

## Calcium Cyanamide as a manure for South Indian Soils.

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It is well-known that the plant-food to which crops react generally readily is nitrogen. The soil surveys of the various districts have pointed to a general deficiency of this ingredient. The natural supplies are mainly Farm Yard Manure and green leaves. These sources are far too poor to supply the demands and the need for chemical manures is great. Of these, the most important ones are Nitrate of Soda, Sulphate of Ammonia, and Calcium Cyanamide. The first is as much a natural manure as Farm Yard Manure since it is dug out of the natural deposits in Chili. Its supply is certainly not inexhaustible and Scientists are entertaining serious fears of its extinction. Till very recent times, Ammonium sulphate was a by-product of the coal-gas industry and its price was rather very high and its future was not much brighter than that of Sodium Nitrate. These and other immediate causes led to the discovery of a method of harnessing atmospheric nitrogen and thus to put up the last link in the world's nitrogen cycle. The first marketable product of nitrogen fixation was calcium cyanamide. The manufacture of calcium cyanamide from atmospheric nitrogen was first patented in 1905 and is within easy reach of any country where electric power is cheap. In view of the great possibilities of its development in this country it was thought likely that calcium cyanamide should be capable of being made cheap and available to the ordinary ryot. It was therefore considered desirable to investigate its value as a fertiliser for the various crops of this presidency.

One of the earliest attempts to test the value of Calcium cyanamide as a fertiliser is reported in the *Journal of Agricultural Science*—Vol. I Part I (pp. 89—91). It was not an exhaustive investigation and resulted in no positive conclusions; but it certainly indicated the great possibilities of this new product. Since then, numerous investigations have been carried out and Calcium cyanamide is firmly established as a serious rival to the more costly Nitrate of Soda or Ammonium Sulphate. The experience of this country has, however, been slightly different. For the first time, it was tried in a number of farms in the year 1916-17 and is being tried even to-day.

By far the most exhaustively tried crop was paddy. At Samalkot, Mangayallur and at the Central Farm, the manure was tried either alone or in combination with green leaf. It was found not quite suitable for delta lands of the northern districts while at Mangayallur the manures had received better praise. In the words of the report, "In all cases where Cyanamide is compared with Ammonium Sulphate the yields are markedly in favour of Ammonium Sulphate." This does not state that cyanamide is not a useful source of nitrogen for paddy. It merely shows that per unit of Nitrogen it is not so good as Ammonium Sulphate. At the Central Farm, the results were again erratic; the smaller dose of 1 cwt being more effective, perhaps less toxic than the longer dose of 2 cwt. The manure has been tried with dry crops both at Koilpatti and at the Central Farm. The results are of the same nature. With tenai (*Setaria Italica*) alone, cyanamide gave significant increases, while Ragi did not fare well. It was effective in the case of a fodder crop. Cotton did not benefit by the application at all. The results of these trials may be summed up in the words of M.R. Ry. D. Balakrishnamurti Garu, as follows:—The results are thus favourable in some cases and unfavourable in others. In most cases, the results whether positive or negative cannot be said to be conclusive as the trials were made in single or duplicate plots.

The reasons assigned for the erratic behaviour of the manure have been of a varied kind—some attributing it to incomplete incorporation of the manure leading to high salt concentrations, others attributing it to the want of interval between its application and planting that is considered essential for the disappearance of certain toxic substances. But all are agreed that the differences are due to the visible set-back that planted seedlings experience in the initial stages of its life. This has created a strong prejudice against the manure and certain dogmas have crystallised themselves regarding the usefulness of calcium cyanamide.

(1) That a certain interval of time is necessary between the application of manures and sowing so as to allow for the disappearance of the toxic substances found by the decomposition of cyanamide.

(2) Under certain conditions, not well defined, the toxic substances persist in the soil permanently damaging the crop.

(3) Cyanamide is not therefore a safe manure.

These views are widely divergent from opinions held in the West and it was therefore thought advisable to investigate how far they are correct. As a first step, laboratory and pot experiments were conducted to find out whether calcium cyanamide gave rise to toxic substances in the soil and if so what its fate is, whether it persists for long in the soil or gets changed into other substances. The results of these experiments are described in detail in the Memoirs of the Department of Agriculture and I shall here briefly outline the conclusions. It was found that of the decomposition products of cyanamide, only dicyanodiamide has been proved to be indirectly toxic to plants and when this is tested for in soils treated with cyanamide, very little of it was found to exist—too little to be of any account. Further nitrification tests also showed that cyanamide nitrifies as smoothly and as well as Sulphate of Ammonia and should therefore be quite as safe a manure. In some of the field experiments examined in the previous paragraph, the higher dose of cyanamide, was found to be much less effective than the smaller dose of 1 cwt. and this was attributed to the nitrogen of the manure becoming too suddenly available for the plant to utilise them all properly. As a result a general tendency to run to leaf was observed without corresponding increases in grain yields. Laboratory experiments hardly justify these assumptions; in fact, if anything, cyanamide takes a longer time to nitrify in soil than ammonium sulphate and in this respect is nearer to organic manures than to Ammonium Sulphate in point of view of its availability.

Pot experiments were also largely in a line with the results of laboratory investigations. Calcium cyanamide was applied to a number of pots so as to give 100 mg. of Nitrogen per kilo of soil. Ragi plants were transplanted in the various pots after varying intervals—one day and one, two or three weeks after manuring. Similar experiments were conducted with paddy also. The results show that there was hardly any difference whether we allowed only a day's interval or three weeks' interval. In every case large increases were obtained over the control pots.

The next step was therefore to repeat some of the experiments already conducted on the various farms. To begin with, it was decided to confine our attention to the cereal crops leaving



out the economic crops like sugarcane and groundnut. Experiments were conducted with cholam at Hagari, with Ragi and Paddy at the Central Farm and with Cumbu at Koilpatti. The manure was tried in two doses of one and two cwt. and as the soils of the presidency were generally deficient in phosphoric acid a combination with super phosphate was also included in the series.

A few precautions dictated by the conditions under which toxic products were likely to be formed were insisted on. As has already been remarked, Dicyanodiamide is the only decomposition product that is toxic and the conditions most favourable to its formations from cyanamide are high temperatures or large concentrations of alkali or acid. Unlike Ammonium sulphate, calcium cyanamide contains a large percentage of free lime. This is certainly a definite advantage in the acid soils of the West; but in the soils of this country, it is likely to produce quite different results. Incomplete dispersal of the manure, but more than that its indifferent incorporation with the soil would produce numerous localities of high alkali concentrations. This is a circumstance which would convert the manure into the toxic and as well as inert dicyanodiamide. It was therefore made as one of the essentials, that the manure should be thoroughly incorporated in the soil. Top dressings were therefore avoided and the manure was always applied prior to sowing or transplanting and by suitable cultural operations intimately mixed with the soil. Further, it is well known that when cyanamide is mixed with super phosphate, a lot of heat is developed and this, as has already been remarked, will also induce the formation of the toxic substance. Mixing of the two manures was therefore avoided by applying the phosphate after transplanting as a top-dressing, but, when given as a basal dose, a certain interval between the two applications has been invariably insisted on.

It is not proposed, in this short paper, to discuss the crops individually. Some general features of the scheme may however be noted here. The experimental plots were specially laid out long and narrow with a view to bring down experimental error. About four to five replications were provided in each case.

The results are tabulated in Table I and are examined statistically. Error calculations are made according to Students'

method as modified by Engledow. A 30/1 chance is considered significant. The results of individual years are examined separately and together and statistical estimates of the variations caused by differing weather conditions as well as that due to substratum heterogeneity are obtained.

The most outstanding feature of the experiments of all the years is their consistency. Far from being erratic in its action, calcium cyanamide has been found to be quite a reliable manure. The experiments were originally intended to be carried on for five seasons; but that was considered superfluous as the general indications after 3 years were almost of the same kind. The conclusions of the experiment are detailed in page 370.

TABLE

## Statement of grain and straw yields

Names of crops.	Year.	Control.		1 N		2 N	
		Grain.	straw.	Grain.	straw	Grain.	straw.
Cumbu ...	1923-24	28.5	96.2	34.6	116.0	38.0	122.0
	1924-25	32.9	31.0	38.6	145.0	44.0	161.0
	1925-26	27.6	82.2	37.4	99.3	40.8	115.4
		29.7	03.1	36.9	120.1	40.9	132.8
Paddy ...	1923-24	136.2	90.3	...	...	162.2	122.3
	1924-25	143.8	99.4	...	...	155.4	148.5
	1925-26	133.9	180.8	...	...	167.6	285.0
		138.0	126.5	...	...	161.7	185.3
Paddy ...	1924-25	2793	2181	2561	2077	...	...
	1925-26	2331	3100	2712	3662	...	...
		2562	2640	2636	2866	...	...
Ragi ...	1922-23	121.7	172	128.5	197	146.4	238
	1924-25	86.9	175	98.3	220	113.2	258
	1925-26	64.8	273	72.8	347	76.2	382
		91.1	207	99.9	255	111.9	293

TABLE

STATEMENT OF  
Ragi.

	...	N	N P	2 N	2 N F
Increase over control	...	...	17.1	23.1	21.5
Increase per acre	...	...	308	416	392
Value of the increase	...	...	Rs. 15.4	20.8	19.6
Cost of manure applied	...	Rs. 7.5	11.75	15	19.25
Profit per acre	...	...	Rs. 3.65	5.8	0.35

Cost of cyanamide is Rs 150 per ton.—

The cereals are valued as under:—Paddy at 16 lb. per rupee.

## No. I.

of cyanamide experiments.

1. P	1 N	1 P	2 N	1 P	Probable error of mean difference.	Effective error.	
Grain. straw.	Grain. straw.	Grain. straw.	Grain. straw.	Grain. straw.			
27.0	96.8	32.8	116.4	40.6	140.2	0.8	...
32.4	137.0	44.8	176.0	53.2	194.0	1.8	...
28.2	81.6	37.4	97.7	48.0	126.0	0.3	...
29.2	105.1	38.6	130.0	47.2	153.4	...	3.1
125.2	83.9	...	...	171.0	130.5	5.4	...
143.5	105.8	...	...	175.3	151.0	7.1	...
140.8	234.0	...	...	167.8	297.0	5.4	...
136.5	174.6	...	...	171.4	192.8	...	9.7
2599	2233	3533	3105	3385	1924	137	...
2662	3762	3125	5650	3487	7650	187	..
2630	2997	3329	4377	3436	4787	347	...
131.9	182	138.2	193	1331	217	4.6	...
84.6	165	105.6	234	118.2	258.4	2.1	...
59.2	245	75.6	350	80.8	397	1.1	...
91.9	197	106.5	259	110.7	291	...	4.6

## II

PROFIT AND LOSS.

N	Paddy.			N	Combu.		
	N P	2 N	2 N P		N P	2 N	2 N P
...	...	...	...	24.0	29.0	37.3	58.3
...	563	...	668	144	174	224	350
...	35.2	...	43.0	9	10.9	14	21.9
...	11.75	...	19.25	7.5	11.75	15	19.25
...	21.2	...	21.5	2.5	0.85	1	2.75

Cost of superphosphate is Rs. 90 per ton.

Ragi at 20 lb. per rupee.—Cumbu at 16 lb. per rupee.

(1) In the case of dry crops, like cumbu, cyanamide is a useful manure. Even the smaller dose of 1 cwt. has given significant increases

(2) In the case of irrigated crops like ragi, the smaller dose is effective under certain conditions but does not however stand the vicissitudes of varying seasons.

(3) With the exception of paddy, the higher dose of 2 cwts. has been effective in all cases i. e., under normal variations of climate and soil.

(4) In the case of paddy, however, even the higher dose has failed to give an increase sufficiently significant.

(5) While superphosphate by itself has not given any increase, it has enhanced the value of calcium cyanamide, when applied together. Even the smaller dose becomes effective as in the case of ragi and paddy. This action of super phosphate calls for a comment. It is remarkably inert when applied alone and its activity when used along with nitrogen cannot therefore be attributed to a simple soil deficiency in phosphates. It improves the effect of the dose of nitrogen.

The economics of the manuring is found worked in Table II which is self explanatory. Except in the case of paddy, the profit obtained is nowhere attractive. Along with super phosphate, calcium cyanamide in either dose has given almost the same net profit of Rs. 20 to 25 and considering the advantage of a smaller outlay, the one cwt. dose may be recommended. In the case of cumbu, there is no point in advising the higher doses as proportionate increases are difficult to obtain. The smaller dose of one cwt. has given a net profit of Rs. 2½ but it should be remembered that this is the value of the net increase over a very rich "control" plot; and it would be fair to expect under normal circumstances a great profit; for being then under poorer auspices the effect of the manure would be more fully exerted. Further, a net profit of Rs. 3 is not negligible under circumstances where a six rupee increase is considered a fair margin.