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To our Readers and the Members of the Madras Agricultural Department

The welcome that was accorded to our January number and the ıany kind messages of appreciation sent us by our readers were most ;ratifying to us. We take it as a confirmation of our opinion that here is a real need for a journal of this kind.

Frankly, we feel that the journal is not yet what it should be, and hat it can be made more useful by way of providing more information ıf practical interest to South Indian Agriculture. Long articles are ıot always necessary; the shorter, the better. There is plenty of outlet :lsewhere in the country for articles of a technical nature. We are, ıowever, prepared to devote a few pages for articles of a scientific ıature. But we would like to see a major number of pages of the ournal filled with short articles and brief notes embodying the results ›f observations and experience which are of interest to the practical ıgriculturist.

We would also like news of interest to our officers in the listricts so that they may be in touch with what is going on in the lifferent circles. We should like to see the correspondence pages more fully utilized and controversial points freely discussed. For instance, we expect a flood of correspondence for or against Mr. Hilson's views on reduction of area under paddy.

Notes on the needs of ryots in different localities, the shandies, cost of production, special farming methods, local organization and methods of marketing, and agricultural festivals, are always welcome. We cannot think of a more competent agency to do this than our demonstrators who are our eyes and ears.

Farming will never be a success unless the farmer had more voice in the disposal of his produce.—P. Morrel.

The Madras Agricultural Journal

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(ORGAN OF THE M. A. S. UNION)

Vol. XIX] APRIL 1931 [No. 4

THE RELATION BETWEEN GROWTH AND INTAKE OF NUTRIENTS IN THE CHOLAM PLANT*

By C. NARASIMHA ACHARYA

Assistant Lecturer in Chemistry, Agricultural College, Coimbatore.

This paper reports the results of a Study of the variation in chemical composition of the Cholam plant, at successive stages of growth, as shown by periodical analysis of representative samples taken from a field crop of Periamanjal Cholam. The analysis included the determination of Nitrogen, Phosphoric Acid, Potash, Calcium, Magnesium, Silica, Iron, Alumina, Total Mineral Ash, Carbohydrates and Diastatic Activity.

An examination of the changes occurring in the Chemical composition of the Cholam plant, is of use to us.—Firstly, to understand the mineral metabolism and the Biochemical changes taking place during growth; Secondly, to fix the nutritive value of the plant, which is used widely as fodder, with special reference to the mineral requirements of cattle, the importance of which has been much emphasized upon in recent nutrition researches; Thirdly, it would suggest the best stage at which to cut the crop, either for fodder or for grain; Fourthly, it gives the average composition of the Cholam grain, which is largely used as food by the people of this Presidency; and Lastly, it affords information to the agriculturist, as to how much of the mineral nutrients has been removed by the crop and has to be returned to the soil to keep up its fertility; in other words, it indicates the mineral requirements of the plant.

*(Paper read before the College Day Conference, Coimbatore, July 1929)

MATERIALS AND METHODS

The Cholam Crop (Periamanjal) grown in Field No. 37 of the Agricultural College Estate (a Red Loam Soil) was selected for the experiment. It was sown on August 4, 1928. Representative samples of plants which had grown to the same extent, were chosen from different parts of the Field, once a fortnight, till the end of December, by which time the grain had completely matured and the plants also were getting dry. The samples were all collected at about 7 A.M. on the various days, taken immediately to the Laboratory, where the plants were carefully cleaned of adhering impurities and divided into the various parts, e.g., Leaves, stem, root, grain, etc. A weighed amount of each was taken for moisture determination and the rest was dried and bottled up for future determinations of the Chemical composition.

The analytical methods followed were, in main, those recommended by the A.O.A.C. In the estimation of *Iron, Ca* and *Mg*, the Phosphoric acid was removed as Ammonium Phospho-molybdate, a procedure which was found to give essentially the same results, though more convenient in manipulation than the more commonly adopted basic *ferric acetate* method. Diastatic activity was determined by reacting 1 gm. sample of the dry powder with 20 cc. of 2 per cent Soluble Starch Solution for 24 hours at the laboratory temperature (28° to 30° C), clarifying the solution with alumina cream, making up to 50 c.c and determining the reducing power of an aliquot by *Bertrand's Volumetric Permanganate* method. The results are expressed in milligrams of maltose produced. Phosphoric acid was determined by titrating Ammonium Phospho-molybdate with standard alkali. In the determination of Total Nitrogen, *Gunning's modification of Kjeldahl's* method was adopted.

The data obtained are contained in the annexed Tables Nos. I to V and, for the sake of clearness, have been expressed :—

(1) As percentages of the dry matter in each part—Leaves, Stem, Root etc.

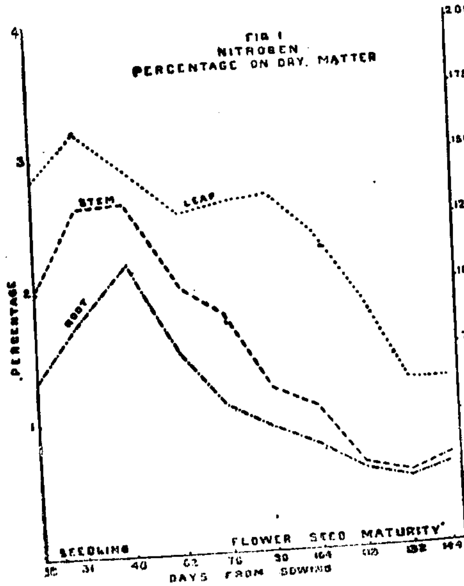
(2) As absolute weights of the constituents per hundred plants, in each part separately, and also in the plant as a whole. The latter enables us to follow the total absorption of the nutrients from the soil by the plant at successive stages of growth.

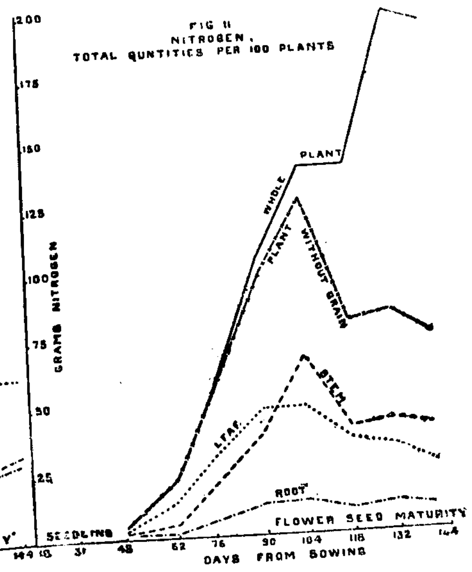
The data are represented also graphically in Graphs Nos. I to VIII.

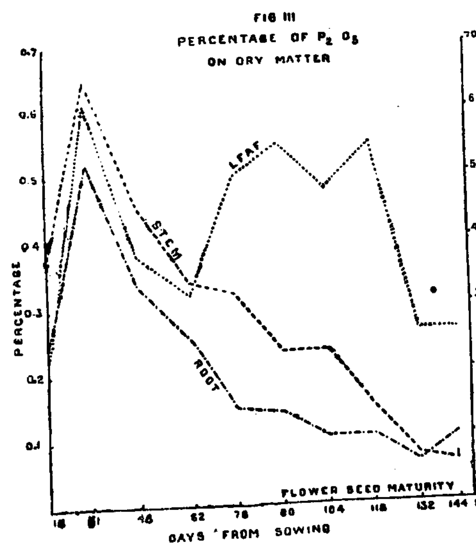
NITROGEN

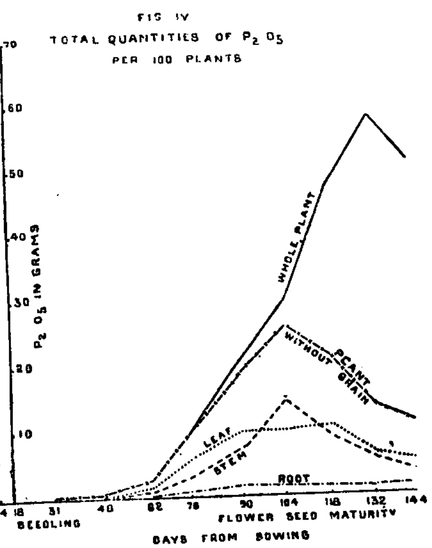
Nitrogen is an important constituent of Cholam Fodder, having regard to the Protein it constitutes, and as such, the variations in Nitrogen content during growth are of special interest.

The changes in the values for Total Nitrogen, expressed as percentages on the dry matter, are represented graphically in Fig. I. From the curves, it will be noted :—(1) that the leaves contain always a higher percentage of Nitrogen than the stem, and the latter, generally more in turn, than the root, and (2) that the proportion of Nitrogen in the dry matter, is highest in the early stages. For example, in the case of the leaves, it is









3·193 per cent, in the stem 2·658 per cent. and in the root 2·192 per cent. The proportion is kept at a fairly high level till the flowering stage. When flower buds appear, there is a sudden fall, due to the translocation of the accumulated nitrogen into the grain.

The values for the total quantity of Nitrogen absorbed and retained by the plant, show a steady rise in the various parts (Leaves, Stem and Root) till the stage of flowering, after which there is a rapid decline. Taking 100 plants as a convenient unit, there are, at the 'seed formation' stage, 49·56 gm. of Nitrogen in the leaves, 67·88 gm. in the stem and 11·30 gm. in the root, i.e., 128·8 gm. in the vegetative parts of 100 plants. After the seeds have become ripe, however, nearly about 60 per cent. of the Nitrogen is transferred into the grain, so that the grains contain more Nitrogen than the rest of the plant put together, even though the grains weigh only about half as much as the rest of the plant. As such, from the point of view of Fodder, the plant cut at the flowering stage, is much richer in Nitrogen than that allowed to ripen its seed.

The continued ability of the plant to absorb and store Nitrogen till the 'Seed' stage, would seem to indicate that the more Nitrogen that is applied as fertilizer to a plant prior to the stage of flowering (within limits, of course), the more will be the absorption and store of Nitrogen in the Tissues, which would be later available for the making of the grain. Hoagland (1) has found that the concentration of Nitrogen in the tissues and tissue-fluids varies directly, though not proportionally with the concentration in the external nutrient medium ; but the problem is complicated by other growth factors, depending on the individual peculiarities of each plant, as shown by Gericke in his interesting experiments on the effect of application of Nitrogen at different periods in the life of the wheat plant. He found (2) that very early applications, say, at or prior to sowing, merely tend to increase vegetative growth, whereas later applications (of course, before flowering), increase the protein content and hardness of wheat.

By a closer study of the Nitrogen Metabolism of the Cholam Plant, it might be possible for the Farmer so to regulate the quantity and time of application of Nitrogenous fertilizers to his crop, as to control the protein content of the grain, on which depend important factors like quality, fitness for Malting purposes etc.

PHOSPHORIC ACID

The requirements of the plant for Phosphoric Acid are much smaller and steadier than for Nitrogen. It can be said in general, that the changes in Phosphorus follow those in Nitrogen.

Expressing the figures in terms of percentages of dry matter, we note that the curves show two maxima—one at the seedling stage, corresponding to a period of rapid root-development, and the other at the stage of grain-formation, showing the demand for Phosphorus at the two stage. As in the case of Nitrogen, the leaves usually contain more phosphorus than the stem, and the latter more so than the root. Taking the absolute quantities of Phosphorus present in the tissues, there is a progressive increase upto the seed formation stage, after which there is a decline, due to the transfer of a portion of the phosphorus to the grain. Thus the Phosphorus content of 100 plants (excluding grain), reaches a maximum value of 26·03 gm. at the seed formation stage, after which there is a fall to 10·86 gm. corresponding to the dead ripe stage, when the leaves and stem get dry.

From the point of view of use as Fodder, the crop cut at the flowering stage contains almost double the quantity of Phosphorus contained in the crop cut after the grains have become fully ripe.

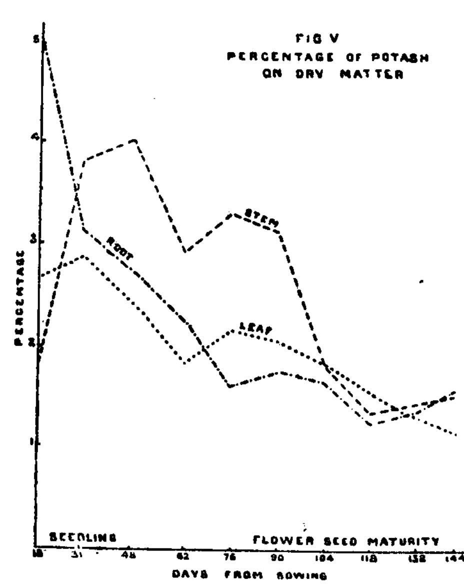
In the case of Phosphorus, the plant does not appear to have the capacity to store it in the tissues, as it does Nitrogen. In the case of Nitrogen, out of about 200 gm. present per 100 plants, (including grain) at the stage of maturity, about 75 per cent. was already present in the plant at the stage of seed-formation, and only 25 per cent. was thereafter absorbed from the soil. This storage capacity in the case of Nitrogen is physiologically valuable, since, in the normal soil, there is only a small and steady supply of Nitrogen available in the form of Nitrate at any moment ; and even this supply is apt to be leached away, if not immediately absorbed by the plant and stored for future requirements.

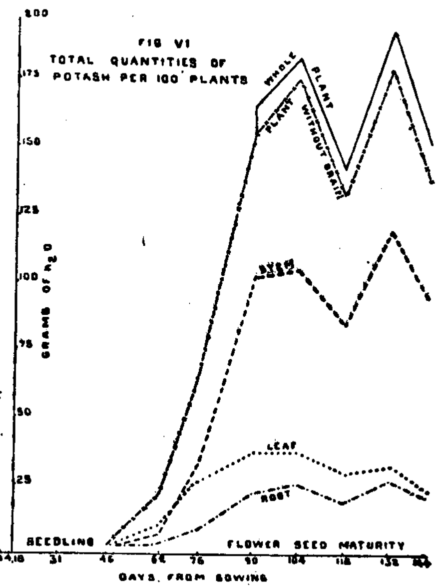
In the case of Phosphorus, out of about 58 gm. present per 100 plants at the stage of maturity, only about 21 gm. were present at the stage of flowering. After the grains are formed, however, there is a rapid absorption of phosphorus from the soil, to meet the physiological requirements of the plant, as shown by the rapid rise in the curve during the later stages of the plant's life ; as much as 37 gm. are translocated to the grain within a period of about a month, of which only about 7 or 8 gm. have come from the previous store in the tissues and about 30 gm. have been freshly absorbed from the soil.

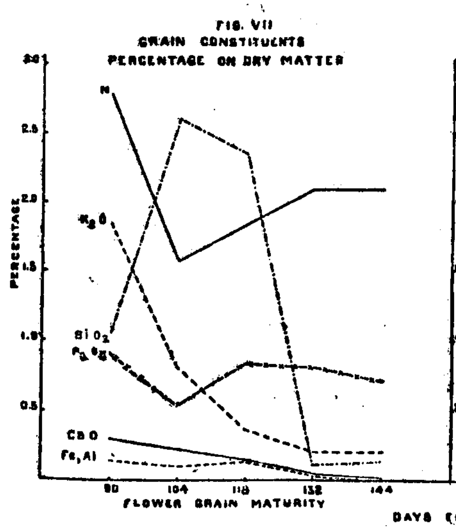
POTASH

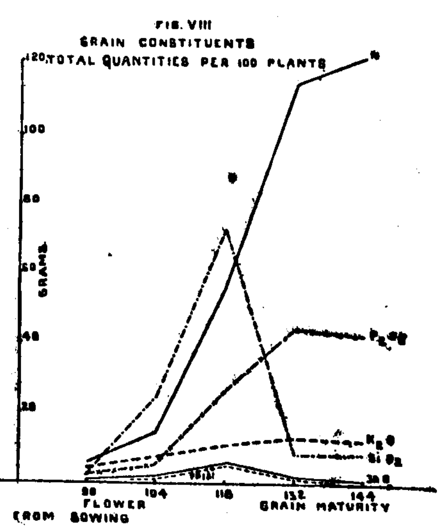
The demand for Potash, as in the case of Nitrogen and Phosphoric acid, seems to be particularly great in the early stages, for in the seedling stage, the percentage of Potash on the dry matter is highest (Leaf : 2·886 per cent, Stem 4·040 per cent and Root 5·178 per cent). The saying ' Potash goes to make carbohydrates ' seems to hold good in a general way, for Potash accumulates chiefly in the stem and root, where there is also an accumulation of carbohydrates. There is however an essential difference between Potash Metabolism and that of Nitrogen or Phosphoric Acid, namely that, whereas in the latter two cases, all the extra Nitrogen or Phosphoric acid stored up in the vegetative tissues, is carried later on to the grain, the Potash is mostly left behind in the tissues and only small quantities are taken up by the grain. In the present experiment, out of about 180 gm. of Potash in 100 plants weighing about 12,000 gm. (dry matter without grain), only about 13 gm. are transferred into the grain, weighing about 6,000 gm. This seeming anomalous behaviour of Potash might serve to explain why increasing yields of grain are generally obtained by applications of Phosphoric acid and Nitrogen, while, Potash above a minimum value has no such effect. The absorption and accumulation of Potash in the stem continues so long as Carbohydrates are manufactured and stored. The fact that the Potash so accumulated, is left behind in the tissues,

NUTRIENTS IN CHOLAM









while a large amount of the carbohydrates is transferred to the grain, would seem to indicate that Potash is more necessary in the manufacture of the Carbohydrates than in their translocation from one part of the plant to another.

CALCIUM

Calcium shows a somewhat different variation, inasmuch as there is a continuous accumulation of this element in the leaf, from 0·644 per cent in the early stages to 1·190 per cent in the later stages. Such accumulation is not noted in the case of the stem or root.

The accumulation of Calcium in the Leaves, in the later stages might be closely connected with the translocation of Nitrogenous products to the grain. Parker and Truog (4) advanced the hypothesis that Calcium helps in the synthesis of Protein from the Carbohydrate and Nitrogen, by neutralizing the acids that are formed as by products of such synthesis. But the present experiments show that the main accumulation of Calcium takes place after most of the Nitrogen required has been absorbed and the results seem to indicate that Calcium plays an important part in the translocation of Protein and other Nitrogenous products from the tissues to the grain. In this connection may be cited the interesting results obtained by Gericke (3) who found that the Protein content of wheat grown for 10 weeks in a complete nutrient solution and later transferred to a solution devoid of Calcium, was only half the Protein content of the grain obtained from the normal plant.

DEVELOPMENT OF THE CHOLAM GRAIN

Analysis of the Cholam flower, grain and Bhusa at various stages of development of the plant was also made, with special reference to the mineral constituents and Diastatic activity. The data are set out in Table No. IV and also graphically in Figs. Nos. VII and VIII.

The data show that the course of development of the Cholam grain, can be divided roughly into two periods of almost equal extent. The first period is one of building the cell-walls and tissue-fabric of the grain, for which a large amount of mineral matter, principally Silica and Calcium seem required. There is a simultaneous accumulation of nearly the whole of the Nitrogen and Phosphoric acid required by the grain. After the first stage of building the cell-fabric of the grain is over, certain of the auxiliary elements, which obviously find no further place in the economy of the grain, e.g., Silica, Calcium, Iron, Alumina, etc., are rapidly ejected from the grain, leaving only small quantities of them behind. These excrements find their way into the Bhusa, leaves and other tissues of the plant. In the second period, there is a rapid accumulation of carbohydrates. Potash and Magnesia show a steady increase throughout.

The chemical changes in the development of the grain follow in miniature that of the plant itself; the flower corresponds to the seedling stage, inasmuch as it is rich in the various nutrient elements (Nitrogen 2·768 per cent, Phosphoric acid 0·904 per cent, Potash 1·85 per cent, CaO 0·306 per cent). The curves representing the percentage of the elements on the dry matter show generally a fall from the flowering stage to the earlier stages of grain formation, followed by a gradual recovery. The Bhusa is very poor in Nitrogen (0·657 per cent on dry matter) as compared with the flower (2·768 per cent) and grain (2·11 per cent).

The variations in the content of Silica during the development of the grain are very marked. Thus the flowers contained 1·032 per cent on dry matter, whereas in the initial stages of grain-development, the proportion rose up to 2·702 per cent. In the second half-period of development, however, there was a rapid fall to 0·140 per cent. This decrease is not due to the accumulation of other constituents but is absolute, as shown by the total quantities of Silica present in the seed at different stages. Expressed in grams per 100 plants, the flowers contained 2·23 gm., the seed in the earlier stages 25·43 gm. and 70·31 gm. and in the later stages 7·64 gm. and 8·32 gm. It is interesting to note that the Bhusa in the later stages contains nearly 70·15 gm. of Silica per 100 plants, showing that the excess of Silica has been returned from the grain to the Bhusa. Obviously, Silica plays an important part in the early stages of development of the grain, either in helping the transportation of organic Phosphorus compounds into the grain or in the building up of the cell fabric. Like *CaO* and *Iron*, once its function is fulfilled, it is expelled from the grain into the Bhusa, which becomes rich in this element and contains as much as 7·872 per cent of it on the dry matter.

In the case of Iron and Alumina, and also Calcium, there is a similar rapid intake in the first-half period of the development of the grain, and a rapid fall in the Second period, not merely in the relative percentages on dry matter, but in the absolute quantities as well, in the grain of 100 plants. The causes underlying this characteristic fluctuation in Silica, *CaO*, Iron and Alumina require a more detailed examination of the matter, before definite conclusions can be arrived at.

LOSS OF NUTRIENTS BY THE PLANT

It is interesting to note that after the grains become fully ripe, there appears to be set up a backward flow of nutrients from the plant to the soil. Thus it is found that at the stage of maturity, there are present per 100 plants, 1466·4 gm. of mineral matter but a fortnight later, at the 'dead' or 'over-ripe' stage when the leaves and stem get dry, the content of mineral matter falls to 1147·8 gm.—the fall being chiefly due to Potash from 193·7 gm. to 152·7 gm. Calcium from 86·3 gm. to 66·6 gm., Magnesium from 87·5 gm. to 69·5 gm. Iron and Alumina from 75·5 gm. to 45·2 gm. and acid insoluble matter taken as Silica from 906·7 gm. to 702·4 gm.

Though in the above interval, there is a slight increase in the content of Nitrogen, Phosphorus and other constituents in the grain, still, considering the above great loss of nutrients to the extent of about 20 per cent from the plant to the soil, it would seem economically better to cut the crop at the ripe stage and not to allow it to become 'dead' or 'Over-ripe': such practice would help to preserve the nutritive value of the fodder.

The above results, showing a loss of nutrients from the plant to the soil after the stage of maturity, is supported by the experiments of Burd (5) and Sekera (6) working on Barley and Jones and Huston (7) working on

Maize. All of them note a period of rapid absorption by the plant just prior to the beginning of head formation, followed by a long period of slow absorption, and finally a period of absolute loss from the plant.

Wilfarth, Romer and Wimmer (8) found that wheat and barley plants contained very considerably less Potash and Nitrogen at maturity than previously. They were of opinion that these elements after assisting in the performance of the physiological processes within the plant, return again to the soil through the roots.

It is interesting to note that the Soil Solution studies conducted by the Government Agricultural Chemist, Coimbatore, (unpublished record) with reference to cotton, also indicate a backward flow of nutrients from the plant to the soil after the stage of maturity.

APPLICATION OF FERTILIZERS

The importance of choosing the time of application of fertilizers to coincide with the stage of maximum physiological capacity for asssimilation on the part of the plant, has been much stressed upon in recent researches in regard to other crops. Thus, Steece (9) in his Report on the Agricultural Experimental Stations of the U. S. A. for 1927, notes that at the Alabama Experimental Station, Nitrate of Soda, applied at the rate of 600 lbs. per acre for cotton, 14, 40 and 61 days after planting, was absorbed in 36, 14 and 11 days respectively. He finds a close correlation between the rates of growth and of Nitrate-absorption and observes :—'The results suggested that the loss of soluble Nitrogenous fertilizer, might be reduced by delaying the application until the crop is able to absorb it rapidly.'

In the case of Cholam, it will be premature to draw conclusions from one experiment and that not intended to examine the effect of application of manures at different periods of the plant's life, but the curves for the assimilation of Nitrogen and Phosphorus would tend to show that the demand for the nutrient elements is great at two stages—first, at the seedling stage, and secondly, prior to flowering. Though the intensity factor is great at the seedling stage, the total assimilation capacity is small, and hence in the case of fertilizers like Nitrates, which are apt to be leached away, it would seem advisable to apply only a small portion at the time of sowing, and reserve the bulk of the fertilizer for a somewhat later application, but not so late as to affect flowering and seeding.

CONCLUSIONS

From the foregoing, it would therefore appear that :—

(1) The Cholam plant has got the capacity to absorb large quantities of Nitrogen in the early stages, and after meeting the requirements of vegetative production, store the remainder for translocation to the Seed.

(2) There is an accumulation of Nutrients in the plant till the stage of flowering: the rate of absorption increases at first with growth, and is most rapid during the period just prior to flowering; after flowering, the rate slows down—the main business of the plant being the translocation of the absorbed Nutrients to the Seed.

(3) The Tissues are richest in plant Nutrients at the flowering stage or immediately following it. The present practice of cutting the fodder

crop at the above stage, is generally explained as due to the fear of the occurrence of cyanogen compounds in the earlier stages, but the present experiment shows that the practice is a sound one from the economic as well as the nutritional points of view.

(4) The varying capacity of the plant for assimilation of Nutrients, at different stages, would seem to indicate the advisability of regulating the application of manures in regard to time and quantity, to coincide with the periods of maximum capacity for absorption on the part of the plant; thus, nitrogenous manures in the form of nitrates, might, with a view to secure maximum growth and economy, be applied partly at the time of sowing as a basal dressing, and in much larger quantities at a later stage, prior to flowering.

(5) The data show that after the grains become ripe, there appears to be set up a backward flow of nutrients from the plant to the soil; and it is suggested that in order to preserve the nutritive value of the fodder, the crop be cut before becoming over-ripe.

(6) Taking an average crop of Cholam in these parts to yield about 1,000 lbs. of grain and 2,000 lbs. of (dry) straw per acre, the mineral nutrients removed by the crop, which have to be returned to the soil in the form of fertilizers, in order to keep up its fertility, are per acre, roughly as follows:— Nitrogen 35 lbs., Phosphoric acid 10 lbs., and Potash 32 lbs.

In conclusion, I wish to thank Mr. H. Shiva Rao and Rao Bahadur B. Viswa Nath for their kind interest in the experiment and for helpful criticism.

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TABLE I.—SHOWING THE VARIATION IN COMPOSITION OF THE DRY MATTER OF THE *LEAVES* OF PERIAMANJAL CHOLAM AT SUCCESSIVE STAGES OF GROWTH.—DATE OF SOWING AUGUST 4, 1928

No. of sample ...	I	II	III	IV	V	VI	VII	VIII	IX	X
Date of sampling ...	22-8-28	4-9-28	19-9-28	5-10-28	19-10-28	2-11-28	16-11-28	30-11-28	14-12-28	26-12-28
No. of days from sowing... ...	18	31	46	62	76	90	104	118	132	144
Stage of growth ...	Rapid Vegetative growth.					Flowers	Seed forms	...	Grains ripe	Over-ripe
Weight of dry matter in leaves of 100 plants, in grams ...	3·33	16·86	66·0	558	1150	1800	2080	1920	2592	2080
Constituents expressed as percentages on dry matter										
I. Total Nitrogen ...	2·836	3·193	2·904	2·575	2·658	2·685	2·383	1·891	1·260	1·260
II. P_2O_5	0·2192	0·6081	0·3827	0 3203	0·4989	0·5480	0·4820	0·5438	0·2593	0·2576
III. K_2O	2·703	2·886	2·368	1·829	2·151	2·045	1·822	1·547	1·286	1·158
IV. CaO	0·6442	1·066	0·9630	0·8722	0·6774	0·8420	0·9738	1·019	1·190	1·116
V. MgO	0·3239	0·6176	0·6320	0·5703	0·6063	0·6787	0·6210	0·6548	0·5954	0·5902
VI. SiO_2	2·461	6·127	5·533	5·381	5·538	7·403	9·625	12·55	14·58	14·03
VII. $Fe_2O_3 + Al_2O_3$ ...	0·7032	0·4161	0·3386	0·3363	1·303	0·4068	0·5170	1·352	0 9074	0·3623
VIII. Total Mineral Ash ...	12·81	13·38	11·54	10 51	10·85	13·38	14·64	18·40	19 38	18·21
IX. Diastatic Activity per gm. dry matter in Mg. Maltose ...	...	...	...	816·4	1450	850	823 0	606·7	204·2	79·20
Total weight of constituents present in the dry matter of 100 plants, in grams										
I. Total Nitrogen ...	0 095	0 538	1·916	14·36	30·56	48·33	49 56	36·31	32·66	26·21
II. P_2O_5	0 007	0 102	0·253	1·786	5·737	9·865	10·02	10·44	6·720	5·358
III K_2O	0·090	0·487	1 563	10·21	24·74	36·81	37·90	29·70	33·34	24 08
IV. CaO	0·022	0·180	0·635	4·866	3·895	15·16	20·26	39·10	30·84	23·21
V. MgO	0·011	0·104	0·417	3·182	6·972	12·22	12·92	12 57	15·43	12·27
VI. SiO_2	0·082	1·033	3·651	30·02	63·68	133 2	200·2	240·9	377·9	291·8
VII. $Fe_2O_3 + Al_2O_3$ ...	0·023	0·070	0·224	1·876	14·98	7·323	10·76	25·95	23·52	7·537
VIII Total Mineral Ash ...	0·427	2·256	7·615	58·64	124·8	240·8	304·6	353·3	502·3	378·7

TABLE II.—SHOWING THE VARIATION IN COMPOSITION OF THE DRY MATTER OF THE *STEM* OF PERIAMANJAL CHOLAM AT SUCCESSIVE STAGES OF GROWTH—DATE OF SOWING 4-8-1928

	No. of sample ...	I	II	III	IV	V	VI	VII	VIII	IX	X
	Date of sampling ...	22-8-28	4-9-28	19-9-28	5-10-28	19-10-28	2-11-28	16-11-28	30-11-28	14-12-28	26-12-28
	No. of days from sowing.	18	31	46	62	76	90	104	118	132	144
	Stage of growth ..	...	...	Rapid vegetative growth.			Flowers	Seed forms	—	Grains ripe	Over-ripe
	Wt. of dry matter in Stem of 100 plants, in grams.	1·26	4·20	19·92	248	1,040	3,290	6,350	6,263	8,060	6,300
	Constituents expressed as percentages on dry matter										
I.	Total Nitrogen ...	2·028	2·644	2·653	2·028	1·808	1·233	1·069	0·6302	0·5480	0·6575
II.	P_2O_5	0·3853	0·6524	0·4551	0·3395	0·3184	0·2293	0·2291	0·1462	0·0718	0·0605
III.	K_2O	1·819	3·806	4·040	2·940	3·296	3·118	1·801	1·352	1·486	1·495
IV.	CaO	2·122	1·309	1·059	0·926	1·014	0·679	0·632	0·533	0·528	0·538
V.	MgO	0·849	0·847	0·946	1·164	1·468	0·864	0·665	0·606	0·539	0·481
VI.	SiO_2	10·35	3·912	3·987	3·011	2·782	2·930	3·050	2·739	4·331	4·091
VII.	$Fe_2O_3 + Al_2O_3$ ...	1·797	0·248	0·224	0·263	0·358	0·261	0·287	0·228	0·320	0·287
VIII.	Total Mineral Ash ...	14·50	14·41	13·08	10·14	10·62	9·324	7·523	6·116	7·690	7·454
IX.	Diastatic Activity per gm. dry matter in Mg. Maltose.	...	...	...	822·4	540·0	722·8	730·8	140·7	138·3	22·9
	Total weight of constituents present in the stems of 100 plants, in grams										
I.	Nitrogen (Total) ...	0·026	0·111	0·529	5·03	18·80	40·56	67·88	39·47	44·17	41·42
II.	P_2O_5	0·005	0·027	0·091	0·842	3·311	7·560	7·274	9·158	5·790	3·808
III.	K_2O	0·023	0·160	0·805	7·291	34·28	102·6	114·4	84·67	119·8	94·19
IV.	CaO	0·027	0·055	0·211	2·295	10·54	22·32	40·10	33·36	42·52	33·86
V.	MgO	0·011	0·036	0·183	2·887	15·27	28·44	42·20	37·96	43·43	30·27
VI.	SiO_2	0·130	0·161	0·794	7·467	28·93	96·40	193·7	171·6	353·1	257·7
VII.	$Fe_2O_3 + Al_2O_3$ ...	0·023	0·010	0·045	0·665	3·727	8·570	18·21	14·30	25·81	18·09
VIII.	Total Mineral Ash ...	0·183	0·605	2·605	25·15	110·4	306·8	477·8	383·0	619·7	469·6

TABLE III—SHOWING THE VARIATION IN COMPOSITION OF THE DRY MATTER OF THE *ROOT* OF PERIAMANJAL CHOLAM AT SUCCESSIVE STAGES OF GROWTH—DATE OF SOWING 4-8-1928

	No. of sample ...	I	II	III	IV	V	VI	VII	VIII	IX	X
	Date of sampling ...	22-8-28	4-9-28	19-9-28	5-10-28	19-10-28	2-11-28	16-11-28	30-11-28	14-12-28	26-12-28
	No. of days from sowing.	18	31	46	62	76	90	104	118	132	144
	Stage of growth ...	...	...	Rapid vegetative growth.			Flowers	Seed forms	...	Grains ripe	Over-ripe
	Wt. of dry matter in Root of 100 plants, in grams.	0·96	5·88	37·60	184·0	560	1250	1480	1458	2040	1500
	Constituents expressed as percentages on dry matter										
I.	Total Nitrogen ...	1·343	1·767	2·192	1·507	1·096	0·9040	0·7672	0·6029	0·5480	0·6028
II.	P_2O_5	0·2384	0·5216	0·3347	0·2515	0·1459	0·1381	0·0985	0·1048	0·0605	0·1131
III.	K_2O	5·178	3·138	2·736	2·259	1·591	1·754	1·653	1·254	1·353	1·546
IV.	CaO	0·806	0·888	0·763	0·841	0·725	0·541	0·602	0·571	0·532	0·502
V.	MgO	0·609	0·618	0·434	0·596	0·692	0·538	0·467	0·450	0·420	0·390
VI.	SiO_2	12·58	9·374	15·170	16·70	13·21	7·628	10·28	9·723	8·237	9·642
VII.	$Fe_2O_3 + Al_2O_3$ ...	1·771	1·488	2·861	2·545	2·429	2·023	1·740	1·387	1·199	1·190
VIII.	Total Mineral Ash ...	20·66	18·60	23·55	24·58	18·47	12·75	15·19	14·37	12·02	12·61
IX.	Diastatic Activity per gm. dry matter in Mg. Maltose ...	...	...	...	1888	1108	1191	482	74·1	159·4	41·4
	Total weight of constituents present in the roots of 100 plants, in grams										
I.	Total Nitrogen ...	0·013	0·104	0·824	2·773	6·139	11·30	11·36	8·790	11·18	9·04
II.	P_2O_5	0·002	0·031	0·126	0·463	0·817	1·726	1·457	1·528	1·233	1·696
III.	K_2O	0·050	0·185	1·029	4·157	8·910	21·93	24·46	18·28	27·60	23·19
IV.	CaO	0·008	0·052	0·287	1·547	4·061	6·756	8·910	8·322	10·85	7·532
V.	MgO	0·006	0·036	0·163	1·097	3·875	6·719	6·920	6·563	8·563	5·842
VI.	SiO_2	0·121	0·551	0·571	30·73	73·98	95·37	152·1	141·8	168·1	144·6
VII.	$Fe_2O_3 + Al_2O_3$ ...	0·017	0·088	0·108	4·682	13·60	25·28	25·74	20·23	24·46	17·84
VIII.	Total Mineral Ash ...	0·198	1·093	8·855	45·23	103·4	159·3	224·8	209·5	245·2	189·1

TABLE IV SHOWING THE VARIATION IN COMPOSITION OF THE GRAIN OF *Andropogon Sorghum* AT DIFFERENT STAGES OF GROWTH

DATE OF SOWING 4-8-28

	No. of sample ...	I	II	III	IV	V	VI
	Date of sampling ...	2-11-28	16-11-28	30-11-28	14-12-28	26-12-28	26-12-28
...	Part analysed ...	Flowers	Grain	Grain	Grain	Grain	Bhusa
	Weight of dry matter of the part in 100 plants in grams.	216	941·2	3,100	5,460	5,770	890

Constituents expressed as percentages on dry matter

I.	Total Nitrogen ...	2·768	1·562	1·835	2·110	2·110	0·6575
II.	P_2O_5	0·9038	0·5195	0·8090	0·7920	0·8167	0·1038
III.	K_2O	1·850	0·7941	0·3513	0·2369	0·1954	0·6135
IV.	CaO	0·3064	0·2481	0·1501	0·0380	0 0341	0·3574
V.	MgO	0·5460	0·3410	0·3553	0·3678	0·3655	0·2393
VI.	SiO_2	1·032	2·702	2·268	0·1398	0·1441	7·872
VII.	$Fe_2O_3 + Al_2O_3$ ...	0·1332	0·0955	0·1618	0·0319	0 0301	0·0715
VIII.	Total Mineral Ash ...	5·909	5·151	4·562	1·816	1·911	9·766
IX.	Diastatic Activity per gm. dry matter in Mg. Maltose.	...	522·8	482·8	138·5	35·90	...

Total wt. of constituents present in the grain of 100 plants in grams

I.	Total Nitrogen ...	5·980	14·70	56·90	115·2	121·8	5·86
II.	P_2O_5	1·953	4·889	25·08	43·24	47·15	0·925
III.	K_2O	3·997	7·473	10·89	12·93	11·28	5·468
VI.	CaO	0·6619	2·335	4·654	2·075	1·969	3·185
V.	MgO	1·180	3·209	11·02	20·08	21·10	2·132
VI.	SiO_2	2·229	25·43	70·31	7·635	8·320	70·15
VII.	$Fe_2O_3 + Al_2O_3$ ...	0·2877	0·8986	5·016	1·742	1·738	0·637
VIII.	Total Mineral Ash ...	12·77	48·48	141·5	99·15	110·4	87·12

TABLE V SHOWING THE TOTAL WEIGHTS OF CONSTITUENTS PRESENT PER 100 PLANTS, *Andropogon sorghum*, AT SUCCESSIVE STAGES OF GROWTH: DATE OF SOWING AUGUST 4, 1928. ALL WEIGHTS IN GRAMS

	No. of sample ...	I	II	III	IV	V	VI	VII	VIII	IX	X
	Date of sampling ...	22-8-28	4-9-28	19-9-28	5-10-28	19-10-28	2-11-28	16-11-28	30-11-28	14-12-28	26-12-28
	No. of days from sowing ...	18	31	46	62	76	90	104	118	132	144
	Stage of growth ...	Rapid vegetative growth.					Flowers	Seed forms	...	Mature	Over-ripe
	Total weight of constituents in vegetative parts of 100 plants (Plants without grain)										
	Weight of dry matter in vegetative parts of 100 plants, in grams ...	5·6	26·94	123·5	990	2750	6340	9910	9641	12,692	9,880
I.	Total Nitrogen ...	0·133	0·753	3·269	22·16	55·50	100·19	128·79	84 57	88·01	76·67
II.	P_2O_5 ...	0·014	0·161	0·469	3·091	9·865	19 15	26·03	21·13	13·74	10·86
III.	K_2O ...	0·163	0·831	2·469	21·66	67·93	161·34	176·74	132·65	180·74	141·46
IV.	CaO ...	0·056	0·287	1·133	8·708	18·49	44·24	69·27	61·23	84·21	64·69
V.	MgO ...	0·027	0·176	0·769	7·166	26·12	47·38	62·03	57·09	67·42	48·38
VI.	SiO_2 ...	0·333	1·748	5·016	68·22	100·0	238·96	546 0	554·3	899·1	694·1
VII.	$Fe_2O_3 + Al_2O_3$ ...	0·043	0·168	0·376	7·223	32·31	41·17	54·71	60·48	73·79	43 47
VIII.	Total Mineral Ash ...	0·808	3·954	19·08	129·0	338·6	706·9	1007	945·8	1367	1037
	Total weight of constituents in 100 complete plants (Plants with grain)										
	Weight of dry matter in 100 complete plants, in grams ...	5·6	26·94	123·5	990	2750	6556	10851	12741	18152	15652
I.	Total Nitrogen ...	0·133	0·753	3·269	22·16	55·50	106·17	143·49	141·47	203·21	198·47
II.	P_2O_5 ...	0·014	0·161	0·469	3·091	9·865	21·10	30·92	46·21	56·98	58·01
III.	K_2O ...	0·163	0·831	2·469	21·66	67·93	165·34	184·21	143·54	193·67	152·74
IV.	CaO ...	0·056	0·287	1·133	8·708	18·49	44·89	71·61	65·89	86·29	66·57
V.	MgO ...	0·027	0·176	0·769	7·166	26·12	48·56	65·24	68·11	87·50	69·48
VI.	SiO_2 ...	0·333	1·748	5·016	68·22	100·0	241·2	571·1	624·6	906·7	702·4
VII.	$Fe_2O_3 + Al_2O_3$ ...	0·043	0·168	0 376	7·223	32·31	41·46	55·61	65·49	75·53	45·21
VIII	Total Mineral Ash ...	0·808	3·954	19·08	129·0	338·6	719·67	1055·7	1087	1466·4	1147·8

BETTER FARMING, OR, AGRICULTURAL CO-OPERATION.

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The Indian peasant is proverbially poor, ignorant, illiterate, improvident, depending on the vicissitudes of precarious monsoons and subject to disease and famines. 'Chronic poverty leads to low agricultural production and low agricultural production leads in turn to poverty'. This, in general, is the case of the 73 per cent of the population living in the 700,000 villages throughout India. The miserable position of the Indian is very deplorable with his average life of 22½ years and average income of Rs. 46 per year. The agricultural indebtedness of the peasantry is appalling and the mortgage indebtedness of India has been computed by experts at 600 crores, so much so that it has reduced the Indian cultivator to the position of 'one who is no better than a serf.'

The uneconomic character of the holdings, the lack of irrigation facilities in dry parts, the loss of income to the ryots caused by the destruction due to foreign exploitation of the cottage industries which offered them a source of subsidiary occupation in slack seasons, and the ignorance and the conservative spirit of the cultivator, have all tended to low agricultural production and very low standard of living in India. Above all, the increasing indebtedness of the ryot has sapped his energy and enthusiasm.

The solution for the Indian agricultural problem has been sketched out ably by Sir Horace Plunkett in his evidence given before the Royal Agricultural Commission. He says that 'Agriculture must be treated as an industry, as a business, and as a life.' The industry must be levelled up to the efficiency of urban industries by the application of the modern science. To develop it as an industry is chiefly the concern of the State. While the organization of the business side of agriculture properly belongs to private enterprise, in backward rural communities, the State will have to take the initiative. The main point to be borne in mind is that the form of co-operation must be the Co-operative and not the Joint-stock plan. Lastly, the building up of agriculture as life, and improving social and intellectual existence is best done by individuals and social service organizations, although the Government should be prepared to direct and help rural reconstruction.

The agriculturist in India lacks capital and the knowledge to increase the yield from his land as much as possible. It is only by harnessing capital with knowledge that there could be any hope of redemption. The development of the credit activities in volume and variety cannot alone solve the problem so much as non-credit activities devoted primarily to development of agriculture in all directions. How can Co-operative Societies help to gain this end? The question is best answered by a preliminary study of the history of co-operation in Western countries.

Ireland has many resemblances to India and therefore the achievements of co-operation to improve the agriculture of that country will, and are sure to be a lesson of profit to us. Agricultural societies in Ireland undertook at

the beginning two important functions, namely, (1) the improvement of livestock and (2) the establishment of experimental plots. It enabled the small farmers to provide themselves with pure-bred bulls, boars, rams and stallions by judicious introduction of strains suited to local conditions. The livestock was thus improved immensely by the Auxiliary Agricultural Associations. These societies were the principal distributors of agricultural requirements in Ireland. By the use of associated credit these societies were able to produce at the most favourable terms and at the same time to give credit to their members when required, the period of repayment not exceeding ten months at the most. Some societies also took up the manufacturing of their own manure mixtures thus producing their own agricultural requirements, some co-operative societies purchasing and hiring machinery as well.

Experiments made in the co-operative sale of agricultural produce by the Irish Agricultural Wholesale Society proved successful. They secured better price—they dealt in manures, seeds, machinery, implements, dairy requirements and feeding stuffs and all descriptions of agricultural requirements and the local societies came to appreciate the important part played by the I.A.W.S. and the protection offered to weaker societies.

Joint purchase of seed and manure yielded better crops. Instructions given by the departmental lecturers and county instructors led to an expansion of the production of compound manures. Bank facilities being needed, Trading Federations were started and societies were compelled to become members thereof by the I.A.W.S. and to deal exclusively with them and individual members had similarly to be bound to their societies.

Some of the Irish Agricultural Societies did scarcely anything except to purchase seeds and manures and it was thought, that they might with advantage add loan business to their activities. The societies were ignorant as to the state of the market. The societies therefore thought it would be better to arrange with the Wholesale to supply them with the latest market information and thus it was considered that agricultural societies should produce for their members everything they needed for their agricultural industry. If the area was small, two or three societies should unite together for the purpose. They employed really competent secretaries and established adjunct veterinary societies for the benefit of the members. Introduction of co-operative membership of agricultural machinery got over some of the difficulties. Dairy societies appointed creamery inspectors, cowtesting associations undertook periodical bacteriological examinations, and all the year round supply of fodder and above all, efficient managers did excellent work everywhere.

Thus the Irish farmers were determined to self-determine their own industry. By 1920, every shade of opinion accepted the co-operative movement as an indispensable element to national welfare. The General Purpose Society helped them a great deal. As ignorance of what co-operation was, and the failure to apply co-operative doctrines would lead to the failure of many societies the work of the I.A.W.S. in education and propaganda throughout the country under the lead of its great leaders and pioneers was immense and benefitted the people very much.

The example of Denmark is even more striking. The population of Denmark is not more than 3½ millions; but this small country has merely by co-operative organizations raised itself from the verge of bankruptcy to a state of affluence and contentment. At one time the fame of American wheat in the Denmark market created a good deal of consternation amongst the agricultural population of that country. The soil of Denmark was poor and the wheat produced in it could not compete with American wheat. The people were in despair. The State and the people however rose to the occasion, introduced co-operative methods of farming and marketing and saved the country.

The Danish farmer now restricts his attention mainly to production and leaves the marketing to be done by organizations formed for the purpose. In marketing co-operative societies, each member when delivering his produce, receives part payment according to quality, generally 9/10ths of the market price. The Danish farmer rears his poultry, pigs and cows and rears them well, and brings out the best results. There are in Denmark 900 creameries or dairy factories as they are called, and 686 of them are co-operative. For the whole country there is an association, the object of which is to establish a sustained high standard of quality in all milk-products. There are societies for the supply of fodder to cattle and in the distributive societies 4/5ths of the members are agriculturists. In seed-cultivating co-operative societies there were in 1926 2,800 qualified seed-growers.

In 1925 the Danish Co-operative Committee had had under it 45 federations with 9,745 co-operative societies and credit organizations. Being a nation of small free-holders the number of holdings was 200,000, while the turn-over of the co-operative societies for 1925 was 541 million dollars. The share of the Danish holdings in the co-operative movement may be seen from the following figures :—

Dairying ...	89·5 per cent	Manure-supply ...	24·3 per cent
Slaughter-houses ...	69·4 "	Egg-packing ...	21·5 "
Fodder-supply ...	31·2 "	Cattle-breeding ...	14·7 "

This small country through its co-operative societies now annually exports to the United Kingdom, butter, cheese, bacon and eggs worth-more than 30 crores.

There is no definite legislation in Denmark, and members lay down their own regulations which have the force of law—dispute among members of co-operative societies being settled by arbitration courts. The movement arose from the realization of the necessity and value of co-operation and belief in the strengh of union. The legal obligations of the members are slight, but those imposed by rules are severe.

In the matter of education there is a co-operative course every year, besides several courses in agricultural schools; the co-operative system has revolutionized the methods employed by the peasants and has lifted and enriched the nation.

In 1844 the French farmers found their prosperity threatened by an extensive foreign competition and turned to co-operation for the preservation of life. The agricultural syndicates grew up and legislation legalized them. The chief aim of the association from the start was to assist the

cultivators. Joining the Syndicate, the agriculturist had the advantage of better prices, technical assistance, cattle insurance and credit. The syndicate organized an industry, combined various classes of men and enriched the agricultural work.

The recent history of agricultural development in Soviet Russia is bewildering. They have far exceeded their estimate in the five-year plan and 40 million hectares of land have been newly brought under cultivation and an up-to-date factory for the manufacture of agricultural implements on a very large scale has been set up. In formulating plans for the development of the agricultural industry in India, attention must be directed to raising the best crop possible. This can be done only by introducing improved seeds, manures and scientific methods of cultivation in a manner which can find popularity with the farmers. The foregoing methods by which Ireland and Denmark improved their agriculture by forming agricultural associations and organizing co-operative societies for certain purposes, with a central agency at the top to guide and help, can be copied with profit in our country.

Co-operative Marketing.—The farmer should concentrate on raising the best crop possible from his land with healthy cattle and through improved methods and as for marketing his produce, it must be done for him by other organizations. In Europe the two functions are clearly divided. The producer gives his best and undivided attention to his produce and the marketing society of which he is a member finds out how to obtain the best value for his crops. In this country unless the above method is adopted and the middle-man eliminated (since the ryots are ignorant and helpless), a large share of the profit cannot, and will not, go to the actual producer. The financing banks can play a great part in helping to find a suitable market for the raw products of a country. Here is an example.—The Agricultural Bank of Bulgaria in 1919 undertook an investigation into the marketing of the silk cocoons in their country and abroad. At that time there was much exploitation by merchants, and producers consequently lost heavily and many were forced to stop raising cocoons, inspite of the excellent condition of their production. The Agricultural Bank knowing exactly the price of cocoons abroad, began to operate in two directions (1) by laying cocoons for itself and (2) by inducing the producers to deposit their cocoons against provisional advance. The results of the intermediation of the bank were striking. The prices doubled immediately, and within a period of five years, the producers got for their cocoons five times the value that they were getting when their produce passed through the hands of the middlemen.

Till recently, America led in marketing by sale of agricultural produce on co-operative lines. In 1922, the turn-over of all the agricultural sale societies in that country was over three hundred crores. Japan supplies more than 64 per cent of the world's supply of raw silk. There are at least 20,000 syndicates dealing in the purchase of seeds, leaves, and sale of cocoons which are all not incorporated but formed on co-operative lines.

In India, only in two provinces co-operative marketing has been attempted; the paddy and jute-sale societies in Bengal and the cotton-sale societies in Dharwar in the Bombay Presidency. In Madras there is a cotton-sale society at Tiruppur which is yet in the infant stage. In the Madura district, Co-operative Banks have been successfully worked out for the cardamom planters, who on the model of the Bulgarian Bank, have been taking their stock and lending money on the pledge of the produce. But for the marketing of their cardamom produce, an incorporated company has been started with headquarters at Kombai and with sale branches throughout India. If this marketing could be successfully done through co-operative lines as well, it would be a marked achievement in Indian co-operative marketing. The entire profit would then go to the producer. Here is a good opportunity for the business co-operator.

Much remains to be done in the direction of marketing of agricultural produce in our country at the present day. The defects noticed in the co-operative movement in India to-day, are all due to the disproportionate development of credit activities in the past quarter of a century to the utter neglect of other vital agricultural problems crying for help and redemption.

The Indian agriculturist is between two fires—the village money-lender and the middleman. For all his requirements, both for family and cultivation expenses, the village money-lender lends him in cash and in kind, and either takes back the money lent out with compound interest, or contracts with the borrower to purchase his entire crops, or to the extent of his dues which is done usually at rock-bottom prices. The borrower is thus a double loser, paying high rates of interest and selling cheap. What is left by the village money-lender is taken away by the middleman who is the thin end of an unbroken chain of an organization in this country who by a mechanized process of transport, carry away the raw products of the country, slowly and silently to the big warehouses on the coast to be shipped away to the foreign countries steeped in industrialism, only to be shipped back to this country as finished goods selling at four to ten times their original price. The magnitude of this trade will be evident from the figures supplied annually by the Government which amounts to several crores. Serious attention should be paid to this vast national problem by all co-operators, economists, business-men and leaders of the country. Efforts should be made to arrest this national annual drain, to store the agricultural produce in India, and to manufacture them for the various national wants. Only the surplus should be shipped away and at fair prices, the business being done by wholesale co-operative societies. The problem is immense as it is urgent and may seem impossible, but nothing is impossible to the one who wills, be it a nation or an individual.

State Aid.—Not the least but perhaps the foremost should be the help rendered by the Government to gain this end. The gratitude of the millions in India is theirs for having instituted the great co-operative movement in India 25 years ago and guided it safely by offering it very many facilities that as a result, it has taken deep root spreading its branches everywhere and benefitting the people in many ways. The next great step that the Government should take and pursue in the succeeding quarter of a century should be taken in the direction of advancing agricultural co-operation and helping agriculture through it. Even in Germany, where credit co-operation and banking are highly developed, the number of agricultural co-operative societies is as high as 34,000, helping and aiding the agriculturist from start to finish. The greatness of Germany before the War was through scientific agriculture. In Italy, the State has thrown open its Exchequer to help the co-operative societies and develop the agriculture of the State. The Bavarian Government gave generous support

to agricultural societies in the first few years. For some years, grants aggregating to £600 per annum were made to such societies and the State made both advances and grants on a large scale to the erection and equipment of crop granaries.

The State of Japan, has helped its primary industry, namely silk, by grants of loans of very large sums at low interest and by the establishment of Schools and Colleges for the teaching of Sericulture. At the head of all is the Sericultural department of the State, which with its exports and abundant resources have helped to develop this primary industry through the aid of Co-operation that it stands to-day unrivalled in the face of International competition in trade.

In England, in 1919 the Ministry of Agriculture agreed to make grants to the Agricultural Organization Society from the Development fund on an extensive scale, gradually diminishing every year for four years. It was expected that by that time the society would be self-supporting and no further assistance would be needed thereafter. The sums actually paid to the Agricultural Organization Society under the above arrangement were as follows :—

1919–20	£ 51,000	1921–22	£ 11,586
1920–21	£ 28,000	1922–23	£ 4,556

If this were so in the case of a country in which the occupation of agriculture is confined only to a small percentage of the population, most of whom are rich landlords owning large farms and estates, and where the proportion of agricultural co-operative societies to the total number is ludicrously small, how much more should be the magnitude and amount of interest and care to be taken by the Government of India to develop the agriculture of the country through co-operation and to help the poor, miserable and petty-holding peasants !

Subsidiary Occupation.—It is a well-known fact that the Indian peasant works on his land, only from six to eight months in a year and has no occupation to do in slack seasons and off-hours. This is another national waste and Richard Gregg in his book on *Economics of Khaddar* has at a moderate calculation computed the loss at 180 crores of rupees for the 107 million of the population directly working on the land. Old decadent cottage industries which have received a rude shock by unhealthy foreign competition, should be revived and new ones introduced in villages as suited to local conditions for utilizing the spare hours of the farmer which he spends in idleness. Subsidiary occupations such as hand spinning and weaving, fruit-gardening, mat-weaving, poultry-rearing, sericulture and a host of others could be organized and encouraged to bring more money into the pockets of the farmer and the poor.

A Scheme of Agricultural Education.—The primary duty of the State is to educate the Indian agriculturist in the newer methods of cultivation with improved appliances. Knowledge should precede and following it, he should be supplied with good seeds, manures and implements and machinery, and good breed of cattle all easily available for him at his door, with an instructor to guide and help him through his agricultural operations.

Agricultural supervisors, on the model of the co-operative supervisors should be trained in large numbers to take charge of from 25 to 30 villages, and be made to move more closely with the villagers and be a constant guide to the ignorant ryots.

Demonstration-farms on co-operative lines on the model of the one at Lalgudy, under the guidance and supervision of the Agricultural department should be started in as many centres, particularly in all taluq headquarters where there is a constant concourse of villagers for purposes of business, both official and trade. Agricultural societies should be started in large numbers for the supply of good seeds, manures, and implements, and the loans granted to members for the purchase of the above should only be disbursed in kind from such societies. Loan and sale business should be done in the same society and for the marketing business, it should be connected with a Wholesale society at the top, managed by experienced and business-knowing persons thus completing the structure.

The Government may train men doing honorary work by giving them agricultural education and giving them training in organization work, and they in turn may be entrusted with doing a lot of preliminary work, as it is being done in the case of co-operative and village panchayat movements. A beginning could be made by training the office-bearers of the co-operative unions and societies. In the various co-operative training institutes now being conducted in the Madras presidency, the students may be given training in agriculture from 4 to 6 months at least, as the present-day business training is not sufficient to equip persons who are to work in the villages. Besides, when the plague of unemployment visits such institutions as it has done in the case of so many schools and colleges, the students trained in such institutes may have the confidence to stand on their own legs by forming agricultural co-operative societies and working for them.

Similarly, co-operative training could be given to the students and officers in the Agricultural, Industrial and Dairy departments, since hereafter non-credit activities have to be entrusted to experts in the particular line so as to be sure of the success and continued progress. A liberal and forward step to meet the situation is what is necessary at the present moment.

[1]NEED FOR AGRICULTURAL IMPROVEMENTS AND WHAT THEY ARE WITH SPECIAL REFERENCE TO SOUTH KANARA

BY K. UNNIKRISHNA MENON, DIP. AGRI.

(*District Agricultural Officer, Tellichery*).

To improve the position of the farmer either with regard to his economic position or health—two inter-dependent factors—is the problem on hand. I shall in this paper attempt to place before you certain hard facts which every ryot in the country, especially in the West Coast, has to care for to improve his agricultural programme. We have to remember at the outset that the prosperity of the country with about 80 per cent of its population engaged in agriculture, must be identical with the advance that the country will make in economic farming, in providing food for the increasing population and in supplying raw materials for the industries at home and abroad so that the farmer may increase his purchasing and earning capacity.

[1]Extracts from a paper read before the Fourth Agricultural and Industrial Exhibition, Mangalore—January 1931

Communications have improved and transport facilities have increased, so that whatever we produce has, in fact, to be placed in the world market to compete with the produce of highly organized scientific farmers of more advanced countries. The economy in production must, therefore, be by way of reduction in the cost per unit produced. Increased production has, by itself, little value unless it ensures, along with it, reduced cost of production. One has to practise economy day in and day out, particularly in the following instances :—(1) Prevent waste, (2) utilize the waste products and try to make a capital out of them, (3) increase the production of such materials as are now imported from other countries, especially for food purposes, and (4) diversify cropping so as to maintain the intrinsic fertility of the soil, defying adverse weather conditions; this last will make the farmer more self-contained than he is now and enable him to have some saleable commodity throughout the year to meet his cash requirements. In the economy of a farm, diversity of cropping, perhaps, will count higher than anything else to make the owner successful in the business side of farming. The rearing of livestock of all sorts will also be one of the aspects of diversified farming incidentally helping the farmer to better utilization of waste.

For a moment let us look at the amount of food-stuffs that we import into this Presidency. We had, within the last one year, imported about 10,000 cwts. of dairy products mostly condensed milk, about 100,000 cwts. of sugar, and about 40,000 cwts. of starches like sago, etc. On the West-Coast, though we have ample rainfall for six months and consequently luxurious growth of grass on our hill slopes, our cattle are starved to death during the hot months. If any, with tenacity of life, luckily survive the hot weather, they cannot but be the half-starved poor specimens which the West Coast cattle now are. They yield little or no milk. To maintain poor animals is itself bad economy. It is very imperative that we should improve our animals as fast as we can. Milk food is becoming more and more popular and is being recognized as an important article of diet. The shortage of its supply is a cause for national degeneration. Stronger and better working animals are also necessary factors for economic farming. Without losing any more time, we have to start work with regard to improvement of our livestock, by paying attention to better feeding, breeding and housing of our animals. We must arrange to conserve the large quantity of hill grass which is now practically wasted, by converting it into silage, for later use in hot weather. Silage is as good as green stuff for cattle, and can be made from hill grass by cutting it when in tender flowers, packing well and preserving under ground. I am very grateful, in this connection, to Mr. and Mrs. Sreshta and to the Mission Farm at Moodbidri, for the very valuable demonstration they have made for silage making on their estates. Besides this, a farmer must be able to grow fodder crops as well. Cholam and the various pulse crops are well suited for this purpose. Even under shade of coconuts we have been able to produce 8,000 lbs. of green stuff per acre in Kasargod, and in the open ground it must yield more. I wish to lay emphasis on the fact that the grower of the coconut must, in particular, devote attention to produce some crop between the rows of the trees and a fodder crop of cholam must certainly find its place in the rotation. Guinea grass and elephant grass can also be cultivated in all places where there are facilities for irrigation during the hot weather. If better milkers are kept, it will pay the owner to feed them with cotton seeds, oil cakes and the like, in addition to fodder.

As regards breeding, we have got only half a dozen bulls of the right type on the West Coast. I wish that every village had its own breeding bull which, if maintained properly and made to serve not less than 40 cows a year, will be paid a premium of Rs. 100 a year by the Government. The bulls can be worked in the fields for half the day as they want exercise. Therefore, if a farmer maintains a pair of them for part-time work as well, he will be able to derive the full benefit out of them and make it an economic proposition. The two bulls now stationed at Mangalore are serving a large number of cows, but the progeny do not all receive the better feeding and attention they deserve. I am grateful to the District Advancement Association for the interest they have shown in this affair by having given housing facilities for these bulls. Let me add that goats, pigs and poultry are also necessary for every farm. They will, if properly managed, contribute, in no small measure, to the prevention of waste.

Next we come to the enormous import of sugar into a country that has large areas under sugar-cane. Even with the present area under sugar-cane we can in due course double the yields of sugar and approach the Java yields of 6 tons of sugar per acre which are only the result of improvements in varietal, manurial and cultural methods. When sugar-cane becomes a more paying crop it will certainly spread over a larger area and help us to keep down the import.

As regards starchy foods, the cultivation of tapioca, plantains, sweet potatoes and various other root-crops, will certainly augment the food-supply and money return to the farmer. Groundnut as a money-crop is in no way unimportant. Cambodia cotton grown as a dry-land crop in the Pattambi Research Station promises to be a paying crop of the future. Mention may here be made also of both pepper and coconut in suitable areas.

The extensive dry lands now lying waste can be gradually devoted to cashewnuts which are expected to give an average income of Rs. 50 per acre from fruits alone besides supplying fuel. The cultivation of fuel trees of all sorts must be encouraged in the rural economy of the country so that the large supply of cheap fuel available will put a stop to the vicious habit of burning cattle-dung as fuel. It is a serious mistake to think that the burning of any dry stuff will convert it into valuable manure. On the other hand, the organic matter which is a very valuable ingredient in any soil for improving its water-holding capacity and its drainage, is fully lost when any stuff fit for manure is burnt, not to speak of the loss of nitrogen. Therefore, I have to appeal to you, farmers of the West Coast, to have a compost-pit or two in the immediate vicinity of your dwelling house and deposit in them any sort of waste organic matter (animal or vegetable) including the leaves on which you eat, the skins or ribs of vegetables carved for the kitchen, etc., with intervening layers of cow-dung and keep it covered with a layer of earth. Sweepings of the yard or threshing floor, waste straw, plant stubbles, etc., not fit for litter, can all go into this pit. In the course of a couple of months, this deposit of very valuable capital will begin to pay you interest, when you are able to use it as manure. This is the most important way to prevent waste in the rural areas. In the urban parts there is more of such wastes and less of cultivation, but it is grievous

to note that even a small fraction of this waste is not properly utilized by the neighbouring farmers for manuring purposes. The night-soil dumping grounds of this Municipality must be able to produce plenty of good fodder to serve also as a source of profit to the Municipality, if the area can be enclosed and leased out for the purpose. Vegetables also may gradually take the place of fodder in the dumping grounds. The sewage of our town is itself a very rich manure, if we can only utilize it. In the interior villages also, bore-hole latrines must help to preserve the human excreta within the soil to form manure in the near future. The dumping of well-preserved cattle-manure in the open without even a layer of earth is a practice which should be condemned. The proper conservation and utilization of the excreta of all farm animals is as important an item in the utilization of waste as it is from a sanitary point of view.

If waste is prevented by the above method we are in a position to augment our manure supply by the use of more concentrated manures like bonemeal, oil-cakes, etc., which are now largely exported. This is in fact a drain on our resources. The amount of export of these materials for this Presidency alone is 115,630 tons of oil cakes, (including that sent in the shape of oil-seeds), 7,429 tons of bones and 1,000 tons of other organic manures. If we begin to use more of these things, we shall be helping to maintain the fertility of our soils. We may export all the cotton lint and oil beyond our requirements as they do not carry with them our soil fertility. The use of chemical manures is a step after adopting the above procedure in maintaining the fertility of our lands. They must be applied judiciously with great care and in suitable mixtures, only to supplement the the bulky organic manures. By adopting the more economic method of conserving bulky manures and utilizing wastes of all sorts, the Chinese have been able to maintain the fertility of their soils for the past several scores of centuries. The Chinese get an average yield of 4,000 lbs. of paddy and Japan about 6,000 lbs. per acre, while 2,500 lbs. will be considered a heavy yield in South Kanara and the average yield is only about 1,500 lbs. per acre. Yet we pretend to be some of the best rice-cultivators of the world!

Every one knows that the cost of cultivation for raising a pure or mixed crop will not vary much but in the outturn, the pure seed will certainly beat down the other. This is how the plant-breeder helps the farmer to realize better profits. Seeds like G. E. B. 24 and other selections of paddy, for instance, bear bigger ear-heads, mature more uniformly and yield better quality of rice with less of husk and therefore they are really more profitable than the local ones. Again in situations of shortage of water-supply, where the local varieties have failed, G. E. B. 24 has given a satisfactory second crop. Even with the local varieties, the simple method of bulk selection (selection of ear-heads) has proved to ensure heavier yields and when proper manuring is adopted, these heavier yields won't affect the soil fertility at all. In some places of South Kanara where the continuous cultivation of green-manure crops has tended to increase chaff in paddy, the land must receive a corrective application of bonemeal of about 2 cwts. per acre per year. Amongst sugar-cane varieties, Fiji B. for instance, stands better manuring. I have come across certain plots of red cane and Fiji B, manured purely with chemical manures. The crop is good this year, but it is a great damage done to the land and to future crop, as the ryot has not added enough organic manures to the fields. Besides this, sugar-cane comes into the same field once in two years. I wish there should be at least 3 years' interval between two sugar-cane crops in the same field. As we do not adopt these principles in our cultivation, we have been damaging our crops and deteriorating our lands.

Efficient implements will require slightly higher investments than inefficient ones, but the profits will in the long run out-weigh the increased investments several times. An implement like the Meston plough is really a more efficient one as it moves the whole surface soil in one operation. A guntaka of the type exhibited here by a cultivator, to stir the soil, to collect weeds and to break clods, is worth the investment on it. A *mammotti* fork that pulverizes the seed-bed or digs out manure much sooner than an ordinary *mammotti* is a necessary investment to save the labour of the farmer. The iron mill, the introduction of which has been helped to a considerable extent by the District Advancement Association, has practically replaced the old sugar-cane mill throughout the sugar-cane area. So too, have the adoption of Sindewahe, Poona and Battery furnaces. They have considerably more room to spread, and to save fuel, which must necessarily go to replace the cow-dung cake of the kitchen.

Timely action to adopt preventive and remedial measures of fungus diseases or insect pests must be considered very important. Timely reports of such attacks will help in dealing with them and in saving the crop over large areas.

AGRICULTURAL SCIENCE—ITS HISTORY AND RECENT DEVELOPMENT[1]

BY DR. BERNARD A. KEEN, D. Sc.

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I propose to deal with the subject in the nature of a general address for two reasons. Firstly, your Secretary's request for a lecture by me, reached me just before I left on tour, leaving me very little time for adequate preparation. I should have liked to deliver a considered scientific lecture, but, that meant equipping myself with diagrams, statements, slides, and all those paraphernalia which one scientist would like to have, when addressing fellow-scientists. On thinking over, I thought it would not be a bad plan to give, instead of a formal scientific address, a general talk. It is a great advantage for research workers to take from time to time, a broader and a more general outlook by reading the history of agriculture and agricultural science. In fact, I would suggest to some of the younger members of the Association that they should take up the subject as a hobby, and I can assure them it will be of absorbing interest. In this country, with its long civilization, you will find the history of agriculture and agricultural practices is a unique subject that will more than repay the attention you devote to its study.

The history of agricultural science is very short; it is hardly a century old. Most of the agricultural practices had developed before agricultural science even began. Compared with Engineering, for example, the position is quite the reverse in agricultural science. Electrical Engineering in fact is a child of the laboratory and an application of pure science,—physics, and you have only to conceive of what modern industry would be without Electrical Engineering, to realize this. With agriculture, however, actual knowledge is, and for some time will be, far ahead of the scientific theories and explanations.

Modern agricultural science developed from the days of Liebig and Schubler in Germany, Boussingault in France, and Lawes and Gilbert in England. These latter two worked in Rothamsted, and as most of you are generally familiar with it, I will trace the growth of agricultural science with the history of Rothamsted as a background, giving personal and interesting details of its growth.

Lawes was an English country gentleman, a type that is fast disappearing in these days,—and he succeeded to a small estate at about the time of the end of the Napoleonic wars. He found his estate impoverished and the fertility of his soils low. He recognized that he had to get more money out of his lands somehow. He had been to Oxford, but for some obscure reason returned without a degree. He fitted up a room in his house as a chemical laboratory, and tried various experiments. The only manures generally available and used in those days, were farmyard manure and chalk. He found that liberal doses of farmyard manure and chalk gave bigger

[1] A lecture delivered under the auspices of the Association of Economic Biologists, Coimbatore on February 17, 1931.

yields of crops and he set himself to find out why this was so. He started analyzing soils and plants, and began supplying to the soil, the ingredients that it was deficient in.

In this manner, phosphate was the first thing he started with. In those days phosphatic manures were generally used mainly in the form of powdered bones, but the phosphate in them was not very available. Lawes set himself to make this more available by treating bones with sulphuric acid, and tried this treated product in a number of pot-experiments on turnips—a very responsive plant. He had the luck of a successful scientist, for the pot-experiments showed that phosphoric acid had been made available by sulphuric acid. That bones treated like this could increase yield, set him thinking. He was a unique man with a clear, far-reaching, scientific outlook associated with good business sense, a rare combination of two different mental qualities. He realized that it would be to his financial advantage and to that of agriculture if he could start marketing his phosphate product as a fertilizer. The serious trouble was that the supply of bones was not sufficient for the manufacture of 'super'. The only other source in England of phosphates were the deposits found in the various parts of the country, known as *coprolites*, of which only small supplies were available. At this time however, the geologists' discovery of large areas of rock-phosphate in different parts of the world solved the problem and brushed aside difficulties about the source of raw material.

Lawes set up a small factory for the manufacture of 'super' with rock-phosphate obtained from Africa, and sulphuric acid available at home. It is interesting and amusing to read how careful he had to be, because about a hundred years ago it was not considered correct for a gentleman to be engaged in such pursuits, and he had therefore to carry out the manufacture in a somewhat obscure manner. We have in the archives at Rothamsted an original copy of the *Gardener's Chronicle*—a paper of those days,—in which can be found the first advertisement that Lawes put in about his new 'super'. It is a small one occupying about half an inch in one column.

In a short time, Lawes' finances improved. But he had more at heart the improvement of agriculture in the whole country and the enhancement of agricultural returns by the application of phosphates in an available form to stimulate yields. He set out a number of plots, to test over a number of seasons, the effect of 'super' and of farmyard manure on the growth of crops. He carried out chemical analysis of the farmyard manure, the soil and the crop, to trace any relationships between each other and to see whether any particular manure could be advantageously applied. Analysis showed that farmyard manure contained several fertilizing ingredients, and later on, he started a series of plots manured with farmyard manure and these chemical compounds. This indeed was the beginning of the famous Broadbalk experiments at Rothamsted, started in 1839 and continued without change up to the present day.

Not being himself a fully trained chemist, he felt the need for the co-operation of one, and he appointed as his private assistant Dr. Gilbert, who had studied in Germany and in University College, London. This was in 1843. Gilbert was a magnificent worker on the detailed side. Lawes could sweep out the broad outlines and Gilbert could fill in the details, and thus started the combination of this fortunate pair. It was at about this time that Liebig working in Germany, set forth his theory of plant-nutrition

based on his analyses. He held that the soil consisted essentially of phosphates, potash, and silicates, and supplied these mineral ingredients to plants, which got their nitrogen indirectly from the air. According to him therefore, the only necessary manure was a collection of minerals to be applied to the soil. His theory sounded quite reasonable, and he was so confident of it himself that he patented and put on the markets, compounds to provide potash and phosphorous for soils. Trouble was however, in store for Liebig. His manures failed to produce any increased yield. During one stage of the process of manufacturing these compounds, fusion was employed. This rendered the ingredients unavailable; they were in fact, only potential manures. He was also in error in asserting that nitrogen need not be included in the ingredients to be added to the soils.

Lawes showed by practical experiments that nitrogen was necessary. He laid out a number of plots manured with farmyard manure, Liebig's mineral mixture, the same mixture plus nitrogen in increasing doses and a no-manure control plot, and the results were conclusive. (For supplying nitrogen he used ammonium sulphate which was available as a by-product of the gas industry). The plot manured with the mineral mixtures of Liebig gave yields little better than the no-manure plot; the three plots with mineral mixtures plus increasing doses of nitrogen gave larger yields, and the yield of the last plot—that manured with the largest dose of nitrogen—was equal to the yield of the farmyard manure plot itself.

Lawes thus showed the importance of nitrogen, potash and phosphoric acid as essential elements, recognizing at the same time the importance of temperature, climate, etc., on making these available. Thus the conclusion of Lawes' first agricultural demonstration was practical and obvious. 'Supply the impoverished soils in England with nitrogen, phosphorous and potash.' The results of his experiments were remarkable. In a few years, the yield of wheat per acre in the surrounding areas rose by about 10 bushels or 600 lbs. This is perhaps the greatest single achievement in modern agriculture, and was entirely due to Lawes and Gilbert.

Lawes extended his manure factory and began to manufacture, besides 'super', other manures as well. His finances improved and he soon became a wealthy man. But he devoted himself at the same time to carrying on scientific work. Throughout his life, he kept his scientific and his commercial activities separate from each other. Thus Rothamsted was from its beginning, an independent research station and not a research laboratory attached to a manure manufactory.

They were an ideal pair; Gilbert refusing to move one step forward until he had proved to the hilt the soundness of every hypothesis, and Lawes, eager to push forward with new ideas; the wise, far-seeing man with his broad outlook, and the trained research worker passionately fond of details formed a pair in perfect harmony. They can be compared to a steam-engine; Lawes was the piston, and Gilbert the flange on the wheels.

Their note-books, which are preserved at Rothamsted, give an insight into their natures. Lawes' note-books are neatly kept, but are relatively empty, although the main plan and the background are there. Gilbert's, on the other hand, are almost unintelligible, crowded with figures and calculations. But every figure there, and every calculation was a brick in the edifice he was building. These note-books convey more than anything else, the true characteristics of these two men. It was fortunate that both were endowed with vigorous constitutions and thus they worked together for nearly 60 years—Lawes died in 1900, and Gilbert in 1901—and the length of this partnership is unique in agricultural science, or in any other science for that matter.

Lawes' and Gilbert's studies on artificial manures and yields of crops were only two aspects of their activities. They did other work besides. They devoted attention to the permanent meadow land at Rothamsted and to the improvement of pastures. They tried to find out that indefinable term in agricultural produce—*quality*—as they realized that yield (or quantity) was not the sole criterion; the flours from the wheats of the different plots of Broadbalk field were given to an expert baker, for a proper assessment of their quality and suitability to produce good loaves. They thus tried to trace a relationship between quality and manurial treatment, which only in recent years has come to be fully investigated. They also tried experiments in plant breeding and the differential response of varieties to treatment. They experimented as well on the feeding of animals, as they realized that the kind and quantity of agricultural produce fed to animals, is reflected in the quantity of milk and meat produced. Thus they started nutritional experiments on pigs and cattle, analyzing carcases of animals and accumulating vast stores of detailed information. The modern science of animal nutrition started in fact, from their work.

Thus, the whole gamut of agricultural science, plant-breeding, botany, chemistry, physics, bacteriology and even animal breeding and animal nutrition—was traversed by Lawes and Gilbert. More important than anything else, they had an eye for the future. They knew their methods were not final, and saw the importance of the repetition of their experiments on the same material at some later date. They established therefore, a museum of raw materials—soil samples, wheats, barleys, hays, and even samples used in the animal nutrition experiments. You can see to this day at Rothamsted, soil samples from depths of 9 inches to 9 feet, taken as early as 1843, kept in bottles hermetically sealed. The inestimable value to future workers of such a procedure was perhaps not fully visualized, even by Lawes and Gilbert themselves. To give only one example, when recently there arose a question as to how long amœbæ could remain alive in the cyst form in a dry soil, the problem would have necessitated examining the dry soil at intervals over a very long period. But the foresight of Lawes and Gilbert enabled the answer to be obtained in a few days. For the experiment could be done 'backwards', as it were, by taking in turn the older samples until one came to a sample in which no amœbæ had survived. The philosophy of their lifework was 'do everything you can thoroughly, and with the best apparatus, but leave some of the original material for re-examination when improved methods of attack and analysis develop later.' Their work has resulted therefore in the preservation of continuity—so important in research. I may add that, to this day, this is the ruling idea of all the workers in Rothamsted. Lawes and Gilbert became world-famous; they were honoured by Queen Victoria, Lawes was made a Baronet, and Gilbert a Knight, at a time, mind you, when such honours were rarely bestowed on men of science.

When their work was over, one phase of the history of our subject was passed. Specialization was already coming in, and this brought with it advantages and also dangers. It is inevitable that the development of a

subject should lead to specialization but this tends to divide a science into water-tight compartments, with a corresponding lack of co-operation between the different specialists. It is obvious for example, that no one man can become an authority in all the branches of Entomology. But, as it takes years to achieve authority in any given subsection of a science, some form of specialization on the part of scientists is inevitable, if progress is to be rapid. Specialization was also accelerated by the great War, when it became necessary to explore every avenue of science in the attempt to increase our food supply.

A point of interest to be noted is, that up to the end of the Lawes and Gilbert era, chemistry was predominant in agricultural science.

But other sciences were being pressed into service. Plant-breeding was perhaps the next in historic order. The rediscovery of Mendel's Law opened up a new vista, and two striking examples can be given. One was the simple selection method, leading to the creation of *Marquis* wheat in Canada by Saunders and his father. Their aim was to obtain a good quality wheat producing a strong flour and they tested their wheats by chewing a few grains until the starch was removed, and then estimating the quality of the glutinous residue on which the strength of the flour depends. This was a simple but laborious method, for many hundreds of samples had to be examined. Another example is that of Biffen in England who, working on genetical lines was able to produce a good English wheat giving a strong flour, in contrast to the great majority of English varieties, whose flour is weak.

Animal-breeding was the next branch of agricultural science to develop, although historically it goes back a long way to the days of Bakewell of the 18th century—who made some remarkable improvements in cattle. This branch of agricultural science has made rapid strides, so much so, that sheep which formerly had to be reared for four or five years to make them fit for the market, hardly pass a summer through now. Again cattle which formerly required quite a number of years to grow to size for the butcher, are now brought to condition to produce 'baby' beef in under a year.

Then, recently there has been the development of soil microbiology which is now studied in great detail. This branch of science is associated especially with Sir John Russell, the present Director of Rothamsted.

I should like to remind you, however, that these developments I have just mentioned were foreshadowed by Lawes and Gilbert, and Warington (an associate of theirs), for as I have already told you, they ranged over the whole field of agricultural science.

At the present day there is hardly a science that is not directly applicable to agriculture. Physics—which had been worked at tentatively by Schubler—and which was thrown into the background by the chemical achievements of Lawes and Gilbert—is now coming into its own again, and much work in this branch has been recently done in America and England. Mathematics has come to be recognized as an important science in agriculture and is particularly of value to economic biologists in the design and in the interpretation of experiments; statistics has in fact removed the elements of uncertainty in our field experiments and has given us a definite knowledge of the degree of reliability. Branches of chemistry, biological sciences, mycology and entomology have all entered the field of agricultural research until practically no pure science has been left out.

The question therefore arises how we can most usefully employ these sciences for the advancement of agriculture—whether we, its practitioners and consultants, should be primarily agriculturists or pure scientists. I think there are no two answers to that: I share the general opinion that an agricultural scientist should be primarily a research worker of proved merit in some pure science, who has turned his attention to agriculture, rather than a trained agriculturist who has turned his attention to agricultural science. For, in the latter case, the man, (unless he is a genius and therefore, bound by no generalizations) cannot envisage the real nature of the scientific problems he is endeavouring to solve.

I will now put before you a number of lines of investigation along which I believe, will lie the immediate future development of agricultural science. There is the prevention and control of diseases of animals and plants; this is the outstanding problem for mycologists, entomologists and pathologists. A reputation is awaiting a worker or a team of workers, who will unravel the problem of virus disease which is now baffling the whole world of science. The indications are, however, that the solution will not be arrived at in one stroke, but will be secured by a gradual working up of small advances made by different workers and in different places. The amount of money lost to agriculturists by diseases in India and England is impossible to estimate—probably it will run to crores of rupees and millions of pounds; and so, work on this branch is going to pay for itself many times over.

Secondly, plant physiological studies, particularly of the extensive material used in plant-breeding work, will provide the clue for unravelling many difficulties now facing the plant-breeder. I have great hopes of this branch of work, for there is still great scope for plant-breeding studies in this country.

Thirdly, the bio-chemistry of what we mean by *quality* in agricultural produce, will receive great attention. Work on this is already being done in England, and in this connection I may mention the production of barley for malt. Malting involves traditional knowledge, and quality is tested by empirical methods based on previous experience. Biochemical studies are now providing a scientific explanation of these empirical tests; in particular the amount and composition of the various nitrogenous compounds in the barley grain has been examined and relationships have been found between these and certain other barley grains, characters on which the maltster relies for his estimate of quality. I need hardly point out to this audience that the nutritive value of various agricultural products whether for humans or animals is essentially a bio-chemical problem.

Fourthly, there is a line of work familiar to you in Coimbatore, namely, the base exchange phenomena in soils. In spite of the vast amount of work done so far on the chemical analysis of soils, the bearing of the results on the inherent fertility of the soil was only qualitative. But recently base exchange studies founded on modern physico-chemical theories of replaceable ions and the nature of the soil particle surface have resulted in new analytical methods which have vastly improved our measurements of soil fertility. This problem, therefore, is of considerable economic importance,

and it will help the analyst to give the farmer advice on the kind and quantity of manure to be applied. This branch of study is a line of work where two types of scientists, physicists and chemists are able to co-operate to their mutual benefit.

Fifthly, soil physics (started so early by Schubler) is now ripe for further research and advances. Soil moisture, the determination of the effects of irrigation, the implements for promoting tilth, are all studies repaying attention. India has already won fame in the realm of pure physics research through the work of Professor Sir C. V. Raman and others, and I see no reason why her younger physicists should not make great advances in soil physics.

Sixthly, the new conception of soil classification will receive increasing attention. This work started in Russia, and has already been adopted in America, but so far little concerted attention has been given to it in the British Empire. It was started as an academic pursuit without reference to any possible direct useful end. The Russian studies showed that the tpye of mature soil which developed in any given area was very largely decided by the climate of that area. In fact, the climate zones and the soil zones practically coincided. In America, the original soil surveys based on mechanical and chemical analyses were revised during the past 2 or 3 years in conformity with Russian method, and they have shown that soil characteristics are explained more by this survey, than by the old laboratory methods. It is often said that this kind of survey is unnecessary in long settled countries such as India. Even if this were true—and I do not subscribe to the statement—a survey is of great value to agricultural scientists. To give only one example, the plant-breeder's problem is made more precise if he knows the soil types of the areas for which he is breeding fresh varieties. The new Imperial Bureau of Soil Science at Rothamsted is attempting to co-ordinate soil survey work in the Empire, with the object of drawing up a soil survey map of the British Empire. The ultimate result of surveys in all countries will be that the whole world will be divided into unified systems of soil zones, universally understood—and recognized and it will be a most striking unification indeed. In agricultural science—as in other sciences unification is desirable. All nations are members in the brotherhood of scientists and in the search for truth; among scientists at any rate, there are no barriers between one country and another.

Notes and Comments

Duty on Sugar.—The report of the Tariff Board on the subject of protection of sugar industry was officially published during the second week of March. They state that the depression in the sugar industry throughout the world is the result of excess of production over demand and the consequent increase in the stocks held by the sugar producing countries of the world. The recent tariff arrangements by various countries of the world have imposed restrictions on the free markets for sugar, and this has been an additional contribution for the sugar slump. It is gratifying to note that the Board record an increase in the efficiency of extraction from 6·85 to 9 per cent in the Indian factories, in the decade between 1920 and 1930 and that the conditions of labour in Indian factories are satisfactory. It is also very pleasing to note that the Board recognize the excellent work of the Sugar-Cane Station at Coimbatore in saying that it has contributed to a 50 per cent increase in output.

The substance of the recommendations of the Board are :—

(i) a duty of Rs. 7–4–0 per cwt. on all classes of sugar for the first seven years and of Rs. 6–4–0 per cwt. for the next eight years, the total period of protective tariff being fifteen years.

(ii) an additional eight annas per cwt. if, and when the landed price of sugar at Calcutta, (ex-duty) falls below Rs. 4 per maund.

(iii) There will be no duty on molasses.

In making the recommendations the Board have kept to the forefront the agricultural aspect of the case and consider that in the national interests the area under sugar-cane should not diminish and to this end they suggest an outlet for cane by encouraging the expansion of the white sugar industry.

The Board estimate the present fair selling price of white sugar manufactured in a typical Indian factory at Rs. 9–5–9 per maund and anticipate a fall to Rs. 7–12–5 per maund at the end of the protection period, while the price of Java sugar landed in Calcutta would be Rs. 4–0–0 a maund or even less. It is problematical whether India will ever be in a position to produce sugar as cheap as in Java, where, the country, the government and everything else is planned and organized solely for the production of sugar.

Royal Ploughing.—Elsewhere in this issue we publish an interesting account of the Siamese Royal Spring Ploughing. Siam, an agricultural country like India, is using it as a means of awakening interest in agriculture. The revival of agricultural ceremonies and festivals and the active participation of the educated public and State in them, are likely to establish more points of healthy contact with the agriculturist and to produce a responsive appreciation by the State and the land-lord of the arduous nature of the farmer's work and the inadequate return he gets for his labours.

Indigo as a Green-Manure and Dye.—Mr. Mahalingam Ayyar, Pattadar of Maharajapuram, writing in *The Hindu* of 7th March on the development of green manure, advocates its cultivation on river-banks and

emphasizes the advantages of extending the cultivation of indigo and manufacturing the indigo dye from it. It is well known that since the advent of synthetic indigo, the natural product lost its position and has almost disappeared to the detriment of South Indian agriculture. Mr. James Morton in a recent number of *Chemistry and Industry* discussing the extinction of natural dyes, says of indigo thus :—

'We had in India some 1,300,000 acres growing indigo plant, yielding 22,000 tons a year of what is now known as our standard 20 per cent indigo paste, valued at about £4,000,000 and employing, it is said, some 6,000,000 people. By 1913, Germany was producing some 34,000 tons of the same strength indigo. The Indian trade was reduced to very meagre dimensions, and the buyer got his indigo at less than one-third the price of the former product. So that by a small group of chemists and a few hundred people in Germany there was replaced a great and ancient industry largely under British control in India, and the amount of the new product represented what would have meant an area of over 2,000,000 acres and the employment of over 9,000,000 people or about twice the population of the whole of Lancashire.'

Under the circumstances, the revival of the manufacture of indigo even for consumption within India, has no prospects unless the duty on synthetic indigo and on materials containing synthetic indigo is levied to bring up the price level to that of natural indigo. Such a step is not without precedent and is recommended for protecting Indian sugar. In England, similar protection was given for certain dyes manufactured by the British Dye Stuffs Corporation.

The Groundnut Slump.—The figures for the area under groundnut in the presidency given in the Madras Legislative Council, in answer to a question by Mr. K. Koti Reddi, show that the fall in the area from 1927–28 to 1929–30 was only 4 per cent while the fall in price in the same period was nearly 15 per cent. After the War, a number of countries which were not producing groundnuts and other oil-seeds before, turned their attention to these crops with the result that the production of oil-seeds has considerably increased. The present depression in groundnut trade is, therefore, mainly the result of over-production elsewhere. A slight improvement in the tone of the market may be expected but the chances of again attaining the previous high price levels are rather remote. India must make efforts at increasing the home consumption of groundnut and its products for edible and industrial purposes and also by persuading countries from which she imports soaps, candles, and vegetable fats, to buy her oil-seeds and oils.

The Carpet Industry.—An exhibition is now being held at Delhi in which carpets made in India by Indian craftsmen are on show. The history of the development of carpet manufacture in India shows how Royal initiative and patronage by the nobles of the land can establish an entirely new industry which directly or indirectly helps the farmer by way of providing him a means of disposing of his wool and by providing him secondary occupation. Carpet-weaving is not indigenous to India and was imported from persia by the special efforts of the Emperor Akbar in the 16th Century. He brought weavers from Persia and started a Royal factory at Lahore. Progress was slow in the beginning but as time went on, Indians imbibed the talents of the Persian artisans and produced carpets which compared favourably with the best carpets of Persian manufacture.

With the closure of the Royal factory at Lahore, as would be expected, the industry declined, the art deteriorated and lost the richness of colour and design which were once attained. The industry has, however, not died out and the art of weaving carpets is not altogether lost. We have still remnants of it here and there. Ellore in the Godavari district is still weaving carpets of a sort.

The Central and Provincial Budgets.—The following are the summaries of the Central and Provincial Budgets :—

The Central Budget.—The revised estimates for 1930–31 show a deficit of 13·56 crores as against an anticipated surplus of 86 lakhs. A deficit of 14·82 crores is estimated for 1931–32. This deficit is proposed to be converted into a surplus of 31 lakhs by taxes on silver, sugar, liquor, luxuries and by increasing taxes on income.

Madras.—1930–31 closes with a deficit of 56 lakhs. For 1931–32 a fairly normal season is expected.

Bengal.—A deficit of 94 lakhs for 1930–31. The total deficit expected for 1931–32 would be 140 lakhs.

Bombay.—For 1930–31 an anticipated surplus of one lakh has become a deficit of 119 lakhs. A deficit of 85 lakhs is expected for 1931–32.

United Provinces.—A deficit of one and a half lakhs for 1930–31 and an anticipated surplus of 70 lakhs for 1931–32.

Central Provinces.—Present deficit 22 lakhs. In 1931–32 a surplus of 24 lakhs is anticipated consequent on the retrenchment proposed in Civil Works and Education.

Bihar and Orissa.—54 lakhs deficit expected for 1930–31. Worse position apprehended for 1931–32.

The Punjab.—A very appreciable deficit for the year that is closing and for the year to come.

M. Sc. Degree in Agriculture.—We understand that the subject of instituting a Master of Science Degree in Agriculture or of recognizing the Bachelor of Science Degree in Agriculture as a basic qualification for proceeding to the Master of Science Degree, is engaging the attention of the University authorities. We are not greatly enamoured by the multiplication of University Degrees, but recognize at the same time that these are definite passports in securing appointments. The absence of the Master of Science Degree in our University will thus seriously handicap, before the Public Services Commission, Madras candidates as against candidates from other Universities where these degrees and facilities for getting them, exist. We would therefore urge upon the University authorities, the adoption and the institution of the degree at the earliest possible moment.

Praise for Coimbatore Canes.—From distant Miami in Florida comes report of the excellent performance of the Coimbatore varieties of Sugar-cane. It would appear that these varieties showed remarkable powers of resistance to results of flooding and inundation caused by a cyclone. They have thus proved themselves as varieties most suitable for areas that are liable to flooding.

Gleanings

The Siamese Royal Spring Plowing.—One of the oldest and most interesting of the royal ceremonies in Siam is the *Raak Na*, or plowing ceremony. De la Lonbere in his *Royaume de Siam* states that he believes the *Raak Na* had its origin in China, where it has been observed for five thousand years, and was brought into the country now called Siam at the time of the migration of the Lao-Tais southward. The Siamese ceremony, however, resembles that of India where it is seven thousand years old more closely than that of China. The *Raak Na* is Brahmin in form and Brahmin priests officiate although at times Buddhist priests are called on to take part in the ceremony.

This plowing ceremony has come down to the present in its original form except for a few minor changes. It has been held annually since written history began for the Siamese, with the exception of a few years before the middle of the nineteenth century. The *Raak Na* officially opens the plowing season. Until it has been performed, the farmers will not begin work. This is not a law but a custom. The ceremony takes place some time around the first of May depending on the day appointed by the King on the advice of the Brahmin priests.

Phya Thai Field, the place set aside for the annual observance of the *Raak Na*, is on the outskirts of Bangkok. It is a large field and the surrounding country gives the ceremony a rural setting.

The portion of *Phya Thai* Field actually used is not large. It is rectangular in shape. On entering the field, one passes to the left of the Royal Pavilion. At the front and on each side, on the occasion of the *Raak Na* in May, 1930, there were some five-tiered white paper umbrellas. The Royal Pavilion is a permanent structure while the other pavilions are temporary. On the left of the ceremonial ground was the foreign colony pavilion; at the opposite side of the field and to the right of the Royal Pavilion was the pavilion for the priests; other parts of the field were roped off and chairs were supplied for the spectators. The Royal Pavilion was for the King or his representative, the royal family, and the wives of the princes.

The centre of the Royal Pavilion is a raised platform on which the King and the most influential princes sit. Below on the level of the ground, but also in the pavilion, are chairs for the other members of the Royal Family. When I arrived, I noticed there were no women in the Royal Pavilion although the princesses are allowed to attend. The occupants appeared to be young men and boys. They were all dressed in blue, the official color, well creased *panungs*, white stiff jackets, women's hose and pumps. These royal young men seemed bored and tired of waiting. The guests in the foreign colony pavilion were also interesting. There were Englishmen, Frenchmen, Danes, Americans, and representatives of many other nationalities. Many had *kodaks*, and not a few had moving picture cameras. A Royal Prince, noted for his success with his moving picture camera, ran out on the field along with newspaper camera men and members of the foreign colony to take pictures of the procession. The pavilion for the priests was more or less a mystery to me as I did not enter it. But I saw yellow-robed Buddhist priests and white-robed Brahmin priests going in and out. Outside of the roped-off sections were the most interesting people. They were from every class and every condition of life. These people were to take part in the most exciting part of the ceremony.

The Ministry of Agriculture takes this opportunity to distribute pamphlets on agriculture. By the use of this ceremony, the government hopes to awaken interest in agriculture and to show that its progress is essential to the prosperity of all classes. Although the educated Siamese do not believe in the portents and prophecies of the priests, the common farmer still retains his faith.

The ceremony itself is exceedingly interesting. Excitement begins with the arrival of the King, or his representative, either the Crown Prince or another very high ranking prince. As Rama VII was out of Bangkok in May, 1930, His Royal Highness Prince Nakon Sawan, the present Crown Prince, presided. The Sirens sounded and every one stood erect. A yellow car drew up and out of it stepped His Royal Highness. Accompanied by other princes he walked to the Royal Pavilion and ascended the platform. When he was seated, every one else sat down.

Immediately after the arrival of the Crown Prince, the procession formed. First came the musicians dressed in ancient costumes, playing a weird tune on ancient instruments. Then came the Minister of Agriculture who is appointed by the King to do the actual plowing. He wore a gorgeous robe of gold cloth and a many-tiered crown. After him came the white-robed Brahmin priests who carried the sacred conch shells some of which were filled with holy water while others were blown at intervals by the priests. They give a very weird note. The musicians were followed by Brahmin priests who preceded the Minister of Agriculture. Then came more priests, and the plow, pulled by the attendants. The plow is a beautiful, graceful, slender implement with one handle. The framework is of wood covered with gold leaf. The implement is about five meters in length and of primitive design not unlike that of the Philippine plow. The long, graceful beam is high. It curves in an upward sweep so that when the oxen are hitched to the plow the beam is even with their necks and the end curves downward. The plow has one share of ordinary size and at the back of it is a handle almost shoulder high that is used for guiding the plow. This same plow has been used for many years. When it is not in use, it is in the Royal Museum, where also can be seen the robe and crown of the official who performs the plowing ceremony.

The procession entered the field to the left of the Royal Pavilion, went down the field past the foreign colony pavilion, turned and proceeded to the pavilion for the priests where it stopped. The Minister of Agriculture and the priests entered the pavilion where the Minister knelt before an altar and prayed, after which he chose a skirt from three offered him. The choice of the skirt is very important, and the choice is anxiously awaited by the people. If the skirt is a short one there will be a drought the coming year, and if it is a long one floods can be expected. But if the skirt chosen is medium in length, as it was at the ceremony I saw, then normal rains are the prospect. The Minister of Agriculture donned the skirt and left the pavilion to continue the ceremony.

The procession then went on to the Royal Pavilion. After the procession left the Priests' Pavilion, four beautiful, glossy, tawny oxen were led on to the field and tied in a covered stall erected for the purpose.

On reaching the Royal Pavilion, the procession stopped. The Minister of Agriculture advanced to a position immediately in front of the Crown Prince where a mat had been placed. Here he knelt, placed his hands together in an attitude of prayer, described a small circle three times, then bowed low. This obeisance was repeated three times.

After this ceremony, two of the four oxen were led out and hitched to the plow. At the head of each ox walked a green-robed attendant. The Minister of Agriculture now walked behind the plow. He placed his hand on the handle but did not do any of the actual work. The work was done by an attendant who in a stooping position pressed the plow into the earth. This was not very difficult as the ground had been previously plowed and harrowed. Some of the Brahmin priests now ranged themselves alongside the oxen and behind the plow.

After three furrows were plowed around the field, four very old women of noble rank, each carrying two baskets suspended from a bamboo stick, Chinese fashion, took their places behind the Minister of Agriculture. In the baskets were seeds. As the procession proceeded the Minister called a halt from time to time and broadcast the seeds from the baskets of the old ladies. The Brahmin priests at intervals would shake water from the conch shells they carried. This proceeding continued until the field was plowed, all the seeds scattered, and all the water sprinkled.

When the procession withdrew from the field, many Siamese ran on to the field to pick up the seed. They were driven back by the guards as the time for this had not yet arrived.

The oxen were unhitched from the plow and led in front of the Royal Pavilion where two plates of grain and vessels of water and wine had been placed for them. What the oxen eat is of great importance as it foretells the crop-yield for the coming year. On this occasion the oxen were rather perverse and it was some time before they would deign to eat anything. But the priests were ready for any contingency and when the portents gathered from the ceremony were announced to the public, it was prophesied that the main crops of Siam were to be normal in yield and one very minor crop was to be poor.

After the oxen had eaten or rather had failed to eat, the most interesting spectacle occurred. The populace broke through the rope and ran on to the field. Men, women, children, the wealthy, the poor, the farmer, the merchant, the student, the office-holder all were eager to pick up some of the seed that had been broadcast. It is the belief that even one grain from the field, if mixed with the grain to be used for planting, will bless the crop and increase the yield.

This plowing ceremony is observed at central places in the kingdom on the same day as the ceremony is performed in Bangkok. The King appoints officials to represent him in the outlying districts. Thus Siam is trying to use one of her oldest ceremonials as an agency in awakening interest in and distributing information about her most important industry, agriculture. (Anne F. Cole, in the *Philippine Agriculturist, January 1931.*)

Effect of ploughing under cane trash on available Nitrogen of the soil.—The results of an extensive experimental investigation are summarized as follows:—(1) The addition of fresh cane trash to soils containing nitrates causes a very rapid transformation of the nitrogen into organic forms. (2) The depressing effect of cane trash upon nitrates diminishes at a fairly constant rate when this crop residue is in contact with the soil. (3) Fresh trash retards appreciably the rate of growth of corn plants, but incorporation of trash which has been partially buried for several months increased the yields and the initial rate of growth. (4) Addition of cane trash increases the water-holding capacity of soils and decreases their rate of drying. (5) There is addition of appreciable quantities of total nitrogen. Apart from these advantages, whether the continued practice of incorporating such large quantities of organic matter with a carbon: Nitrogen ratio of approximately 1: 40 would tend to so increase the accumulation of the more resistant constituent, *lignin*, as unfavourably to affect the composition and the productiveness of a soil, is a question the importance of which warrants further study (*Facts about Sugar*, February 1931).

Sugar-cane Varieties for Districts liable to inundation.—At the time of the cyclone at Miami (Florida) the Coimbatore, especially Co 281 showed remarkable powers of resistance to the results of flooding which lasted for over three months. When the waters subsided, all the shoots that were without physical defects were large and healthy, and the germination of the shoots below ground, was normal (*International Review of Agriculture*, January 1931.)

REVIEWS

'A Handbook of (Systematic) Forest Botany for Madras.'—Second Edition, by G. Viswanathan, B.A., Curator, Forest Museum, Coimbatore. Rs. 5. Available with the author. As many as 438 species of the more important seed plants common in the forests of the Madras Presidency have been very briefly described of which 431 are *Angiosperms* while the remaining seven are *Gymnosperms*. The author has followed the system of Bentham and Hookes in the arrangement of the plants. For each plant all the available vernacular terms in Tamil, Telugu, Kanarese, Hindustani and Malayalam have been given while in some cases trade names are also given. The description is just enough to enable one to identify the species whether it is in flower or not, and the distribution of the species and its uses are clearly indicated in each case. The author has taken considerable pains to make the book useful to the student of Forest Botany by adding notes such as Synopsis of Natural Orders, a chapter on classification, a glossary of botanical terms; and appendices 1 and 2 dealing with the industrial uses of wood and other minor forest produce. Though the author has very modestly expressed that the work is mostly of the nature of a compilation of the many existing works on Forest Botany in the field, still he deserves our warm congratulations on the extraordinary labour which a work of this kind involves. One feels that in a work of this type, a few photographs or pen and ink drawings at least of the important timber trees, such as the Teak, the Rosewood, the Irul, etc., would certainly add to the value of the book and make it a hundred-fold more attractive. (S. N. C.)

Rural Reconstruction by K. S. Srikantan, M. A., F. R. Econ. S. (London), Professor of History and Economics, Published by V. S. Swaminathan, Bookseller, Madura. Price Rupee One.—At a time when the air is full of the cry 'back to the land' and Rural Reconstruction is preached through press and platform, this little book of Mr. Srikantan comes in as a handy volume to clear up many misapprehensions on the subject. Though it does not contain anything startlingly original, it gives in a very concise manner, the existing ideas on Rural Reconstruction and the practical way of effecting it. A short account is given as well of the various experiments at Rural Reconstruction that are being carried out by various agencies in the country.

The Gurguon experiment, the Benares experiments, the Bholpur scheme, the Y. M. C. A. centres of Rural Reconstruction, are all referred to and their salient features mentioned.

The book will be an excellent text-book for students and others on the elements of the subject and provide the necessary equipment and clearness for more serious studies in village economics. It is refreshing to note that the author instead of following hackneyed and worn-out arguments in the exposition of the subject, displays in more than one place, frank and candid expression of opinion. We commend the book to all students of agriculture. (M. R. B.).

Correspondence—Queries and Answers

(With a view to economize space, it is proposed from this issue, to publish questions from correspondents in the form of serially numbered queries, and answers to the same will be given as far as possible then and there. The numbering has been commenced from the January issue of this year. Ed. M. A. J.)

Answer to Query No. 5.—(February issue—'Application of Fertilizers' —T. P. Subrahmanya Kandar, Salem).

That application of fertilizers like super-phosphate and ammonium sulphate hardens the soil and makes it not easily workable, is news to us. The Agricultural Chemist at the Research Institute, Coimbatore, to whom we have referred, says that he has had so far no experience of such a phenomenon. He would be glad to have full details of such experiences. We would suggest that a detailed statement of such experiences might be sent to the Agricultural Chemist, who would be glad to look into the matter. Ed. M. A. J.

Answer to Query No. 6.—(February issue—'Manures for and Crushing of Sugar-cane'—A. R. Nagappa Gounder, Ayyampalayam).

1. A mixture of groundnut cake and ammonium sulphate in the proportions of 4 : 1 or 3 : 2 appears to be the most profitable to apply for cane, the total mixture to supply from 100 to 150 lbs. of nitrogen per acre. This will mean roughly 800 lbs. of groundnut cake and 1½ cwts. of ammonium sulphate. The mixture should not be applied all at once, but in two or three doses, once before planting and later as a top dressing and

then earthed up during the growth of the crop. (Vide pp. 421 to 427—August 1930—*Madras Agricultural Journal*). M. R. B.

2. & 3. The Chattanooga bullock power mills available from Messrs. Volkart Brothers, Madras, and mills of very similar design like the 'Massey' mill made by Messrs. Masseys (1930) Ltd., Madras, and the 'Macrown' mills available from Messrs. Rowntree Mckenzie & Co., Ltd., Poona; are recommended by the Agricultural Department. A 'heavy' type of mill should be used for the crushing of hard canes like J. 247. Particulars of the mills may be had from the firms mentioned. N. G. C.

Answer to Query No. 7.—(March issue—V. Thirumal Rao, Berhampur).

1. No definite experimental evidence is available in regard to effect of silage on the vitamin content of milk but it appears reasonable to expect milk from cows fed on silage to possess better vitamin content than milk from cows fed on dry parched fodders. 2. The soda powder used in the cooking of *dhal* is so small that its action, if any, in bringing about indigestion is negligible. It must, however, be noted that soda powder destroys, if not all, some of the vitamins in the *dhal*. 4. Some preliminary work carried out in the Agricultural Chemist's laboratary indicates that after-setting or ripening of paddy grain occurs when paddy is stored. The liquifying or gelatinizing power of starch is decreased, hardening the starch-granule and making it less gelatinous when cooked. 5. The vitamin contents of different vegetables will be published in a later issue of the journal. Ed. M. A. J.

Query No. 11.—(Manuring of Pine-apple—D. Subrahmanyam, Samalkot).

I have gone through your Journal for February 1931 and noted with great interest on the farming of Pineapple Cultivation done at Simhachelam uphills. On page 71 of your Journal and Para 10 on the application of chemical and organic manures, it is stated that oil cake and ammonium sulphate application in addition to *Penta* would be advantageous for better yield. Will you please arrange to publish in the next issue of your valuable journal, if any other chemical or compound manures can be applied along with *Penta* and whether there is any harm by doing so (to the soil mixture) for future crops.

This information is required for general public.

Answer.—There is no harm in applying chemical manures simple or compound along with *Penta*. Ed. M. A. J.

Query No. 12.—(Use of the chaff cutter for soft fodders—'One interested') I shall be thankful if any of your readers will enlighten me on the following point.

Is it necessary to cut soft fodders like paddy and ragi straws with a chaff cutter before feeding them to the cattle and what is the reduction in the wastage of fodder by this operation? If the wastage is not diminished, it strikes me that mere crushing of the hard straws like cholam and cumbu, by passing through fluted rollers of a mill will make them more pliable and thus lessen the wastage more efficiently than the cutting of the straw with a chaff cutter.

FARMING CALENDAR FOR THE COIMBATORE DISTRICT

May

Rains in this month are very useful for the agriculturist. After the ploughing ceremony referred to in the last month's calendar the ryot anxiously awaits one or two good thunder-storms which are usual in this month in order to prepare the land for the coming monsoon sowings. There is a proverb in Tamil which reads as follows :—

'பரணிமழை தரணியெல்லாம் பொலி'

(If there be rain in *Bharani*, the harvest will be plenty all over the earth.)

This word '*Bharani*' here refers to the solar period from about the 26th of April to the 10th of May. The rains received therefore in the first part of May as indicated by this adage are very valuable and the ryot puts his plough on the land and sees that preparatory tillage is done satisfactorily.

The showers are received off and on in this month and, in all, amount to 2½ to 3 inches on an average.

The ploughed soil absorbs the rain very well, and the moisture is conserved in by repeated cultivations.

The south-west monsoon indications are already visible in the last week of May, and fairly strong west winds begin to blow towards evenings. Sometimes occasional drizzles are also received along with the south-west winds.

An intelligent farmer is able to predict from the weather conditions of this month as described above, the setting in of the monsoon at the right time in June and its character as well.

The very first sowings of the year in light dry soils, especially of red gram and gingelly, as also of *cumbu* are attempted in certain parts if rains are favourable and sufficient moisture obtained.

This sowing season is very often known as 'கடும்பட்டம்' which means that the ryot is prepared for a failure of the crop but risks it in the hope that a favourable season following would give a bumper outturn.

Preparation for ragi in garden lands is in full swing; seed beds are raised in different weeks. The main field is manured, sometimes penned with sheep and planting of ragi taken up towards the last week.

Irrigated cholam is in ears.

The first crop of Cambodia cotton being over, a few intelligent farmers remove this crop whilst others hoe and irrigate it, with a view to induce a second flush and get a subsequent picking. This practice is not sound—and ryots are recommended not to keep the crop for this second flush, as the cotton plants continue to be a welcome host for the increasing number of insects (Stem Weevil and Boll Worm) that will breed in them.

Summer brinjals will be coming in abundance during this month.

In wet lands, dry seed-beds are prepared for raising paddy nursery.

Ryots gather leaves in the near forests and waste lands and stock them ready for applying to the paddy fields after the rains. Cultivators from distant parts like Erode and Karur visit the interior dry tracts of the district Dharapuram and Palladam and purchase Kolinji leaves stocked by the dry-land farmers for applying to paddy fields in the river valleys.

The dry-land ryots make it a business to encourage the growth of Kolinji in their lands, take 1 or 2 cuttings of this and stock the stuff for sale as leaf manure as above mentioned.

Sugar-canes, plantains and plantations like coconuts receive their usual attention and are kept up by irrigation as necessary.

College News and Notes

Student's Corner.—The students of the College were busy throughout March preparing for the various examinations. The first year students finished their Annual Examination and an innovation has been introduced this year by announcing the results, before the students leave for their mid-summer break up. While this system would relieve many lads of suspense, it will also help those who have not been found to be up to the standard here, to choose during the vacation, other walks of life more congenial to their tastes and temperaments.

The second and third year students have finished the theory portions of the B. Sc. (Ag.) Degree Examinations in Parts I and II and are awaiting their Practical examination which are due to commence after the Easter holidays.

There was quite an epidemic of 'Teas' during the month, we trust that neither students nor the staff suffered from the effects of indigestion at this busy part of the year characterized by farewells and expressions of good will and good wishes.

Athletic Activities.—Save for a hockey match on February 25, with the Foresters, which we lost by 3 goals to 2, there was no other marked athletic activity.

The Association of Economic Biologists.—A meeting of the Association was held on 13th instant, when Dr. J. S. Patel, Ph. D., and Mr. N. Parthasarathy, B.A., B. Sc. (Ag.) read two papers on 'Animal Sex-Physiology' and 'A Note on *Oryza sativa* var. (Plena) Prain' respectively. The papers were followed by a lively discussion.

The Scout Movement.—After a number of years during which there was a lull in the activities of the scouts, the movement has been revived and boys are busy and enthusiastic preparing for the various tests, and trying to be useful on the estate, in several ways. We wish the new scouts all success and trust they will live up to the traditions of the former troop which was one of the finest and most serviceable ever going.

Visitors.—Mr. T. Murari, Officiating Deputy Director of Live-stock, was here during the month in connection with the inspection of the Dairy herd.

Weather Review

MARCH 1931

Rainfall data

Division	Station	Actual	Departure from normal	Total from January 1st
Circars ...	Gopalpore ...	0·5	0	0·5
	Vizagapatam.	0·1	– 0·2	0·1
	Cocanada ...	...	– ·04	...
	Masulipatam.	...	– 0·4	...
Ceded Districts	Kurnool ...	0·4	+ 0·1	0·4
	Bellary ...	...	– 0·2	...
	Anantapur ...	...	– 0·1	...
	Cuddapah ...	...	– 0·2	...
Carnatic	Nellore ...	...	– 0·2	...
	Madras ...	...	– 0·3	0·1
	Cuddalore ...	...	– 0·2	2·9
Central ...	Vellore ...	...	– 0·2	...
	Salem ...	...	– 0·5	...
	Coimbatore Town ...	...	– 0·5	...
	Coimbatore Res. Inst. ...	...	– 0·8	...
	Trichinopoly.	...	– 0·3	0·4

Division	Station	Actual	Departure from normal	Total from January 1st
South ...	Negapatam ...	...	– 0·3	1·7
	Madura ...	0·1	– 0·5	0·6
	Pamban ...	...	– 0·5	6·9
	Palamkottah.	...	– 1·3	1·3
West Coast	Trivandrum.	0·2	– 1·3	0·7
	Cochin ...	2·3	+ 0·4	2·8
	Calicut ...	...	– 0·5	...
	Mangalore ...	...	– 0·1	0·1
Mysore and Coorg	Bangalore ...	0·1	– 0·4	0·1
	Mercara ...	0·3	– 0·6	0·3
Hills ...	Kodaikanal ...	...	– 3·0	1·9
	Coonoor ...	...	– 2·5	1·7

General Summary of weather conditions:

Pressure was generally above the average over the peninsula and for the greater part of the month the distribution was of a type not unusual in March. An area of high pressure lay over the peninsula as a belt running from north-east to south-west, with areas of low pressure to the north and south. This pressure distribution determined northerly winds of an anti-cyclonic character over the Carnatic and south and consequently dry weather prevailed during the month. Feeble hot weather conditions prevailed over the central regions of the peninsula but these failed to develop, and the moist indraught of sea winds failed to be set up.

Sporadic thunder showers appeared about the 8th but were confined to the Malabar coast and near the hills and in the Circars. Rainfall associated with them was small in amount, except at Cochin which reported a fall of 1·8 inches on the 8th. Rainfall was generally in defect throughout.

Temperatures were in defect in the Deccan and about normal elsewhere. Skies were generally free from cloud and humidity low.

Weather Report for the Research Institute Observatory:

Summary of daily observations:

Absolute Maximum in shade	...	...	100°·0
Absolute Minimum in shade	...	...	63°·0
Mean Maximum in shade	...	...	95°·7
Mean Minimum in shade	...	...	70°·7
Total rainfall in month	...	...	nil
Departure from normal	...	...	—0·79 inches
Mean daily wind velocity	...	...	2·5 M.P.H.
Mean 8·00 hours wind velocity	...	...	2·4 ,,
Mean humidity at 8·00 hours	...	...	70·6 per cent.
Total hours of sunshine	...	...	327·7
Mean daily hours of sunshine	...	...	10·6

Summary of weather conditions:

Weather was fine throughout the month with dry hot days. Pressure was steady except towards the end of the month when a fall set in with rising day temperatures. No rain occurred and but distant lightning was observed on a few days, a feature rather unusual for March when thunderstorms are a common feature. Day temperature rose to 100° on the afternoon of the 29th. Diurnal variation was high on that day with a difference of 32·3° between the day and night temperatures. Skies were free from cloud, and the air dry in the afternoons.

P.V.R.
B.S.N.

Departmental Notifications

Promotions.—G. Ganapathy Ayyar, Assistant in Chemistry, promoted from IV to III Grade. P. Krishna Rao, Assistant in Millets from V to IV Grade.

D.A.'s Office Orders.—V. V. Varadarajan, Lower Subordinate, IV Grade, II Circle, to be A.D., V Grade (Upper Division) from 1-3-31. The Millets Specialist will submit proposals for the transfer of an officer from the Agricultural to the Research side. The date of transfer of this officer can be arranged to suit the convenience of the M.S. and the officer under whom the A.D. is now working. U. L. Srinivasa Rao, Lower Subordinate, V Grade, will remain at the Millets Station until the actual date of arrival at the Millets Station of the A.D. referred to above. The post of Sub-Assistant now vacant in the Millets Section and the post of A.F.M. to be vacated by U. L. Srinivasa Rao, will both be abolished with effect from 1-3-31.

Second Circle.—K. V. Seshagiri Rao, A.A.D., Vinukonda, granted l.a.p. for 14 days from 8-4-31 with permission to prefix Easter holidays.

Fourth Circle.—A. Ramaswami Ayyar, F.M., Palur, granted l.a.p. for one month from 10-3-31 or date of relief. R. Narasimha Ayyar, A.A.D., Mycology, Cuddalore, granted extension of l.a.p. for 1 month and 15 days from 18-2-31. V. Suryanarayana, F.M., Kalahasti, granted l.a.p. for 2 months from 8-4-31 with permission to prefix Easter holidays. C. Annamalai, F.M., Palur, posted to Kalahasti, *vice* V. Suryanarayana. P.K. Palaniswami, F.M., Palakuppam, posted to Palur. P. S. Venkatasubramanian, A.D., Cuddalore, granted l.a.p. for 16 days from 3-3-31.

Fifth Circle.—R. Kolandavelu Naicker, A.D., on probation, under training at the A.R.S., Aduturai, granted l.a.p. for 6 days from 8-4-31, with permission to prefix Easter holidays.

Sixth Circle.—V. Chidambaram Pillai, F.M., Koilpatti, to be A.D., Srivaikuntam. P. K. Natesa Ayyar, A.D., Srivaikuntam, to be F.M. Koilpatti. C. S. Namasivayam Pillai, A.A.D., granted further extension of leave on m.c. on half a.p. for one month from 16-2-31. C. S. Namasivayam Pillai, A.A.D., transferred to VIII Circle. K. K. Subrahmania Ayyar, A.D., Paramakudi, granted l.a.p. on m.c. for 2 weeks from date of relief.

Seventh Circle.—A. Gopalan Nair, H.M., Taliparamba Middle School, granted extension of leave on medical certificate for 10 days from 5-2-31. G. Sakharama Rao, A.D., Puttur, granted l.a p. for 24 days from 8-3-31, with permission to affix Easter. A. P. Balakrishna Nair, F.M. granted extension of l.a.p. for 1 month on m.c. C. Raman Moosad, F.M., on leave, transferred to the A.R.S., Taliparamba. P. Abdulla Haji, A.A.D., granted extension of l a.p. for 4 days. K. G. Nambiar, A.D., Calicut, granted l.a.p. for 15 days from 2-3-31. K. G. Nambiar, A.D., granted extension of leave for 17 days with permission to affix Easter holidays. E. Acutha Nair, A.A.D., Ponnani, granted l.a.p. for 9 days from 24-3-31 with permission to avail Easter holidays. G. Sakharama Rao, A.D., Puttur, granted extension of l.a.p. by 15 days.

Eighth Circle.—P. S. Manian, A.D., Annur, granted extension of l.a.p. on m.c. for 13 days from 13-3-31. P. S. Manian, A.D., Annur, to report for duty to the A.D., Udumalpet on 8-4-31.

D. D. L. S.'s Section.—T. S Lakshmanan, F.M., Kavali, under training, transferred to L.R.S., Guntur, from 23-2-31. The services of K. Thomas Benjamin, F.M., on probation, L.R.S., Hosur, will terminate from 19-4-31, for not having passed the Account Test for Agricultural Officers.

Principal's Section.—K. L. Ramakrishna Rao, A.L.A., transferred to the III Circle to be relieved on 20-4-31. M. Satyanarayana, A.D., III Circle, on relief by K. L. Ramakrishna Rao, to join duty as A.L.A., Coimbatore, on 1-5-31.

G.A.C.'s Section.—G. K. Chidambaram, Assistant, granted l. a.p. for one month from 5-3-31.

G.M.'s Section.—P. S. Suryanarayana Ayyar, Sub Assistant, granted l. a.p. for 4 months from 9-3-31. C. S. Gopalaswami Rao, Assistant, granted l. a.p. for one month from 8-4-31 with permission to prefix Easter holidays.

G.E.'s Section.—N. Krishna Menon, Sub Assistant, granted l. a.p. on m.c. for 5 weeks from 23-3-31.

P.S.'s Section.—C. Rajasekhara Mudaliar, Assistant, Pattambi, granted l. a.p. for 23 days from 8-4-31 with permission to prefix Easter holidays.

M.S.'s Section.—V. Gomathinayagam Pillai, Assistant, granted l. a.p. for 10 days from 9-2-31. C. Vijayaraghavacharya, Asst., transferred to A.R.S., Hagari, to be in charge of the station.

APPENDIX

ADDITIONS TO THE LIBRARY DURING FEBRUARY, 1931

A. BOOKS

'*The Genetical Theory of Natural Selection.*'	By R. A. Fisher ...	1930

B. REPORTS, PROCEEDINGS, Etc.

1.	Proceedings of the Board of Agriculture in India...		1929
2.	Annual Report of the Agricultural Department	Bengal.	1929–30
3.	Do.	Mysore ...	1928–29
4.	Do.	Gambia ...	1929–30
5.	Do.	Zanzibar Protectorate.	1929–30
6.	Do.	St. Lucia, West Indies.	1929
7.	Do.	England, Imperial Agricultural Bureau.	1929–30
8.	Do.	Experiment Stations—Bihar and Orissa.	1928–29
9.	Do.	Northern Circles—Central Provinces and Berar.	1926–27
10.	Do.	Southern Circle—Central Provinces and Berar.	1928–29
11.	Do.	Hawaii ...	1929
12.	Year Book of the U.S.A., 1928.		

C. BULLETINS, PUBLICATIONS, ETC.

13.	Indian Plant Remedies used in Snake-bite ...	*Indian Medical Research Memoirs*—19
14.	'Ox Warble Fly'—Report on the demonstration and experiments carried in 1928-29.	*England—Worcestershire County Council Publication.*
15.	Ecological Studies of the Beet-Leaf Hopper ...	*U.S. Agricultural Department Technical Bullettin No.* 206
16.	Tobacco culture	*U.S.A. Farm. Bulletin No.* 571
17.	Breeds of Draft-Horses	,, ,, 619
18.	Tuberculosis of Hogs	,, ,, 781
19.	Potato Storage and Storage Houses	,, ,, 847
20.	Tuberculosis in Live-stock	,, ,, 1069
21.	Feeding Cotton Seed Products to Live-stock ...	,, ,, 1179
22.	Permanent Fruit and Vegetable Gardens ...	,, ,, 1242
23.	American Moles	,, ,, 1247
24.	Growing Sweet Corn for the Cannery	,, ,, 1634
25.	Rat-Proofing Buildings and Premises	,, ,, 1638
26.	Construction of Chimneys and Fireplaces ...	,, ,, 1649

27.	Classified list of projects of the Agricultural Experiment Stations.	*U.S.A. Miscellaneous Publication No.* 89
28.	The Agricultural outlook for the Southern States—1930-31.	,, ,, 102
29.	The World Cotton Situation with outlook for 1931-32.	,, ,, 104
30.	Papaya Culture in Hawaii	*Hawaii Agricultural Experimental Station Bulletin No.* 61

D. LEAFLETS, CIRCULARS, Etc.

31.	The method of sending plant specimens to the Government Systematic Botanist.	*Madras Agricultural Department Leaf.* 71a
32.	Loan to Ryots	,, ,, 74
33.	The 'Hyderabad' Cotton-Seed Defibrating 'Machine.'	*Hyderabad Industrial Department Circular No.* 1
34.	Insecticides and Fungicides	*England—Ministry of Agriculture and Fish. Adv. Leaf. No.* 9
35.	Mole draining	,, ,, 12
36.	The Apple Sawfly	,, ,, 13
37.	Swine Erysipelas...	,, ,, 17
38.	The Cabbage Root fly	,, ,, 18
39.	'Black Head'—(infectious disease) of Turkeys ...	,, ,, 20
40.	Lamb as you like it	*U.S. Agricultural Department Leaf. No.* 28
41.	Fertilizers for Pecan Soils	,, ,, 71
42.	Fowl Cholera	*The Cyprus Gazette No.* 2103—*Agricultural Supplement* 30
43.	British Markets for Cyprus Products	*The Cyprus Gazette No.* 2111—*Agricultural Supplement* 31

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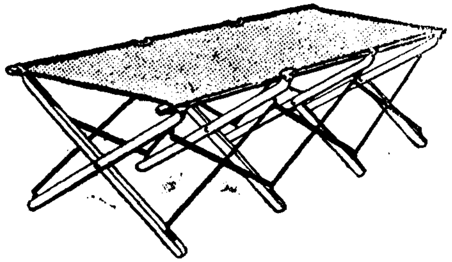

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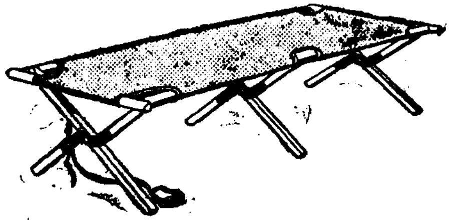

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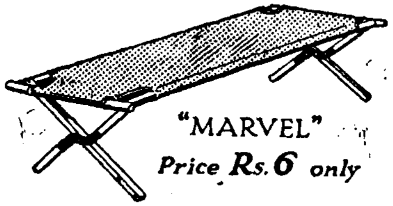

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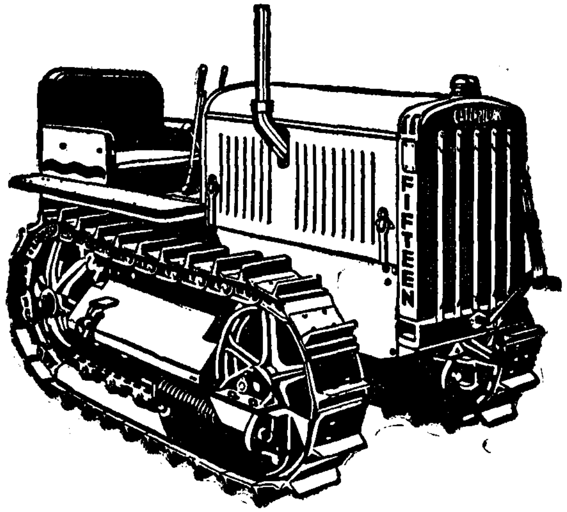

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1. The Prize will be awarded in July 1931.

2. The Prize will be in the form of a Medal and will be awarded to the member of the Union who submits the best account of original research or enquiry, carried out by him on any agricultural subject.

3. The subject matter shall not exceed in length twelve foolscap pages, type-written on one side.

4. Intending competitors should notify the Secretary of the Madras Agricultural Students' Union not later than the 15th May the subject of the paper which they propose to submit and the paper should be sent in so as to reach the Secretary, Madras Agricultural Students' Union not later than the 1st June 1931, with a covering letter showing full name and address of the sender. The author's name should not be shown on the paper but should be entered under a *nom de plume*.

5. Four type-written copies of the essay should be sent in.

6. The name of the successful competitor will be announced and the prize awarded at the time of the Conference.

7. Papers submitted will become the property of the Union and the Union reserves to itself the right of publishing all or any of the papers.

8. All references in the paper to published books, reports or papers by other workers must be acknowledged.

Any further particulars may be obtained from the Secretary, Madras Agricultural Students' Union, Lawley Road P. O., Coimbatore.