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Fodder Scarcity and the Possibilities of Exploiting Straw Processing in the Madras Presidency.

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Introduction: Fodder scarcity has been a permanent factor in India, which in recent times is becoming more and more acute with the increase in population and devotion of more attention to money crops like cotton, tobacco, sugarcane etc. According to a recent census in Madras, an area of 7 million acres of cultivated land has passed over from food crops to commercial crops in the Madras Presidency in the present decade (8). As a result of the introduction of money crops and the conversion of grazing lands for cultivation, the Madras Livestock Development Officer (10) has roughly computed that the ryot is short of 50% of his grazing land and 15% of his fodder growing land.

The total number of bovines (cattle and buffaloes) in the Madras Presidency as per the census of December 1944 (14) comes to nearly 226 lakhs (vide Table I).

TABLE I.

Statement showing the number of Bovines in the Madras Presidency (culled from the census held in December 1944.)

Bovines.	Population.
I. Cattle:	
Males over 3 years	6,942,549
Females over 3 years	5,807,079
Young growing stock 3 years and under	3,605,286
II. Buffaloes:	
Males over 3 years	1,179,375
Females over 3 years	3,042,827
Young growing stock 3 years and under	2,067,123
Total:	22,644,239

The fodder available for this head of cattle consists mainly of straws of food grains (cereals and pulses) and fodder crops like cholam, maize, sunnhemp, lucerne, guinea grass etc. The total roughage thus obtained annually in the Madras Presidency is culled from the latest figures available and presented in Table II.

TABLE II.

Roughages available in the Madras Presidency from arable lands.

No. (I)	Crops. (II)			Normal Area sown with crops Average of 5 yrs. 1941-44; From Season & Crop Report 1944-45 (16) (III) 1000 Acres	Normal Yield of seed per acre (As found in 1919) From Season & Crop Report 1944-45 (16) (IV) lb.	Total Yield of Grain (III & IV) (V) 1000 lb.	Ratio of grain to straw (as per Wright Ref. No. 14 & Fodder Committee Ref. No. 15) (VI)	Total Production of straw (VII) 1000 lb.
	Cereals:							
1	Paddy	...	irrigated	7,948	1,787	14,202,183	1 : 1·5	21,303,273
2	,,	...	unirrigated	2,226	1,301	2,896,755	1 : 1 5	4,345,131
3	Cholam	...	irrigated	412	1,467	604,638	1 : 3	1,813,916
4	,,	...	unirrigated	4,454	577	2,570,436	1 : 3	7,711,310
5	Cumbu	...	irrigated	315	1,207	380,663	1 : 3	1,141,990
6	,,	...	unirrigated	2,322	544	1,263,309	1 : 3	3,789,928
7	Ragi	...	irrigated	941	1,492	1,404,345	1 : 3·5	4,915,207
8	,,	...	unirrigated	782	715	558,958	1 : 3·5	1,956,354
9	Korra (tenai)	...		1,458	384	559,833	1 : 3·5	1,959,417
10	Varagu			948	876	830,334	1 : 3·5	2,906,169
11	Samai			567	441	250,002	1 : 3·5	875,010
12	Maize			69	1,060	73,161	1 : 3	219,483
13	Other cereals			573	(Av. Yield ½ ton of straw per acre (Vide p. 75 of Wright (14)			320,728
							Total Cereal Straws ...	53,257,930
	Pulses:							
14	Total Pulses			2,837	Av. Yield ½ ton of straw per acre (Vide p. 75 of Wright (14)			1,589,101
	Fodders:							
15	Guinea grass, maize, cowpea, lucerne etc.,			453	200 mds. of green fodder as per Fodder Committee (15)		Or taking moisture as 80%-40 mds. of dry fodder.	1,489,869
							Grand Total ...	56,336,893

Even if all this 56,337 million pounds of fodder from arable lands are apportioned off to the bovines of this Presidency, it works out to only 6·8 lb. of roughage per animal per day. But in practice part of this food is consumed by other livestock like sheep, goats, horses and ponies. And some dry straws like cumbu, ragi and the variety of cholam Thalai-virichan cholam or Konda or Montha jonna are not fed to cattle in some parts of this Presidency.

So, the actual availability is much less than 6.8 lb. roughage per head per day. But the average requirement of an animal is nearly 15 lb. of roughage per day. Working out the requirement at this rate of 15 lb. of roughage per head per day, the total annual requirement of the Presidency would amount to 123,977,208,525 lb. or 123,977 million pounds nearly. Computing the deficiency of fodder on this basis, the annual shortage in the Madras Presidency works out to (123,977–56,337) or 67,640 millions pounds. Part of this deficiency is however relieved by grasses from pastures of which no account has been taken in this computation for lack of means of estimating it accurately at present, though the Departmental forest and Panchayat forest areas, excluding the areas closed for grazing is known to afford facilities for grazing to $2\frac{1}{4}$ million head of cattle annually. Hence it is patent that there is a very heavy deficit in fodder in the Madras Presidency.

To circumvent this deficiency many recommendations and suggestions have been made in recent times by the various scientific bodies constituted to study this problem at high technical and administrative levels. Chief among them are :— (1) Increasing areas under fodder crops by a combination of persuasion, concession and compulsion on the ryots. Persuasion by propaganda, concession for growing the less remunerative fodder crops by abatement of water tax and compulsion through legislation, are possible means of effecting an increase. (2) Improving pastures by manuring and proper seeding and (3) Increasing the digestibility of the available food by processing of straws and green fodder through alkali-treatment and ensilaging respectively. This paper deals mainly with processing of straws and partly with the utilization of fodders like cumbu which are not fed to cattle in some tracts.

Processing of Straws: By processing is meant the pre-treatment of the straws before feeding it to cattle. Processing of the straws of the important cereal food crops has been studied in other countries and in recent times, it has claimed the attention of workers in India as well.

Processing is aimed at improving the nutritive values and its digestible coefficient. The different nutrients like carbohydrate, proteins etc., present in the straw are partly protected by a ligno-cellulose coating and hence are not wholly available for digestion. Processing of straws therefore aims at releasing these nutrients from their protective coating.

This has been achieved in various ways by different workers. Earlier attempts have been confined to mechanical methods, like chopping, grinding or steaming under pressure. These mechanical processes scarcely improve the nutritive values, though they save energy in masticating and probably improve palatability. One has therefore to turn to chemical processes for any tangible results. Almost the first attempts under this head were those of Lehmann and Kellner (7 & 9) wherein the use of hot alkali for the pre-treatment was advocated. The process consists of soaking and boiling straw under pressure in an aqueous alkali-solution. This gave a fillip for further research and Germany faced with fodder scarcity in the 1914 war, started large-scale plants (2 & 9) to prepare straw pulp, using solutions of the alkali in weaker strengths than before. Godden (6) in 1917 followed this up in England by treating the straw with caustic soda, first in the cold and then subjecting it to hot steam treatment. This was modified by Beckmann in 1919 (3) by cutting out the heat treatment by repeated cold water washings to free the straw of the alkali.

This last process has to-day come to stay in England with the plant devised and supplied by the Imperial Chemical Industries Ltd. (1). The plant consists of two concrete basins in either of which chopped straw is treated with 1.25% alkali, the alkali is syphoned off and the straw washed with fresh water till neutral to litmus. The syphoned alkali is received in the other concrete basin, fortified to the original strength and re-used.

In India, processing has been done by Sen (11) and his co-workers at the Imperial Veterinary Research Institute, Izatnagar, practically on the same lines as Beckmann, treating straw with 8 times its weight of 1.25% caustic soda solution. The processing is done in two cement tubs, one placed lower than the other, so as to facilitate collection of the once used alkali, for a second treatment after fortifying the spent alkali with half the amount used in the first.

Food Value of the Treated Straw: The changes in food value effected by the treatment have also been considered by previous workers. Fingerling (5) found the treated straw to maintain good condition in horses when fed with a protein supplement. Even wood meal when thus treated and fed with protein supplements was found to replace hay or oats with good results. Brierem (4) also reports that milch cows and heavy stock can be well maintained with hydrolized wood meal if fed in a balanced meal.

Slade and others (12) have found digestibility to increase in wheat straw and oat straw from 13·9 to 34·3 and from 23·2 to 43·4 therms respectively. In England (13) feeding treated straw was found to be a success in 3 out of the 5 centres tried by the Ministry of Agriculture. A recent work done in Cambridge (17) has aimed at preparing cellulose from

straws by the paper-manufacturing process which is merely alkali-treatment under pressure. The animal is said to relish this cellulose if fed slightly sprinkled with molasses.

Sen's work (11) in India on wheat and paddy straws has shown the following advantages to accrue by the alkali-treatment:—

(1) 16% of the original lignin present in wheat straw was removed; (2) Starch equivalent was 60% and 47% higher in treated wheat and paddy straws respectively, which affects protein saving; (3) Protein, calcium and phosphorus were assimilated to a greater extent when treated straw was fed; (4) Growth rate was doubled and (5) In paddy straw, two-thirds of the harmful potassium which causes diuresis was removed.

The process has also been tried out on a farm scale by Sen and his co-workers in Bengal and Orissa. One such attempt of Sen at Puri, Orissa Province was studied in detail by the author and this paper deals with the study made therein, compared with the trials subsequently attempted at Coimbatore and ends with the deductions drawn therefrom towards possibilities of its adoption for the Madras Presidency.

Study of the Puri Trials: The treatment of paddy straw was conducted at Puri on practically the same lines as originally designed by Beckmann (3).

The cost of setting up and working a plant for treatment was worked out as follows by the author after studying the plant at Puri:—

			Rs.	A.	P.
I. Initial Outlay:					
Chaff cutter	1	...	250	0	0
Gunny bags	24	...	12	0	0
Cement tubs	2	...	91	15	0
Drain pipes	3	...	5	0	0
Wooden ladles	2	...	1	0	0
Buckets	2	...	8	0	0
Spring Balance	1	...	8	0	0
			375	15	0
II. *Running cost* for every 480 lb. of straw treated:—					
(A) *Labour:*					
(a) Carting straw from the haystack to the chaff cutter		...	0	4	9
(b) Cutting straw in the chaff cutter		...	0	3	6
(c) Preparing the alkali and steeping the straw		...	0	10	6
(d) Washing of the treated straw		...	0	13	0
(e) Drying and stacking		...	0	7	0
			2	6	9
(B) *Materials:*					
(a) Caustic soda for 2 consecutive treatments at Rs. 25/- per cwt.		...	8	0	7
(b) Groundnut oil for protecting the legs of workers		...	0	1	5
			8	2	0

Hence, for every 480 lb. of paddy straw to be treated with alkali, the running costs comes to Rs. 8—2—0 + 2—6—9 = Rs. 10—8—9. Therefore, for treating a ton of straw Rs. 48—2—0 will have to be invested apart from the initial outlay.

It was also noticed that a large amount of dry matter was lost in the Puri Trials, as only 70% of the straw was recovered after treatment, the rest having been probably dissolved out by the alkali or leached out by the subsequent washings.

Godden in England (6) reported 20% as lost in dry matter when oat straw was treated, while Sen's initial work at Izatnagar (11) records a loss of 25%, but the Puri trials gave a 30% loss in Paddy straw. If this loss is taken into account, the Rs. 48—2—0 invested in treating one ton of straw, yield only 7/10 of a ton of *treated* straw. Therefore, for every ton of *treated* straw, the running cost would amount to 10/7 of Rs. 48—2—0 = Rs. 70—5—8, which is prohibitive.

In England (1), the cost of the pre-cast concrete plant is said to cost £ 35 to 40 and the cost of processing £ 3/- per ton without taking into account the dry matter losses. But the cost of production in India is comparatively very high due to the high cost of caustic soda here. Thus the economics of the process is not favourable for its adoption.

Besides, the processing has been stated to increase the starch equivalent of the paddy straw from 24·4 to 35·9 lb. per 100 lb. of straw (11). In calculating the increase, no account has been taken of the loss of 30% of the dry matter of the paddy straw in the process. If this is allowed for, the starch equivalent has to be calculated for the resulting 70 lb. of the product. This works out to 70/100 of 35·9 = 25·13 lb. which is not far different from the original Starch Equivalent of 24·4 lb. for untreated straws. Thus the loss in dry matter besides putting up the cost of production, neutralised the increase in starch equivalent of the paddy straw from 24·4 to 35·9 lb., which is one of the main advantages claimed for the process.

Studies at Coimbatore: These studies were undertaken with a view (i) to replicate the alkali-treatment on a small scale in the locally available straws so as to minimise loss in dry matter and (ii) to find a cheaper alternative to alkali-treatment. With these objects in view the following experiments were done at Coimbatore :—

(a) Alkali-treatment of Paddy, cholam and cumbu straws.
(b) Analysis of the Puri alkali-treated samples for feeding values.
(c) Composting of straw and
(d) Feeding trials.

(A) *Alkali-treatment of paddy, cholam and cumbu straws*: These straws which are locally grown were subjected to alkali-treatment on the same lines as at Izatnagar and Puri. The dry matter and ash were estimated in the treated samples. The results are presented in Table III below :—

TABLE III.

Straws treated at Coimbatore.

Trials	Date of Treatment	Treatment	Wt. taken for each Treatment	Dry wt. of treated straws	Loss in dry matter % age	Heads of analysis	
						Moisture % age	Ash (on dry basis)
			I. Cholam Straw.				
First trial	6—12—1945.	Ist.	35 lb.	23½ lb.	32·86	6·16	7·39
	7—12—1945.	IInd.	,,	27½ ,,	21.43	9·87	9·81
Duplicate trial	10—12—1945.	Ist.	,,	24 ,,	31·43	7·80	8·41
	11—12—1945.	IInd.	,,	28 ,,	20·00	6·88	8·82
			II. Paddy Straw.				
First trial	13—12—1945.	Ist.	35 lb.	30 lb.	14·29	7·20	17·86
	14—12—1945.	IInd.	,,	31 ,,	11·43	7·27	19·16
Duplicate trial	18—12—1945.	Ist.	,,	30 ,,	14·29	8·01	14·49
	19—12—1945.	IInd.	,,	31 ,,	11·43	8·28	16·29
			III. Cumbu Straw.				
First trial	20—12—1945.	Ist.	35 lb.	27 lb.	22·86	6·32	10·14
	21—12—1945.	IInd.	,,	29 ,,	17·14	5·02	8·77
Duplicate trial	27—12—1945.	Ist.	,,	26½ ,,	24·29	6·99	9·50
	28—12—1945.	IInd.	,,	28½ ,,	18·57	6·42	8·63

From the data presented above, it will be evident that (i) the loss in dry matter varies with the variety of straw treated. Taking the first fresh alkali-treatment alone, the loss in dry matter comes to 32% for cholam straw, 14% for paddy straw and 24% for cumbu straw. The loss in paddy straw (viz., 14%) is very much lower than the losses reported in Izatnagar and Puri trials.

(ii) the loss in dry matter could therefore be minimised by careful handling; and

(iii) there exists a difference between the first "fresh alkali treatment" and the second "spent and fortified alkali" treatment, as will be seen from the dry matter and ash content in both cases.

But the Izatnagar workers (9) had claimed that the first and subsequent treatments, even upto a third time, yielded a straw of the same quality as the first, as will be seen from their results below :—

Paddy straw composition after treatment with Regenerated and Recovered alkali (Izatnagar Results (11).)

	First treatment.	Second treatment.	Third treatment.
1. Percentage of recovery of dry matter	74·8	76·0	76·5
2. Percentage of crude fibre	46·10	45·52	45·00

(B) *Analysis of Alkali-treated straws collected at Puri*: The author had collected samples of both treated and untreated straws from the trials conducted at Puri which were done on the same lines as in Izatnagar under the guidance of the Izatnagar workers. These were subjected to analysis for feeding values in the light of the above difference noted between the first and second treatments. The results of analysis are presented in Table IV.

TABLE IV.

Analysis of Paddy Straw samples collected at the Puri Trials.

Paddy Straw Samples	Moisture	Heads of analysis—Percentages (On oven dry basis)							
		Ash	Ether extractives	Crude Protein	Crude Fibre	Carbohydrates (by difference)	Insolubles	CaO.	P_2O_5
I. Untreated Paddy Straw (Old stock)	8·808	25·45	1·07	4·94	26·37	42·17	23·92	0·16	0·16
II. Treated Paddy Straw (1st and 2nd treatments mixed lot)	7·233	15·75	1·01	4·79	37·47	40·98	13·68	0·58	0·13
III. Untreated Paddy Straw (New stock)	7·150	18·95	1·28	4·52	29·96	45·29	14·81	0·42	0·22
IV. First Treated Paddy Straw	7·331	10·67	1·18	3·61	46·48	38·06	7·48	0·63	0·18
V. Second Treated Paddy Straw	8·814	13·99	1·27	4·24	39·00	41·50	10·92	0·49	0·17

It will be seen from the figures obtained that the second treated lot with recovered regenerated alkali, differs from the first treated lot with fresh alkali and is inferior in quality to the first. Taking the crude fibre content alone the second treated lot is less by 7·5% than the first. In spite of the author meticulously following the same technique as the Izatnagar workers and though the Puri Trials were conducted under the control of Izatnagar workers, the sample of straws yielded from the first fresh alkali-treatment and the second waste alkali-treatment vary in chemical composition.

(C) *Composting of Straw*: As alkali-treatment was found to be decidedly prohibitive from the economic point of view and as the most important advantage claimed for alkali-treatment, viz., increase in starch equivalent was offset by the dry matter loss, it was sought to see whether

fermentation of the straw would pre-digest the cellulose and thereby improve the quality of the straw giving incidentally a process of lesser monetary commitment.

With this object in view cumbu straw was composted with (1) Molasses and (2) Ammonium sulphate as starters in two cement tubs (2′ x 2′ x 2′) for a period of 2 months; 50 lb. of finely cut cumbu straw with 10% of molasses by weight was packed into one tub and sealed with earth. Another 50 lb. was similarly packed and sealed with 2% Ammonium sulphate, 0·2% super and 0·4% Calcium carbonate by weight.

Samples were drawn for analysis before and after packing and after one and two months' of fermentation. The composting could not be continued longer than 2 months, as under the conditions of experimentation the bottom layers had commenced to completely rot and take on a manure-like appearance, which would have been unfit for feeding. The samples drawn were analysed for their feeding values and the results are presented in Table V.

TABLE V.

Cumbu Straw Composting, Trials — Results of Analysis.

S. No.	Samples analysed with dates of sampling.	Original Moisture.	Heads of analysis on dry basis.						
			Moisture.	Ash.	Ether extractives.	Crude Proteins.	Crude Fibre.	Carbohydrates (by diffce.	Insolubles.
		%	%	%	%	%	%	%	%
1	Cumbu straw — Original sample 19—6—1946.	...	6·61	8·71	1·51	5·29	33·72	50·77	3·10
2	Cumbu straw with 10% molasses before fermentation 19—9—1946.	49·74	7·42	10·81	1·55	6·30	29·47	51·67	4·83
3	Do. after 1 month of fermentation 19—7—1946.	71·81	6·37	11·58	2·86	5·28	32·46	47·82	5·50
4	Do. after 2 months of fermentation 19—8—1946.	75·44	5·94	12·73	3·29	6·00	32·64	45·34	5·31
5	Cumbu straw with 2% Ammonium sulphate - Before fermentation 20—6—1946.	68·31	9·15	12·72	1·55	6·24	33·30	46·19	5·47
6	Do. after 1 month of fermentation 20—7—1946.	74·23	7·65	13·38	1·60	6·31	32·47	46·24	5·34
7	Do. after 2 months of fermentation 20—8—1946.	75·51	6·44	12·51	1·06	6·03	35·29	45·11	4·54

It will be seen from the results obtained that composting for 2 months had not materially improved its feeding values, though the products obtained at the end of 2 months of fermentation had a good silage-like appearance and smell.

The main object of the treatment, namely the increase in the total carbohydrate moeity (crude fibre and carbohydrate) remained unaffected. There was however some perceptible difference in ash and ether extractives, but the other values remained practically unchanged.

(D) *Feeding Trials:* As the alkali-treatment was prohibitively high in cost and as the composting tried out as an alternative measure did not tend to improve the feeding values of the straw, processing of the straws normally fed to cattle was given up and only straws like cumbu which were not normally fed to cattle in tracts like Coimbatore, were considered for processing. These latter straws had to be made palatable as otherwise they were wholly lost as a fodder to the Presidency. With this object in view the feeding trials were undertaken with cumbu straw treated and untreated.

(i) *Feeding of Treated Straw:* Alkali-treated cumbu straw was fed to two animals at the Central Farm, Coimbatore, to see whether the animals would eat treated cumbu straw. As a preliminary measure the animals were fed for 3 days only and though they did not take to it on the first day, yet within a short span of 2 days they consumed the straw wholly without any deleterious effect.

(ii) *Feeding of Untreated Straw:* Before attempting any large scale treatment of the unpalatable straw like cumbu, for incorporating it in the regular feed of the animal, information was sought as to whether feeding of the straw as such without treatment would be possible and if prolonged feeding would cause any deleterious effect on the animal.

If no deleterious effect was produced and if the animals were to take to it without any special treatment, then the 4,931 million pounds of cumbu straw annually produced in the Madras Presidency and not utilised as fodder in places like Coimbatore and other places adjoining hills, could be used as fodder instead of as thatching material. This would go a great way to relieve the fodder scarcity of the Province.

With this object in view a controlled feeding experiment with 4 work bullocks was started at Coimbatore at the Central Farm in collaboration with the Superintendent, Central Farm. The experiment lasted for 4 months. Two animals were kept as controls and two as experimentals. The two controls received the normal farm rations, consisting of 20 lb. of roughage, 1 oz. of mineral mixture, 1 oz. of salt and 1 to 3 lb. of concentrates depending on the work. The two experimental animals were also fed the same rations with 25% of cumbu straw substituted in the roughage usually fed. The proportion of cumbu straw in the roughage was gradually increased and brought on wholly to cumbu straw in the course of 6 weeks for the experimental animals. Weekly live weights were recorded.

It was seen that the liveweight was not affected by the feeding. The health and condition of the animal did not in any way deteriorate due to cumbu straw feeding. It could therefore be concluded from the preliminary trials so far conducted, that the antipathy against cumbu straw feeding is not borne out by controlled feeding and no special treatment may be needed to incorporate it in the feed.

Discussions and Conclusions: The studies made at Puri and later followed up in Coimbatore revealed that processing with alkali was not an economical proposition. Nor would the cheaper alternative of composting tried out, help in giving a better quality straw. The high cost of soda which mitigates against the alkali-treatment, it is hoped will come down in normal times and the processing cheapened to that extent and possibly come within the means of the proverbially poor Indian ryot. For, it cannot be gainsaid that alkali-treatment bestows certain improved qualities to the straw, which would offset the prevalent fodder scarcity by making the available fodder better digested and utilised by the animal.

Coming to the question of fodder scarcity, as mentioned at the outset there are certain varieties of straws and fodders, which are not fed to cattle in some tracts particularly adjoining the hills. Some of these straws are the cumbu straw as mentioned before, Konda or montha jonna or Thalaivirichan cholam, dry ragi and dry tenai straws. These if fed to cattle would alleviate the fodder scarcity to a certain extent. Some of these, like cumbu straw could be even incorporated without treatment as was shown by the feeding trial. But for some of the others, treatment may be necessary. For these, alkali-treatment could be adopted irrespective of the cost, if the treatment is going to make these straws palatable to the animal and to a great extent swell the available fodders of the Presidency.

But for other fodders which are relished by the animal and which are usually fed to the cattle, processing does not compensate the monetary drain on the cattle husbandman.

It should however be pointed out that this is only a preliminary investigation and more information will have to be gathered before any definite conclusion could be drawn.

Summary:

1. The annual deficit in fodder in the Madras Presidency is worked out as 67,640 million pounds.

2. To circumvent this deficiency processing of straws is discussed to make the available fodder better utilised in the animal system.

3. Alkali-treatment is considered as the chief means of processing but is economically not paying.

4. Composting of straws tried out as an alternative does not materially change its feeding value and is therefore not worth attempting.

5. Certain straws like cumbu and some varieties of cholam like Thalaivirichan cholam etc., are not fed to cattle in some tracts of the Presidency. These, it is tentatively concluded, should be processed irrespective of the cost, to relieve the fodder scarcity of the Province, if they could not be directly incorporated by a judicious admixture with other straws as is shown in the case of cumbu.

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