

## MANURIAL EXPERIMENTS WITH RICE—PART III

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THESE experiments have already been described and preliminary reports have appeared in this Journal\*. The present paper reports further results and summarises all results to date. In addition general recommendations for the manuring of rice are made.

It was stated in Part I of this paper that it was intended to try other ammonium phosphates in a new series C. The results of this new series will be found in Tables I to IV. These are of considerable interest and will be discussed later. Tables V to XI summarise the results of all the trials to date.

The different series at the four stations have not all the same experimental value but even those which have been largely affected by soil heterogeneity and other causes are still of some use in indicating general manurial response. Undue importance must not be attached to the percentages figures in the Wariyapola trials. Owing to the very restricted water supply the yields of the control plots varied from 4 to  $6\frac{3}{4}$  bushels per acre. These are very low yields and a small increase in yield due to the manures implies a very large percentage increase. In spite of the poor water supply at Wariyapola the response to the manures was remarkable and the increases obtained from some of the treatments were sufficient to meet their cost. It is probable that here the effect of phosphoric acid in stimulating root development gave the plants receiving this plant food an advantage throughout the whole growing period.

The effect of smaller dressings of green manure was investigated at Peradeniya during the *maha* season of 1929-30. Five and one-ton dressings of green material brought in from outside were tested and the results will be seen in Table XII. The trial satisfies the requirements of the *z* test. Wild sunflower, *Tithonia diversifolia*, was used to supply the green material. The one-ton dressing has given a very satisfactory increase in yield of grain. The dressing five times as great has given an increase two-and-a-half times as great. The cost of cutting and transporting green material is frequently high and it is not thought that in most places dressings of more than one ton per acre will be possible.

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## DISCUSSION OF THE RESULTS

These manurial experiments have not yet been carried out for a sufficiently large number of years to allow more than general conclusions being drawn as to the results of most of the treatments tried. There is very definite evidence of the value of green manure at all stations except Labuduwa where the soil is naturally richer in organic material but even at Labuduwa when the limiting factor of phosphoric acid is added the application of green manure has been beneficial. The decomposition of the organic matter furnished by green materials, weeds and crop residues not only supplies plant food for the rice plant but also supplies carbon dioxide for the algae which are supposed to be so important in the supply of oxygen to swamp rice. Where crops occupy the land for the majority of the year (as in parts of the Central Province) or where natural weed growth is poor in quantity (as in dry districts and where fields are grazed bare by cattle) the application of at least some additional green material is important and in some places may be essential if the full benefit of applying artificial fertilisers is to be obtained.

The application of superphosphate and steamed bone meal, alone, has given economical results at all stations and it must be concluded that phosphoric acid is perhaps the most important plant food to be added to Ceylon paddy soils. It is estimated that the application of 1 cwt. of ordinary superphosphate or of 100 lb. steamed bone meal will give on average soils an increase of about 25% with a residual effect on the succeeding crop of about 12%. The addition of small dressings of sulphate of ammonia to these manures has had no effect. There is evidence, however, that with larger dressings of superphosphate additional nitrogen will be effective and it is thought that if superphosphate is applied alone for a number of years yields will fall off unless nitrogen is also given.

The addition of potash to nitrogen and phosphoric acid has had no effect and it may be concluded that applications of potash are not necessary on Ceylon paddy soils.

Apart from the effects of phosphoric acid alone, and of green manuring, the chief interest in these trials is the effect of the different ammonium phosphates. The value of this compound fertiliser has been masked at Anuradhapura owing to the high fertility of the fields. The control plots yielded at the rate of 2,568 lb. per acre which for unmanured land is a yield which compares favourably with yields in any part of the world. Some explanation of the quantities per acre of the fertilisers used in this series is necessary. Treatments 1, 2 and 4 at the time the experiment was started were based on equal costs. Prices have varied since then. Treatments 3 and 5 contained similar



**Table I**  
**LABUDUWA—MAHA 1929-30**  
*New Series C*

Treatment per acre	Yield per acre based on mean of 4 plots of 1/100 acre		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs. 2/- per bus.	Cost of manures F.O.R. Colombo
	lb.	Bus. of 48 lb.			
1. 104½ lb. Ammophos 16N/20 P <sub>2</sub> O <sub>5</sub> (16.72 lb. N + 20.9 lb. P <sub>2</sub> O <sub>5</sub> )	1512	31½	210.80	33 00	9 38
2. 96½ lb. Ammophos 11 N/45 P <sub>2</sub> O <sub>5</sub> (10.61 lb. N + 43.42 lb. P <sub>2</sub> O <sub>5</sub> )	1565	33	218.11	36 00	10 77
3. 80 lb. Leunaphos 20N/20 P <sub>2</sub> O <sub>5</sub> (16 lb. N + 16 lb. P <sub>2</sub> O <sub>5</sub> )	1242	26	173.17	22 00	7 74
4. 76 lb. Diammonphos 21N/53 P <sub>2</sub> O <sub>5</sub> (15.96 lb. N + 40.28 lb. P <sub>2</sub> O <sub>5</sub> )	1517	32	211.49	34 00	10 95
5. 80 lb. Sulph. of Ammonia (16 lb. N) 112 lb. Superphosphate (20.2 lb. P <sub>2</sub> O <sub>5</sub> )	1417	30	197.56	30 00	{ 5 00 3 75
6. Control: no Manure	717	15	100.09	—	

Standard error of the difference between means =  $\frac{10.53\%}{z}$

$$z = 1.1748$$

$$5\% \text{ point } z = .5326$$

**Table II**  
**LABUDUWA—NEW SERIES C. YALA 1930**

*Residual Effects*

Treatment per acre	Yield per acre based on mean of 4 plots of 1/100 ac.		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs. 2- per bus.
	lb.	Bus. of 48 lb.		
1. 104½ lb. Ammophos 16 N/20 P <sub>2</sub> O <sub>5</sub> (16·72 lb. N + 20·9 lb. P <sub>2</sub> O <sub>5</sub> )	1345	28	118·76	9 00
2. 96½ lb. Ammophos 11 N/45 P <sub>2</sub> O <sub>5</sub> (10·61 lb. N + 43·42 lb. P <sub>2</sub> O <sub>5</sub> )	1612	33½	142·38	20 00
3. 80 lb. Leunaphos 20 N/20 P <sub>2</sub> O <sub>5</sub> (16 lb. N + 16 lb. P <sub>2</sub> O <sub>5</sub> )	1237	25¾	109·27	4 50
4. 76 lb. Diammonphos 21 N/53 P <sub>2</sub> O <sub>5</sub> (15·96 lb. N + 40·28 lb. P <sub>2</sub> O <sub>5</sub> )	1437	30	126·93	13 00
5. 80 lb. Sulphate of Ammonia (16 lb. N) 112 lb. Super (20·2 lb. P <sub>2</sub> O <sub>5</sub> )	1327	27¾	117·22	8 50
6. Control : no manure	1132	23½	100 00	—

Standard error of the difference between means =  $\frac{15.94}{\sqrt{z}}$  %  
 $z = .0790$   
 5% point  $z = .5326$

**Table III**  
**ANURADHAPURA—MAHA 1929-30**  
*New Series C*

Treatment per acre	Yield per acre based on mean of 6 plots of 1/100 acre		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs. 2/- per bus.	Cost of manures F.O.R. Colombo
	lb.	Bus. of 48 lb.			
1. 104½ lb. Ammophos 16/20 (16.72 lb. N + 20.9 lb. P <sub>2</sub> O <sub>5</sub> )	2777	58	108.11	9 00	9 38
2. 96½ lb. Ammophos 11/45 (10.61 lb. N + 43.42 lb. P <sub>2</sub> O <sub>5</sub> )	2908	61	113.23	15 00	10 77
3. 80 lb. Leunaphos (16 lb. N + 16 lb. P <sub>2</sub> O <sub>5</sub> )	3005	63	117.01	19 00	7 74
4. 76 lb. Diammonphos (15.96 lb. N + 40.28 lb. P <sub>2</sub> O <sub>5</sub> )	3102	65	120.77	23 00	10 95
5. 80 lb. Sulphate of Ammonia (16 lb. N) 112 lb. Super (20.2 lb. P <sub>2</sub> O <sub>5</sub> )	2793	58 1/5	108.76	9 40	{ 5 00 3 75
6. Control : no manure	2568	53 1/2	100.00	—	—

Standard error of the difference between means =  $\frac{5.45\%}{z}$

$$z = 0.5370$$

$$5\% \text{ Point } z = 0.4783$$

*N.B*—Results of residual effects were spoiled due to floods.

Table IV  
**WARIYAPOLA—MAHA 1929-30**  
*Series C*

Treatment per acre	Yield per acre based on mean of 2 plots of 1/100 acre		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs 2/- per bus.	Cost of manures F.O.R. Colombo
	Lb.	Bus. of 48 lb			
1. 104½ lb. Ammophos 16/20 (16.72 lb. N + 20.9 lb. P <sub>2</sub> O <sub>5</sub> )	585	12	216.66	12 00	9 38
2. 96½ lb. Ammophos 11/45 (10.61 lb. N + 43.42 lb. P <sub>2</sub> O <sub>5</sub> )	510	11	194.44	10 00	10 77
3. 80 lb. Leunaphos (16 lb. N + 16 lb. P <sub>2</sub> O <sub>5</sub> )	510	11	194.44	10 00	7 74
4. 76 lb. Diammonphos (15.96 lb. N + 40.28 lb. P <sub>2</sub> O <sub>5</sub> )	500	10	185.18	8 00	10 95
5. 80 lb. Sulphate of Ammonia plus 112 lb. Superphosphate (16 lb. N + 20.2 lb. P <sub>2</sub> O <sub>5</sub> )	550	11½	203.70	11 00	{ 5 00 3 75
6. Control : no manure	270	6	100.00	—	—

Standard error of the difference between means =  $\frac{8.83\%}{z} = 1.3054$   
 5% point z = 0.8097

Table V  
**PERMANENT MANURIAL TRIALS**  
 Series A

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots									
	Labuduwa		Anuradhapura		Peradeniya		Wariyapola			
	1928-29	1929-30	1929	1930 (double dose)	1928-29	1929-30*	1928-29	1929-30	1928-29	1929-30
1. Control : no manure	100 00	100'00	100 00		100'00	100'00	100'00	100'00	100'00	100'00
2. $\frac{1}{2}$ cwt. Sulphate of Ammonia (11'2 lb. N)	97 35	68 38	106'27		109'66	95'69	109'66	95'69	109'66	192'86
3. As in 2 plus 1 cwt. Super (20'2 lb. $P_2O_5$ )	112'63	115'44	104'50		114'99	98'26	114'99	98'26	114'99	198'98
4. As in 3 plus $\frac{1}{2}$ cwt. Muriate of Potash† (28 lb. $K_2O$ )	111'92	118'62	111'73		114'84	102'74	114'84	102'74	114'84	164'29
5. 1 cwt. Super. (20'2 lb. $P_2O_5$ )	114'81	109'43	108'52		113'04	109'78	113'04	109'78	113'04	236'73
6. $\frac{1}{2}$ cwt. Sulphate of Ammonia plus 5 tons Green Manure‡	107'61	75'24	118'00		135'29	110'70	135'29	110'70	135'29	202'04

\* Results not reliable due to floods

† Muriate of Potash was replaced by Sulphate of Potash in 1929-30 and 1930

‡ 5 tons Green Manure were reduced to 1 ton in 1929-30 and 1930

Table VI  
**PERMANENT MANURIAL TRIALS**  
*Series A—Residual Effects*

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots					
	Labuduwa		Anuradhapura	Peradeniya		1930 <sup>o</sup>
	1929	1930		1929	1930	
1. Control : no manure	100.00	100.00	100.00	100.00	100.00	100.00
2. $\frac{1}{2}$ cwt. Sulphate of Ammonia (11.2 lb. N)	99.16	88.59	101.02	105.87	97.64	
3. As in 2 plus 1 cwt. Super. (20.2 lb. $P_2O_5$ )	107.01	108.89	106.60	124.58	97.98	
4. As in 3 plus $\frac{1}{2}$ cwt. Muriate of Potash† (28 lb. $K_2O$ )	83.34	110.71	98.98	146.65	108.94	
5. 1 cwt. Super (20.2 lb. $P_2O_5$ )	101.51	109.39	98.23	129.33	112.48	
6. $\frac{1}{2}$ cwt. Sulphate of Ammonia plus 5 tons Green Manure‡	101.96	82.53	106.33	143.02	97.81	

<sup>o</sup> Results not reliable due to floods

† Muriate of Potash was replaced by Sulphate of Potash in 1929-30 and 1930

‡ 5 tons Green Manure were reduced to 1 ton in 1929-30 and 1930

Table VII  
**PERMANENT MANURIAL TRIALS**  
*Series B*

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots							
	Labuduwa		Anuradhapura		Peradeniya		Wariyapola	
	1928-29	1929-30	1929	1930	1928-29	1929-30*	1928-29	1929-30
1. Control: no manure	100.00	100.00	100.00		100.00	100.00	100.00	100.00
2. 91 lb. Steamed bone meal (2.73 lb. N + 20 lb. P <sub>2</sub> O <sub>5</sub> )	171.99	131.89	108.96		104.65	103.81		280.28
3. As in 2 plus 42.35 lb. Sulphate of Ammonia (11.2 lb. N + 20 lb. P <sub>2</sub> O <sub>5</sub> )	160.81	125.28	104.32		—	—		291.55
4. As in 2 plus 5 tons green manure †	171.53	175.39	107.88		128.17	106.68		274.64
5. 1 cwt. Superphosphate (20.2 lb. P <sub>2</sub> O <sub>5</sub> )	169.91	149.65	117.46		—	—		242.25
6. As in 5 plus 5 tons green manure †	190.90	176.53	109.27		—	—		291.55

\* Results not reliable due to floods

† 5 tons green manure were altered to 1 ton in 1929-30 and 1930 — except at Anuradhapura

Table VIII  
**PERMANENT MANURIAL TRIALS**  
*Series B—Residual Effects*

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots					
	Labuduwa		Anuradhapura 1929-30	Peradeniya		80
	1929	1930		1929	1930*	
1. Control : no manure	100·00	100·00	100·00	100 00	100·00	
2. 91 lb. Steamed Bone meal (2·73 lb. N + 20 lb. P <sub>2</sub> O <sub>5</sub> )	115·33	115·04	108·12	118·72	106·07	
3. As in 2 plus 42·35 lb. Sulphate of Ammonia (11·2 lb. N + 20 lb. P <sub>2</sub> O <sub>5</sub> )	131·69	108·48	110·31	—	—	
4. As in 2 plus 5 tons green manure †	127·47	112·00	100·39	144·97	115·68	
5. 1 cwt. Superphosphate (20·2 lb. P <sub>2</sub> O <sub>5</sub> )	112·00	114·56	112·99	—	—	
6. As in 5 plus 5 tons Green Manure †	139·52	103·68	106·99	—	—	

\* Results not reliable due to floods

† 5 tons Green Manure were altered to one ton in 1929-30 and 1930—excepting at Anuradhapura

Table IX  
 PERMANENT MANURIAL TRIALS  
 Series C

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots			
	Labuduwa	A'pura	Peradeniya	
	1928-29	1929	1928-29	1929-30*
1. 93 lb. Ammophos (15 lb. N + 18.6 lb. P <sub>2</sub> O <sub>5</sub> )	169.40	108.81	125.44	85.87
2. 75 lb. Sulphate of Ammonia plus 104 lb. Superphosphate (15 lb. N + 18.6 lb. P <sub>2</sub> O <sub>5</sub> )	162.98	106.28	115.02	108.07
3. Control: no manure	100.00	100.00	100.00	100.00

\* Results not reliable due to floods.

Table X  
 PERMANENT MANURIAL TRIALS  
 Series C—Residual Effects

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots			
	Labuduwa	A'pura	Peradeniya	
	1929	1929-30	1929	1930*
1. 93 lb. Ammophos (15 lb. N + 18.6 lb. P <sub>2</sub> O <sub>5</sub> )	169.40	100.99	97.89	86.93
2. 75 lb. Sulphate of Ammonia plus 104 lb. Super (15 lb. N + 18.6 lb. P <sub>2</sub> O <sub>5</sub> )	143.17	98.89	104.22	83.33
3. Control: no manure	100.00	100.00	100.00	100.00

\* Results not reliable due to floods.

**Table XI**  
**PERMANENT MANURIAL TRIALS**  
*New Series C*

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots					
	Labuduwa		Anuradhapura		Wariyapola	
	Manured 1929-30	Residual 1930	Manured 1929-30	Residual 1930	Manured 1929-30	Residual 1929-30
1. 104½ lb. Ammophos 16 N/20 P <sub>2</sub> O <sub>5</sub> (16·72 lb. N + 20·9 lb. P <sub>2</sub> O <sub>5</sub> )	210·80	118·76	108·11		216·66	
2. 96½ lb. Ammophos 11 N/45 P <sub>2</sub> O <sub>5</sub> (10·61 lb. N + 43·42 lb. P <sub>2</sub> O <sub>5</sub> )	218·11	142·38	113·23		194·44	
3. 80 lb. Leunaphos 20 N/20 P <sub>2</sub> O <sub>5</sub> (16 lb. N + 16 lb. P <sub>2</sub> O <sub>5</sub> )	173·17	109·27	117·01		194·44	
4. 76 lb. Diammonphos 21 N/53 P <sub>2</sub> O <sub>5</sub> (15·96 lb. N + 40·28 lb. P <sub>2</sub> O <sub>5</sub> )	211·49	126·93	120·77		185·18	
5. 80 lb. Sulphate of Ammonia 16 lb. N 112 lb. Super (20·2 lb. P <sub>2</sub> O <sub>5</sub> )	197·56	117·22	108·76		203·70	
6. Control: no manure	100·00	100·00	100·00		100·00	

Trials were spoiled  
due to floods

Table XII

MAHA 1929-30

## Peradeniya Paddy Station—Green Manure Experiment—Grain weights

Treatment per acre	Replications (Yield in lb.)				Total	Yield per acre		C=100%	Value of increased yield over control at Rs. 2-00 per bus.
	a	b	c	d		Lb.	Bus. of 48 lb.		
1. One ton Green Manure	15.7	16.0	25.1	22.2	79.0	1975	41½	140.82	Rs. cts. 24 00
2. Five tons Green Manure	23.5	22.5	36.4	26.9	109.3	2732	57	194.83	55 50
3. Control	15.3	7.9	21.6	11.3	56.1	1402	29½	100.00	—
Block Total	54.5	46.4	83.1	60.4	244.4				

Standard error of the difference between means =  $8.94\%$  $z = 1.6491$ 5% point  $z = 0.8188$