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Some Practical Aspects of Application of Bulky Organic Manures to Sugarcane in Madras

By

M. LAKSHMIKANTHAM, B. SC. (Ag.),
Superintendent, Sugarcane Liaison Farm, Samalkot

Introduction: Maximisation of production is the need of the day. Manuring crops is perhaps the easiest way of stepping up production. Commercial crops always receive better attention in the matter of manuring, in view of the more lucrative prices that can be secured. Concentrated manures are invariably applied to these crops for increasing production. Groundnut cake is the largest produced oil cake in this State and sulphate of ammonia, the most popular fertiliser applied to sugarcane.

Experiments to find out the dose and time of application of these manures to sugarcane, either alone or in combination with other organic and inorganic concentrates were few and far between in this State. It is proposed to present in this paper, a review of the results of experiments so far conducted on sugarcane, using bulky organic manures, alone or in combination with other manures.

Among plant nutrients Nitrogen is the chief limiting factor of sugarcane yields. Hence the efficiency of these manures is mainly considered with reference to their nitrogen supply and its time of availability. Their influence on the physical condition of the soil is also dealt with incidentally.

2. Review of Experiments in Madras: (a) *Farmyard manure:* Of all the bulky organic manures, farmyard manure received the greatest attention in experiments in this State. Samalkot was the earliest to conduct these experiments which extended over a period of 16 years from 1902 to 1917. In none of these experiments was this manure compared with cakes or artificials on a nitrogen basis. In the first few years the cost of manures compared was kept constant (Rs. 40/- per acre) irrespective of its quantity or quality. In certain years the quality of farmyard manure applied was not noted and at times it was noted in terms of cartloads. Thus 60 cart loads, 30 tons, 10 tons, 47,250 lb. and 56,000 lb. were the doses tried. These were compared with ten bags of castor cake, (noted as weighing 1,640 lb. in earlier years and 1,660 lb. later on), which was considered as the standared dose of manure for sugarcane in those years. The analysis figures of castor cake and farmyard manure were reported in some years and nitrogen content of the former varied from 6·05% to 6·34%, while that of the latter ranged between 0·24% to 0·29%.

Assuming one cartload to be equal to $\frac{1}{2}$ a ton, the following data are computed from the results available.

Year	N supplied Farmyard manure per acre lb.	Yield of cane in lb.	N supplied as castor cake (10 bags per acre)	Yield of cane in lb.
1902—03	194·88	32,200	102·83	65,500
1905—06	151·2	78,848	103·98	111,440
Total ...	346·08	111,048	206·81	176,840
Yield per pound of N.		321 lb.		856 lb.

Yield of jaggery in lb. per acre.

	10 tons Farmyard manure.	*10 bags castor cake (1660 lb.)*
1909—10	7,050	11,858
1910—11	4,220	7,460
1911—12	2,767	7,167
Total ...	14,037	26,485
Average ...	4,678	8,828·8

Yield in Farmyard manure treatment as percent of that in cake treatment was 53%.

	30 tons Farmyard manure.	*Groundnut cake 10 bags.*
1912—13	10,166	9,463
1913—14	9,355	13,599
Total ...	19,521	23,062
Average ...	9,760·5	11,531

Yield from Farmyard manure treatment as % of that from groundnnt cake ... ... } 80%

Experiments comparing cattle manure alone with other manures were not conducted at any of the other Research Stations of the State. Varieties tried in the experiments cited above are now extinct and the results are at best only indicative.

Experiments including cattle manure supplemented with other manures were conducted at Samalkot, Anakapalli and Palur. Results from Samalkot are furnished below :

Year	10 tons cattle manure + 820 lb. castor cake.		10 bags of castor cake per acre (1640 lb.)	
	Yield of cane lb.	Yield of jaggery lb.	Yield of cane lb.	Yield of jaggery lb.
1914—15	62,687	8440	73,174	10,827
1915—16	53,432	7240	65,788	9,242

Average yield of jaggery from farmyard manure + cake treatment as % of that from cake alone. } 78%

Year	10 tons farmyard manure + 1230 lb. castor cake		1640 lb. castor cake	
	Cane yield lb,	Jaggery yield lb.	Cane yield lb.	Jaggery yield lb.
1916—17	96,711	11,475	87,177	10,269
1917—18	93,850	10,693	88,065	10,193

Average yield of jaggery from farmyard manure + cake treatment as % of that from cake alone. } 108%

By substituting 410 lb. of castor cake with ten tons of farmyard manure, 8% increased yield was realised. By supplementing 10 tons farmyard manure with 820 lb. of castor cake, 78% of the yield of control could be realised (12).

At Anakapalli the value of farmyard manure as a basal dressing at ten tons per acre to supply about 80 lb. N, was tested during 1944—'47 along with six graded doses of N going up to 250 lb. per acre supplied in the form of groundnut cake. The variety used was Co. 419.

Application of farmyard manure did not influence the different phases of crop performance to any appreciable extent. Under extreme conditions of drought its beneficial influence was more pronounced (9).

The results are summarised below;

Nitrogen.	Yield of cane in tons per acre.					
	0 lb.	50 lb.	100 lb.	150 lb.	200 lb.	250 lb.
With basal dressing	41·38	49·97	52·99	49·78	49·19	51·90
Without do	40·03	44·14	51·18	50·20	50·41	48·43
	Percent sucrose in juice.					
With basal dressing	17·29	16·13	17·10	16·64	16·13	16·24
Without do	17·51	17·26	16·50	17·02	15·93	15·91

Treatment.	Trash alone	Trash + S. A.	Trash composted	Sanai	Sanai + Trash.
Yield in tons per acre	37·7	41·6	41·5	39·6	37·7

Composted trash recorded the same yield as trash buried in the soil when sulphate of ammonia was applied in adequate quantities to serve as starter and facilitate its quick disintegration (17).

(d) *Bulky Manures as soil improvers with residual effect:* Fifty to 70% or more of N in farmyard manure remained unavailable to the crop (16). The low availability of N during the first year of application suggests that farmyard manure should have residual effects. But yield data from an experiment at Risalewala (1934—'36) with sugarcane, wheat-gram-cotton as rotation crops did not show any residual effect when 16 or 18 tons farmyard manure was applied as basal dressing. Even total N in farmyard manure treated plots was not more than in other fields. Farmyard manure supplied easily decomposable organic matter to the soil. At Padegaon continuous cropping with cane for 5 years with an annual dose of 40,000 lb. of farmyard manure and 150 lb. nitrogen as top dressing showed a loss of 52% of N after making allowance for its uptake by the crop. But in the acid alluvium of Jorhat (Assam) residual effect of farmyard manure was noted (16).

Farmyard manure is considered more as a soil improver, rather than as a supplier of N in Bombay. In an experiment conducted at Padegaon (1933—'36) including Pundia and P. O. J. 2878, the distinct influence of farmyard manure in improving soil tilth and thus benefiting the shallow-rooted Pundia could be clearly noted. However, fertility studies at the same station indicated the danger of indiscriminate, heavy applications of farmyard manure, especially in badly drained soils, as it increased C/N ratio beyond the beneficial limit and had actually reduced the fertility status of the soil. This was also applicable to the black cotton soils of Bombay (2). This aspect of manuring with farmyard manure was not studied in the other parts of the country. Similar studies on compost and green manures may throw more light on the subject.

With regard to economics, sunnhemp green manuring was more profitable than growing a rotation crop in the Deccan canal tract according to the findings of Gadgil in 1937. This dictum may be untenable now, because of the soaring prices of cereal grains which normally come in rotation with sugarcane. However, green manuring was found to be more paying than application of 30 cartloads of farmyard manure. (16). Even now this position remains the same.

In a very important experiment started in 1938—'39 and continued now, continuous annual applications of a basal dressing of 20,000 lb. of compost to sugarcane, planted in rotation in the same plots, was studied in a rotation experiment at Padegaon. The rotation adopted was groundnut, sugarcane and '*Jowar.*' The results of 3 cycles of crops are now available. Sugarcane received 300 lb. N as cake alone and sulphate of ammonia alone and in combinations of both in 2:1, 1:1 and 1:2 proportions. There was a duplicate series without basal dressing.

The data indicated that there was a steady decline in yield in spite of application of compost; the deterioration, however, being less in the case of compost series. The decline in yields in the case of top dressings was highest in sulphate of ammonia alone treatment, and least when cake alone was applied. The results are furnished below:

Average response to top dressings, in tons of cane per acre.

Cycle	No. top dressing	Cake alone	Cake + S. A. 2:1	Cake + S. A. 1:1	Cake + S. A. 1:2	S. A. alone
			WITH COMPOST.			
I	17·58	56·91	58·86	58·85	56·60	55·43
II	17·11	47·35	46·08	45·30	42·22	36·39
III	13·21	45·72	45·63	44·38	38·52	31·44
III as % of I.	75·14	80·34	77·52	75·41	68·06	56·72
			WITHOUT COMPOST.			
I	18·31	54·96	57·48	56·89	55·06	43·70
II	12·18	43·87	41·28	37·17	32·15	24·13
III	10·98	42·20	39·68	36·45	28·89	20·41
III as % of I.	60·00	76·80	69·00	64·10	52·50	42·80

There was a distinct superiority in the humus & nitrogen content of soils which received compost as basal dressing. The humus content was 0·84% and 0·497% respectively, for compost and no compost series. The total nitrogen in the compost series increased from 0·059 in the I cycle to 0·076 in the III cycle. For the no compost series the figures were 0·057 and 0·071 respectively. The C/N ratio in the plots which received compost was 15·8 against 14·1 of the "no compost" series. There was 25% increase in P_2O_5 content of soil in the compost series. The results of two years only of the IV cycle indicated that the downward trend in the yields of all the treatments including the sulphate of ammonia treatment was arrested in the series which received the basal dressing. In fact, there was marked increase in yields of all these treatments over the yields recorded in the 3rd cycle, whereas in the series that did not get the basal dressing, deterioration in cane yields continued in all the treatments. Decline in yields was most marked in the treatment which received sulphate of ammonia alone as top dressing (18).

4. **Practices in other countries:** (a) *Australia:* There was no significant increase in yield due to conservation of trash combined with normal fertiliser applications at Bundaberg in Australia (6). Green manuring is common in this country. Von Stieglitz estimated that a good crop of green manure supplies 120 lb. N and 22 lb. P_2O_5 and 110 lb. K_2O. Incorporating trash in the soil and sowing a green manure crop for subsequent turning in, is advocated to facilitate decomposition of trash (21).

(b) *Hawaii:* According to Borden, when cane trash is worked into the soil a fallow of at least 8 months is required before planting cane to avoid loss in yield. In this case N is fixed by soil organisms and is available only at a later period (4). Starting with trash with a C/N ratio of 66·1, Borden found that available N decreased in plots to which different quantities of trash were applied together with ammonium nitrate to give up to 150 lb. N per. acre. Only when Ammonium Nitrate was applied at 200 lb. N was there a slight increase in available N, indicating that this 200 lb. N was required to satisfy the needs of soil micro-organisms. He recommended the use of 25 lb. N as N fertiliser per ton of trash, to save the crop from N deficiency.

(c) *Louisiana:* Cane is grown here after a crop of cowpeas *(Vigna unguiculata)* which is ploughed in.

(d) *South Africa:* Writting about preservation of the fertility of cane fields, Dr. Dodds recommended green manuring before growing cane in South Africa. He advocated composting cane trash in the field with filter cake and growing sunnhemp on the compost fields (5). Results of an experiment on burning cane along with trash, versus non-burning, reported by Sherrard indicated that by burning standing cane with trash there was distinct fall in yields, which increased as the number of ratoons increased (10). The yield date are presented below :

Plant crop, 1941		*Tons cane per acre*	*Sucrose % cane*	*Tons sucrose per acre*
Burnt	...	39·78	15·58	6·20
Trashed	...	42·18	15·18	6·40
First ratoon crop 1943				
Burnt	...	52·83	12·28	6·49
Trashed	...	61·13	12·47	7.62
Second ratoon crop 1945				
Burnt	...	40·26	13·69	5·51
Trashed	...	49·16	13·63	6·70
Third ratoon crop 1947				
Brunt	...	28·10	13·92	3·91
Trashed	...	41·42	13·83	5·74

(e) *West Indies:* Experiments in Trinidad indicated that pen manure with sulphate of ammonia was more efficient than sulphate of ammonia alone (19).

5. Some practical aspects of application of organic manures in this State: A review of results of experiments pertaining to three main bulky organic manures viz: farmyard manure, compost and green manure is made in the foregoing pages. Molasses was not considered in view of the impracticability of its transport and application. Press mud cake, another minor by-product of the sugar factories, received some attention. From this review the following inferences may be drawn.

1. We have not got sufficient data on all aspects of manuring with bulky organic manures to sugarcane in different soils.

2. In the matter of supply of nitrogen as plant food, all the bulky organic manures are inferior to concentrated organic manures like oil cakes as well as to inorganic fertilisers.

3. However there is some beneficial effect in applying these bulky organic manures and that is only indirect. They act as soil improvers.

4. There is an indication that continuous application of these bulky manures like compost will mitigate the adverse effects of continuous application of fertilisers.

5. When there is over irrigation or ill drainage, heavy applications of farmyard manure may lead to increased C/N ratio and depress yields.

6. Response of these bulky organic manures differs with differences in soil types.

7. Generally speaking they do not adversely influence juice quality of sugarcane.

With the background of this information, it is appropriate to consider certain practical aspects of application of these manures in this State; these are discussed below.

(i) *Availability of* (a) *Farmyard manure:* When areas under commercial crops were limited and knowledge of the use of organic concentrates and artificials was not so widespread as at present, cane growers invariably reserved adequate quantities of their farmyard manure to sugarcane. They relied on better preparatory cultivation of the soil and farmyard manure for good crops. And the noble varieties then under cultivation demanded such careful treatment. There are villages like Nadukuru of Srikakulam district, where ryots even now, stick to farmyard manure and never apply any concentrates, organic or inorganic. With the increase in area under sugarcane and other crops, application of farmyard manure in any adequate measure became out of the question. Acharya calculated that only about 120·8 million tons of farmyard manure (containing 50% moisture) is prepared annually and it meant $\frac{2}{5}$ of a ton of manure per acre (1) It can safely be assumed that the position is no better now.

(b) *Compost:* That farm, rural and town wastes can be converted into valuable bulky manures by composting is being realised and getting slowly popularised recently. There is a vast scope for increasing the quantity of compost, provided all the organic waste products are composted. For instance, about 3,35,000 tons of cane trash will be available annually for conversion into compost in this State. Barring a little quantity used for thatching houses, the rest is now being burnt away. If all of this is converted into compost along with other organic wastes, compost will be a valuable and rich source of bulky organic manure. Von Stieglitz (1944) estimated that in Queensland the trash and tops from a 20 ton cane crop, contain 52 lb. N, 22 lb. P_2O_5 and 90 lb. K_2O (21). At this rate about 50,000 lb. N. can be supplied from the surplus cane trash and other wastes from the present cane area in this State.

(c) *Green Manure:* The availability of this manure is practically unlimited.

(d) *Pressmud cake:* Among the factory wastes press mud is a good source of organic N as well as phosphate. The average composition of the stuff is as follows:

	Mushari (fresh) weight percent	Vuyyur percent (fresh)	Queensland (fresh) percent	Natal (airdried) percent
Moisture ...	...	...	70·0	10·0
Nitrogen ...	1·0	1·17—0·65	0·5	0·80
$P_2 O_5$ ...	3·0	1·001	0·5	2·50
$K_2 O$ ...	1·0	0·58	0·06	0·02
Lime ...	8·0	...	0·7	14·0

The production of press mud in this State is estimated at about 14,000 tons with 60 to 70% moisture.

(ii) *Time and method of application:* Generally speaking, application of bulky manures is recommended to be done well in advance of planting cane.

Farmyard manure has to be ploughed in about a month or earlier prior to planting (15). This is to facilitiate decompostion and availability of plant nutrients to sugarcane shortly after its establishment. While reviewing the results of fertiliser experiments, the apparent inconsistency in the effect of application of farmyard manure was largely attributed, by Dr. Rege, to the differences in the state of its decomposition (which is not mentioned in the reports), not to speak of the influences of the particular soil type. If partly decomposed organic matter, is applied in the name of farmyard manure, it increases the C/N ratio, resulting in loss of nitrogen by bacterial action. There are instances, however, of applying excellently rotted cattle manure top dressing in parts of Visakhapatnam and Godavari districts. That is the ideal state in which it should be applied to the crop to derive maximum benefit.

In green manures we have a source of unlimited supply of bulky organic manures. But their use is conditioned by certain limitations which have to be overcome before they can be more widely popularised.

Ploughing a green manure crop '*in situ*' prior to planting cane is being recommended from many years past. But there should be adequate time for it to distintegrate and become useful to the succeeding cane crop. We have no data in this State on the effect of ploughing in a green manure crop at different periods prior to planting cane.

Even in other States, data are extremely meagre. In the black cotton soils of Bombay-Deccan, sunnhemp is grown as a rotation crop and ploughed in in August and cane is normally planted only in next January. There is thus plenty of time for it to disintegrate, but due to heavy rains in September – October, 25% of the added 'N' was leached away (16). In Madras State sugarcane is mostly rotated with paddy

which is harvested in November – December. Sunnhemp or Pillipesara are sown in the standing crops of paddy and after about 2 months, part of the green stuff is utilised for cattle feed and the remaining ploughed in for green manure purposes. So the problem here is proper disintegration of green manure prior to planting cane and not leaching away of nitrates. This is so far as places to which water supply is available till March, are concerned. But in places like parts of Godavari district, Srikakulam district and large areas of Visakhapatnam district, water supply may be available just for planting cane and giving it an irrigation or two, before the canals are reopened or monsoon rains set in. For instance in Chodavaram taluk (growing about 10,000 acre under cane) a large part of the cane area is planted after the receipt of one or two good summer showers only. In such places ploughing in of a green manure crop prior to planting is unthinkable. For overcoming the difficulty of early stoppage of water supply, the cane areas have to be planned just as the second crop paddy area. This planning, can be and has to be done by the cane growers themselves. They should grow an early duration paddy variety in the area proposed to be planted to cane next year. This can be removed from the field in the first week of November and a green manure crop sown in the standing crop of paddy prior to its harvest. By about the end of December it should be ploughed in. Cane planting may be done in February – March after the green manure gets well incorporated into the soil. If this is not systematically done, sunnhemp, which is the most popular green manure crop in this State will get affected by seepage of water from surrounding wetlands having long duration paddy crops. An instance of consolidating cane areas into blocks for facilitating better drainage is available in the Vuyyur Factory area in the Krishna district. In a similar way it should be possible to organise cane areas into blocks and grow short duration paddy followed by a green manure crop prior to planting cane in most of the wetlands of this State.

In areas where there is not enough interval for growing a green manure crop it can be sown as an inter-crop in sugarcane, provided there is a possibility of water supply after about two months. The crop can be buried besides cane rows while earthing them up.

The sunnhemp seed has to be dibbled with the first hoeing to give a satisfactory crop. Where intercultivation with bullock – drawn implements is done the seeds have to be sown close to the cane rows to facilitate working of the implements without uprooting the plants. It is also desirable to adopt 3 feet spacing under such circumstances.

When the intercrop is grown, enough moisture during its growth is necessary, if this is not to make inroads into the moisture required by the main crop during the summer months.

Green manuring is considered the cheapest way of supplying organic nitrogen as well as humus to soils. A crop of sunnhemp aged 50 to 60 days is estimated to supply 60 lb. N per acre (16) Whether increased cane yields and the beneficial effects of green manuring on the physical condition of soil, offset the income that can be derived by alternate crops like pulses or cereals in these days of high prices has to be investigated.

There is yet another aspect that needs consideration when green manuring is proposed prior to planting cane. A thorough preparatory cultivation from the time the previous crop is removed is considered superior to green manuring the land. Progressive cane cultivators in the deltas prefer to plough the land immediately after removing paddy, without taking either a pulse crop or a green manure crop. They feel that by deep cultivation they will be able to improve the moisture-holding capacity of the soil and help the crop to tide over the summer months. In the Central districts the practice of allowing the land to dry up and crack for some time, then letting in water and ploughing the field when in condition is found to give a very good tilth. By doing this, clods will not be formed as in the case of ploughing immediately after paddy. But whether the moisture-holding capacity will in any way be affected by this practice is not known. Thus, whether a thorough preparatory cultivation without growing a green manure crop will be better than green manuring and moderate cultivation needs investigation.

A great handicap which limits composting is the non-availability of vacant spaces near the fields for digging compost pits or putting up compost heaps. If all the surplus cane trash is to be composted, a nearby vacant space is necessary. It will be a costly affair to collect it from the field and cart it to distant places where space might be available. Hence many cane growers adopt the least expensive method of its disposal by burning it. They are thus not only burning away trash but also the roots and other organic material spread over in the top layers of the soil and amounting to about 3,000 lb. per acre (7). To obviate the expensive method of collecting trash and overcome the difficulty of lack of space, composting cane trash in the field itself is recommended. But direct application of trash without proper precautions was found to lower yields, in this and other countries (16,4).

Application of ammonium sulphate at 0·5 to 0·8% on the weight of trash seemed to have kept down the C/N ratio and promoted decomposition of trash without affecting the soil, in Bombay (17).

Pig manure is supposed to quicken disintegration of trash when applied as a starter. Substances like press mud cake are also being tried as starters in place of cow dung-water for composting. In a small-scale trial at Samalkot no adverse effects on the crop (like yellowing of leaves, or scorching of leaf tips) were noted by direct application of trash in summer. There were white ant and rat attacks, which were negligible. It may be of interest to note that to conserve moisture, a light layer of cane trash is spread over the young cane crop beds, in Godavari and Visakhapatnam districts. This trash is collected and removed with the onset of rains. It is recommended that it may be buried besides cane rows in the field itself and the normal manuring with concentrates attended to. The effect of this practice on the nutrition of the cane plant has to be investigated and a method of composting cane trash in the field itself has to be perfected in the interests of economy.

Press-mud cake which is being produced in limited quantities was favoured for application to paddy by ryots in the neighbourhood of sugar factories. Direct application to cane, just like farmyard manure was

tried at ten tons (20 cartloads) per acre on the Sugarcane Liaison Farm at Samalkot during 1950—51. It was ploughed in about two weeks before planting cane, and there were no visible adverse effects on the crop like yellowing of leaves etc. It is reported that direct application to sugarcane is also being tried by some cane growers in recent years. One reason why the application of filter press mud has not given any great increase in crop yields, is reported to be its high wax content. (12% on dry weight; 14 to 22% in Cuba). A process has been recently developed by Dr. Owen for extracting this wax with solvents and reinoculating the mud with desirable soil microbial flora before its application as manure (4). The possibility of removing this wax by some such process may be considered in this State to improve the manurial efficiency of press mud cake.

Before concluding this paper, one point has to be stressed. There is at present a wrong emphasis in practice on the efficacy of artificials for getting high yields. Many cane growers are adopting this short cut (in their opinion) to get high yields. But a note of warning should be sounded against this practice.

The results of the Bombay experiment on continuous applications of compost (18) should be an eye-opener to them. Moreover, Dr. Baver, (Hawaii) writing about translation of results of research into practical field scale achievements, postulated that there was a deterioration in the natural productive capacity of the soil at a rate almost fast enough to offset all the improvements in soil and crop management. He suggested that "ascertaining and application of sound basic facts to the problems of increasing soil productivity would make a sizeable contribution to narrowing the gap between science and practice in the sugar industry". (3) Good soil management, including application of bulky organic manures coupled with proper cultural practices, such as provision of better drainage, optimum irrigation and timely intercultivations are essential for stepping up cane production and maintaining soil fertility.

6. **Summary and conclusions:** Sugarcane is a heavy feeder and to increase its production, large doses of nitrogenous concentrates are essential. There is at present acute short supply in organic concentrates like oil cakes. It is necessary to supply inorganic fertilisers in combination with organic concentrates or on a basal dressing of some bulky organic manure like farmyard manure, compost or green manure. The effect of application of these bulky manures with and without concentrates, as revealed by the results of experiments conducted in this and other States was reviewed. Some practical aspects, especially with regard to doses and time of application were dealt with. The available information is definite only about one thing and that is, that a large quantity of nitrogen in the bulky manures remains unavailable to the cane crop during its life period and that though applied on the same nitrogen basis, bulky manures are inferior to concentrates like cakes or inorganic fertilisers. Information with regard to residual effect is not uniform. Heavy applications were beneficial under certain conditions but were harmful when over-irrigation or bad drainage was prevalent in certain soils. Thus there is need for conducting experiments on all aspects of the application of bulky organic

manures to sugarcane, including the economic aspect (of missing a rotation crop, for growing a green manure crop) taking into consideration certain practical difficulties inherent in the different localities. Only then will it be possible to recommend correct methods for utilisation of these bulky manures based on experimental data, instead of in an empirical manner as is being done now, These experiments, designed as they are, for keeping up the fertility status of the soils and producing better crops over a long period, are of vital importance and should claim top priority in schemes of research on sugarcane.

7. **Acknowledgements:** Results of experiments in other States were mainly taken from the bulletin on 'Fertiliser experiments on sugarcane in India by Dr. Rege and from 'Manuring of sugarcane—a critical review' by Mukerji and Verma. Thanks are also due to the Indian Central Sugarcane Committee, who are partly financing the scheme of developmental work on sugarcane in this State.

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