MANURING OF PADDY IN LOWER BURMA.*

ON the 9½ million acres of swamp paddy land in Lower Burma where almost the whole of the Burma rice of commerce is produced, the paddy crop has hitherto been grown practically without manure. There is an impression abroad that this land receives an annual coating of river silt which enriches the soil and maintains its fertility. But, so far as the main paddy is concerned, this is not so; and the land which does receive this coating of silt, with the exception of some parts of the lower Delta, is generally in such a precarious position, liable to severe damage by floods, that paddy growing there is a very speculative business and may be left out of consideration in the present paper entirely. The main part of the paddy area receives no annual coating of silt, but is on such a level that, while by means of small field embankments it can hold enough rain water to mature a crop with a growing period of 150 to 200 days, it is high enough to be comparatively safe from the flood waters of the Burma rivers during the monsoon.

The comparatively high prices ruling for paddy since the war have encouraged the extension of cultivation into the low-lying and more precarious tracts which do receive silt, and it is chiefly owing to this fact that so much has been heard in the past few years of the increasing damage done by floods to the paddy crop; for these low-lying areas on the margin of cultivation, and more or less recently brought under the plough, have suffered most.

PERMANENT LEVEL OF FERTILITY REACHED.

The system followed, of continuous annual cropping with paddy, is exhausting when practically nothing in the way of manure is returned to the soil; but most of the land has already lost its virgin fertility and has been reduced to a level of productiveness which now appears to be fairly constant, a level at which the plant food removed by the annual rice crop is made good by the natural breakdown of the soil. The only reliable statistics available do not show that there has been any progressive decline in fertility within recent times; and this is supported by settlement and other reports going back farther than 1913-14, from which year comparable records of acreage yields are available. Taking the Hanthawaddy district settlement reports as an example, the reports from 1872 to 1910 show that, in the areas dealt with, there has been no decline in fertility during this time. The actual figures given show yields per acre well above the average now accepted for the country as a whole, and we are probably safe therefore in assuming that under the present system of cultivation a general average yield of about 1,500 lb. per acre, apart from annual fluctuations, may be expected to continue in Lower Burma for some considerable time.

Under the circumstances, this yield may be considered fairly good and compares not unfavourably with that of some other tropical rice-growing countries. The following table compiled from figures extracted from the International Year Book of Agricultural Statistics shows the relation between the principal rice-growing countries in 1926. The figures must be regarded as a rough indication only, since methods of recording yields vary in different

* By David Hendry, M.C., B.Sc., N.D.A., Deputy Director of Agriculture, Southern Circle, Burma, in *The Agricultural Journal of India*, Vol. XXIII, Part V, September 1928.

countries, and China, one of the largest rice-growing countries, records no figures at all. Thus, as an example, the acreage yield in India as a whole is based on the sown area, while that for Burma is on the matured area only.

Principal rice-growing countries.

Country	Acreage of rice	Yield per acre
		lb.
India	79,134,000	1,281
China	...	...
Indo-China	12,795,000	1,041
Java	8,356,000	1,378
Japan	7,738,000	2,875
Siam	7,157,000	1,680
Philippines	4,252,000	1,014
Korea	3,885,000	1,565
French Guinea	2,038,000	890
Formosa	1,400,000	1,761
Madagascar	1,372,000	960
Brazil	1,323,000	1,130
U.S. America	1,014,000	2,252
Ceylon	829,000	676
British Malaya	664,000	1,006
*Soviet Russia	583,000	1,050
Sierra Leone	400,000	1,503
Italy	365,000	4,062
Egypt	191,200	2,847
Senegal	123,300	890
Spain	121,000	5,800
Mexico	118,400	1,360

* Pre-War—1909-1913.

The yields in Spain, Italy and Japan are outstanding, and have been so for many years, due to the intensive methods adopted there; but it is worth while noting that until 1916 the yield in America was approximately the same as for Burma, and the higher figure now shown is a comparatively recent achievement. This increased yield has been brought about principally by the more extended use of fertilisers; and, although a similar increase could be brought about in Burma by the same means, this could not in the past be done at a profit for reasons which will be adduced later.

NEED FOR MANURING.

The need for manuring of paddy land in Lower Burma has been one of the subjects under investigation at the Hmawbi Experimental Station for a number of years, and among other experiments a series of plots treated with different manures was laid down in 1913 designed to ascertain what manurial constituents were deficient in these soils and to what manurial treatment they would probably respond best. This experiment was continued for ten years, the individual plots being manured as shown below for five consecutive years, and the controls left untreated. Manuring was then discontinued and all plots were observed for a further period of five years to record the residual effect of the different manures employed. The results have been published in the annual reports of the Hmawbi Station, but I have condensed them here into a single table which is given below.

No. (a)	Treatment (per acre) (b)	Five years' manure. Per cent increase over average of controls (c)	Five years' residual effect. Per cent increase over average of controls (d)
1	Cattle manure at 30 lb. nitrogen	+37·5	+21·8
2	Cattle manure at 50 lb. nitrogen	+52·3	+34·5
3	Cattle manure at 70 lb. nitrogen	+68·7	+37·8
4	Cotton cake at 50 lb. nitrogen	+54·8	+29·2
5	Cattle manure at 30 lb. nitrogen, superphosphate at 30 lb. P_2O_5 sulphate of potash at 30 lb. K_2O.	+53·0	+54·0
6	Cattle manure at 30 lb. nitrogen, superphosphate at 20 lb. P_2O_5.	+43·5	+27·6
7	Cattle manure at 30 lb. nitrogen, bone-meal at 20 lb. P_2O_5.	+51·0	+31·8
8	Bone-meal at 20 lb. P_2O_5.	+26·5	+ 9·5
9	Superphosphate at 20 lb. P_2O^5.	+35·3	+15·3
10	Sulphate of potash at 20 lb. K_2O.	+ 5·0	+ 6·6
11	Sodium nitrate at 30 lb. nitrogen	+17·0	+35·5
12	Sodium nitrate at 30 lb. nitrogen (Applied as to dressing).	+ 5·0	+25·0
13	Nitrolim at 30 lb. nitrogen	+11·0	+64·2
14	Ammonium sulphate at 30 lb. nitrogen	+32·5	+25·5
15	Lime at 2,000 lb.	+24·0	+ 1·9
16	Ammonium sulphate at 30 lb. nitrogen, superphosphate at 20 lb. P_2O_5, sulphate of potash at 20 lb. K_2O.	+33·5	+17·5

Among other information provided by this table, the most important facts are the indications given that the chief requirements of paddy on these soils are nitrogen in the form of ammonia and phosphate; that potash is not shown to be a definite limiting factor; and that nitrogen in the form of nitrate is distinctly harmful. The deficiency in nitrogen and phosphate shown is confirmed by the chemical analyses of these which are also published in the station reports, and subsequent experiments have borne out the correctness of the conclusions drawn. The Lower Burma soils differ from the Upper Burma soils in being distinctly acid, and respond to dressings of lime although in no very great degree; and experiments with lime have shown that while it is beneficial to the soil and increases the crop, the cost renders its use uneconomic.

INDIGENOUS MANURES AVAILABLE.

The more or less readily obtainable indigenous manures able to supply the deficiencies indicated include cattle dung, bats' guano, fish waste, bone-meal, rice bran, cotton cake, green manure crops, etc., but the quantities of each are quite inadequate for the purpose of bringing about any marked increase in fertility. Cattle dung is by far the most important and the quality and amount of this available for paddy land may well be considered first.

In the system of cultivation followed, one pair of bullocks is able to work from 8 to 12 acres, and, as there is practically no land other than paddy land worked by bullocks, an average of one pair of bullocks to every 10 acres is a reasonable figure to assume for the ratio of livestock to cultivated area. Cattle are only bred locally to a negligible extent owing to the unsuitable swampy conditions, and nearly all the working bullocks are imported from the dry zone of Upper Burma. This being so, the cultivator seldom keeps more bullocks than are strictly necessary to cultivate his land, and he has no young stock to augment his supply of cattle dung. Other cattle there are kept on the uplands by Indian cow-keepers for milk purposes, but these contribute practically no manure to the paddy land. The ratio of one pair of bullocks to 10 acres of land is borne out by the figures of livestock and the cultivated area for the two great paddy-growing divisions in Lower Burma. The Pegu and Irawaddy divisions comprise between them 7,342,174 acres of cultivated land including gardens, which constitute only about six per cent. of the whole; the livestock, comprising bulls, bullocks, cows and young stock, and including all classes of buffaloes, amounts to 1,490,134 animals, or 745,067 pairs, which is near enough 1 : 10 for our purpose.

The amount of dung which a single bullock will contribute to the manure pit in the course of a year, according to records kept at the Hmawbi Station, is about three tons, or approximately six tons per pair. If carefully conserved, this amount would be available each year for 10 acres of paddy land; but under village conditions the need for careful conservation is not appreciated, and the wastage is so great that not more than half this quantity ultimately finds its way to the land. In fact so little is the value of cattle dung appreciated in some of the more fertile tracts that I have seen a cultivator throw it into a near-by creek to avoid the trouble of storing and carting it on to his land.

The more ordinary way of using the available cattle manure is to collect what has been loosely stored in the open for the past year and spread it on the nurseries which constitute a tenth of the holding; the main area is not manured at all. The manure so applied, in addition to being deficient in quantity, is lacking in quality; concentrates are only fed to the cattle on a small scale, and when the manure has been stored in the open through part of the rains it is very poor stuff indeed, as analyses show.

There is a good deal of scope for improvement in the methods of conserving and applying this best of all manures, and efforts towards bringing this about are being made by the Agricultural Department; but, even when the best has been done, the fact remains that there is not enough cattle manure to go round, and a dressing which at best averages about three tons for 10 acres can hardly be considered sufficient to maintain the fertility of the land, far less to improve it.

Of the other manures such as bats' guano, fish waste, bone-meal, rice bran, cotton cake, etc., these are either strictly limited in quantity like the first three, or fetch higher prices for other uses outside general agriculture than they are worth as manure. Even the purely manurial substances like bats' guano and fish guano sell for much higher prices to gardeners and concerns growing valuable money crops than a crop of low money value per acre like paddy can afford to pay. The use of these expensive manures on paddy although it increases the outturn per acre considerably results in a heavy monetary loss, as experiments at the Hmawbi Station clearly show. Bone-meal is on the border line and just manages to pay its way.

The growing of green manure crops constitutes a well-recognised method of maintaining and improving soil fertility, but on the old paddy land these cannot be grown with any reasonable prospect of success. When the rains finish in early November, the soil dries up very quickly and assumes a cement-like hardness in which no green crops will grow; even seeds broadcasted among the ripening paddy crop fail to establish themselves. Most of the known green manure crops and the different methods of growing them have been tried under these conditions, but have failed. The hard condition of the ground associated with the long rainless spell from November till May renders growth difficult, but on some of the retentive soils of the middle zone to the north of the main paddy area I have seen a green crop of sunn hemp grow very well indeed.

These are the main sources of indigenous manure. Night soil is not included, for the people of the country will not touch it; and the attainment of a high standard of permanent and increasing fertility by this means, similar to that existing in China and Japan and described in King's *Farmers of Forty Centuries*, appears to be outside the bounds of possibility.

Synthetic farm-yard manure appeared an attractive proposition for Burma, but it is expensive to make, and experiments with it at Hmawbi since 1923 have been disappointing so far as profits are concerned. The prospect of its use has not been abandoned, however, and experiments with this form of manure are being continued.

ARTIFICIAL FERTILISERS.

This brings us to the use of imported fertilisers to augment the scanty supplies of indigenous organic manures, and the reasons why these have not been more strongly advocated for paddy in the past.

To supply the important constituents of ammoniacal nitrogen and phosphoric acid, the manures available hitherto have been sulphate of ammonia and superphosphate, and these have proved entirely suitable for the swampy conditions under which paddy is grown. But it has already been mentioned that a crop of low money value per acre like paddy cannot give an economic return for expensive manures. As I shall show later, imported sulphate of ammonia and superphosphate are cheaper than the indigenous manures already dealt with, and the question of whether it was economic or not to use these manures has depended upon the relative prices of the manure and the paddy, both of which have fluctuated considerably in the past.

The prices of sulphate of ammonia and superphosphate at Rangoon before the war, and at the present time, are as follows:

Year	Sulphate of ammonia per ton	Superphosphate (18-20) per ton
	Rs.	Rs.
1914	240	75
1919	488	150
1928	170	75

For ten years before the war, the threshing floor price of paddy in the districts close to Rangoon fluctuated from Rs. 96 per 100 baskets (approximately 5,000 lb.) to Rs. 152 per 100 baskets. The price in 1914 was Rs. 125, and the average for the ten years' period prior to the war was Rs. 124. Since 1920 the price has fluctuated between Rs. 145 and Rs. 196 with an average of Rs. 176. In the present year the threshing floor price was Rs. 170, but, contrary to custom, has fallen since to Rs. 160 at the beginning of the rains.

Taking the general average crop as 1,500 lb., or 30 baskets per acre, an application of 1 cwt. of sulphate of ammonia plus 1 cwt. of superphosphate per acre can be expected to increase the crop by approximately 30 per cent. The actual increase to be expected varies with soil and other conditions, but that this figure is not an over-estimate will be shown by the results of a recent experiment to be quoted later.

Taking the situation as it was in 1914, let us see what the monetary results of such an application to such a crop would have been.

Adding Rs. 10 per ton to the cost of sulphate of ammonia and to that of superphosphate to get the manure from Rangoon on to the cultivator's holding, 1 cwt. of the former would cost Rs. 12-8 and of the latter Rs. 4-4, a total of Rs. 16-12. A thirty basket crop at Rs. 125 per hundred baskets would be worth Rs. 37-8. An increase of 30 per cent. on this would be Rs. 11-4; and the difference between Rs. 16-12, the cost of the manure, and Rs. 11-4, the resulting increase in the crop, would be a loss of Rs. 5-8 per acre.

In 1928 the corresponding figure would be: cost of manure Rs. 13-4; value of crop Rs. 51; value of 30 per cent. increase, Rs. 15-5; result, gain of Rs. 2-1 per acre.

These figures are shown more concisely in the following form :—

	Paddy price per 100 baskets	Value of crop of 30 baskets per acre	Value of 30 per cent. increase	Cost of manure per acre	Difference
	Rs.	Rs.	Rs.	Rs.	Rs.
1914	125	37·5	11·25	16·75	Loss 5·50
1928	170	51·0	15·30	13·25	Gain 2·05

NEW ARTIFICIAL FERTILISERS.

This shows clearly the change which has been brought about since before the war, partly by the drop in the price of artificial manures and partly by the rise in the price of paddy. But a circumstance has arisen which is of greater importance. This is the advent of the new manures combining ammoniacal nitrogen and phosphate in one, produced at a cheap rate by methods evolved as a result of the work done on high explosives during the war. Two of these are available now in India and one of them has been tried over the past three years on paddy land at Hmawbi and in the surrounding districts. With another now under trial, calculating the cost per acre on exactly the same basis as in the previous table, the cost of the same quantities of nitrogen and phosphate to produce the same effect would be Rs. 11-2 instead of Rs. 13-4, and the price of paddy would have to fall below Rs. 1·24 per hundred baskets before the balance of profit and loss was tipped in the wrong direction. These new manures also possess the added advantage of being single chemical compounds which require no mixing; and, owing to their concentration, the transportation charges are cut in half.

EXPERIMENTAL RESULTS.

The first of these new manures to come to hand for trial in 1924 was Ammo-Phos which was obtained from New York in two grades, 20-20, and 13-48. This gave promising results, and an experiment was put down last year to determine the optimum dressing per acre. The quantities used were 50, 100, 200, and 300 lb. per acre, and the plots for each were laid out in a continuous series, each treatment being replicated six times. The size of each individual plot was approximately 1/41 of an acre. The response to the manure was remarkable, and, although the season was a good one and the appearance of the plots during the growing season bore out the final weighing results the uercentage increases of from 47·7 per cent. to 118·6 per cent. are higher than can be normally expected. Taking the cost per ton of Ammo-Phos plus freight at Rs. 230 for the 20-20 grade, and Rs. 255 for the 13-48 grade, paddy at Rs. 170 per 5,000 lb. and allowing nothing at all for the increased straw which has no value in Burma, the results of the experiments with the 20-20 grade and 13-48 respectively were as follows :—

Ammo-Phos. 20/20 grade. Fields Nos. 75 and 76. Size of plots—0·024 acre. Variety of paddy—C19-26. Replicated six times: 32 plots.

No.	Nature of treatment per acre 1	Yield per acre		Increase per acre		Value of increase per acre 6	Cost of treatment per acre 7	Profit per acre due to manure 8	Per cent. increase in grain per acre 9
		Grain 2	Straw 3	Grain 4	Straw 5				
		lb.	lb.	lb.	lb.	Rs. A.	Rs. A.	Rs. A.	
1	Control	1,250	3,292	—	—	—	—	—	—
2	50 lb.	1,846	4,158	596	866	20 4	5 2	15 2	47·7
3	100 lb.	2,096	5,267	846	1,975	28 12	10 4	18 8	67·7
4	200 lb.	2,542	6,504	1,292	3,212	43 15	20 8	23 7	103·4
5	300 lb.	2,733	7,250	1,483	3.958	50 7	30 12	19 11	118·6

Standard error................................ 4·6 per cent.

Ammo-Phos. 13/48 grade. Fields Nos. 51 and 52. Size of plots—0·024 per acre. Variety of paddy—C19-26. Replicated six times: 32 plots.

No.	Nature of treatment per acre 1	Yield per acre		Increase per acre		Value of increase per acre 6	Cost of treatment per acre 7	Profit per acre due to manure 8	Per cent increase in grain. per acre 9
		Grain 2	Straw 3	Grain 4	Straw 5				
		lb.	lb.	lb.	lb.	Rs. A.	Rs. A.	Rs. A.	
1	Control	1,533	3,846	—	—	—	—	—	—
2	50 lb.	1,971	4,358	438	512	14 14	5 11	9 3	28·6
3	100 lb.	2,017	5,200	484	1,356	16 7	11 6	5 1	31·9
4	200 lb.	2,575	6,071	1,042	2,225	35 8	22 12	12 12	67·9
5	300 lb.	2,650	5,659	1,117	1,813	38 0	34 2	3 14	72·9

Standard error................................3·7 per cent.

These are exceedingly promising results and raise several points of interest which there is no space to discuss here; but one thing is made clear, and that is that profitable manuring of paddy with artificial fertilisers available in quantity is now within the scope of possibility. After discounting the admittedly high increases, which are nevertheless given as they are weighed out, it must be remembered that the profits shown are for one year only, and previous experiments at Hmawbi have shown that the effect of this manure lasts for two years, the increase in the second year being from one-third to two-thirds those in the year of application. The second year, or residual effect of the 13-48 grade is higher than that of the 20-20 grade, which is to be expected from the higher phosphate content of the former; but the quick returns obtained with the 20-20 grade in the first year are all important where money for expenditure on manures of this sort may have to be borrowed at excessively high rates of interest. Incidentally, interest charges have not been included in the above tables, but the profits shown allow for a fair addition of this kind.

In both cases the optimum rate of application is 200 lb. so far as profit per acre is concerned, but the outlay involved in such a dressing is hardly likely to commend itself to such landowners and cultivators who may be induced to take up these manures for some time to come. Application of 50 and 100 lb. are quite satisfactory, however, and these should be good enough to begin with. The time of application is important. The best time is when the fields have been more or less drained off before transplanting; applied later when the fields are full of water the manure is wasted.

NITROGEN-PHOSPHORIC ACID RATIO.

Before leaving these two grades of manure, I am tempted to quote another Hmawbi experiment showing the optimum ratio of nitrogen to phosphoric acid for the paddy soils being dealt with. The experiment was a pot experiment and the results obtained indicate that the best ratio lies somewhere between 1 : 1 and 1 : 3 of N : P_2O_5 with a strong assumption that it is about 1 : 2.

Optimum nitrogen-P_2O_5 ratio. Variety of paddy C15-10. Replicated ten times : 60 plots.

No.	Treatment N: P_2O_5 ratio	Tillering	Outturn			Grain straw weight ratio	Remarks
			Grain	Chaff	Straw		
1	2	3	4	5	6	7	8
			gm.	gm.	gm.		
1	Control	8·6	29-58	0-98	45-47	1:1·54	
2	1: ½	10·0	25-23	1-31	55-50	1:2:20	Standard error 1·6 or 5·3 per cent.
3	1:1	9·5	30-17	1-00	52-10	1:1·69	
4	1:2	8·6	34-68	0-45	50-93	1:1·47	
5	1:3	8·7	32-69	0-63	56-87	1:1·73	
6	1:4	9·2	28-53	0:75	58-98	1:2·07	

These figures, though fairly regular and indicative of whereabout the ratio lies, are not accepted as final, and the experiment is being repeated this year on a field scale. Another experiment on a field scale showing the ineffectiveness of potash when added to nitrogen and phosphate manures on these soils might be quoted, but the full experiment will be found in the printed report of the Hmawbi Station, and it will suffice here to say that at present this manure does not pay its way.

COMPARATIVE COSTS OF COMMON MANURES.

While on the subject of these manures and their relative costs, it is of interest to note the unit values of those which have been referred to in this paper, and, taking present prices, I have tabulated these below. With the exception of the slow acting bone-meal it will be seen that indigenous manures are dearer per manurial unit than the new artificial fertilisers. Of course, organic manures have an additional value of their own, but here they are limited in quantity, and any increase in demand is followed by sharp rises in price as has been noticed in the case of bats' guano.

No.	MANURE	Place	Price per ton Rs.	Analyses			Unit values in Rs.		
				N	P_2O_5	K O	N	P_2O_5	K_2O
1	Ammonium sulphate	Rangoon	170	20·6	...	...	8·25	...	...
2	Superphosphate 18—20	do	75	...	19	...	...	4	...
3	Sulphate of potash	do	205	...	...	50	...	...	4·1
4	Ammo-Phos 20—20	do	220	16·48	20	...	8·42	4·08	...
5	Ammo-Phos 13—48	do	245	10·70	48	...	7·21	3·50	...
6	Bats' guano	Kyaukse	55	5·03	1·86	0·83	8·67	4·20	4·31
7	Bone-meal	Rangoon	85	2·04	32·78	...	4·82	2·34	...
8	Fish manure	do	150	7·71	2·95	0·65	15·8	7.7	7·88
9	Cotton seed meal	do	82·5	5·90	2·70	1·45	10·40	5·10	5·3
10	Cotton seed cake	do	88·4	6·71	2·34	1·33	10·2	4·95	5·15
11	Diommonphos 20—53	do	307	20·60	52·50	...	6·66	3·23	...
12	Leunaphos 20—20	do	213·6	20·20	20·30	...	7·10	3·45	...

The cheapest manure of suitable composition in this list is No. 12. There have been alterations in the prices of these new manures recently, but there appears to be reasonable prospect of their settling at lower level later. Import duty of 15 per cent. *ad valorem* has recently been imposed on these ammonium phosphates, but this is not likely to continue and has not been taken into consideration above. Other manures such as urea and cyanamide, etc. have not been mentioned here although experiments have also been carried out with them. Unit for unit, however, they are not so effective as the fertilisers dealt with, and more extended experiments have not been included in the annual programmes.

CONCLUSION.

This then is the situation we have arrived at. The cultivation of rice in Burma on the present enormous scale is of comparativelly recent origin; from 1866 until the present year the paddy area has grown from 1,760,271 to 11,826,700 acres; and in this time the original virgin fertility of the soil has been largely exhausted. To maintain the standard of fertility at its present level, the indigenous manures are barely sufficient, and to increase it they are quite inadequate. To achieve the desirable end of increasing the production per acre, there are several lines of approach; improved implements and cultivation can do a little, and the use of improved and higher yielding strains of paddy can also do a little; but the total improvement which can be attained by these means is small, and a really significant increase can only be brought about by better feeding of the crop.

Before the war and for some time after, the relation between the price of paddy and the price of the artificial fertilisers which were suitable for this purpose was such that manuring of this sort could not be undertaken at a profit. Since the war, the position has changed: the price of paddy has risen and the cost of the old manures has fallen to its previous level. Furthermore, a new class of manures has become available, peculiarly adapted to the needs of Lower Burma soils, and considerably cheaper than the sulphate of ammonia and superphosphate which have been the standard manures in the past. The consequence is that artificial manuring has now become a paying proposition for paddy, as it has been for more valuable crops in the past, and the Agricultural Department is now for the first time in a position to recommend these manures to the cultivators, with the assurance that under suitable conditions a reasonably good profit will result. It is most decidedly not intended that these manures should displace cattle manure which is still the best of all, but that they should be used to supplement what little supplies of this are available under the rather abnormal system of agriculture which obtains in Lower Burma. Thirty-six district trials were carried out with Ammo-Phos in the Southern Circle last year, and although the conditions for carrying out experiments in the district are not such as to yield data comparable in accuracy with that obtainable in a fully equipped Experiment Station, the results showed that the response to the manure was sufficient to justify the belief that the Hmawbi experience is likely to be repeated further afield. About one hundred field demonstrations are therefore being put down on cultivators' holdings this year, and, as experience accumulates, this work will be extended.

The question may be asked whether the Burmese cultivator will take to these new manures; I think he will. The process will be a slow one, but there are indications that a beginning will not be difficult to make. Bone-meal and rice bran are beginning to be bought for manurial purposes even now, and I know of one village which bought twenty tons of bone-meal last year for its paddy land. These last-mentioned substances are slow acting and return a very meagre profit, so that, when new and more profitable manures are put at his disposal, the cultivator is likely to respond. It is even just possible that experience of such manures may have an indirect effect of creating a keener appreciation of the manurial substances already at his hand. The chief difficulties lie in his chronic indebtedness and the excessive rates of interest he has to pay for any money he may have to borrow for additional expenditure, and one can only hope that the Co-operative Department may be able to do something to lighten this difficulty. Still, there is a sufficient number of land-owners with means to make a beginning, and when a conservative country like China with its traditional methods of maintaining soil fertility doubled its already considerable consumption of sulphate of ammonia between 1925 and 1926, mainly for paddy as I am informed, there appears to be no reason to doubt that some progress can be made here too.