917. Trans. to Bulls and Bullocks. 30 Sep. 1919.	Bani. Born on 11 Jan. 1909. Sold on 1 Mar. 1914.	Bull. Born on 23 Jan. 1910. Sold on 29 Mar. 1912.	Bullock No. 31. Born on 10 May 1911. Sold on 15 Dec. 1914.	Bull. Born on 22 July 1912. Sold to Mr. Thomas.	Bull. Born on 15 July 1913. Breeding Bull.	Heifer. Born on 26 Oct. 1914. Died on 29 Apr. 1916.	Heifer. Born on 4 Jan. 1915. Heifer No. 8.	Bull. Born on 2 Jan. 1917. Sold on 19 Jan. 1918.	Bull. Born on 8 May 1918. Died on 11 July 1918.	Bharathi. Born on 12 Feb. 1914. Died on 14 Apr. 1918.	Bull. Born on 2 Feb. 1915. Sold on 5 Oct. 1917.	Bull. Born on 8 Mar. 1916. Sold on 5 Oct. 1917.	Heifer. Born on 4 Mar. 1917. Died on 6 May 1918.	Heifer 63. Born on 31 July 1918. Weaned heifer.	Heifer. Born on 8 July 1919. Suckling calf.

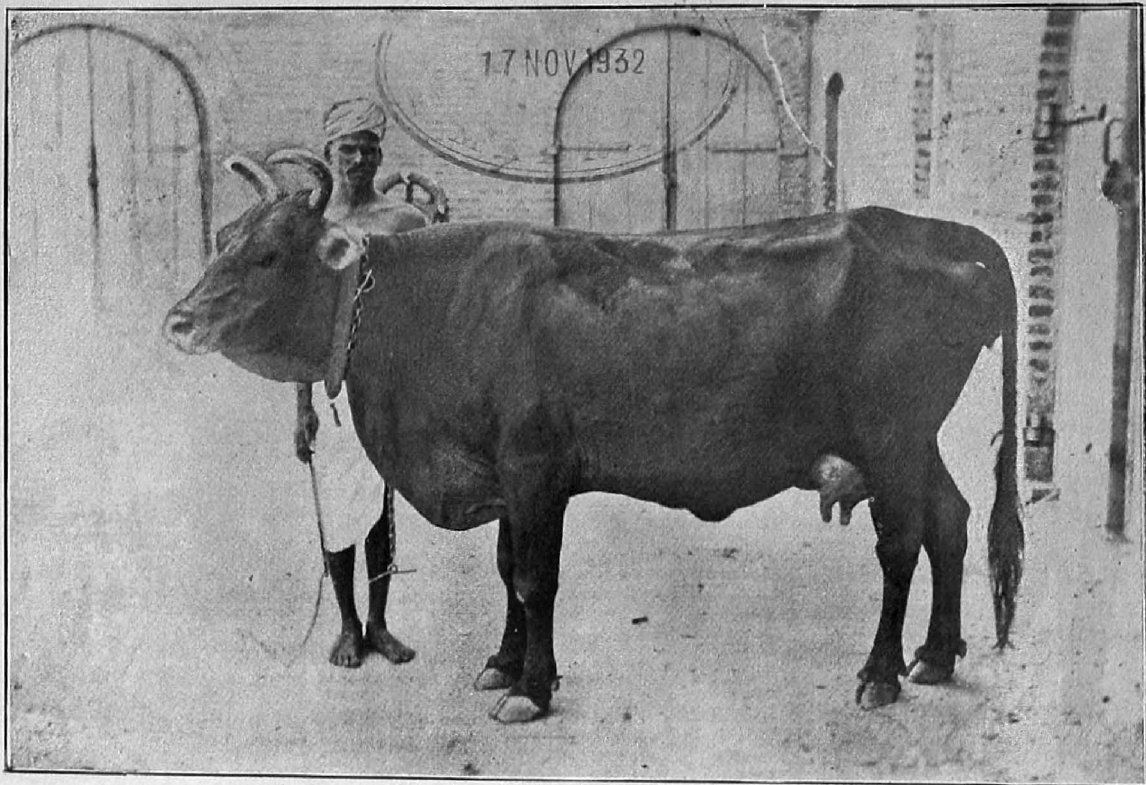
By Rajam.	By Rajam.
Bull. Born on 7 May 1916. Sold on 5 Oct. 1917.	Bull. Born on 29 Oct. 1917. Weaned calf.

By Badsha.	By Badsha.
Bull. Born on 26 Apr. 1912. Sold on 11 Feb. 1915.	Bhadrakshi. Born on 12 May 1913.

By Rajam.	By Rajam.	By Rajam.
Heifer. Born on 10 Jan. 1917. Died on 27 Feb. 1919.	Aborted. 5 July 1919.	Bull. Born on 25 July 1918. Weaned calf.

By Looper.

Bull. Born on 17 Apr. 1917. Died on 12 Dec. 1917.



IDA, A HALF-BRED AUSTRALIAN COW. NOTE THAT THE HUMP HAS PRACTICALLY DISAPPEARED.

The cows in milk are classified according to their yield of milk into (1) A class which gives 10 lb. of milk or more a day, (2) B class which gives 5 to 10 lb. of milk a day and (3) C class which gives under 5 lb. a day. The idea underlying this system is that it costs almost as much to feed a poor milker as a good one and as a business concern it is unprofitable to feed all alike. Animals which are better milkers ought to receive more food. Even a very good cow, naturally, as the period of lactation advances, yields less milk and can do with less food. The writer has already given figures regarding the average yields of individual breeds but the following records of individual cows may be of interest, which indicates their maximum output during a particular week in any one lactation.

Jersey (pure bred)	.	.	25 lb. per day
Cross breeds	..	..	22 „ „
Kangayam	...	...	10 $\frac{3}{4}$ „ „
Nellore	.	...	19 „ „
Buffalo (Delhi)	...	...	24 $\frac{1}{2}$ „ „

Feeding.—As explained above, all cows are stall-fed, and according to the class to which they belong in their milking capacity. The following table gives the rations of different classes of cows in milk and of those which are dry or are nearing the period of calving (parturition).

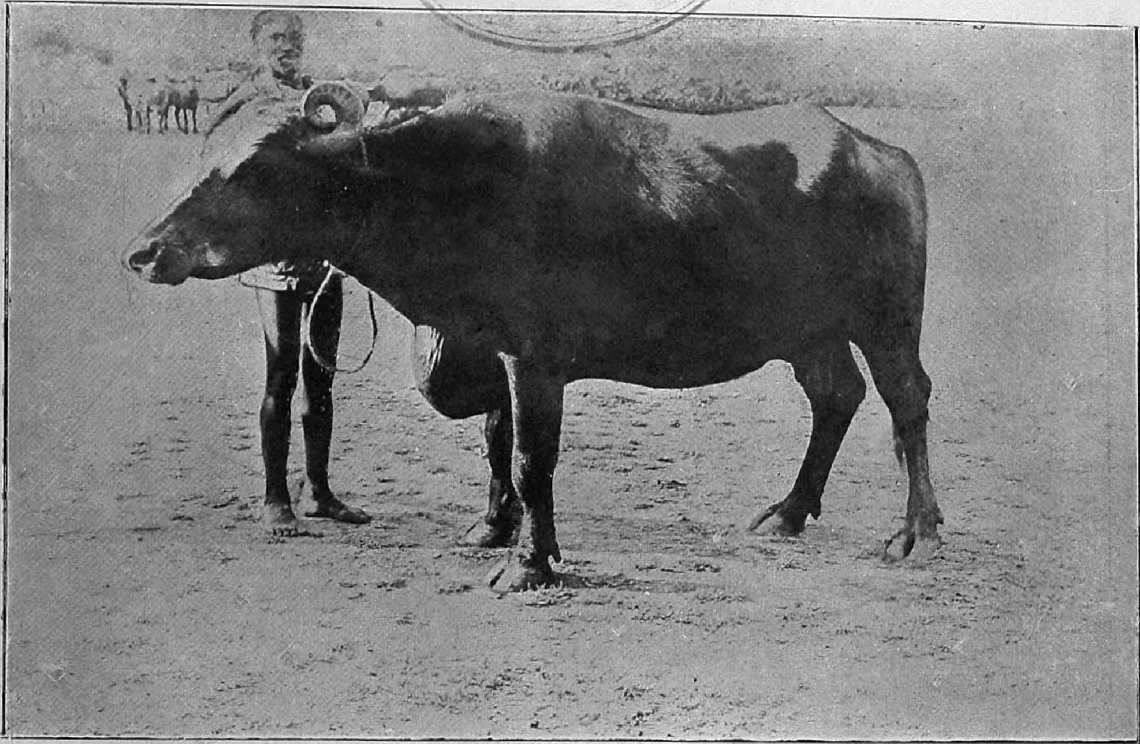
Class of cows or buffalos.	Cotton seed	Ground-nut cake.	Dholl husk.	Salt.	Green fodder	Total cost per day	
	LB OZ.	LB. OZ	LB OZ.	LB. OZ.	LB.	RS	A. P.
A class	2 4	1 12	3 8	0 $\frac{1}{4}$	45	0	8 5
B class	1 8	1 4	2 4	0 $\frac{1}{2}$	45	0	6 6
C class	0 12	0 8	1 4	0 $\frac{1}{2}$	45	0	4 5
Cows nearing parturition.	1 0	1 0	1 0	0 $\frac{1}{2}$	45	0	5 *0
Cows, dry	.	...	...	...	12 (dry fodder)	0	2 9

The total cost per day would fluctuate monthly owing to the changes in the price of food-stuffs and if

at all, the chances are for the prices to go still higher. The rations are arrived at by working out the nutritive ratio or the proportion of nitrogenous to non-nitrogenous foods in the rations. It will be found from the above statement that it costs more to feed a dry cow which is about to calve than a cow yielding 5 lb. of milk per day. This is so, because the cow at that time requires special nourishment to maintain not only her system but also her foetus. The milch cows are fed twice daily, after milking in the morning (7 a.m.) and before milking in the evening (3 p.m.). Of concentrated food, cotton seed is crushed in a roller mill, and groundnut cake, broken into pieces and soaked overnight. The foods are mixed in sufficient quantity of water according to the proportions given above. Salt is necessary for the health of the animals and sometimes in places rock salt is hung at convenient spots for cows and calves to lick. Besides the concentrated food, a plentiful supply of bulky fodder is essential. The bulky fodder is fetched twice daily and chaffed before feeding. Green grass is also obtainable chiefly during rainy months from field bunds from the forty acres of wet lands.

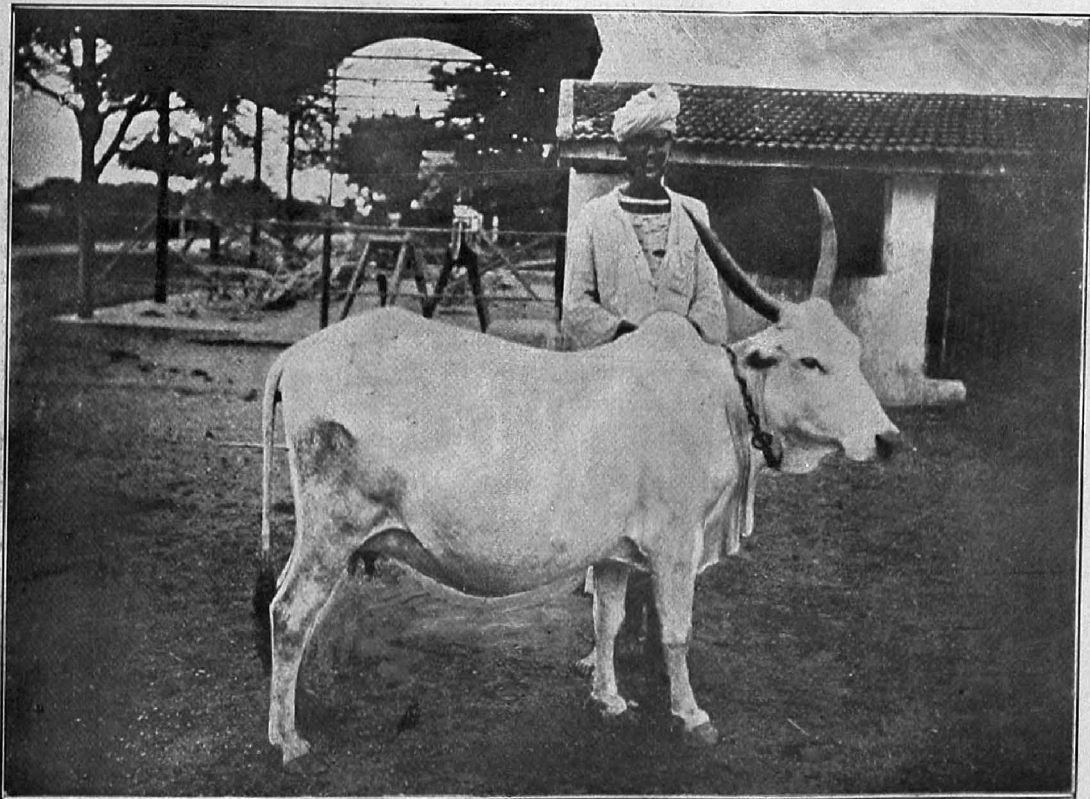
Rearing of calves. The calves receive from the first their own mothers' milk. In order to make them more independent of the mothers, calves are trained to drink milk from the pail from the time they are a week old. This is done by dipping the fingers into the milk and training the calf to suck the fingers and while so doing, it takes in some milk. This is continued until the calf is able to drink milk from the pail direct. It at first gets twice a day a quantity not exceeding a pound. By three weeks it begins to drink freely when the whole milk is substituted by skim milk. At six weeks, a conjee ration is given consisting of cotton seed and linseed meal and salt. At two months, this is substituted by a 4 oz. mixture of cotton seed, groundnut cake

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NIZAMBE, A FINE-BRED DELHI BUFFALO.

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AMMAI, A COUNTRY COW.

and $\frac{1}{4}$ oz. of salt which is given twice daily until the calf is weaned. Good and promising calves receive extra rations.

Although weaning of calves at birth is not practised on the farm, it is a practice worth adopting because in the first instance it is economical from the point of view of the farmer. Milk is costly and as a business concern it does not pay the farmer to let the calf suckle as much milk as possible. Although in the very early stages the weaned calves should get cows' milk, preferably from their own mothers, later it can be substituted by foods which are as wholesome as, and cheaper than, milk. Besides, the amount of milk that the calf gets according to the local method of letting the calf drink before and after milking, is not regulated. In some cases it perhaps gets more than its due share and sometimes it may be underfed. For these reasons, it is desirable to feed to the calves a definite quantity and increase it gradually. The secrets of successful calf weaning seem to be that the calves should be weaned from their mothers at birth, that as far as possible calves get their own mothers' milk but be hand-fed, that the milk is fed at blood heat being the body warmth of the cow and that the calf is taught to feed through the pail as described above.

Weaned calves.—These consist of both bulls and heifers which are weaned from their mothers after the latter become dry. These ordinarily get 8 oz. each of a mixture of cotton seed, groundnut cake and dholl husk and $\frac{1}{4}$ oz. of salt and are fed once daily. Special calves get higher rations. This kind of ration is continued with a gradual increase as becomes necessary until the young stock are about $2\frac{1}{2}$ years old, when they are drafted into the bull herd or heifer herd. In all the above cases as much grass as they can eat is supplied.

PART III.

CREAMERY.

We must distinguish between a creamery and a dairy. In the latter we include the dairy herd from which we obtain the milk: in the former we are simply concerned with milk, which is usually purchased from a contractor or from individual salesmen. Sometimes the business of the creamery may start with cream alone. For convenience, at the College, we divide the dairy farm into (a) a dairy which is concerned with the production of milk and (b) a creamery wherein the main business is to purchase milk from various customers, which is then separated by machinery into cream, which in turn is manufactured into butter. The creamery also purchases milk from the dairy at a fixed rate and disposes of it to the customers at the same rate without charging extra for straining and for loss due to retail disposal.

In the earlier years of the creamery, the policy was to make only a very small quantity of butter, chiefly as a training for students, so that very little milk was purchased. It was, however, soon found that the demand for good butter was great, and it was thought that it would be a good plan to increase the purchase of milk, so that the dairy would not only be supplying a want, but also teaching the students how to make the sale of butter a business proposition. With this object in view, the equipment of the dairy was increased and more efforts were made to purchase buffalo milk. For this purpose up to 400 lb. of milk are purchased at present daily, though in times of scarcity, it goes down to half the quantity. It is the policy of the College not to buy more milk than is required for the training of the students. That this aspect of the business has

considerably increased of recent years is evident from the statement below and were it not for the restriction on purchase, the present long waiting list of applications for butter would expand the sales much further :—

Official year	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.
	LB.	LB.	LB.	LB.	LB.
Quantity of milk purchased.	15,343	25,952	42,936	68,818	107,291

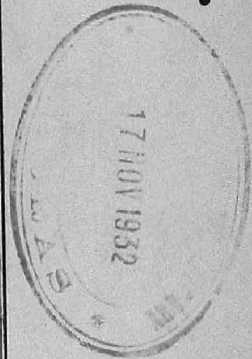
The milk from the villages is brought to the dairy between 7-30 and 9 in the mornings. The villagers generally prefer to keep the evening's milk for their consumption and also for ghi making. Small quantities ranging from 2 to 20 lb. are brought in brass vessels oftener covered than not. This is immediately tested with a lactometer, weighed, filtered and the weight recorded both in the milk register and in small books supplied to the sellers. The accounts are settled monthly, and when the number to be dealt with is as high as 70, one can imagine the amount of time required both for purchase and in account keeping. All attempts at wholesale purchase have so far proved futile, as there is not enough trust in each other, owing to regular insistence on the part of the creamery on a minimum amount of butter fat present. The lactometer being only a rough and ready test, whenever a sample is suspected of adulteration, it is tested for butter fat by actual analysis.

The creamery has now existed sufficiently long for gauging the character of the milk suppliers, and while none of them is above suspicion, some play the game much better than others. Samples of milk, milked in the presence of an officer in the villages in the morning contained 6.6 per cent of butter fat, and therefore of the average of about 6 per cent in roughly about 300 lb. of

milk purchased at the creamery there is not much to complain. To what extent adulteration can go on was tested in the dairy in 1915, and the results of the experiment find a place in the *Agricultural Journal of India*, Vol. XIII, Part I, January 1918. (Vide Appendix A.)

The milk after purchase undergoes separation by means of an Alfa Laval Separator. The cream is then pasteurised and is ripened by means of "starters." These may be either natural like butter-milk or artificially manufactured ferments like "Hanson's Lactic Ferment," which is a pure culture of lactic bacteria. These develop acidity in the cream which facilitates the easy separation of butter. The "starter" each day is made by boiling a small quantity of skim-milk and inoculating it with a small quantity of previous day's starter. These artificial starters are usually sold in bottles in Denmark and elsewhere with clear instructions for their preparation. The total output of butter per day varies from 20--30 lb. depending upon the quantity of milk purchased and an average of 7 per cent of butter to milk is generally obtained. It is found advisable to use ice in connexion with the manufacture and storage of butter. A cold store has not been erected, but the same conditions for preserving butter are secured by the use of ice. A point of great importance in the successful manufacture of butter is that it must be in a granular form (see photo) to enable a good deal of butter-milk to be washed out. The granular form can only be obtained if the water is cold enough and as the temperature during the major portion of the year is high, it is deemed necessary to have recourse to ice. The butter-milk if not removed will induce putrefaction and affect the keeping qualities of butter.

The art of butter-making cannot be learnt from a book, nor is it pretended in the bulletin to attempt



METHOD OF WEIGHING AND PACKING BUTTER.



BUTTER PACKETS OF VARYING SIZES. NOTE THE PRINTS WITH 'COLLEGE DAIRY' ON THEM.

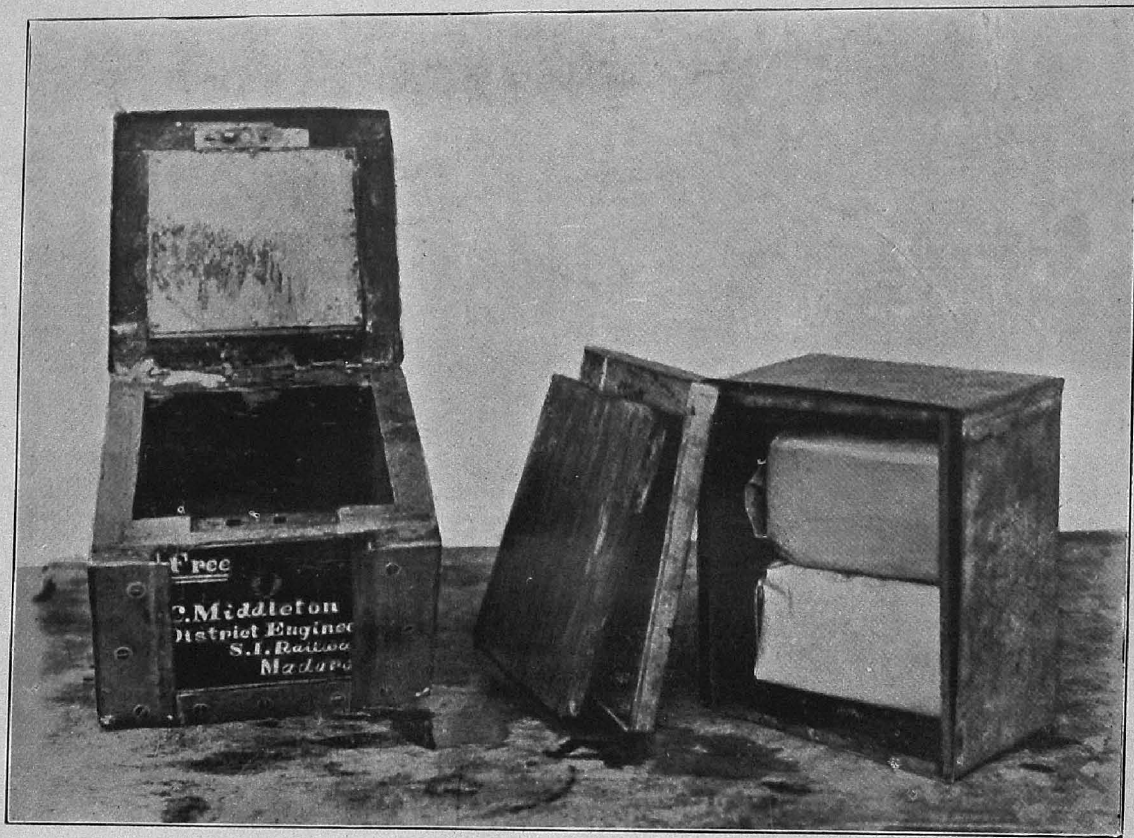
teaching it. It can only be learnt practically in the dairy. The butter manufactured is mainly consumed by the people outside the estate, and a very brisk trade in it is carried on with many Europeans in the town and in the mufassal. The College butter has earned for itself a reputation both for its keeping qualities and flavour, and when once customers purchase the butter, there has never been a case of cancelling owing to its poor quality. The annual increase in butter business from 1913 onwards, is given below :—

							LB.
1913-1914	...	...	...	...	...	...	1,358
1914-1915	...	...	.	...	...	...	1,886
1915-1916	..	...	...	...	..	.	3,939
1916-1917	...	...	...	..	..	..	5,608
1917-1918	...			...	..	...	9,038

It is gratifying that without any attempts at advertisement the College butter has on the whole met with considerable patronage and if testimonials are of any value, the dairy has an abundance of them. It may be of interest to note that the College put up an exhibit of a working dairy at the Madras Exhibition in December 1917, for which it was awarded a silver medal. It was a marked feature that the great interest of the public in the exhibit at the opening of the exhibition was steadily maintained throughout.

For mufassal transmission of butter, the dairy staff after considerable experience devised a suitable box to meet all cases. Till 1915 the creamery used cylindrical tins similar to those usually used in large manufactories, except that they were not made airtight. During the war, the price of tin rose very high and a local company which undertook the manufacture, could not keep to its specifications, and increased the prices, which became almost prohibitive. It was then thought advisable to devise a box of wood instead

of tin. The wood had to be light and yet durable and impart no smell to butter. These difficulties were got over after repeated trials, by choosing cedar wood, and orders were placed with a contractor at Trichinopoly to supply planks similar to those made for cigar boxes. Experience showed before long that the planks could not stand the rough handling through the post, and in hot weather the butter melted, and soaked into the wood, which it was found extremely difficult to clean. Thicker planks meant extra expense both in initial cost and postal charges although their cost even at that was cheaper than tins. Except for its cheapness there was nothing in favour of the wooden boxes when compared with tins, so that when the contractor was very irregular in his supplies, it was decided to put a stop to this arrangement. Non-returnable boxes whether of tin or wood being declared unsuitable for the reasons given above, attention was directed to find a suitable returnable box. This consisted of a double box—a wooden one made of any cheap and durable wood, enclosed in one of tin, as will be found in the accompanying photograph. This is provided with double covers similar to the box. The box is charged to the customers in the first instance; but after some time if it is returned in good condition, the price is credited to the customers. The box is returned by customer every time for replenishment. A fresh box is supplied when it is worn out by usage at customer's cost. The duration of the box depends upon the number of times it travels to and fro. If it is returned weekly, it is estimated to last six months, if once in ten days its life time is nine months and it is likely to last for a year if the box is returned once a fortnight. The cost of the boxes of this nature which hold $\frac{1}{2}$ lb., 1 lb., $1\frac{1}{2}$ lb. and 2 lb. is respectively As. 9-6, 13-6, 15-6, and 15-6. To keep track of various boxes and for distinguishing easily, boxes of different



RETURNABLE BUTTER BOXES.

THE ONE ON THE LEFT IS A SPECIAL BOX MADE BY THE PURCHASER FOR RAILWAY TRANSMISSION. THE ONE ON THE RIGHT IS THE BOX IN USE AT PRESENT

sizes are numbered A, B, C, D, and all boxes of a particular size are again serially numbered. If there are 20 two-pound boxes each box bears a number marked inside from A-1 to A-20. This system has so far proved satisfactory although it may be better sooner or later to revert to tin boxes which are also made airtight. Parcels of varying sizes from $\frac{1}{2}$ to 4 lb. are despatched every day to all parts of the Presidency, including Madras City, and customers are pleased to pay Re. 1-2-0 per lb. plus the postal charges for the box both ways, which works out to 8 annas per lb. extra.

In connexion with the manufacture of butter a large quantity of skim-milk becomes available. As this resembles milk in every way except that almost all fat has been removed from it, the skim-milk ought to find a ready sale. At the creamery there is a good sale for this except during the cold months of November to February when the demand is less. It finds a sale among the hotel-keepers for coffee and curds. There are several creameries in the neighbourhood of Coimbatore and fair profits are derived from these. It is proposed to discuss the profits of creamery trade in Part IV, and for further information on these creameries, the reader's attention is invited to the article on the "Dairy Industry around Coimbatore" published in the *Agricultural Journal of India*, Vol. XIV, Part II, April 1919. (Vide Appendix B.)

Fresh cream finds a sale in large cities but in Coimbatore, owing to delivery difficulties, there has never been any large demand. Otherwise selling cream is one of the most profitable lines. Experience has also shown that a demand for certain specialities like Devonshire cream, and cream cheeses can be created. The cold season seems to be the most suitable time for such departures, as the temperature is then low enough to obtain the best results.

The equipment of the creamery will now be considered. As explained before, as the butter business expanded, more machinery had to be purchased. For example the creamery started with a small churn, a small separator and a small butter-worker. Larger ones were added later on. The following is the list of machinery with their pre-war prices :—

Equipment of the College Creamery.

	RS.	A.	P.
Alfa Laval cream separator	305	0	0
Do. Viola No. 2	140	0	0
Champion churn, big 	130	0	0
Do. small 	70	0	0
Two butter-workers 	120	0	0
One butter drier 	80	0	0
Ice chest (locally made) 	260	0	0
Refrigerator 	145	0	0
Sandringham herd recorder 	35	0	0
Avery's balance 	60	0	0
Butter scales with brass weights	14	0	0
Hygeia filter 	15	0	0
Ufax filter 	16	0	0
Stove with six burners 	32	0	0
Twelve steel buckets 	42	0	0
Lactometer (metal) 	21	0	0
Aluminium measuring cans, two sets	17	0	0
Two tables and two Almirahs 	100	0	0
Leffman Beam milk testing apparatus	50	0	0
Five butter boards 	11	0	0
Thermometers 	10	0	0
Miscellaneous dairy outfit including scoops, squeegees, brushes, buckets, plates, spoons, scotch hands, sieves, cream cups, etc.	100	0	0
Total	1,773	0	0

It is not intended to suggest that this amount ought to be sunk on equipment by one who wishes to start a creamery. Using the same prices, a modified list is given below which would be amply sufficient for a

creamery dealing with 400—500 lb. of milk daily. In fact the same would be enough even if the quantity of milk is doubled except perhaps for buckets, filters, and other minor items. We must, however, sound a note of warning that the prices of all machinery have of late risen abnormally high and the valuation in all probability is an under estimate. There is no reason why some of the articles should not be made locally and such likely articles have been marked with an asterisk and the probable prices quoted against each if locally made.

	RS.	A.	P.
One Alfa Laval cream separator (capacity 30 gallons per hour) ...	305	0	0
One champion churn (capacity 40 lb. of cream)	130	0	0
* One big butter-worker	70	0	0
One refrigerator	145	0	0
One Sandringham herd recorder ...	35	0	0
One Avery's balance	60	0	0
One Ufax filter	16	0	0
One stove with 6 burners	32	0	0
One lactometer (metal). Glass could be procured for a cheaper price, but not so lasting	20	0	0
* Aluminium measuring vessels, one set. .	10	0	0
* Three butter boards at Re. 1-8-0 each.	4	8	0
Two thermometers	8	0	0
* Two butter scoops	3	0	0
* Two pairs of scotch hands at 1-8-0 ...	3	0	0
* Butter prints	3	8	0
* Butter box	8	0	0
Twelve steel buckets	42	0	0
Washing equipment consisting of a hearth, a large vessel, and a tub ...	60	0	0
Two almirahs and one table ..	100	0	0
Miscellaneous outfit including brushes, squeegees, sieves, towels, separator oil, ordinary buckets	70	0	0
	1,125	0	0

If butter making is dispensed with and cream separation alone is attempted, the cost of equipment can easily be reduced to a third. This is what is being done by those who export cream to the Nilgiris from various villages in this district.

Besides the permanent equipment, a certain amount of current expenditure is incurred in the manufacture and packing of butter. For example grease-proof paper, packing paper, salt, soda, matches, for which about Rs. 20 per month may be estimated. In a business like this, it must not be forgotten to take into consideration the expenditure on postage stamps for posting bills and correspondence. This from experience has been estimated to cost Rs. 8 per month, although the creamery has so far not brought this into account because Government stamps are used. In a private concern this must be included.

No attempt is made at ghi manufacture. The readers' attention is however drawn to the paper on "Economics of Ghi Trade" in the Madras Agricultural Department, 1919 year book (vide Appendix D) where it is clearly discussed from experiments conducted that at the present prices, it is impossible to make pure ghi. The natural inference is that, in such circumstances, the ghi is sold either badly adulterated or at less than the cost price. Both are possible, because in the one case the ghi woman does not profess to maintain cows for profits, and in the other she is not beyond reproach.

PART IV.

BUSINESS ASPECTS—(A) DAIRY.

Like a manufacturer, the dairy farmer must consider his farming as a business, and determine where his profits and losses are under each head. The business itself ought to be attractive to any one who likes animals, and unlike in many another business, the returns are fairly quick. The problem we are concerned with, is the cost of producing milk on the farm, which is by no means easy of solution, and from the view point of the cultivator who maintains no correct accounts, his idea whether his cows or buffalos are a profit is rather obscure. In India, at any rate, few writers on dairying have so far made any attempt to work out the cost of producing milk. It is admitted that it is not an easy matter. It means the correct recording of many facts, which are difficult of elucidation. Sooner or later this problem must be faced, and all who are concerned with dairy herds will solve this intricate problem for themselves. Only then can they know whether or not dairy farming in this country for milk production is a profitable undertaking. At the College Farm, however, as accounts are kept of various items of food, housing and labour, and as a record of the quantity of milk that each cow produces in each lactation period is also daily maintained, it is not difficult to arrive at fairly accurate figures. It must be pointed out that the dairy business is attended with many risks; moreover it entails a large initial outlay, and, one has to be cautious before proceeding with the business and to take stock at every turn to see if it is a paying concern.

The success or failure in this concern chiefly depends upon the proper selection of the dairy herd.

This in itself calls for technical skill and a good knowledge of the animals, backed with a large amount of experience. Cows whose milk yield is low, whose dry period is long, and which are irregular in calving, cannot but increase the cost of production of milk. It is the experience of the College Farm as already explained in part II, that Kangayam cows are not to be kept for dairy purposes and that half breeds are the most useful, although unfortunately owing to their being partly of foreign blood, are more susceptible to contagious and infectious diseases-like rinderpest and foot and mouth disease. These are formidable obstacles to successful dairying, specially with imported breeds. In the case of rinderpest, in the majority of instances losses of animals themselves will occur. Foot and mouth disease in this country is not so serious, but it is certain that loss in produce occurs during the lactation period in which the animal takes the disease. Both these diseases are fertile causes for considerable reduction in the milk of the herd and in view of the consumers, these ought to be guarded against. On the other hand, from a business point of view, the maintenance of buffalos purely for milk is a step in the right direction. Popular sentiment, however, in this Presidency is against it, presumably because of the habits of the animal and the unsuitability of its milk for children owing to its high fat contents. The price of buffalos' milk is consequently cheaper than cows' milk. In parts of Bombay, however, this prejudice does not seem to exist and buffalos' milk is reported to sell dearer.

Equally important are the considerations of food, housing and care of the dairy herd. With regard to concentrated food, its cost is of utmost importance. In these days of high prices, the dairy farmer ought to pay particular attention to the cost of both the concen-

trated food and bulky fodder. The food must always be wholesome, and must be such as to which the cattle are accustomed. The food has to be prepared so as to be made full use of by cattle. For example, groundnut cake must be broken and soaked, cotton seed crushed, and bulky fodder chaffed. These items though minor, are all important. Sufficient has already been said of the bulky fodder, but emphasis may yet be laid on one or two important aspects. A fair but constant supply of green fodder is essential to dairy animals as it tends to increase the flow of milk. Secondly, it is highly desirable, by intensive cultivation to grow heavy yielding crops. Thirdly, to minimise wastage, all fodder should be chaffed. A certain amount of grazing is essential, both to enable the herd to pick some grass when it is found and also to provide sufficient exercise to keep them in good condition.

It is obvious that the dairy herd has to be properly housed ; the greater the price paid for them the higher the depreciation and the greater the need for their proper care. The cattle sheds on the farm cost Rs. 3,700. This is perhaps high when the value of the herd is about Rs. 6,000, and economies could be made in this direction. If properly constructed, the depreciation on them can be as low as 2—3 per cent.

When dealing with expensive animals, their proper care is a necessity. Although young cattle do appreciate up to a certain period, a time will come, when even expensive cattle will depreciate. The rate of depreciation depends upon the care and treatment accorded to them. If the herd is kindly handled, properly housed, all cases of illness are immediately attended to under expert advice, there is no reason why the charge under depreciation should be very high. It is of utmost importance that cattle are attended to immediately in cases of sickness. One often sees animals

being brought to the hospital for treatment in advanced stages of illness when practically anything that European medicine or surgery can render becomes useless. "A stitch in time saves nine" is a safe motto that all cattle owners will do well to bear in mind. On the farm, where the animals are all valued annually the depreciation on an average of five years works out to a little less than 13 per cent. The farm possesses a Veterinary officer whose business is chiefly educational but who is also the expert adviser on cattle. He attends to them during their illness and in times of calving. We have already referred to losses due to contagious and infectious diseases. Deaths due to natural causes should also be taken into account. Sometimes a little carelessness during the calving period may result in the teat of an animal going permanently blind resulting in such cases in a high depreciation of the cow during the rest of her economic life. Barrenness in cows increases depreciation and this quality in cows is just as bad as their being poor milkers. In all such cases all unprofitable cows must be periodically and ruthlessly weeded out and sold for whatever price they fetch. For this reason too much importance cannot be laid on the annual valuation of the individuals of the herd. This will indicate at once which cows are working at a profit and which are not.

A certain amount of labour is necessary in the maintenance of the herd. Items which require attention are milking, feeding, grazing and grooming; a small staff to supervise the labour employed is essential, unless the farmer himself undertakes it. On the farm a full time *maistri* and the part services of an assistant manager are allowed under this head. In private concerns it is quite possible for supervision to be done more economically. When all these expenses are taken into account, the amount of money that has

to be sunk on such an undertaking becomes enormous. With a herd of 44 cows and their calves at foot and allowing for only 2 breeding bulls, the total outlay

	RS	is calculated to be Rs. 23,600* and
Dairy herd	5,900	the annual average current expendi-
Buildings ..	3,700	ture for 5 years amounts to Rs. 8,500.
Garden land (if		It is not at all easy for an ordinary
purchased) ..	12,000	individual to possess such a large
Reserve capital		capital and the only possibility of
for current		obtaining it is by way of a loan
expenditure ...	2,000	either from a private money-lender
	<hr/>	
	23,600	
	<hr/>	

or a Co-operative Society. In any case, it is considered that 10 per cent is a reasonable rate of interest in these days. Taking all these items together, the details of the cost of milk production are worked out per annum, of an average for 5 years from 1913 to 1917 (both years inclusive)—

	RS.	A.	P.
1. Food—			
(a) Concentrated food	1,732	0	0
(b) Cost of bulky fodder deducting the value of manure	2,290	0	0
(c) Preparation of food, chaffing, etc.	158	0	0
(d) Value of grazing at Rs. 6 per head per annum ...	276	0	0
2. Interest on capital—			
(a) Live-stock on Rs. 5,888 at 10 per cent	588	0	0
(b) Cattle sheds, stores, etc. (Rs. 3,700) at 10 per cent	370	0	0
(c) Rent on 20 acres of garden land at Rs. 25 per acre (if purchased it would cost at least Rs. 600 per acre)	500	0	0
(d) Working capital on Rs. 2,000 at 10 per cent ...	200	0	0
3. Depreciation—			
(a) Live-stock (according to valuation statement) at 12·8 per cent	756	0	0
(b) Cattle sheds, stores at 3 per cent	111	0	0
4. Labour—			
(a) Expert supervision	300	0	0
(b) Coolie labour	714	0	0

5. <i>Buildings</i> —	RS.	P.
Repairs and upkeep (actual)	74	0 0
6. Loss due to barren cows (included in depreciation of stock in item 3 (a) above) ... ..	...	...
7. Loss of produce during attacks of disease (deducted from yield of milk) ... ..	...	...
8. Death rate during economic life (loss of one animal per year included in depreciation) ... ..	...	...
9. Death rate due to contagious diseases	353	0 0
10. Sickness charges including medicines at Rs. 40 per year and skilled attendance at Rs. 5 per month...	100	0 0
11. Service allowance included in upkeep of cattle ...	...	...
Total ...	8,522	0 0

The relation per cent that individual items in the above expenditure bear to the total is as follows :—

1. Food 52'00	5. Buildings, repair and upkeep ... 1'00
2. Interest on capital 19'42	9. Death rate due to contagious diseases ... 4'16
3. Depreciation ... 10'14	10. Sickness charges ... 1'18
4. Labour 12'00	100'00

Very little further comment on the above is necessary. It may, however, be pointed out that as far as the farm is concerned during the five years under review, it was fortunate practically to escape deaths on account of contagious diseases, but in the year following there was a heavy toll on half and pure bred cattle owing to rinderpest. It is, therefore, thought expedient to make provision for an expenditure of this nature and consider this a necessary evil, inasmuch as expensive cross-bred cattle are kept in the herd. Such expenditure must be foreseen. It is not the practice of the Government to insure cattle against this risk, but 6 per cent has been allowed on this as an approximate figure. It is quite evident that when

such a large proportion as 52 per cent is spent on food alone every effort should be made to see that greatest care is bestowed on it; no over-feeding is to be permitted and especially to wrong kind of animals. It is quite possible to reduce the cost under the heads of depreciation and labour.

Now, the receipts of milk from the cows require notice. By taking the annual average yields of milk of the herd for five years it was found that 63,982 lb. of milk were obtained. This quantity is from 44 cows, allowance having been made for their dry periods, the actual number in milk at a time being about two-thirds. The average cost of producing 1 lb. of milk is As. 2-1·5 or roughly As. 2-2. It is assumed that the cost of rearing calves is equal to the price obtained for them when sold. This, however, requires verification. The price of As. 2-2 is the actual cost of the milk at the place of production. At the farm, however, the milk is sold at As. 1-2 per pound thus losing in the transaction 1 anna on every pound sold. As explained at the outset it is essential to keep the price of milk reasonably low to make it possible for all people to purchase pure milk—a possibility to which is so largely attributed the freedom from milk borne diseases. Any undue rise in price will only mean that there will not be a sufficient demand for the farm milk, so long as there exists a class of people in the neighbourhood who are anxious to dispose of the surplus milk.

In the case of milk being sold retail, an additional allowance will have to be made for the cost of pasteurising, cooling, delivery charges and losses in distribution. To this must be added the expenditure incurred under preparation and collection of bills.

Now for profits. Private dairy farmers must remember that they cannot maintain a dairy permanently

unless a profit is made, and it must be a reasonable amount to make such a speculation worth the trouble and expense. Profits are admissible and this is a matter which should be left entirely to private individuals to settle for themselves according to their circumstances. To attract a better class of men to the business, and to give a stability to the industry, it is desirable to obtain reasonable profits. In this particular instance, it will be worth while for an educated man to undertake a business of this sort only if a profit is made of at least 2 pias for every pound of milk sold. It must, however, be pointed out that being a Government farm, there are certain items of expenditure which it may not be possible to economize in as easily as a private one can, but on the whole, although the figures are reliable, it is believed that the greatest improvement at present lies in the possession of a better dairy herd.

The cost of producing milk may vary in different localities. If grazing areas are within easy reach and are plentiful, it is possible to lessen the cost. But on the whole as the dairy farms will be kept in the vicinity of large towns, one should be prepared for high charges in food and labour.

(B) CREAMERY.

That the creamery industry has caught the fancy of the Coimbatore villager has already been mentioned. That the creameries so run are profitable has been indicated in the article published in the *Agricultural Journal of India*, Volume XIV, Part II (vide Appendix B) on "Dairy Industry around Coimbatore." These creameries are mainly concerned in supplying cream to the butter-making dairies in Wellington and Cónoor on the Nilgiri hills. Their experience has

been shared by the College creamery. There are, however, two points which should be made clear. Firstly, the creamery must purchase entirely buffalo milk as it is almost twice as rich as cow's milk. Secondly, proper arrangement must be made for the disposal of the skim milk. As far as is known in this Presidency its scope for usefulness is limited. It is sold either for use with coffee or for conversion into curds. But in the Presidency of Bombay, this problem has, it is understood, been solved by the cultivator himself who converts it into casein, for paints, varnishes, etc., by first curdling it with buttermilk, then pressing it under crude wooden presses and then drying and powdering it for export. There is thus a large field of profit yet unexplored in this direction in this Presidency.

There are yet other difficulties in the way which are, however, not insurmountable. There is the irregular supply of milk to be contended against. During the months of August to October there is a considerable drop in the quantity of milk brought to the creamery, and if the butter receipts fall down, as they are bound to in these months, the reputation of the creamery is at stake. It needs therefore great caution in booking orders ahead. Again, one is beset with all the disadvantages of a retail trade. If too much butter is manufactured a good deal of risk entails, because at best butter can be kept in a dairy in good condition only for a fortnight or so. If too little is made and sent round the customers are dissatisfied. But if the product is genuine and good, there need not be much fear on this score. The experience at the creamery has been that in the majority of cases the supply has fallen short of the demand. The butter business if at all successful brings one face to face with all sorts and conditions of people. It therefore calls for a good deal of tact, patience and humour to keep on

the right side of all customers, but on the whole, if regularity in supply is maintained, there is little doubt that the creamery will have the gratification of having satisfied at least in a measure, a real want. Accounts must be accurately and systematically maintained and posted up to date. A note of warning must be sounded. As in all other businesses, there will be some bad customers, and it is only from experience that one can learn whom to avoid and whom to approach.

Now to turn to profits. We publish below a profit and loss statement of the creamery for the year 1917-18. Side by side is another statement to show where adjustment could be made with a view to economy, if private enterprise should undertake a concern of this nature.

Balance sheet, 1917-18.

Fuel @ Rs. 20 per month	240	0	0	240	0	0
Ice 13,908½ lb @ Ps. 6 per pound	434	10	3	434	10	3
Ice purchased at Madras	50	8	8	...	...	...
Conveyance charges @ Rs. 15 per mensem	180	0	0	178	0	0
Contingencies	595	12	3	300	0	0
	17,106	0	2	15,686	11	3
By loss or profit...	988	8	11	1,030	12	0
	16,717	7	3	16,717	7	3

NOTE.—The cost of buildings and working expenses vary in different localities

* Building 2,500, Machinery 1,500, Working capital 1,000, Total 5,000.

† Manager on Rs. 35, 420; Dairyman on Rs. 15 per mensem, 180, 1 coolie on Rs. 8, 96; 1 coolie on Rs. 7, 84; Total Rs. 780.

‡ Single bullock cart 3 times a week @ As. 8 per half day.

Only a few comments are called for, as the statement is sufficiently self-explanatory.

Receipts.—The creamery is considered to purchase the milk of the dairy herd from the farm and sold at the same price, namely, at 1 anna per pound for 8 months in the year and at As. 1-2 per pound for the remaining 4 months. The milk is only strained but not pasteurised or bottled. Boiling is done by the customers themselves before consumption. Similarly butter was sold at Re. 1 per pound till November and at Rs. 1-2-0 later. Curds are manufactured usually in summer, as there is a fair demand for butter milk from February onwards. It is assumed that practically no ghi is manufactured owing to the fact that at the price it fetches it is uneconomical to sell it pure. We are continually faced with the question of the disposal of a large quantity of skim milk during the cold months. Skim milk cheeses are sometimes made and are appreciated but this again requires some practical training. It is, however, got rid of by feeding it to all the dairy animals and if necessary even to the working cattle. Reference has already been made to the training of calves to drink milk from the pail for which purpose a certain amount of milk is utilized.

Under *expenditure*, it will be noticed that a large sum of Rs. 6,700 was expended on the purchase of buffalo milk for the manufacture of butter, but this large amount is settled in monthly instalments, as the butter bills are being paid up. An allowance of 10 per cent has been made for interest on capital, which is rather high amounting to an annual expenditure of Rs. 1,200. This is due to the very substantial dairy building which costs Rs. 9,000. Such a building is unnecessary and in the adjoining statement provision has been made for only Rs. 2,500. This will on the whole satisfy all conditions, although the amount required is bound to vary in different parts of the

country. With regard to the machinery, the farm valuation in that year was Rs. 2,000 and the second statement provides a very liberal amount of Rs. 1,500 taking into consideration the present prices, although it will be noticed that in Part II, will be found an estimate of machinery for only Rs. 1,125. In both cases it is considered Rs. 1,000 for working capital is essential. The depreciation and repairs of building are only 3 per cent while 10 per cent for the same on machinery is considered reasonable. With regard to the establishment on the creamery, it must be remembered that one of the chief duties of the manager is to teach students in practical work, so that for pure dairy work alone, he is allowed Rs. 35 per month. Similarly, during the 8 months that students work and for the services rendered by them during this time, a deduction in wages of two coolies for 8 months is made. In the case of a private person, a staff consisting of a manager on Rs. 35, a dairyman on Rs. 15 and two coolies is considered sufficient. If, however, the owner himself manages such a concern, he can exercise further economy.

- The farm has a large quantity of dry combustible material in the shape of cotton stalks, red gram stalks, castor stalks, etc., so that the expenditure under fuel is not high. If, however, a boiler is provided, proper wood may be necessary. In the case of a private man, there is no reason why an ordinary oven with a large copper vessel should not serve the purpose equally well.

Ice is a very important item. When it is manufactured on the farm it is reasonably cheap : but when this is not possible, its purchase from Madras would certainly make it prohibitive for a private individual. Conveyance charges are reasonable, and although the creamery spent Rs. 180 per year, a cheaper conveyance is quite possible. Contingencies include butter paper,

salt, soda, matches, filtering mediums, butter colour, etc., and Rs. 25 per month under this head ought to be ample. Although the creamery worked at a loss, it is quite possible to secure a profit by the economies suggested and when all things are considered a profit of Rs. 1,000 is nothing out of the way. If the money is one's own, Rs. 5,000 capital would bring in a monthly income of Rs. 80 which is very reasonable. In this case he is able to entertain an assistant. If on the other hand, the concern is started on borrowed capital, the transaction would bring in an interest of 20 per cent. Since a person could borrow money at 10 per cent, it is possible for him to manage with the remaining 10 per cent. It is assumed that in this case, until his business expands he has to manage the concern himself with the aid of trained servants and a dairyman. In these circumstances even supposing the business is stationary, which it is hoped will not be, within 10 years the loan could be wiped off under the supposition that Rs. 35 is a fairly reasonable income for a young man without much education starting business on borrowed capital.

These profits are only rough approximations, as they differ according to varying conditions. The purchase price and quality of milk, the cost of the manufacture of butter on the one hand, and the selling prices of dairy products on the other are some of the factors that determine the profits. There is little doubt that under proper precautions as already indicated and where buffalo milk is obtainable at fairly reasonable rates, the scope for creameries is indeed great, and one would welcome the day when more young men direct their attention to this aspect of farming with comparatively little capital, with no risk on livestock and with quick returns, in preference to other lines of farming where initial capital needed is large, with no commensurate profits or early returns.

SUMMARY.

(1) The Dairy at the Agricultural College is kept for instructional purposes, and for supply of milk and milk products to the members of the estate. Students while being trained in technical methods also learn the business aspects of dairying.

(2) The dairy building is spacious and well ventilated and is provided with fly-proof arrangements. It is cool being surrounded by verandahs and has a heating apparatus for efficient washing. The cow stalls are close to the dairy. Green succulent fodder is desirable and the farm grows a sufficient supply of fodder, sorghum and Guinea grass. Green food largely available in cold weather increases the flow of milk.

(3) The dairy herd consists of Kangayam, Ongole, local and cross bred cows. Of these the Ongole and the cross bred cows are the best milkers. The buffalos are of the local type, but some from Delhi are also included in the herd. Breeding bulls of different breeds are kept for service.

Herd and pedigree registers are systematically maintained. These clearly show which cows are profitable to keep and which are not. This facilitates weeding out bad milkers for sale during their dry period. Bulky and concentrated food is prepared previously. The herd is stall-fed, but whenever opportunities offer, it is extremely desirable to locate the dry herd and young stock in separate areas where grazing is available, as this would tend to economy in upkeep.

Calves are not weaned in early life. But weaning at birth is recommended because it is economical and the cow and calf become independent of each other. which is a favourable point, should one of them die. Weaned young calves should be taught to drink their own mothers' milk from the pail. at blood heat.

(4) The chief business of the creamery is to sell the herd milk and to purchase outside milk for preparation of butter. The butter sales have during the last five years increased from 1,358 lb. to 9,038 lb. The butter is transmitted to the mufassal in returnable boxes. The skim milk is sold in a limited quantity for curds and coffee. The equipment of the creamery is estimated at Rs. 1,700, but it can easily be reduced to Rs. 1,100. If butter-making is omitted it could be equipped at one-third the cost. Ghi manufacture is not considered a business concern as at present managed.

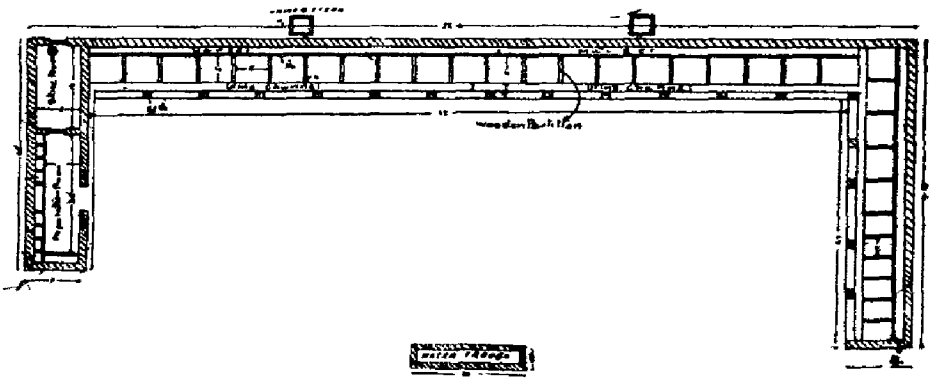
(5) To make dairying profitable, one should have a good dairy herd. A solution to the problem lies in the possession of a cross-bred herd. This, however, means expense and risk due to contagious diseases,

Buffalos are better than ordinary cows, but popular sentiment is against it and must be overcome. A valuable herd should be properly housed, cared for, and supervised: otherwise depreciation on the herd is high. Dairy farming entails a large outlay which if it cannot be obtained individually at a fair rate of interest, the concern should be run on a co-operative basis.

(6) Creamery business is easy, needing only a little skill and small capital. There are, however, some difficulties. If milk is purchased, it must be carefully tested to guard against the chances of adulteration. During dry months the supply of milk becomes minimised; one should exercise caution in booking orders, for regular customers are dissatisfied. Accounts in a retail trade cannot be easily and regularly settled.

For success in a butter making concern, buffalo milk is essential. The skim milk must be disposed of as far as possible. Its conversion into cheeses and casein for paints is strongly recommended. Quick returns and fair profits in a creamery are possible if care and economy are exercised. Twenty per cent on investment is a very reasonable return from an industry started on a small capital.

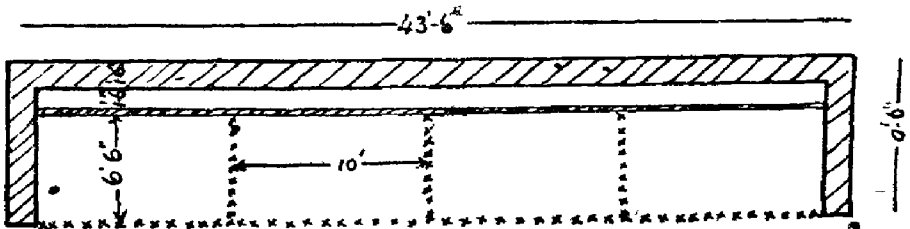
Cow Shed



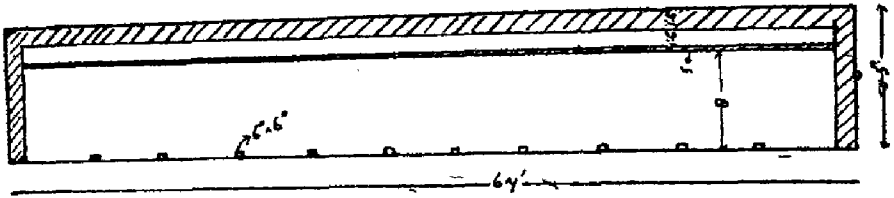
PLAN OF COW STALLS. ON THE LEFT ARE STORE AND PREPARATION ROOMS FOR CONCENTRATED FOOD. MAIN WING IS 132', AND RIGHT WING 47' LONG BOTH ACCOMMODATING 58 COWS. DIVIDED BY WOODEN PARTITIONS INTO COMPARTMENTS EACH 6' X 5' TO ACCOMMODATE TWO COWS. NOTE THE MANGER IN FRONT, URINE CHANNEL AT THE BACK OF THE COMPARTMENTS AND THE WATER TROUGH NEAR BY.



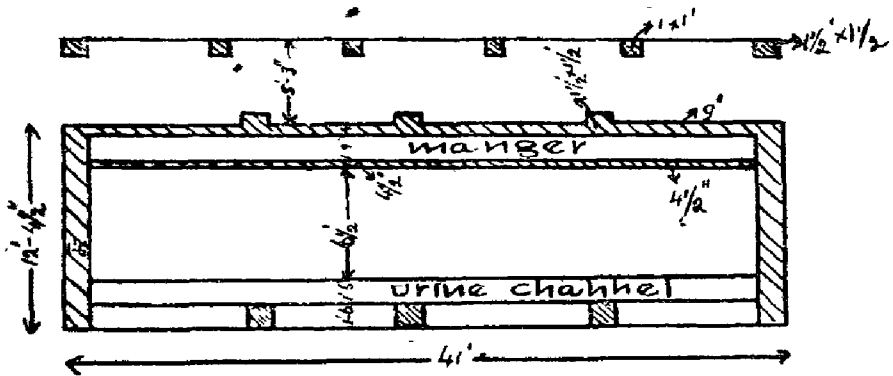
PLAN OF WEANED HEIFER AND CALVING SHED THIS ACCOMMODATES DRY COWS IN ADDITION. STALLS ARE DIVIDED INTO COMPARTMENTS 6' 6" X 8' 3" BY WOODEN PARTITIONS, EACH FOR TWO ANIMALS. CALVING SHEDS EACH 9' X 8' 3" ARE SELF-CONTAINED FLOOR, HARDENED AND WELL RAMMED, SLOPING TOWARDS A DRAIN



PLAN OF CALF SHED. EACH COMPARTMENT IS 10' X 6' 6". IN EACH ABOUT HALF A DOZEN CALVES ARE LET LOOSE



PLAN OF WEANED BULL CALF SHED. ACCOMMODATES THIRTY-TWO YOUNG BULL CALVES. FLOOR EARTHEN, HAS A GENTLE SLOPE.



PLAN OF BULL SHED. - THERE IS A SPACE OF 6' 6" X 6' 4" FOR EACH. NOTE THE MANGER IN FRONT AND URINE CHANNEL BEHIND.

APPENDIX A.

THE DAILY VARIATION IN THE COMPOSITION OF MILK

BY

D. ANANDA RAO, B.Sc.,

Assistant Principal, Agricultural College, and Research Institute, Goimbatore.

Experiments on rather an elaborate scale have been conducted on the composition of milk of some breeds of cows and buffalos by Drs. Leather and Mann and Mr. Meggitt. The subject of this paper is not an attempt at a work of similar nature either in experimental detail or accuracy, but was merely instituted to see if any light could be thrown on the great variation that there is in milk which is purchased at the College Dairy, Coimbatore, from milkwomen of the neighbouring villages for the manufacture of butter. The writer laid his hands on the data referred to above only after the present experiment had been completed, so that, if the results happen to be similar, these help to emphasize, though in a modest way, the accuracy of the previous workers.

Although the College Farm possesses a mixed herd of its own, its main purpose is to supply pure milk to the residents of the estate. In the manufacture of butter some 200 lb. of buffalos' milk is required daily, and this is mainly obtained by purchasing milk brought to the counter by women from adjoining villages. The milk is daily tested by the lactometer only, and is paid for at so many pounds per rupee and not by the fat content. The lactometer readings are not very accurate, and yet the writer has often noticed from day to day a good deal of variation in the readings of milk brought by the same individual. There was neither the staff nor the time to test composite samples of milk periodically, and all that could be done was to test for fat by the Leffmann Beam method occasionally whenever the milk sample raised one's suspicion, and if it was below standard the individual was severely fined. This procedure for a time creates wholesome fear, and the woman brings unsuspecting milk until such time as she considers it safe enough to lapse into her old ways.

When the College closed for the Michaelmas vacation last year, some simple experiments were instituted to seek answers for the following problems: Is there any daily variation in the quality of milk in the same animal? Does that variation differ in different animals like cows and buffalos? What is likely to be the normal variation? What is likely to be an abnormal variation and what are the causes? Is there any relation between quantity and quality of milk?

The experiment consisted in taking milk samples from (a) a dairy cow, (b) a dairy buffalo, (c) an outside buffalo whose owner was suspected of bringing adulterated milk, and (d) the average mixed purchased milk, and testing them for fat *daily* for a number of weeks. The milk from (c) was always carefully taken without in the least exciting the individual's suspicions, so that she was allowed to bring as she liked without let or hindrance.

The results from the morning's milk are tabulated below :—

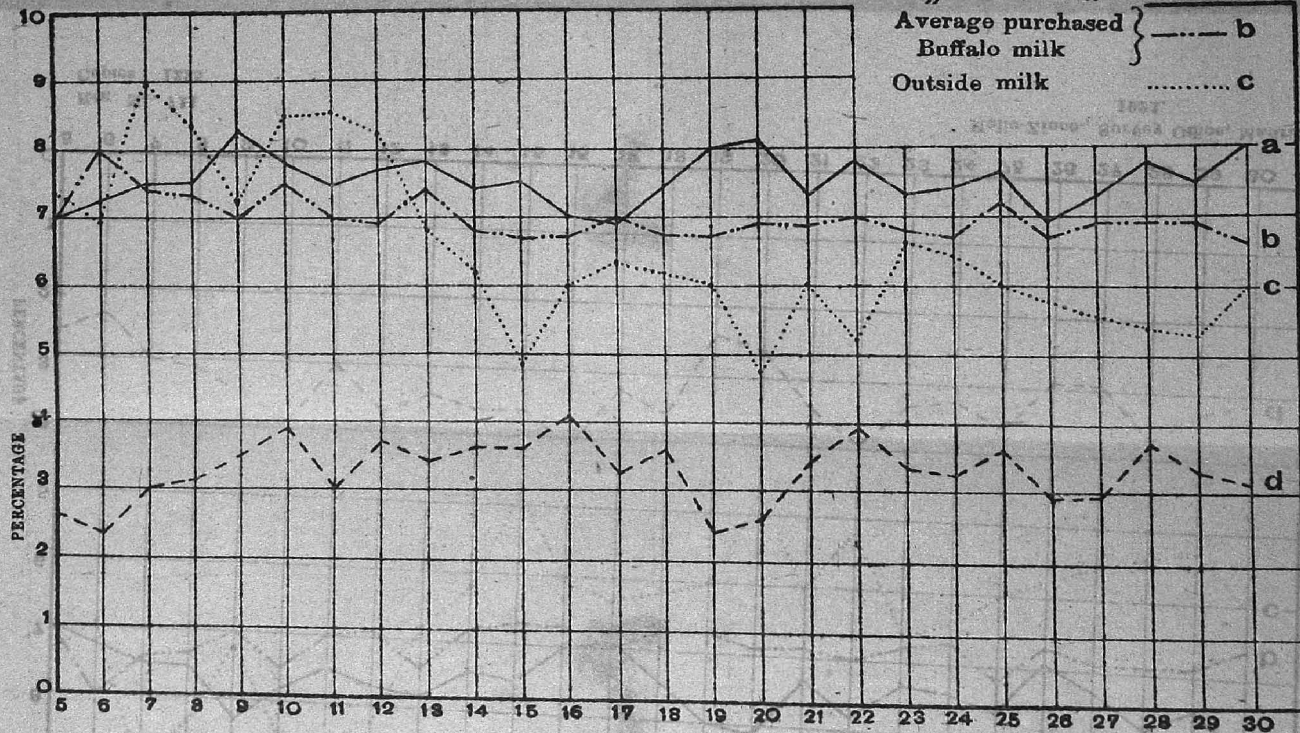
Date.	(a)		(b)		(c)		(d)	
	Milk from single cow, College herd.		Milk from single buffalo, College herd.		Milk from single buffalo (outside).		Average of purchased buffalo milk.	
	Per-centage of fat.	Yield.	Per-centage of fat.	Yield.	Per-centage of fat.	Quan-tity bought.	Per-centage of fat.	Total quantity bought.
		lb. oz.		lb. oz.		lb. oz.		lb. oz.
September 5	2.6	3 4	7.0	4 8	7.3	6 4	7.0	204 0
" 6	2.3	3 0	7.2	4 0	6.9	6 0	8.0	207 0
" 7	3.0	3 12	7.5	4 8	9.0	5 4	7.4	207 0
" 8	3.1	3 0	7.5	4 0	8.3	6 8	7.3	189 12
" 9	3.5	4 0	8.3	4 4	7.2	5 12	7.0	201 0
" 10	3.9	3 4	7.8	4 8	8.5	5 8	7.5	195 0
" 11	3.0	3 8	7.8	4 4	8.5	5 12	7.0	203 4
" 12	3.7	3 0	7.7	5 0	8.2	5 8	6.9	205 4
" 13	3.4	3 12	7.8	5 0	6.8	5 4	7.4	209 12
" 14	3.6	3 8	7.4	4 8	6.2	7 0	6.8	209 4
" 15	3.6	4 8	7.5	4 8	4.8	7 12	6.7	210 0
" 16	4.1	2 12	7.0	4 8	6.0	7 8	6.7	202 8
" 17	3.2	3 0	6.9	4 12	6.8	5 4	7.0	164 12
" 18	3.6	2 12	7.4	4 8	6.2	5 0	6.7	163 8
" 19	2.4	3 4	8.0	4 0	6.0	5 0	6.7	178 4
" 20	2.6	3 4	8.1	4 4	4.7	5 0	6.9	153 8
" 21	3.3	3 12	7.3	4 0	6.0	5 0	6.9	177 4
" 22	3.9	4 0	7.8	4 0	5.2	5 0	7.0	174 4
" 23	3.4	3 4	7.3	4 0	6.6	5 8	6.8	175 0
" 24	3.2	3 12	7.4	4 4	6.4	5 8	6.7	175 0
" 25	3.6	3 0	7.6	4 4	6.0	4 12	7.2	155 0
" 26	2.9	3 0	6.9	4 0	5.8	4 8	6.7	163 12
" 27	2.9	3 12	7.3	4 8	5.6	5 8	6.9	155 0
" 28	3.7	3 8	7.8	3 8	5.4	5 12	6.9	173 4
" 29	3.3	3 12	7.5	4 4	5.5	6 12	6.9	183 8
" 30	3.1	3 0	8.0	4 0	6.0	6 12	6.6	173 12
October 1	3.3	4 0	7.5	3 8				
" 2	3.4	3 8	8.1	4 0				
" 3	3.2	3 0	7.7	4 8				
" 4	4.0	3 8	7.5	4 4				
" 5	3.7	3 0	8.1	4 4				
" 6	3.1	3 0	7.4	4 0				
" 7	3.8	2 12	7.8	3 4				
" 8	3.2	3 4	6.8	3 12				
" 9	3.1	3 4	7.3	4 0				
" 10	3.9	3 8	7.1	3 4				
" 11	3.3	2 12	7.4	3 0				
" 12	3.2	3 4	7.0	3 12				
" 13	3.3	2 8	7.0	3 12				
" 14	3.1	3 0	8.0	3 0				
" 15	3.7	3 0	6.8	4 0				

The results are graphically described in Chart I. It is very clear from the above figures that, whether cow or buffalo, the variation in fat in daily milk is evident. This is mainly due to the Indian practice of allowing the calf to suckle before and after milking, and the amount left by the milkman in consequence. The food might also influence

CHART I.
PERCENTAGE VARIATION IN FAT.

Reference

Farm Buffalo milk ——— a
 „ Cow „ - - - - - d
 Average purchased }
 Buffalo milk } - - - - - b
 Outside milk } c



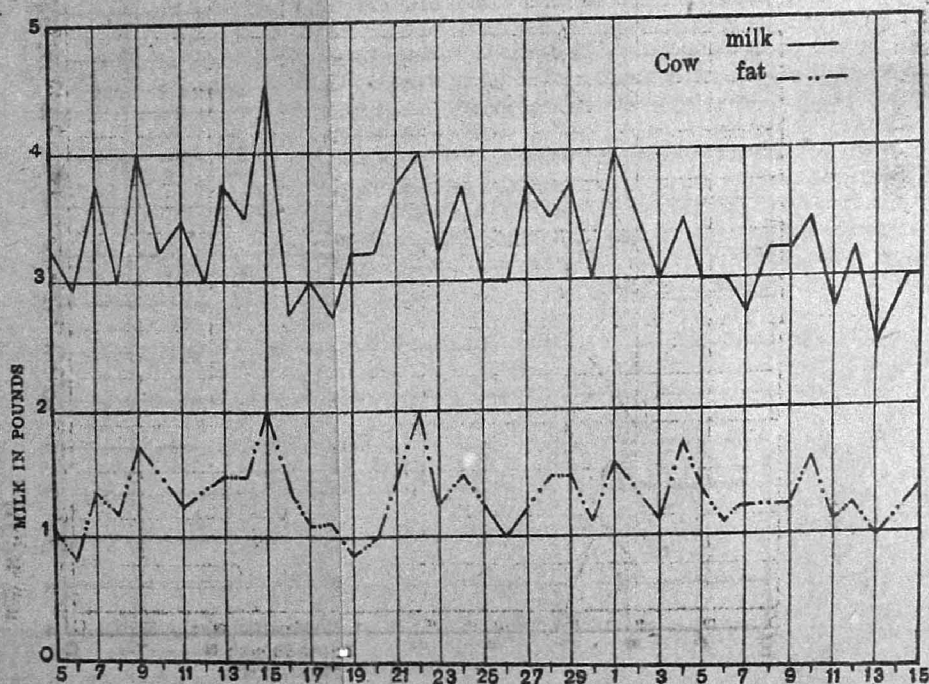
Reg. No. 711
 Copies 1225

Helio-Zinco., Survey Office, Madras.
 1921.

CHART II.

RELATION BETWEEN TOTAL AMOUNT OF FAT CONTENT AND TOTAL AMOUNT OF MILK.

8 divisions = 1 lb. of milk.
100 " = 1 lb. of fat.



the daily variation, but the dairy herd received throughout the experiment a definite ration of concentrated food consisting of cotton-seed cake, groundnut cake, and *dholl* (*Cajanus indicus*) husk together with a uniform quantity of green fodder, chiefly consisting of either one or more of fodders like green grass, Guinea-grass, and fodder *Sorghum*. The herd is taken out to graze in the day, but at this time of the year there is not very much bite on the land. The food given could not have influenced the variation so much either in quality or quantity. While there is such variation to be found in the individual cow's and buffalo's milk, the variation is very much less in the case of the average mixed purchased milk. A glance at the graph will make it very clear. It also points out the tremendous variation that there is in the milk purchased from the woman. It varies from 9 to 4.7 per cent or there is a difference of 4.3 per cent between extremes, while the dairy cow and buffalo show an extreme variation of 1.8 per cent and 1.5 per cent respectively. The average milk, however, shows a variation of 1.4 per cent only. The variation in daily fat content is more marked in the cow than in the buffalo. In other words, the buffalo is the steadier one of the two. As far as this experiment goes, it must be assumed that the extraordinary variation of 4.3 per cent in the buffalo milk purchased from outside is not due to natural causes. Knowing her propensity for admixture of milk, it may be safely assumed that the woman had interfered with the purity of milk, either by the addition of water or by letting the milk stand for a while and removing the top milk which contains more fat; she may have perhaps taken recourse to both the methods.

The second part of the experiment was to see if any relation exists between the quantity and quality of milk that a cow or buffalo gives. This is represented in the form of a graph (Chart II). The two top curves represent the quantity of milk given by the buffalo and the total weight of the fat present in the milk obtained each day respectively. To make it clear, take the 5th of September (vide table above). The buffalo gave 4 lb. and 8 oz. of milk, which had 7 per cent fat in it: so that 4½ lb. contained 0.31 lb. fat. This is what is represented in the curve. The lower ones indicate the same for the cow. In the majority of instances, when the secretion of milk increased the fat content also increased both in the case of the buffalo and the cow, but specially so in the former. Another point that is brought to evidence is that, although there is a deal of variation in the quantity of milk from day to day, the fat content in that quantity is fairly constant.

APPENDIX B

DAIRY INDUSTRY AROUND COIMBATORE

BY

D. ANANDA RAO, B.SC.,

Assistant Principal, Agricultural College, and Research Institute, Coimbatore.

There are few places in the Madras Presidency which are more favourably situated than Coimbatore. It enjoys a very equable climate, neither too hot nor unpleasantly cold, with a steady western breeze blowing through a portion of the year. Geographically also it occupies a unique position. Situated in close proximity to the Nilgiri Hills, commanded by a railway, it affords facilities for any trade or industry that caters to the needs of the hills, unsurpassed by any other mufassal station in the south. It has a fairly large European population—certainly larger than in the ordinary headquarters of a district—due to the official as well as commercial importance that it commands.

Agriculturally too, Coimbatore is important. Owing to the even distribution of the annual rainfall which in itself is only moderate, the farmers have facilities which their fellows in other districts have not. Even in dry lands they raise crops very early, as the light soils nearer the hills are ready for cultivation earlier than black soils which are more remote. In light soils they often raise two crops—a cereal, generally cumbu (*Pennisetum typhoideum*), and a pulse—while in the heavy soil, the season being later, only one crop is possible. In the latter type of soil the usual rotation is cholam (*Sorghum*), cotton, and Bengal gram (*Cicer arietinum*). Besides these, there are garden and wet lands. The former are commanded by wells, while for the latter the sources of irrigational supplies are river channels or tanks. The supply of water in the wells in garden lands is fairly steady throughout. The water is lifted by means of mhots drawn by bullocks which walk up and down a steep ramp. Three crops, two cereals, generally cholam and ragi (*Eleusine coracana*) and an industrial crop like tobacco, are raised. These are very intensively cultivated with heavy application of cattle manure.

In wet lands there is only one crop—paddy—though sugarcane is also cultivated in small patches. Green leaves for paddy and sheep penning for sugarcane are the recognized manures. It is obvious that whether it be for cultivation, irrigation, or manure, the garden land ryot is in continual demand for cattle.

With regard to cattle, Coimbatore is exceptionally privileged. Situated in the Kangayam country which is famous for its remarkably good breed of cattle, Coimbatore enjoys the enviable position of possessing one of the finest types of working cattle, both for mhots and draught purposes. It also draws on Kollegal grazing tracts for a large proportion of its working cattle. The cows of this breed, however,

contrary to one's expectations, are but poor milkers and are maintained more for breeding purposes than for their performances at the pail.

The grazing grounds for cattle in the neighbourhood are not abundant. These are, however, available a few miles distant near the hills, where the hill tribes—Irulars—graze cattle for a nominal fee during the off season. Stall-feeding is a necessity, although there is a kind of grazing obtainable, throughout the year, on the tank bunds and roadsides, which carries with it all the evils which communal grazing entails. The bulky food consists of any available green fodder like *cholam* and *ragi* straw or green grass. For concentrated food, cotton seed is given twice daily along with some *cholam* water obtained by soaking the grains overnight. Cakes and bran are little known. When dry, the animals are put on a dry ration.

Cow keeping being unprofitable, the buffalo is the mainstay of the dairy industry. Being an animal which thrives on rather coarse food such as that rejected by other live-stock, and one which can without prejudice be put to work in wet lands, when not milking, the milch buffalo is sought after especially on account of the milk which is better both in quality and quantity than the cow's. Popular sentiment, however, among the educated classes is against buffalo milk owing to the belief that it is prejudicial to the health of young children. The average buffalo justifies its existence by yielding 10 to 12 lb. of milk per day, and such an animal is worth about Rs. 75 at the present prices. The upkeep of such an animal per day is about 5 annas, while the milk it produces is worth annas 10 to 12 at 1 anna per pound. Cheaper animals can, of course, be had which yield correspondingly reduced profits. Their maintenance through the dry period presents no great difficulty. Bad milkers are disposed of, as soon as they calve, even at a small loss.

The dairy industry is also carried on as a subsidiary source of income by cultivators who are either tenant farmers or peasant proprietors. These are usually Tamils of whom Goundans, Vellalas and Konaris claim particular mention. Besides these, there are two sections of the Telugus, namely, Gollas and Kammas, who immigrated into these parts from the north and are reckoned to be as good cultivators as their Tamil neighbours.

Among these those who possess garden lands are fairly well-to-do. They include in their herd a few milch buffalos which supply milk, curds, and *ghi* (clarified butter). The ryot does not keep more buffalos than he can find a use for, but a landlord owning 10 acres would probably have two or three buffalos in milk, and the surplus milk generally goes to meet the needs of the town. The peasant proprietor, however, content himself with only one, rarely two. The usual custom is to have two animals, one of which is always in milk.

Of the castes mentioned above, Konaris are professional traders in curds and *ghi*. Their condition is not so prosperous as that of Goundans and they prefer cash transactions to monthly settlements. The trade is entirely in the hands of the womenfolk. It keeps a woman fairly independent of her husband for her daily necessaries, besides saving her from earning her livelihood as a day labourer. Though it means a good part of the day spent in the town, she prefers to carry her headload inasmuch as she gets her business done and contributes her share to the village gossip which she loves so much.

Let us consider the profits of *ghi* trade. From a buffalo yielding 10 lb. of milk daily, $\frac{1}{2}$ lb. of *ghi* is obtained, according to actual tests. At the present prices this is worth only 5 annas. This is therefore too

low a figure to derive any profits from. The *ghi* is, therefore, heavily adulterated so that it fetches nearly the value of 10 lb. of milk. Besides *ghi*, she obtains curds which are diluted to make up 15 to 20 lb. which will sell at about As. 2-6. This then is probably the profit in the transaction. At the present rates pure *ghi* manufacture is certain to mean loss, and the only course left to the traders is to adulterate it and thus keep the price as low as possible.

The existence of the College Dairy in this vicinity has created a market for some portion of the surplus milk of the locality. It obtains from the surrounding villages milk totalling up to about 400 lb. daily. This milk is put through the separator, and the cream is pasteurized and converted into butter, which finds a ready sale not only in Coimbatore but in different parts of the Presidency. The average monthly sales of butter alone come to about 700 lb., besides disposing of rich fresh milk, obtained from a good herd of cross-bred and country animals. A good portion of the separated milk used to be sold at 4 pies a lb., but recently the price was raised to 6 pies and even at this rate there seems to be a good demand. The College Dairy has thus demonstrated an industry to the ryots, to the peasant proprietor in particular, in which class may be included the day labourer and the Government peon whose meagre income is insufficient to support his family in comfort. Even these realize that there is profit in a milch buffalo, and in fact one of the arguments once brought forward by a peon in defence of a second wife was that a buffalo would maintain her!

Yet another industry has sprung up in the last decade in the surrounding tract, which is certainly not indigenous and which is not unworthy of our consideration, if not merely for its intrinsic merit, at least for its popularity among the village folk.

Reference has already been made to the nearness of Coimbatore to the Nilgiris. These hills, besides being the summer headquarters of the Madras Government, attract in summer numerous visitors. Besides, the fertile soils of these hills, combined with the climatic advantages, offer exceptional facilities for the existence of a fairly permanent population, which, being mostly European, has created a demand for dairy products in the shape of milk and butter. To meet this demand a special industry has been organized.

A little over 15 years ago there came to the hills a young Parsee on business. With the foresight and business acumen which seem to be inherent in his race, the Parsee grasped the situation and set himself to solve it. There was a large European population in need of genuine dairy products. The local supplies were barely sufficient to meet the demands for milk, but where was the butter to come from? He started with the hill buffalos, but the demand soon outweighed the supply. Then he visited many villages in the neighbourhood of Coimbatore and established a sub-station within a couple of miles of Coimbatore and arranged for an agent who purchased milk in the neighbourhood, separated it, and sent the cream by rail to Wellington, while disposing of the separated milk locally as best as he could. He could hardly touch 50 lb. at that time. The Parsee made friends with villagers, and even went so far as to obtain for them cream separators free, and appointed agents who supplied him with cream. The result has been that, to-day there is a chain of villages dotted all along the railway line running north to the hills from Coimbatore in which there is a well organized system of creameries, run for all intents and purposes on business lines, and at the present moment without exaggeration it could safely be estimated that about 3,000 lb. of milk are being dealt with

daily in the season at these creameries in about nine villages, excluding the town of Coimbatore itself.

The management of the creameries may now be considered. Although the supply of milk is in the hands of the cultivating classes, the management of the creamery itself is not with them. The creamery man is of diverse callings. He may be a petty building contractor, or a discharged cook of a wealthy landlord, or again a poverty-stricken weaver thrown out of his trade. Sometimes he is a Christian originally of an enterprising caste, or a leisured village postmaster, but hardly ever a genuine cultivator. The farmers view this enterprise with suspicion, probably because creameries are speculative concerns and naturally the ryot looks well before he leaps. They, however, admit that there is money in it if properly run. The creamery draws its supplies of milk from the cultivating classes of the villages in the neighbourhood. The creamery itself is a part of the dwelling house often rented for the purpose. It is invariably an ill-ventilated and insanitary corner of a main room in which children play and women cook. Or sometimes if the owner is desirous of having more ventilation, he makes use of the verandah where pedestrians and flies congregate. To such a place the milk is brought by the village women, frequently in open copper vessels, never earlier than 10 o'clock, and the creamery is at its busiest between that hour and noon. The milk is tested by the lactometer in each case, not filtered but poured into large copper vessels after the quantity is measured. The woman gets her book filled in, and while doing so the creamery man makes a large allowance for any suspected sample. He then records in his register the quantity purchased. Any reduction in milk is generally echoed in a protest, but the woman has the cure for it in her own hands.

To encourage customers to bring more genuine samples, certain creameries adopt different prices for milk, but it is not likely to work very satisfactorily as they rely entirely on the lactometer which at best is only a rough and ready test.

Fat analyses of samples of milk taken at random from some creameries are tabulated below, and give an idea of the standard of quality maintained in them. The milk is invariably buffalo's but sometimes there is an admixture of cow's.

Village.	No. 1	No. 2	No. 3	No. 4	No. 5	Average.
	%	%	%	%	%	%
Ganapati	65	45	38	42	48	54
Kiranattam	53	52	...	...	...	54
Savuripaliem	54	50	55	54	49	...
Papanaikampalaiyam	33	21	46	39	55	46
Perianayakkanpalaiyam	70	66	82	85	52	66
Vellakkinar	67	71	48	90	...	77

* The average sample was taken from a quantity of milk varying from 100 to 200 lb.

Taken all round, except in Papanaikampalaiyam where the milk is exceptionally bad, the samples are of fairly good quality, and especially so in Perianayakkanpalaiyam and Vellakkinar which are far from the evil urban influences: The creamery men pay at 16 lb. per rupee in the last named places, while in the others 20 lb. per rupee is the rate.

The equipment of the creamery cannot be simpler. It consists of a separator usually secondhand, the size depending upon the quantity dealt with. The separator is of various makes, but the commonest is Alfa Laval. Diabolo and Heinrich Lang Mannheim are also found. A lactometer (metal or glass), two large brass vessels, milk measuring cans, and a number of old kerosene tins make up the rest of the equipment.

The following is a rough estimate of a creamery as equipped above :—

1 Separator (secondhand)	RS.	A.	P.
1 Lactometer (metal)	250	0	0
2 Brass vessels	10	0	0
2 Measuring vessels	30	0	0
12 Kerosene tins	2	0	0
	6	0	0
	<hr/>		
	298	0	0 or

roughly Rs. 300.

Let us consider the returns of one who has no room rent to pay. It is estimated that 300 lb. of milk produce one tin of cream weighing about 36 lb. His expenditure is as follows :—

Cost of 300 lb. milk @ 20 lb. per rupee	RS.	A.	P.
Coolie from creamery to railway station	15	0	0
Railway freight on one tin from creamery to Wellington	0	1	0
One girl to help in washing up	0	7	0
Depreciation on separator, etc. per day	0	2	0
	<hr/>		
	15	12	0

The dairyman pays the creamery man at 11 annas for every pound of butter manufactured, and the usual proportion of butter to cream is between 66 and 70 per cent ; so that from one tin of cream about 24 lb. of butter is obtained which is valued at Rs. 16-8-0, and this means there is a gain of only a few annas by the transaction. Where then is the attraction for this industry ? The townsman has of late found separated milk to be a good substitute for milk. This finds a ready sale in coffee and sweetmeat shops, in Hindu hotels, and in fact even in well-to-do Indian homes. If the creamery is at all get-at-able, there is an excellent sale for separated milk, so that, even at a conservative estimate of 3 pies per lb., there is a net gain of about Rs. 3, provided the whole of separated milk is disposed of. This, however, is not the case. The creameries are not all situated near a large town like Coimbatore. Even those which are more favourably situated, are sometimes unable to dispose of it owing perhaps to a dislocation of trade due to epidemics like plague. Wherever conditions are less favourable, the separated milk is converted into curds and sent either to Coimbatore or railed to Palghat where demand exists for curds. If this is not possible, then the separated milk has to be thrown away. These all mean reduction in profits, so that if Rs. 3 per day is obtained under exceptional conditions even a rupee under less favourable circumstances is not too little to be ignored. It is clear, therefore, that the larger the quantity of separated milk sold, the greater the profits of the creamery.

It may be quite a pertinent question to ask if this enterprise has been successful throughout. As in every other enterprise, this has not been without its pitfalls and some have profited from the failure of

others. It cannot be said that every one succeeds. The writer's attention was drawn to a particular instance where a creamery man, believing the words of a wily Muhammadan agent of a dairy at Madras, kept sending on cream until his liabilities went as high as Rs. 1,500; eventually, assisted by his old master, the creamery man threatened to go to law. When settlement was made, he was the loser to the extent of about Rs. 800 in the concern.

The conditions suitable for a successful creamery are: firstly, there should be facilities for the purchase of good milk; secondly, the creamery should be able to dispose of the major portion of the separated milk; thirdly, the creamery man must have business instincts; and fourthly, there must be a steady demand for the cream. The small initial outlay, the little trouble attached to the business, and the quick returns tempt a non-agriculturist to launch on this speculative undertaking. Granting that conditions mentioned above are available, it is undeniable that there is money in this business.

Should we trace the destination of the cream we should find it still more interesting. One would notice, while travelling in the morning train to the hills, a number of kerosene tins packed in plantain sheaths arriving at Coonoor and Wellington. They contain cream consigned to dairies. These are unostentatious in appearance. One which did the greatest business had for its activities the out-houses of a modest villa situated in an unfashionable locality of the town. Although the conditions were filthy to the extreme and the methods of manipulation totally crude and unscientific, it was amazing how fine a product was obtained with the cream which reached its destination in varying degrees of fermentation. The knowledge of technique of the dairyman was nil, his apparatus was meagre, and yet he was daily manufacturing 100—120 lb. of butter at the time of inspection and which he disposed of without any difficulty in the neighbouring hill stations. Thanks to the climatic facilities, the texture of the butter was good, although there was a good deal of room for improvement in the matter of cleanliness. Samples of butter obtained from three dairies are given below which speak for themselves:—

Particulars.	Government Military Dairy, Wellington.	The Nilgiri Dairy, Wellington.	Coonoor Dairy.	Remarks
Moisture	11.72	14.16	7.81*	* Sent packed in tissue paper which absorbed some of the original moisture.
Fat	86.60	84.06	90.43	
§ Solids, not fat	1.60	1.61	1.16	
Total ..	99.92	99.83	99.40	
Containing casein Reichert Meissl number	0.59 29.6†	0.49 21.7†	0.50 22.80	† Mean of two determinations No. 1 was very soft butter.
Refractive Index corrected to 40° C.	1.4549	1.4554	1.4551	

The manufactured article is placed in different sizes on dishes covered over with cloth and sent round to customers who gladly purchase it at Re. 1 per lb. The recurring expenditure is small. The water is cold enough to render the use of ice unnecessary. One man is employed in churning and another for selling. Even allowing that he pays 3 annas a pound for initial capital, recurring expenditure, and establishment, the dairyman makes in the busy season a clear profit of 2 annas on every pound of butter manufactured, but during the off-season he would necessarily manufacture less. This industry demonstrates clearly what an extensive demand there is for dairy products around Coimbatore, and it does not need much imagination to peer through this vista into the future of the dairy industry in India managed with scientific and business knowledge.

APPENDIX C.

A PRELIMINARY EXPERIMENT ON THE INFLUENCE OF
DIFFERENT FODDERS ON THE QUANTITY AND
QUALITY OF MILK

BY

D. ANANDA RAO, B.Sc.,

Assistant Principal, Agricultural College.

The College Dairy is mainly intended to supply pure and wholesome milk to the residents in the estate. A mixed herd of cows and buffalos is maintained for this purpose which is always growing in numbers to keep pace with the demands of the also growing population.

The herd is always fed with a concentrated ration twice daily in addition to the bulky fodder which usually consists of green fodder like Guinea grass, fodder sorghum or green grass. Occasionally, either due to insufficiency of green fodder or absence of it due to a precipitation of rain which would prevent cutting it, it is replaced by dry fodder like sorghum or paddy straw. It often happens that the yield of milk gets reduced due to various causes, e.g., change of milkmen, inclement weather, variation in the quantity of milk left for calf, etc. But the milkmen invariably attributed the reduction to the dry fodder fed and it almost always synchronized with the feeding of the paddy straw. This set the writer to initiate the preliminary experiment to test the popular belief regarding the deleterious effects of paddy straw as fodder for milch cattle, at the same time to see what information could be obtained by feeding various fodders available at the time. The writer claims no great thoroughness or accuracy for the experiment. The ideal set before him was high although in conducting it, he could not come anything near it. The animals experimented upon should have been of nearly the same age; only animals of the same lactation period, or as near it as possible, should have been included; steps should have been taken to strip the cows instead of the usual practice of suckling the calves before and after milking, and the same milkmen should have been employed to milk the same animals throughout the experiment. This was all found impossible owing to the smallness of the herd and the long period through which the experiment had to be conducted. If prominence was given to selecting animals of similar age and lactation period, the number of animals experimented upon would have been reduced to so small a figure that the accuracy ensured by a large number would not have been attained.

The total herd numbered 23 of which 17 were cows and 6 buffalos. The milk of cows and buffalos was kept and weighed separate, and the average sample of each of which was tested for fat in duplicate by the Leffmann and Beam method.

The herd received a basal concentrated ration consisting of 1½ lb. cotton seed, 1½ lb. groundnut cake, 1 lb. dholl husk and 2 lb. rice bran throughout the experiment. The fodders were fed in the evening and the samples of milk were weighed and analysed the next morning. The fodders fed were: Teff grass, Tenai straw (*Setaria italica*), Paddy

straw, Sorghum straw, Cumbu fodder (*Pennisetum typhoideum*), Guinea grass and Fodder sorghum. These were analysed at the time of the experiment by the Government Agricultural Chemist, and analyses are recorded in Statement No. 1.

STATEMENT No. 1.—Analyses of fodders and straws fed.

Particulars.	Tenai straw (Setaria ita-lica)	Teff grass (Eragrostis abyssinica).	Paddy straw (Oriza-Sativa).	Cholam straw (Sorghum vul-garis).	Cumbu fodder (Pennisetum typhoideum).	Guinea grass (Panicum maximum).	Fodder cholam green (Sorghum vulgare).
Moisture	8.70	6.38	8.26	14.20	73.96	64.57	64.05
* Soluble mineral matter.	5.24	5.27	3.76	2.80	2.15	2.23	1.60
Insoluble mineral matter	6.32	4.74	13.06	4.20	0.98	2.35	1.35
Fats and Extractives	1.95	2.08	1.64	2.00	0.53	0.83	0.66
X Crude Proteids	3.69	8.31	2.94	4.81	2.28	1.62	1.86
Fibre	32.84	31.98	32.06	30.84	7.75	13.00	10.00
Carbohydrates	41.26	41.24	38.28	41.15	12.35	15.40	20.48
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Containing							
Potash (K ₂ O)	1.79	1.91	1.09	0.98	0.94	0.77	0.55
Phosphoric acid (P ₂ O ₅)	0.13	0.49	0.075	0.14	0.14	0.16	0.10
Lime (CaO)	0.84	0.49	0.51	0.40	0.20	0.21	0.065
X Albuminoids	2.88	7.06	2.81	2.66	1.55	1.27	1.34

The quantity of albumen, fat and carbohydrates present in each fodder was calculated and the albuminoid ratio for each was worked out (vide Statement No. 2). The dry fodders were each fed at 15 lb. per animal at a time, while the green fodders fed were at 40 lb. per animal, so that the dry matter present in either fodder was approximately the same.

STATEMENT No. 2 showing the actual quantity of nutrients present in each ration.

Name of straw or fodder.	Quantity fed in lb	Amount of albuminoids present	Amount of fats present	Amount of carbohydrates present	Total of nutrients fed.	Albuminoid ratio.
1. Tenai grass	15	.432	.292	6.189	6.913	1/15.9
2. Teff grass	15	1.059	.312	6.186	7.557	1/66.5
3. Paddy straw	15	.421	.246	5.742	6.409	1/14.9
4. Sorghum straw	15	.399	.300	6.172	6.871	1/17.2
5. Cumbu fodder (green)	40	.620	.212	4.940	5.772	1/ 8.3
6. Guinea grass (green)	40	5.08	.332	6.616	7.456	1/13.6
7. Fodder sorghum (green)	40	.536	.264	8.192	8.992	1/16.4

Previous to the experiment, the whole herd was fed with paddy straw for four days, with the view that the previous feeding would have had time to work itself out through the animal's system. Then each fodder was fed for seven days between each of which the herd received paddy straw for three days for the reason stated above.

Paddy straw was chosen upon the assumption that it is the poorest of all fodders. The experiment lasted nearly ten weeks, having been started on the 1st February and completed on the 9th April 1915. Of the seventeen cows present at the beginning of the experiment, one cow dropped off owing to its becoming dry. On the 10th February, one more cow dropped off for the same reason and the herd was left with fifteen till the 23rd March during the period when teff grass, sorghum straw and cumbu fodder were fed. On the 24th March when the Guinea grass ration began, one more cow dropped off leaving fourteen, and just before fodder sorghum was begun another cow went dry, and during the same week two more followed suit, so that during the last few days of the experiment there were only eleven cows.

In the case of buffalos, one went dry within three days of the beginning of the experiment, leaving five in the herd till the 20th March after which one more dropped off, so that there were only four when the experiment was completed. Besides this, owing to the lactation period of all the animals having advanced, some allowance has to be made for the diminished yield, if any, during the later stages, which probably meant a higher fat content.

Although the fat was tested for in duplicate, the fat percentages were afterwards reduced to the total quantity present in the individual average milk of the cow and buffalo. Similarly in the case of the total quantity of milk produced by the herd, it was subsequently reduced to the average per animal per day for each fodder.

The results of the experiment (vide Statements Nos. 3 and 4) are not particularly striking. There is a deal of variation from day to day both in the quantity of milk produced and the amount of fat present which may be due possibly to the amount of milk the calf is allowed to take, change of milkmen, weather conditions, etc. Ignoring these for our present purpose and taking into consideration the effect of the fodders on the whole herd of cows and buffalos together, the experiment so far conducted does not seem to bear out the popular opinion held with regard to the paddy straw. From the chemical point of view it is much more nutritious than tenai or sorghum straw both of which are considered better than it. Both in the amount of milk produced and fat yielded paddy straw stands very high in the list. It is surprising that it is superior even to guinea grass which is a succulent fodder, invariably fed to our dairy animals. If the yield of milk is reduced during the time when paddy straw is fed, it may be due perhaps to the sudden change effected in the animal system by transferring them suddenly from a succulent ration to a dry straw. It does not however seem to indicate that a prolonged feeding of paddy straw is deleterious to milch cattle. In the Northern Circars, in Deltaic tracts it is the custom to feed paddy straw to milch cattle during periods when green fodders are not available.

Feeding experiment with fodders.

(Abstract of Statements 3 and 4.)

Date.	Name of straw.	Cows.					
		Rate given per animal in pounds	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in.	Percentage of fat (average of duplicates)	Total amount of fat present in milk in column (6).
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1915.							
6th to 11th February .	Tena straw ...	15	16	55 4	3 8	3.7	0.125
15th to 21st February ..	Teff grass ...	15	15	55 13	3 12	3.9	0.140
25th February to 3rd March.	Paddy straw ...	15	15	55 11	3 11	4.0	0.150
4th to 10th March ...	Sorghum straw .	15	15	51 5	3 7	3.8	0.125
14th to 20th March ...	Cumbu fodder ...	40	15	55 0	3 11	3.6	0.126
24th to 30th March ...	Guinea grass ...	40	14	49 2	3 8	3.9	0.130
3rd to 9th April .	Fodder sorghum	40	11	46 6	4 2	3.7	0.152
Date—cont.	Name of straw—cont.	Buffaloes.					
		Rate given per animal in pounds	Number of animals experimented upon.	Total quantity of milk given in.	Average milk per animal in.	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column (12).
(9)	(10)	(11)	(12)	(13)	(14)	(14)	
1915.							
5th to 11th February .	Tena straw	15	5	25 9	5 1	6.2	0.369
15th to 21st February...	Teff grass ..	15	5	25 2	5 0	6.4	0.320
25th February to 3rd March.	Paddy straw ..	15	5	25 9	5 4	7.0	0.360
4th to 10th March ...	Sorghum straw ...	15	5	24 6	4 14	6.9	0.329
14th to 20th March ...	Cumbu fodder ...	40	5	25 3	4 10	7.9	0.339
24th to 30th March ...	Guinea grass ..	40	4	18 0	4 14	7.2	0.336
3rd to 9th April ..	Fodder sorghum ...	40	4	20 2	5 3	6.8	0.324

STATEMENT No. 3.—Feeding experiment with fodders on cows.

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column (5).
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1915.				LB. OZ.	LB. OZ.		
Feb. 1	Paddy straw ..	15	17	60 0	3 8	3.2	0.11
2	Do.	15	17	59 8	3 6	2.95	0.10
3	Do.	15	17	56 4	3 5	3.3	0.10
4	Do.	15	16	50 4	3 2	4.85	0.15
	Average per day ..	15	17	56 8	3 6	3.6	0.115
5	Tenai straw	15	16	54 12	3 7	3.45	0.12
6	Do.	15	16	62 12	3 15	3.7	0.14
7	Do.	15	16	51 4	3 4	3.7	0.12
8	Do.	15	15	54 12	3 10	3.6	0.13*
9	Do.	15	16	54 12	3 6	3.7	0.12
10	Do.	15	16	57 0	3 9	3.75	0.13
11	Do.	15	15	51 8	3 7	3.75	0.12*
	Average per day ..	15	16	55 4	3 8	3.7	0.125
12	Paddy straw	15	15	52 4	3 8	4.05	0.14*
13	Do.	15	15	49 4	3 5	3.65	0.11*
14	Do.	15	15	52 0	3 7	4.05	0.14*
	Average per day ..	15	15	51 2	3 7	3.9	0.130
15	Teff grass	15	15	52 0	3 7	4.15	0.14*
16	Do.	15	15	53 8	3 9	3.65	0.13
17	Do.	15	15	56 0	3 11	3.7	0.13
18	Do.	15	15	57 4	3 13	4.2	0.15
19	Do.	15	15	57 4	3 13	3.95	0.15
20	Do.	15	15	59 4	3 15	4.0	0.15
21	Do.	15	15	55 8	3 11	3.75	0.13
	Average per day ..	15	15	55 13	3 12	3.9	0.140
22	Paddy straw	15	15	55 0	3 11	3.95	0.14
23	Do.	15	15	55 12	3 11	4.15	0.15
24	Do.	15	15	58 4	3 14	4.3	0.16
	Average per day ...	15	15	56 5	3 12	4.1	0.150
25	Paddy straw . . .	15	15	56 4	3 12	4.05	0.15
26	Do.	15	15	59 4	3 15	3.95	0.15
27	Do.	15	15	53 8	3 9	4.1	0.15
28	Do.	15	15	55 12	3 11	3.75	0.13
Mar. 1	Do.	15	15	58 8	3 14	4.85	0.16
2	Do.	15	15	54 0	3 10	3.9	0.14
3	Do.	15	15	52 12	3 8	3.85	0.13
	Average per day ...	15	15	55 11	3 11	4.0	0.150

* One cow did not stand.

Statement No. 3.—Feeding experiment with fodders on cows—*cont.*

Date.	Name of straw.	Rate given per animal in pounds	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column (6).
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1915.				L.B. OZ.	LB. OZ.		
March 4	Sorghum straw ...	15	15	54 8	3 10	4.3	0.15
5	Do. ...	15	14	45 8	3 4	4.0	0.13
6	Do. ...	15	15	51 4	3 7	...	
7	Do. ...	15	15	53 8	3 9	4.0	0.14
8	Do. ...	15	15	48 0	3 3	3.0	0.19
9	Do. ...	15	15	52 12	3 8	3.65	0.12
10	Do. ...	15	15	53 8	3 9	3.65	0.12
	Average per day ...	15	15	51 5	3 7	3.8	0.125
11	Paddy straw ...	15	15	53 0	3 8	3.75	0.13
12	Do. ...	15	15	53 4	3 9	...	
13	Do. ...	15	14†	51 12	3 11	3.6	0.13
	Average per day .	15	15	52 10	3 9	3.6	0.130
14	Cumbu fodder ...	40	15	47 4	3 2	3.3	0.10
15	Do. ...	40	15	56 4	3 12	3.45	0.12
16	Do. ...	40	15	57 8	3 13	3.75	0.14
17	Do. ...	40	15	57 12	3 13	3.55	0.14
18	Do. ...	40	15	56 4	3 12	3.6	0.13
19	Do. ...	40	15	55 8	3 11	3.65	0.13
20	Do. ...	40	15	54 12	3 10	3.85	0.13
	Average per day .	40	15	55 0	3 11	3.6	0.126
21	Paddy straw ...	15	15	50 4	3 5	4.0	0.13
22	Do. ...	15	15	52 12	3 8	3.95	0.13
23	Do. ...	15	15	49 0	3 5	4.3	0.15
	Average per day ...	15	15	50 10	3 6	4.1	0.140
24	Guinea grass ...	40	14	49 12	3 9	3.65	0.13
25	Do. ...	40	14	49 12	3 9	3.95	0.14
26	Do. ...	40	14	47 0	3 5	3.9	0.12
27	Do. ...	40	14	48 12	3 7	4.0	0.13
28	Do. ...	40	14	47 12	3 6	3.95	0.13
29	Do. ...	40	14	50 8	3 9	3.95	0.14
30	Do. ...	40	14	50 4	3 9	3.9	0.13
	Average per day ...	40	14	49 2	3 8	3.9	0.130
April 31	Paddy straw ...	15	14	48 12	3 7	4.55	0.15
1	Do. ...	15	13†	43 8	3 5	3.25	0.10
2	Do. ...	15	13	48 8	3 11	4.1	0.15
	Average per day .	15	13	46 14	3 8	4.0	0.130

* One cow was sick.

† One cow did not stand.

Statement No. 3.—Feeding experiment with foddors on cows—cont.

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column (6).
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1915.				LB. OZ.	LB. OZ.		
April 3	Fodder sorghum ..	40	13	50 4	3 14	3.95	0.155
4	Do. ...	40	12	47 8	3 15	3.9	0.153
5	Do. ...	40	12	47 0	3 14	3.7	0.143
6	Do. ...	40	11	45 12	4 2	3.5	0.144
7	Do. ...	40	11	45 12	4 2	...	...
8	Do. ...	40	11	47 4	4 5	3.7	0.159
9	Do. ...	40	11	47 0	4 4	3.7	0.157
	Average per day ...	40	11	46 6	4 2	3.7	0.152

STATEMENT No. 4.—Feeding experiment with foddors on buffalos.

1915.							
Feb. 1	Paddy straw	15	6	24 12	4 10	5.4	0.24
2	Do.	15	6*	29 12	4 15	5.7	0.28
3	Do.	15	6	33 12	5 10	6.85	0.38
4	Do.	15	5	16 0	3 3	7.25	0.23
	Average per day ...	15	6	25 0	4 11	6.3	0.28
5	Tenai straw	15	5	25 12	5 2	6.7	0.34
6	Do.	15	5	24 12	4 15	6.05	0.29
7	Do.	15	5	24 0	4 13	6.05	0.29
8	Do.	15	5	25 4	5 0	6.75	0.33
9	Do.	15	5	29 4	5 13	5.65	0.32
10	Do.	15	5	25 4	5 0	6.15	0.30
11	Do.	15	5	24 8	4 14	6.15	0.29
	Average per day ...	15	5	25 9	5 1	6.2	0.309
12	Paddy straw	15	5	24 12	4 15	6.05	0.29
13	Do.	15	5	24 8	4 14	6.55	0.31
14	Do.	15	5	22 12	4 8	6.75	0.30
	Average per day ...	15	5	24 0	4 13	6.4	0.300
15	Teff grass	15	5	24 12	4 15	6.25	0.30
16	Do.	15	5	25 8	5 1	6.15	0.31
17	Do.	15	5	25 0	5 0	6.15	0.31
18	Do.	15	5	25 8	5 1	6.25	0.31
19	Do.	15	5	23 8	4 11	7.05	0.33
20	Do.	15	5	26 4	5 4	6.65	0.34
21	Do.	15	5	25 8	5 1	6.75	0.34
	Average per day ...	15	5	25 2	5 0	6.4	0.320

* One buffalo did not stand.

Statement No. 4.—Feeding experiment with fodders on buffaloes—cont.

Date.	Name of straw.	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates)	Total amount of fat present in milk in column (6).
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1915.							
Feb. 22	Paddy straw ...	15	5	LB OZ. 24 0	LB. OZ. 4 12	6.95	0.33
23	Do. ...	15	5*	24 12	4 15	6.9	0.34
24	Do. ...	15	5	30 4	6 0	7.15	0.42
	Average per day ..	15	5	26 5	5 4	7.0	0.36
25	Paddy straw ...	15	5	24 8	4 14	7.75	0.37
26	Do. ...	15	5	24 8	4 14	6.6	0.32
27	Do. ...	15	5	32 6	6 6	7.0	0.44
28	Do. ...	15	5	29 0	5 13	7.2	0.41
March 1	Do. ...	15	5	28 12	5 5	6.75	0.35
2	Do. ...	15	5	25 4	5 0	6.8	0.34
3	Do. ...	15	4*	16 12	4 3	6.95	0.29
	Average per day ..	15	5	25 9	5 4	7.0	0.36
4	Cholam straw ...	15	5	23 4	4 10	6.85	0.31
5	Do. ...	15	5	23 4	4 10	6.9	0.319
6	Do. ...	15	5	26 0	5 3	6.7	0.34
7	Do. ...	15	5	24 4	4 13	7.0	0.33
8	Do. ...	15	5	25 8	5 1	6.65	0.336
9	Do. ...	15	5	23 8	4 11	6.85	0.32
10	Do. ...	15	5	25 0	5 0	6.85	0.342
	Average per day ...	15	5	24 6	4 14	6.9	0.329
11	Paddy straw ...	15	4*	19 0	4 12	6.65	0.316
12	Do. ...	15	4*	21 0	5 4	6.5	0.341
13	Do. ...	15	5	19 4	4 12	7.2	0.342
	Average per day ...	15	4	19 12	4 9	6.8	0.333
14	Cumbu fodder ...	40*	4*	22 12	5 11	6.5	0.369
15	Do. ...	40	5	22 0	4 6	7.5	0.262
16	Do. ...	40	4*	21 8	5 6	6.55	0.352
17	Do. ...	40	5	26 12	5 5	6.75	0.358
18	Do. ...	40	5	24 12	4 15	7.6	0.373
19	Do. ...	40	5	21 0	4 3	7.35	0.307
20	Do. ...	40	5	23 12	4 12	7.4	0.351
	Average per day ...	40	5	23 3	4 10	7.9	0.339
21	Paddy straw ...	15	4	21 0	5 4	6.45	0.339
22	Do. ...	15	4	18 12	4 11	7.0	0.328
23	Do. ...	15	4	19 12	4 15	7.05	0.348
	Average per day ...	15	4	19 13	4 15	6.8	0.338

* One buffalo did not stand.

Statement No. 4.—Feeding experiment with toddlers on buffalos—*cont.*

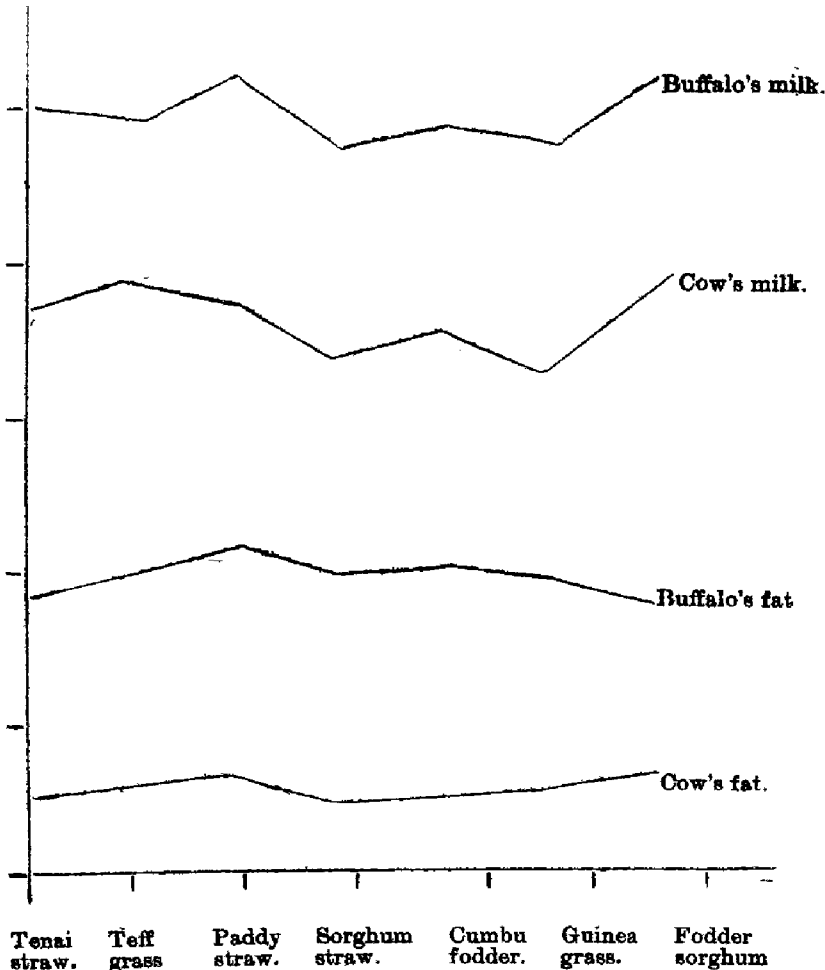
Date.	Name of straw	Rate given per animal in pounds.	Number of animals experimented upon.	Total quantity of milk given in	Average milk per animal in	Percentage of fat (average of duplicates).	Total amount of fat present in milk in column (6).
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1915.				LB. OZ.	LB. OZ.		
March 24	Guinea grass ..	40	4	19 12	4 12	7.4	0.351
25	Do. ...	40	3*	14 0	4 10	6.65	0.307
26	Do. ...	40	3	13 8	4 8	6.85	0.308
27	Do. ...	40	4	18 0	4 8	7.8	0.351
28	Do. ...	40	4	19 12	4 15	7.0	0.345
29	Do. ...	40	4	20 8	5 2	6.55	0.335
30	Do. ...	40	4	20 8	5 2	6.9	0.354
	Average per day ..	40	4	18 0	4 14	7.2	0.336
April 31	Paddy straw	15	4	18 4	4 9	6.7	0.305
1	Do. ...	15	4	22 0	5 8	7.0	0.385
2	Do. ...	15	3†	11 8	3 13	7.15	0.272
	Average per day ...	15	4	17 4	4 11	7.0	0.321
3	Fodder cholam ...	40	4	19 4	4 13	7.8	0.374
4	Do. ...	40	4	16 4	4 1	7.15	0.292
5	Do. ...	40	3†	10 12	3 9	6.25	0.224
6	Do. ...	40	4	19 0	4 12	6.65	0.313
7	Do. ...	40	4	23 8	5 14	6.3	0.370
8	Do. ...	40	4	24 8	6 2	...	...
9	Do. ...	40	4	22 8	5 10	6.6	0.371
	Average per day	40	4	20 2	5 3	6.8	0.324

* One buffalo went dry and one did not stand.

† One buffalo did not stand.

Teff grass has a very narrow albuminoid ratio, and probably such a fodder is not economical to feed dairy cows with. Besides it is a difficult crop to grow here and has not even good enough stand to recommend its cultivation. Tenai straw is considered good by farmers for working cattle but not for dairy animals and this opinion seems to be borne out by the experiment. The milk is specially poor in fat. Cumbu as a straw is of such poor quality that it is used for thatching, but it is fed only when green. The experiment does not contradict this opinion with regard to the yield of milk although the albuminoid ratio is very high indeed. The milk however is of high quality when fed with fodder sorghum, and as may be expected, the succulent fodder increased the flow of milk both in cows and buffalos. It is also satisfactory that milk while this was fed was also rich. Unlike fodder sorghum, guinea grass has been disappointing. The nutritive ratio in this fodder is narrower than either paddy straw or fodder sorghum, and yet it is poor in yield and stands on a par with cumbu in quality so that one is tempted to question the desirability of feeding it on a large scale to dairy cattle. From the graph appended it is interesting to note that the general effect of various fodders experimented with seems to be

practically the same on both cows and buffalos regarding quality and quantity of milk.



GRAPH SHOWING THE EFFECT OF DIFFERENT FODDERS ON QUANTITY AND QUALITY OF MILK IN A HERD OF COWS AND BUFFALOS.

This preliminary test proves more than anything else, that experiments concerning cattle, bristle with innumerable complexities, and that it is nothing short of temerity to deduce results from inconclusive experiments, since in dealing with animals one is confronted with factors over which man has very little control. It is proposed to continue the experiment at a future date.

APPENDIX D.

ECONOMICS OF THE GHI TRADE

BY

D. ANANDA RAO; B.Sc.,

Assistant Principal, Agricultural College.

Although the manufacture of butter as such plays no important part in Indian households, except occasionally as a medicine, it is however in a clarified form invaluable. It then goes by the name of ghi of commerce,—a commodity which forms a portion of the food of the people of the country. It goes without saying that if dairy products are adulterated, ghi is no exception to the rule. It is especially so because of the difficulty of the consumer to detect the adulterant. An experiment was initiated to investigate the details of ghi manufacture with a purpose to note if the present method of manufacture of pure ghi is on an economic basis or not.

PART I.

Milk, naturally, is the basis of ghi manufacture, and upon the quality of it, depends the success or failure of ghi trade. Butter is but an intermediate product in the process. The different processes are herein briefly recorded. Milk, preferably buffalo's, is boiled on an open fire, the chief fuel used being dry cowdung cakes. These are preferred in virtue of their slow burning quality—a quality essential in milk boiling. A mud pot is the common utensil used for such a purpose, which is covered with another mud pot when milk is boiled. During boiling, the smoke freely permeates through the milk, which gives the milk and curd the characteristic smell with which all are familiar. The milk is then allowed to cool for a while after it is first brought to the boil, when a small quantity of the previous day's curd is added to sour it. It is then laid aside till next morning. There are two methods common around Coimbatore in the disposal of the curd so obtained: either the whole curd is churned or only the top portion is skimmed and churned. In both cases the Indian beater churn is the instrument employed. The method of skimming with the hand is shown in photo 3. The skimmed curd naturally retains a large portion of cream. Where the latter practice is adopted, the rest of the curd is sold as such, being previously broken up into large pieces, and mixed with a judicious amount of buttermilk* obtained from churning the skimmed curd. Where the whole curd is churned, the bi-product is the butter milk which ultimately contains equal quantities of water added at different periods of the operation. In whichever way

* Buttermilk in this connexion is used for liquid curd which has been churned and from which butter has been removed

the butter is made, hands are freely used in the operation. When butter has formed, it is removed with the hands into another vessel, and by further agitation of the vessel, some more of the butter is squeezed out. The beater churn is then carefully scraped with the fingers to remove the last traces of butter adhering to it. When butter undergoes such a treatment at the hands of the curdwoman, the shades of colour that it takes are easier imagined than described! When all the butter is removed it is made into a ball and it is then slightly washed on the outside and preserved along with the previous day's lot. In this form, the butter has encased in it a fairly large quantity of casein, which unless melted at once, will be tainted with an objectionable odour. When a sufficient quantity of butter is accumulated, it is melted over an open fire. The curd present in the butter probably gives aroma to the ghi, and at the same time leaves a sediment. When all the water is evaporated, and the characteristic sound of bubbling ceases, certain kinds of leaves like *Moringa pterygosperma*, *Gaertn*, *Murraya kœnigii*, *Spreng* are added for flavouring. The ghi is then strained through a cloth and is then ready for the market.

PART II.

In the experiment 10 lb. of farm buffalo milk which was analysed, was taken each evening, and treated as described above. Both the methods were adopted. The table below gives the details of the experiment. The butter obtained by churning was melted either each morning or after a sufficiently large quantity was accumulated.

TABLE I.

Date	Quantity of milk boiled.	Amount of butter fat present in milk boiled.	Butter-milk obtained.	Butter obtained	Ghi obtained.
(1)	(2)	(3)	(4)	(5)	(6)
1918	LB.	LB. OZ.	LB.	LB. OZ.	LB. OZ.
11th March	10	0 10	20	0 11½	} 1 11½
12th	10	0 9½	20	0 11½	
13th	10	0 10	20	0 11½	} 0 6
14th	10	0 9	20	0 8	
15th	10	0 10	20	0 9½	0 6
16th	10	0 9½	20	0 11½	0 7½
17th	10	0 11	20	0 11½	0 8½
18th	10	0 10½	20	0 10½	0 8½
19th	10	0 9½	20	0 11½	0 9
20th	10	0 10½	20	0 11½	0 9
Total	100	6 3½	200	6 12½	5 4

During the 10 days that this experiment was conducted, 100 lb. of milk, whose average percentage of fat was 6.2, produced 6 lb. 12½ oz. of butter, and 200 lb. of buttermilk. The butter on melting gave 5 lb. 4 oz. of ghi.

In the second method, the milk was treated exactly as above, but in the morning, only the top portion was skimmed and churned. The

table below shows the varying quantities of top curd removed from day to day, which is purely arbitrary, depending as it does entirely on the judgment of the worker.

TABLE II.

Date.	Quantity of milk boiled.	Amount of butter fat present in milk boiled	Quantity of top curds removed.	Curds left over.	Butter obtained.	Buttermilk obtained from top curd.	Quantity of broken curd sold mixed with butter milk.	Ghi obtained.	Percentage of fat in butter milk.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1918.	LB.	LB. OZ.	LB. OZ.	LB. OZ.	LB. OZ.	LB. OZ.	LB. OZ.	LB. OZ.	
28th Nov.	10	0 10½	3 0	7 0	0 5½	8 0	12 0	0 9	0.3
29th "	10	0 11½	3 8	6 8	0 6½	8 0	10 8	0 9	0.2
30th "	10	0 11½	4 8	5 8	0 7½	8 8	10 0	0 6	0.3
2nd Dec.	10	0 10	2 0	8 0	0 3½	5 0	11 0	0 2½	..
3rd "	10	0 12	2 8	7 8	0 5½	6 8	10 0	0 4½	0.4
4th "	10	0 10½	2 8	7 8	0 6	7 0	10 0	0 4½	0.3
5th "	10	0 11½	4 0	6 0	0 6	10 0	10 0	0 5	0.4
6th "	10	0 10½	3 8	6 8	0 6½	8 8	9 0	0 5	0.3
7th "	10	0 9½	3 8	6 8	0 4	8 8	10 0	0 3	0.4
8th "	10	0 10½	3 0	7 0	0 5	8 0	10 0	0 4	0.3
Total ..	100	6 12½	32 0	68 0	3 8½	78 0	102 8	2 11½	

Since the quantity of curd skimmed each day varies, the rest which are dependent on it also vary. The butter and ghi obtained by this process is much lower than in the former method, but the price paid for the curd, more than compensates any loss sustained in the diminished quantity in ghi. The quantity of buttermilk added to the rest of the curd depends upon the proper consistency of the curd as judged by the curd woman, and also upon the quantity of curd originally skimmed. It is usual to make up the curd in this way to nearly the original quantity of milk boiled (vide Table II, column 8). In a total of 100 lb. of milk, of an average of 6.7 per cent of butter fat, 102½ lb of mixed curd, 43½ lb. of butter milk, and 2 lb. 11½ oz. of ghi were obtained. The percentage of ghi to butter is 77, while that of the butter to curd is 11. The ghi obtained every day varies with the quantity of top curd removed, with the fat content of each day's milk, and with the amount of butter left in the buttermilk. This last varies as shown in the last column, the average being about .3 per cent of fat.

Let us now consider the economics of ghi manufacture. In the first method where the whole curd was churned and butter made, 5 lb. 4 oz. ghi were obtained from the 100 lb. of milk. At the time of the experiment ghi was selling at 10 annas per lb. and therefore this quantity fetched Rs. 3-4-6. In addition to this there were 200 lb. of buttermilk, which at the rate of 2 pies per pound yielded an additional income of Rs. 2-1-4, making a total of Rs. 5-5-10, whereas the price of 100 lb. of milk if purchased at one anna per lb. would cost Rs. 6-4-0.

Taking the second method, namely, skimming the top curd, besides 2 lb. 13½ oz. ghi, 102½ lb. of mixed curd and 43½ lb. of buttermilk were sold.

	RS.	A.	P.
Therefore 2 lb. 13½ oz. of ghi at 10 annas per lb. was worth	1	11	2
102½ lb. of mixed curd at ¾ anna per lb. was worth	4	12	10
43½ lb. of buttermilk at 2 pies per lb. was worth	0.	7	3
Total ...	6	15	3

In the former case there was a loss of over 14 annas, and in the latter a gain of 11½ annas in the transaction in converting 100 lb. of milk into ghi in each case. In the latter case the profit is entirely due to the curd, which caters to the tastes of a few. It is held that sometimes good curd will fetch 1 anna per lb. and buttermilk 3 pies per lb. At these rates there are the possible profits of As. 2-6 and Rs. 2-8-7 respectively in 100 lb. of milk. In calculating these profits, the writer had so far not taken into consideration the cost of fuel in boiling milk and ghi, the labour entailed in the manufacture of ghi and in the disposal of the products. In doing the experiment it was found that the services of a woman for 3 hours in the morning for churning and selling curd and an hour for boiling milk and ghi were necessary. Half a day's wages for a woman means As. 1-3 to which may be added 3 pies for fuel for boiling milk and ghi, or 15 annas for 10 days. If this amount is added to the expenses already incurred, it will be found that the profits from ghi manufacture will still be less. There are two causes, however, which seem to make it possible for such a bad business to assume such proportions. Firstly, in the majority of cases at least around Coimbatore many of the agricultural classes enjoy the luxury of buffalo's or cow's milk for themselves. But a good buffalo would provide more milk than the needs of a small family. This surplus milk, especially that of the evening is converted into curd and ghi, such people being content with small profits, if any. Secondly, there is the professional ghi woman, who knowing that the profits of ghi could be extended by adulteration which is not easy of detection, indulges herself in it freely until it becomes an art. It is therefore beyond doubt that the ghi that is purchased from a professional ghi woman is decidedly adulterated, but the writer is not prepared to say to what extent this adulteration goes on. Nor does it appear to be within the scope of this paper to discuss the various adulterants used.

There is still a third method of making ghi, which has come to the notice of the writer, and which is often practised in Indian homes, at least in some parts of the Presidency. It consists in boiling the milk and after allowing it to stand for a while, the cream which floats on the top is skimmed. The rest of the milk is disposed of in the usual way. When the cream is accumulated for a number of days, it is soured and churned. The butter is then melted into ghi. It was thought, therefore, worth while to see how much of fat could be removed from milk in this way and of what nutritive value the rest of the milk will be. This test became specially imperative because the writer on more than one occasion has had misgivings as to the genuineness of the purchased

milk as there were traces of boiled cream in suspected samples. It was supposed that the milk must have been boiled overnight, the top cream removed and the rest of the milk sold to the dairy next morning. The details of the experiment will be found below from which it is evident that half the quantity of butter could be removed in this manner.

Date.	Quantity of milk boiled.	Amount of butter fat in		Weight of cream obtained in	Butter obtained from		Ghi obtained from	
		Milk.	Skim-med milk.	Skim-ming.	Cream	Skim-med milk.	Cream.	Skim-med milk
(1)	(2)	(3)		(4)	(5)		(6)	
1918.	LB.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
11th March ...	10	10	5	6½	} 15½	3½	} 10½	} 8
12th " . . .	10	9½	5½	6½		2½		
13th " . . .	10	10	4½	8½		4½		
14th " . . .	10	9	3½	8½	} 16½	3	} 12	} 2½
15th " . . .	10	10	5½	7½		5½		
16th " . . .	10	9½	5½	6½		5½		
17th " . . .	10	11	7½	7	} 15½	6½	} 12	} 4½
18th " . . .	10	10½	6	6½		6½		
19th " . . .	10	9½	4½	9½		3½		
20th " . . .	10	10½	5½	7½	...	5	...	4

The skimmed cream produced 34½ oz. of ghi which is not a small amount when we take into consideration that the ghi woman would get full price for the rest of the milk. Another aspect which may be of interest is that buffalo's milk considered too rich for invalids, if boiled and skimmed could be brought down to the richness of cow's milk.

From the experiments made it is clear that the manufacture of pure ghi at the present prices is not a profitable concern and it is beyond doubt that if the tradeswoman makes her profit it cannot be by straightforward means, and it is all the more probable because the chances of detection are by no means easy. It is also seen that in the country method of making butter as much as 3 per cent of butter fat is retained in the buttermilk (vide table I, column 10). With a view to improve this improper separation, the curd was previously treated similarly in all respects, but was churned in an 'end over end' churn, with the result that the same quantity of curd produced 75 per cent of butter against the average of 67 per cent by the local beater churn and the buttermilk on analysis left very little trace of the presence of butter fat. There is therefore room for improvement in this direction. The price of a churn offers the greatest difficulty, but the inculcation of the principles of co-operative dairying is the only hope.

How far other methods could be substituted to bring the present ghi trade into more favourable economic position yet remains unsolved. This is a line along which further inquiry needs to be made.

