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# Original Articles

## SOME COMMON INDIAN BIRDS

### No. 26. THE HAWK-CUCKOO (*HIEROCOCCYX VARIUS*).

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,
*Imperial Entomologist;*

AND

C. M. INGLIS, M.B.O.U., F.E.S., F.Z.S.

THE common name "Hawk-Cuckoo" conveys a good description of this bird, as it is really a Cuckoo which looks very like a hawk. It is about the size of a mynah, but with a longer tail, greyish-brown in colour, whitish beneath, the breast tinged with pink, each feather with darker cross-bars, eyes and legs brilliant yellow. When on the wing, it looks very much like a small hawk but, when it alights, it at once assumes a slouching, cuckoo-like attitude, with the wings dropped forward so as to touch the perch and the tail slightly raised and expanded, thus presenting an aspect very different from the compact and alert look of a hawk. Seen thus, at rest, this bird can hardly be mistaken for a true hawk, as it has the furtive, peering ways of common cuckoos, constantly jerking itself from side to side and puffing out its throat.

The appearance of the Hawk-Cuckoo is probably less familiar to most people than is its note, which has aptly earned for it the notorious title of the "Brain-Fever Bird." Our Indian gardens and groves contain many sweet-voiced singers amongst their avian denizens and a few whose voices are less grateful to the ear, but there is not one whose notes consist of such ear-splitting and nerve-racking cries as do those of the Brain-Fever Bird. With the most annoying persistence and reiteration this bird repeats its cry, which bears a remarkable resemblance to the word " brain-fever " repeated in a piercing shriek running up the scale. The cry may also be

Head and foot of Hawk-Cuckoo (*Hierococcyx varius*).

written as " Pipiha " and in some districts the vernacular name of the bird is given as *Pupiya.* Another rendering of the call, which includes the overture preceding the triple note, is, " O lor' ! O lor' ! how very hot it's getting—we feel it, *we feel it,* WE FEEL IT." The call is extremely loud and shrill and can be heard—indeed, it cannot but be heard—within a radius of several hundred yards, but one of the most annoying things about it is its intermittent character. The human ear soon becomes accustomed to any continuous and uniform kind of noise. One becomes so accustomed to the buzz of a dynamo that one awakens at once if it stops. The copper-smith *tonk-tonking* in the garden all day is hardly heard consciously unless one listens for it. But the shrieks of the Brain-Fever Bird burst their way without ceremony into one's inner consciousness, whether awake or asleep, and one cannot help but hear them. "We feel it, *we feel it*, WE FEEL IT" go the cries, up and up the scale, and then suddenly stop, and one hopes fervently that this fiend in bird's plumage has burst its throat or at least flown away out of ear-shot. But no; after a short interval it begins again and may continue for hours at a stretch. Very often the performance commences just at dusk, when it has got too dark to make out the culprit, and lasts all night without intermission. When this sort of thing takes place on a really hot night, the victim, who is attempting to woo sleep after a hard day's work, may well be excused if the first dim dawn sees him sallying forth on vengeance bent. But vengeance is not always easy to attain. The bird usually perches high up in a tall tree and keeps so still and is so inconspicuously coloured that, even when its shrieks locate the very branch whereon it is sitting, it is not always easy to make out. Further more, it is wary and often flies off as soon as it sees that it has been detected. There are, however, usually only a few individuals in each locality and a comparatively small reduction in numbers works wonders in abating the nuisance. The call being very penetrating, it often happens that these birds call to one another across a distance of perhaps half a mile and, by shooting one bird forming a link in the chain between others on either side of it, the chain is broken, and a blessed peace reigns once more, at least until another bird invades the immediate neighbourhood. In Bihar the call of this bird coincides with the approach and duration of the hot, dry weather before the monsoon; occasionally it may be heard as early as in December but more usually commences about February and is continued, becoming more frequent and continuous, until the Rains break, when there is a welcome cessation for a few months.

In other districts this may not be so; thus, as regards Calcutta, Cunningham states that "there is hardly any season at which their characteristic notes may not occasionally be heard; but, as a rule, it is during the rainy months that they are most frequent, so that the designation 'hot-weather bird,' that is often applied to the species in other parts of the country, is hardly applicable to it in Calcutta."

According to Blanford, the Hawk-Cuckoo occurs throughout the whole of India and Ceylon, extending as far East as Dacca, but not to Assam, and West to Rajputana, but not to Sind or the Punjab; but, although odd examples may occur throughout this area, its range as a common bird seems to be more restricted. It is extremely common in the United Provinces and Bihar, less common further south in Bengal. Dewar notes that he never heard it in Madras, nor did I ever hear it during my residence in Coimbatore, and it is apparently quite absent in the island of Bombay. In some districts in which it is absent, or at least scarce, the Hawk-Cuckoo is frequently confounded with the Koel and the name "Brain-Fever Bird" given to the latter. As Dewar puts it, "There is certainly some excuse for the mistake, for both are cuckoos and both are exceedingly noisy creatures; but the cry of the koel bears to that of the brain-fever bird or hawk-cuckoo much the same relation as the melody of the organ-grinder does to that of a full German band. Most men are willing to offer either the solitary Italian or the Teutonic gang a penny to go into the next street, but, if forced to choose between them, select the organ-grinder as the lesser of the two evils. In the same way, most people find the fluty note of the koel less obnoxious than the shriek of the hawk-cuckoo."

In spite of its obnoxious vocal efforts, the Hawk-Cuckoo does some little good by feeding on injurious insects, although when it can find time to hunt these out in the height of the hot weather, when it seems to be calling continuously day and night, always seems somewhat of a mystery. Like other cuckoos, it eats hairy caterpillars, whose defensive armament protects them from the attacks of most other birds, and it also eats other caterpillars, crickets, grasshoppers, bugs and beetles. The diet is a mixed one, comprising buds and fruits, particularly wild fig fruits, as well as insects. It is presumably on account of this redeeming feature that this bird is protected in Delhi, the United Provinces, Bengal and Assam (where, however, it does not occur !).

Like other Cuckoos, the Brain-Fever Bird economizes in house-keeping, building no nest of its own but placing its eggs in the nests of other birds, usually the "Seven Sisters" or some allied species of Babblers, the breeding-season lasting from April until June. The eggs are deep blue in colour and measure about 26 mm. by 20 mm., and are about the same size and shape as those of the foster-parents. The Babbler's eggs are wholly blue, very glossy, hard-shelled and broad, blunt ovals in shape; the Hawk-Cuckoo's eggs are very similar in colour but with a softer, more satiny surface, less glossy and with much thicker shells, in shape rather more spherical or elliptical and slightly larger than in the Babblers. When lying side by side in the nest, however, the eggs of the Babbler and of the parasitic Cuckoo are often practically indistinguishable.

The manner in which Cuckoos' eggs are deposited in the nests of other birds is one which has engaged a great deal of attention. It used to be supposed that the eggs were laid in the normal way in the nest of the birds selected as foster-parents and this may occasionally be done, but the more frequent method is for the egg to be laid and then carried by the cuckoo in its bill and dropped into the nest selected for the purpose. The unusually thick texture of the cuckoo egg-shell seems to be specially adapted to this end as, in cases where the nest is placed inside a hole, the egg may have to be dropped into it from a little height. In the case of the Hawk-Cuckoo, it is possible that its hawk-like appearance on the wing may be advantageous in securing a clear field for depositing an egg in this way in the nest of the Seven Sisters, as one observer states that the whole sisterhood make themselves scarce when the Hawk-Cuckoo appears on the scene, and thus give her a fair field for planting her oval imposition on them. Our Plate shows a Hawk-Cuckoo, with an egg in her bill, about to be dropped into the nest of one of these Babblers. It may be added that further observations, on the method of egg-deposition employed by this and other Indian Cuckoos, are very desirable.

The Hawk-Cuckoo is known vernacularly as *Kupak* and *Pupiya* in Hindi-speaking districts, as *Chŏk-gallo* in Bengal, as *Zakkhat* in the Deccan, as *Irolan* in Malayalam and as *Kutti-pitta* in Telugu districts.

PLATE V.

# INTERNATIONAL CONGRESS ON CATTLE BREEDING.

BY

G. S. HENDERSON, N.D.A., N.D.D.,

*Imperial Agriculturist.*

THE International Congress on Cattle Breeding was held at Scheveningen near the Hague beginning 29th August, 1923. The general attendance was good and there were representatives from all parts of the world (Plate V).

The subjects under discussion were as follows:—

*Section I.* Department of Science—

(*a*) Which new ideas and opinions about the doctrine of the heredity should be considered to be of importance for cattle breeding?

(*b*) Which are the opinions of recent date about the method of feeding?

*Section II.* Department of Registration—

(*a*) Which data should be mentioned in the cattle herd-book and how will this information have to be collected so that there will be a sufficient guarantee as to its correctness?

The method of recording the production of milk not to be taken into account here.

(*b*) In which way shall the control (production) of milk be carried out, and is it possible to make international regulations about this?

*Section III.* Interference and care of public authorities and influence of associations—

(*a*) In which way could the breeding of cattle be promoted by the public authorities by other than veterinary measures?

(*b*) In which way would it be possible for associations, whose object it is to improve the cattle stock, to make a practical use of the information to be obtained through science and registration?

*Section IV.* Economical breeding—

(*a*) Which points will have to be taken into consideration when selecting a breed for a certain type of an agricultural enterprise?

(*b*) How could tuberculosis among cattle be combated in a practical way and what is the experience of different countries in this respect?

Subject I (*a*) on heredity was an interesting sub-section and a summary of a paper by Professor Kronacher is appended. A summary of the paper by Professor Per Tuff is also given.

### Summary of paper by Prof. Kronacher.

(*a*)

Selection in breeding signifies nothing else than making use, in practice, of the laws of nature with regard to heredity. Ample knowledge of the results of the laws of heredity that have been acquired is therefore of especial significance for the breeder of cattle. For cattle breeding, the most importance must be attached, in the first place, to the results of investigations in the following three spheres of the law with respect to heredity: the genotype and the phænotype doctrines of Johannsen, the mutation doctrine according to de Vries and also the teachings of Mendel, further developed by many investigators during the past twenty years.

(*b*)

1. The work from Johannsen and his school shows that the differences in the development of distinctive marks and characteristics, among the several individuals, may only be the result and expression of the difference of conditions of life (phænotypical differences, modifications) or they may be the expression of genotypical differences.

Both of these causes may also co-operate, as is the case of foreign impregnation, as occurs in by far the most instances in the manner of our domestic animals.

Owing to the difference of the causes, the value also of the variations among the individual domestic animal is defined for selective breeding.

The appearance and the performances of a breeding animal are unable to tell us anything concerning its breeding and heredity value, because we are not able, without anything else, to see which of the two causes in question, in the particular case, gave rise to the different development of certain characteristics in the individuals to be judged. This can only be ascertained when it is known how the following generation has turned out.

From these views concerning the doctrines of variation and selection of recent times, ignorance and neglect of which has caused great loss of capital and work on breeding to practical cattle raising, the extraordinarily great importance of the individual for selection is seen, and also the necessity of the examination of its progeny—respectively its value as regards heredity, by virtue of the results of that progeny. The breeder must, as far as possible, use for his breeding exclusively those animals whose advantageous characteristics, with respect to breeding, as regards build of body and performances, are the expression, primarily, of an inherited susceptibility, which, even under average circumstances, is to be seen to equally great advantage.

The idea of heredity of acquired characteristics, as if the development (modification) of certain parts of the body and their activity (performances), acquired during the individual lives of the animals under the influence of circumstances, via the one or other course, is transmitted on the germ cells, respectively, the prevailing susceptibility to heredity, is not compatible with the theory mentioned with respect to this; nor is any support to be obtained for this theory from the extensive experimental investigations in that sphere, least of all, however, from the experience gained in cattle breeding itself. For, if inheritance of acquired characteristics, in the above-mentioned sense, and a continual progressive alteration of the total hereditary possession accompanying this, owing to selective breeding, that has been carefully conducted in one direction for such a long time now, took place, in all sheds, where breeding has been carried on efficiently, there would now be exemplary herds in every district.

There are, however, enough ways and means for the cattle breeder to achieve his purpose, even without such speculations as the presumption of the heredity of acquired characteristics, in the foregoing sense.

2. Among a homozygote and heterozygote herd, sudden, spontaneous changes of the susceptibility to heredity occur (changes of the genotype) which make themselves manifest as changes of heredity, occurring under similar conditions, of the actual exterior distinctive marks or performances (changes of the phænotype), mutations. Such a mutation is to be observed among plants, among the lower and higher animals, including our domestic mammals. They may be due to a loss of a factor of heredity, the qualitative or quantitative character of a prevailing factor, or the acquisition of a new. Concerning the occurrences and causes that effect such changes in the germ plasma, so far, nothing is known with any degree of certainty. It would, however, appear that besides inner, exterior influences, via the circuitous route of general alimination, both the body cells as well as the germ cells may be influenced and changes may be affected. Whether in each particular case one has to do with a " mutation " or a " modification," can only be decided by observations among the progeny. Modifications, particularly of quantitative characteristics, which presumably occur more often than is generally supposed. can, as a matter of fact, also be of a less obvious character and even then be within the normal lines of modification. Then, however. since they result in a continual removal of the *average*, in the development of the characteristics in question, under certain circumstances they are of great significance for the results of selection. Further, what is known so far concerning mutation, shows us again the extraordinary importance of the single individual in selection and the necessity of determining its breeding value by means of the

progeny; there is also, however, the necessity of fixing, in figures, the build of body and the performances of the animals in the succession of generations.

3. The Mendel investigations have shown, with absolute certainty, that every factor of heredity (situated in the chromosomen) for the most varying morphological and physiological characteristics behaves, in the process of heredity, perfectly independently, and that on crossing (bastard forming) the introduced hereditary factors in the succeeding generations are subject, according to fixed laws, to a splitting up; it has almost always been possible to find a natural explanation that is quite compatible with this.

Whether, in a few exceptional cases heredity has taken place according to other laws than those regarding the splitting up of the cells, or perhaps also to certain characteristics of the animal body, are not determined by special natural disposition in the kernel, but are general alimentary characteristics of the entire plasma, both of the body and the germ cells, is a question that has remained unanswered down to the present. In any case, the Mendel law of separation, apart from such disappearing and hitherto unknown exceptions, is generally of application, also for the process of heredity among our domestic animals.

With this insight, a great number of conceptions and ideas, which, until quite recently, had an overwhelming influence upon the views of breeders, must disappear. Before everything else, breeders must, once and for all, give up the idea of the existence of a "constant intermediary heredity," of the occurrence of existing middle formations remaining alike for longer than the first generation, on the pairing of animals of similar or different breeds with, in certain directions, opposite hereditary dispositions. But even the view of an arbitrary possibility of mixing characteristics generally, expressed by the terms $\frac{3}{4}$ths. $\frac{7}{8}$ths, $\frac{15}{16}$ths blood. etc., will have to be rejected.

The fact that has been ascertained, that it is not the type of animal as such that is inherited, that the natural disposition of characteristics does not form one whole in the process of heredity, but that, on the contrary, the separate factors of heredity take their own course, gives us a second insight that is extremely important for the practice of breeding: the insight of the possibility in principle, of a systematic combination in one, of the various distinctive marks and characteristics, hitherto distributed throughout several hereditary types and races, i.e., the insight into the possibilities and means for the breeding of new hereditary types and races, by means of crossings.

A decisive influence upon the entire forming of the meanings and general effective mode of thought in breeding, has been the chief consequence of the results of the new doctrine of heredity and especially of the two fundamental views of the Mendel doctrine.

The consequence of these altered ideas in the world of breeding will be: uniform general methods of breeding and a uniform explanation of the appearances which occur on the carrying on of breeding, as these, as a matter of fact, are already beginning to occur everywhere in breeders' circles.

(c)

Regarding the question concerning special possibilities of making use, in practical breeding, of the new doctrines of heredity:

1. The method of the choice of individual breeding which must fix the "breeding (as to heredity) value" (in contrast to the "personal value") of a breeding animal and, under certain circumstances, also its homozygote and heterozygote disposition in connection with results of the progeny, as a consequence of its pairings for crossings, respectively, of trial pairings. In practice, it appears that the method of pairing for crossings, which must serve especially for the fixing of the heredity of quantitative characteristics, for the larger domestic animals, however, this is only possible under certain conditions, for the purpose of approving male breeding animals. Even here, however, from an economic point of view, fixed limits have been set for the application of this method as a result of the numerous characteristics that are generally to be taken into account, but also owing to the slow process of increase and the long time before being capable of use, by the larger domestic animals. The method that has been applied, for some time past, upon which

fixing the powers of performance must be based, in England and other countries is experimental.

In order to achieve a result responding to this, it would seem to be necessary to limit oneself, primarily, to the observance of one or just a very few of the most important characteristics and then systematically, one after the other, according to their significance, bring these within the method of selection. For an easier and more certain insight into the heredity disposition of the parents to be approved with respect to quantitative disposition, in the very first place, it would appear also to be effective that the offspring should be reared under normal or even moderate, but in no case under especially favourable circumstances, seeing that otherwise, in such cases, the difference between favourable modifications of moderate and bad hereditary disposition is not to be distinguished from an inferior development of very good hereditary disposition. Those individuals which give evidence, also under comparatively simple conditions of life, of bodily development and performances of high value, are just of the greatest importance to the breeder.

The fact that the Mendel doctrine has laid it down that a whole number of distinctive marks and characteristics of our domestic animals, the so-called quantitative characteristics according to the nature of the quantity of milk, the percentage of fat, etc., just the most important for breeding, are apparently determined by factors of heredity, working, more or less, in the same direction, in any case combining their work, facilitates for the breeder the insight into the symptoms acting in this connection and simultaneously with this the work of cattle breeding. It shows him, in the first place, how indispensable it is to know how the progeny turns out, if he is desirous of correctly estimating the breeding value of the parents, and, secondly, the necessity of the exact carrying out of examinations concerning performances.

For the more extensive practical use of the possibility of an effective combination of economically valuable characteristics, distributed among several races, in one breed, by a systematically founded scientific method, especially for the larger and the largest domestic animals, in a great measure, so far, further knowledge of the nature and the conduct of the hereditary disposition, which determines the economically most important, and in the special case, the characteristics especially required, is lacking. Those methods which, as a matter of fact, are already being applied at the present time with some systematic experiments, even after we shall possess the further knowledge necessary for this, with respect to the main thing determining hereditary disposition, it will still be difficult and especially for complicated combination breeding, the application will continue to be limited. In any case, however, especially for times of drastic change in economic conditions and the need accompanying these of a new formation of the stock of cattle, as also for special occasions, not to be underestimated for prospects for the affecting of an alteration of the stock of cattle, within a corresponding period that will adapt itself, as well as possible, to the altered or special circumstances.

The new doctrine of heredity has an exceptionally lasting influence upon the mode of thought of the breeder, and with this, upon the general measures and the judgment of the results of breeding.

It shows breeders the necessity of making use of individual selective breeding on the basis of the result of the progeny, and shows him the ways and means, truly limited, indispensable to this for breeding domestic animals.

The views of the Mendel doctrine give the breeder very valuable general particulars and also even many special points for combination in carrying on selection in breeding. For any scientifically systematic carrying on of selection, both within a breed, especially with a view to attaining as good results as possible from combination breeding, further knowledge concerning the nature and the conduct of the definite factor of heredity is still lacking.

It is in the interests of the economic breeding itself of domestic animals to investigate in all directions the question of heredity among domestic animals, especially by supporting existing or newly established institutions for biological research and to promote as extensive as possible herd-book relations available for the investigation of heredity.

SUMMARY OF PAPER BY PROFESSOR PER TUFF.

The analysis and investigation of the characteristics and circumstances of heredity in our breeds of cattle must be based primarily on the particulars of the herd-books. Those herd-book particulars are also of great significance for studying the results of various methods of breeding. It would therefore be desirable that the herd-books should be compiled according to a common international plan, so that the particulars from individuals should be similar, complete and as reliable as possible.

By a systematic selection in breeding, it may be attained that within one and the same breed, the herd will acquire a similar exterior, but an uncertain heredity. A system of in-breeding will not only support a choice of breed for similar characteristics, it will also result in a lasting and certain heredity.

The effect of selection in breeding, as regards recessive and dominant characteristics, is different. A recessive characteristic immediately becomes homozygote and will certainly be transferred. Selective breeding of a dominant characteristic, will, in the end, lead to homozygosis; this, however, takes place very gradually. Dominant characteristics, based upon homomere factors, practically speaking, cannot become homozygote solely by selective breeding.

The effect of in-breeding consists in this, that it leads, automatically, to homozygosis of all tendency to characteristics. Harmful results from in-breeding are consequent on the splitting up of recessive weaknesses. Most of the old races of cattle are based upon in-breeding; they are kept intact by this means and are indebted for their constant heredity to this. Simultaneously they have been purified, in a great measure, from disintegrated constitutional weaknesses. Such races, as a rule, will stand in-breeding well. An example of this is seen in the Telemark cattle in Norway. Young races of cattle, and races in which in-breeding has not taken place, will generally not be able to stand this well, and in that case, care must be taken with the application of this method of breeding.

Any harmful results of in-breeding can immediately be got rid of by the introduction of new blood.

It would be desirable that in-breeding should find greater application in practical cattle breeding, as a valuable means of fixing good characteristics, so that these be transferred. Where in-breeding can be applied, greater advantage will also be able to be taken of valuable covering bulls, by allowing these to serve closely related cows (such as, e.g., daughters or grand-daughters).

Probably Wright's[1] in-breeding co-efficient is the best of the various measures or expressions for the degree of in-breeding, as this gives, in a good way, the homozygosis achieved.

Colonel Matson, of the Indian Military Dairy Farms, contributed a paper on the results of crossing of Indian cattle with European breeds.

Subject I (*b*) on feeding was largely of a physiological nature. Some of the chemists present using the languages of their respective countries could not be followed by the writer, but judging from the tone of the discussion there seemed to be some serious differences of opinions.

Subject II was concerned with registration, and discussion ranged round the necessary particulars required in herd-books and other registration forms.

It was pointed out in discussion that a Friesian breeder in Australia might import stock from America, England or Holland and get animals with very different characteristics.

Subject III (*a*) on promotion of cattle breeding by the State is of considerable interest to India. The following summary of a paper by Dr. Attinger gives a catalogue of means whereby the State can usefully help on cattle breeding.

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[1] Wright, Sewall. Co-efficients of In-breeding. *American Naturalist*, Vol. LVI, 1922, p. 320.

SUMMARY OF PAPER BY DR. ATTINGER.

Cattle breeding in all civilized countries enjoys more or less encouragement on the part of the State, because the welfare and food-supply of the nation is dependent upon its development. The many uses to which cattle are put, raise the cow above the other agricultural domestic animals.

It may also be said and proven that the height of the development of cattle breeding is a standard for judging the civilization of a nation. The State is therefore bound to promote the development of stock-keeping.

This may be done by :—

1. Measures in connection with the cultivation of food-crops and the supply of fodder. The cultivation of food-crops forms the basis for the raising of cattle. Those measures have reference to the improvement of pasture lands, the promotion of susceptibility to this, extension of the cultivation of food crops on agricultural land, appointment of advisers, inspectors of seed cultivation, etc. The putting of peat grounds and heath under cultivation, the facilitating of the import of fodder in times of failed harvests.

2. Promotion of the health condition of the cattle, education and advice for breeders in the sphere of feeding, pasture, shed and breeding hygiene.

3. Legal regulations concerning characteristics, the keeping, examination and use for breeding purposes of the male breeding animals (compulsory examination).

4. Promotion of the investigation of powers of production, the training of milk inspectors, the holding of shows and exhibitions with classes for production, institution of controlling associations.

5. The establishment of Government model industries and model breeding farms. Those establishments must not be set up at great cost, which cannot be emulated by the breeders, but the establishments, as regards equipment, manner of working and profit making, will have to be examples capable of being followed by every breeder.

6. Promotion of associations in the sphere of cattle breeding, the appointment of official experts in cattle breeding or by granting

assistance towards their appointment. As breeding associations are the pioneers of the progress of cattle breeding, these should be strongly supported by the State.

7. Thorough training, theoretically and in practice, of breeders in Higher, Secondary and Lower Schools of Agriculture, the foundation of cattle-breeding institutes, the conducting of special courses for cattle breeding, the care of cattle, the regulations regarding food, milking, etc. Promotion of the granting of certificates of suitability to special cattle attendants.

8. Promotion of the holding of shows, examinations of cattle, exhibitions of fattened cattle, public sales of breeding-bulls, the acquiring of lower freights, Government premiums, medals.

9. The appointment of expert cattle-breeding officials, establishment of departments for cattle breeding at the Ministries for Agriculture, the conduct of cattle breeding from a central place.

10. Other measures: the regulation of the import and export of cattle, protective rights, supervision of the cattle trade and markets, effective policy regarding prices, Government cattle insurance, the furnishing of credit in accordance with the needs of the times, support for the great, important activities throughout the whole sphere of cattle breeding.

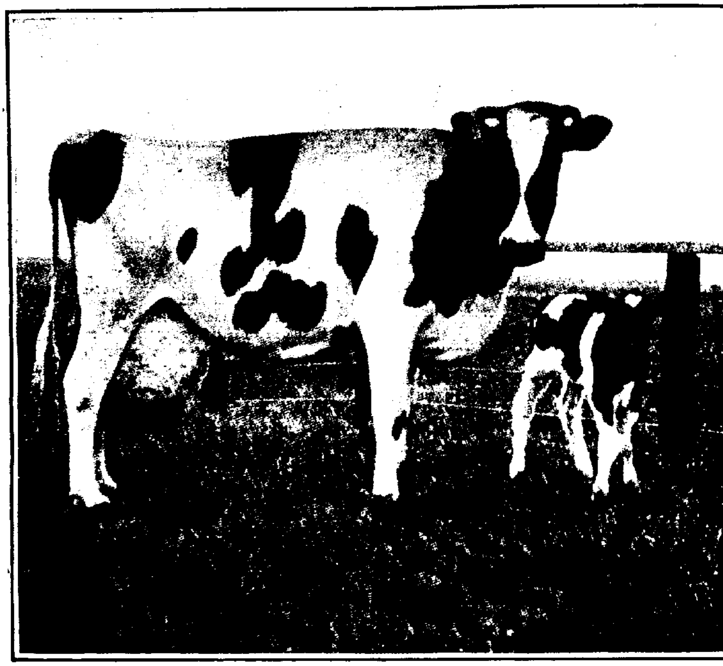
Subject III (*b*) was not of particular interest and few papers were forwarded.

Subject IV produced a paper by Dr. Ulrich Duerst of Berne which starts an original line of investigation. A summary of his paper is as follows :—

" Answering to the question I conclude from the last researches of my own laboratory :

1. The cattle to choose in any race must firstly have a constitutional type corresponding with the desired production.

2. To produce large milk and beef quantities the animal to choose must show a relative small content of dry-substance in its blood.



STIENSER XI, No. 9130 F. H.
(Born 10th March 1896, with her 13th calf.)

RIENK, No. 11132 F. H. (Born 22nd March 1919.)

3. To produce a higher quality of milk (butter-cows) or animals of early-maturity in fattening, we must choose them with a higher degree of blood-dry-substance.

4. To possess a resistent constitution and to be able to stand long journeys (exportation cattle) we must choose cattle with a dark colour without much albino-spots and owning a high degree of blood alkalinity."

Some photos of Dutch cattle are given (Plate VI). The writer was struck with the hardy appearance of the stock seen. There was a conspicuous absence of the coddling usually associated with pedigree milk herds. The cows had to yield milk under ordinary commercial farming conditions or they were quickly got rid of. The general stock to be seen were large, thrifty, commercial animals with big frames and with all the signs of constitution. This is probably why Dutch milk cattle have been a success all over the world.

# NOTES ON COTTON BOLLWORM ATTACK AT SURAT.

BY

M. L. PATEL, B.Ag.,

*Cotton Breeder, South Gujarat.*

In considering the yield of the cotton crop in South Gujarat, and particularly at Surat, over a series of years, two features at once strike the observer. The first is the extraordinary variability of the yield, which is not at all completely explicable by variations in rainfall; the second is the curious way in which, as compared with similar figures for other countries, the early flowering appears to be checked. Before presenting the observations which the author has made in order to proceed towards an explanation of these phenomena, we may look more closely at the facts themselves.

The variability of the cotton crop can be fairly well measured by the average yield of seed-cotton obtained on the Surat farm. For a number of years this is as follows, the total actual rainfall being placed side by side with the figures of yield :—

| Year | Average yield of seed-cotton in lb. | Total rainfall in inches |
|---|---|---|
| 1900 .. .. .. .. | 87 | 34·19 |
| 1904 .. .. .. .. | 242 | 13·40 |
| 1910 .. .. .. .. | 415 | 32·09 |
| 1911 .. .. .. .. | 91 | 17·30 |
| 1912 .. .. .. .. | 643 | 51·68 |
| 1915 .. .. .. .. | 296 | 26·90 |
| 1918 .. .. .. .. | 405 | 17·65 |
| 1920 .. .. .. .. | 631 | 25·02 |

The connection of yield with total rainfall is very slight. The two highest yields were obtained with 25 and with over 51 inches, and the lowest with a rainfall of over 34 inches. The more these figures and others on record are critically examined, the more it is clear that when the rainfall exceeds 17 inches, neither its amount nor its distribution is the dominant influence in determining the yield. A similar examination of temperature records shows no direct influence either of the average maximum or minimum temperatures on the yield of cotton. There is, however, a suspicion that a low cold weather temperature has an injurious effect on the yield of cotton in the succeeding year.

As it seemed clear that some non-climatic influence was affecting yield, the author has, during the last five years, in order to elucidate the question, carefully studied the appearance of flower-buds and flowers, and determined the proportion of these which ultimately forms bolls. Now in cottons belonging to *Gossypium herbaceum* (which include practically all important Gujarat cottons), ordinarily the flower-buds on the first primary fruiting branch (sympodium), on which the flower-buds are formed earliest, appear from the sixth to the ninth week after germination. The period is by no means definite, of course, and varies according to soil and season. Thus, at Surat, with the commonly grown Broach *desi* types of cotton, this branch gave its first flower-buds as follows in the last five years :—

| Year | Appearance of first flower-buds |
|---|---|
| 1918–19 .. .. | 6th to 8th week |
| 1919–20 .. .. | 6th to 8th week |
| 1920–21 .. .. | 5th to 6th week |
| 1921–22 .. .. | 10th to 11th week |
| 1922–23 .. .. | 7th to 9th week |

As the flower-bud takes almost exactly a month to ripen into a flower, it follows that flowers should begin to appear a month later than the first flower-buds.

This, however, rarely occurs, and the first flowers are usually much later. In the last five seasons the first flowers opened as follows :—

| Year | Appearance of first flowers | Time between first buds and first flowers |
|---|---|---|
| 1918–19 .. .. .. | 12th week | 4 to 6 weeks |
| 1919–20 .. .. .. | 17th week | 9 to 11 weeks |
| 1920–21 .. .. .. | 15th week | 9 to 10 weeks |
| 1921–22 .. .. .. | 16th week | 5 to 6 weeks |
| 1922–23 .. .. .. | 15th week | 6 to 8 weeks |

These figures clearly indicate the entrance of a factor, more powerful in some seasons than in others, which causes a large shedding of flower-buds at the beginning of the season, and so brings about delay in flowering due to shedding of flower-buds. This is unusual in other cotton-growing countries, where by far the largest part of the shedding most commonly takes place at the end of the season. This loss of flower-buds is, it seems clear, to by far the largest extent, caused by the spotted bollworm (*Earias* sp.) though other sucking insects, notably Jassids and *Aphis*, are probably indirectly responsible for a small portion of it. The fact that a very large proportion of fallen flower-buds are pierced with bollworm punctures makes it clear that this insect is the principal offender.

This very large (in some cases almost complete) loss of the early flower-buds tends to make the actual flowering concentrated in a very short period. With two of the author's pure strains this concentration is shown below for the last five years. The figures show the proportion of the total flowers formed which appear in the most intense flowering four weeks.

| | Strain "1A Long Boll" | Strain "1027 A.L.F." |
|---|---|---|
| | Per cent. | Per cent. |
| 1919–20 (24th to 27th week) .. | 63·0 | 67·4 |
| 1920–21 (20th to 23rd week) .. | 72·5 | 83·5 |
| 1921–22 (24th to 27th week) .. | 65·8 | 64·7 |
| 1922–23 (22nd to 25th week) .. | 67·6 | 70·9 |

Now out of these four weeks of intense flowering, the bulk of the actually successful bolls was produced from flowers opening in *two* weeks only. This is shown in the following table, which shows the percentage of the flowers opening, which ultimately produced ripe bolls.

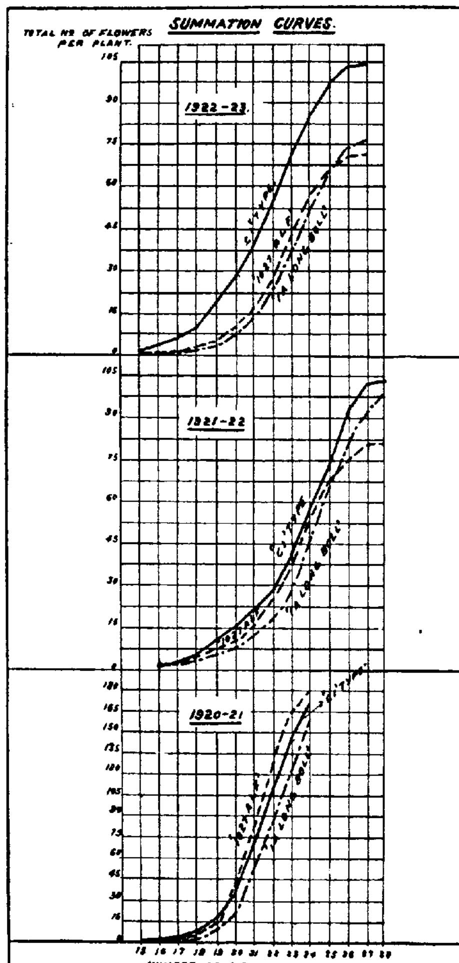
| | Strain "1A Long Boll" | Strain "1027 A.L.F." |
|---|---|---|
| | Per cent. | Per cent. |
| 1920-21 | | |
| 1st week .. .. .. | 72·0 | 69·0 |
| 2nd week .. .. .. | 67·0 | 36·0 |
| 3rd week .. .. .. | 38·5 | 18·5 |
| 4th week .. .. .. | 16·0 | 8·5 |
| 1921-22 | | |
| 1st week .. .. .. | 63·0 | 58·0 |
| 2nd week .. .. .. | 58·0 | 45·0 |
| 3rd week .. .. .. | 28·5 | 10·0 |
| 4th week .. .. .. | 4·0 | 1·5 |
| 1922-23 | | |
| 1st week .. .. .. | 66·4 | 57·0 |
| 2nd week .. .. .. | 52·0 | 54·2 |
| 3rd week .. .. .. | 30·1 | 15·7 |
| 4th week .. .. .. | 7·7 | 5·7 |

Thus the major portion of the ultimate cotton crop *is produced from the flowers opening in two weeks*. This is more true, of course, of some strains than of others, and those pure strains which have either a tall open habit of growth, or a spreading habit of the bracts of the flower-buds, or a large proportion of flowers to leaves, seem to have a longer *effective* flowering season than others. It would appear, however, that if the *effective* flowering period could be lengthened, the yield would be greater though the early produce will be diseased. It was obvious almost immediately that a very important cause not only of the failure of the early flowers but also of the later flowers to some extent was the spotted bollworm (*Earias* sp.), which is thus a great factor in shortening the effective flowering season.

The facts just brought out are illustrated very well by a series of curves * representing the flowering of the plants belonging to pure

* These curves are framed on the lines suggested by J. A. Prescott in his studies of the flowering of the Egyptian cotton plant. (*Ann. Bot.*, **36** (1922), p. 121.)

strains of cotton grown at Surat. These curves for three such strains are shown below for three years. They show the total




number of flowers formed up to any particular date, and on comparison with those for Egypt, for instance, it will be noticed that there is a very marked check in the early part of the flowering, and then a sudden rise in the number of flowers formed. This check, which does not occur in Egypt or, for the matter of that, in any other area even in India to the same extent, is, as has been noted, due, in by far the largest measure, to the effect of the spotted bollworm.

How proportionately great is the effect of the spotted bollworm is shown by the following set of figures in which is shown the total shedding of flower-buds, flowers and bolls on four plants, which, on a careful examination of the shed material, is due to bollworm and to other causes.* The figures given show the number of flower-buds, flowers and bolls shed :—

| Month | Shedding due to bollworm | Shedding due to all causes except bollworm |
|---|---|---|
| November 1920 .. .. | 226 | 66 |
| December 1920 .. .. | 124 | 659 |
| January 1921 .. .. .. | 19 | 397 |
| Total .. | 369 | 1,122 |

It will be seen that even though the sheddings of October were not counted, by far the greater part of the early loss is due to bollworm, but that its relative importance tends to disappear later in the season.

Three points seem, therefore, clear :—

(1) The relatively small yield of Broach *desi* cottons at Surat is largely due to the fact that there is a very obvious check to the flowering of the early formed flower-buds.

(2) This check causes the *effective* flowering period to be very short.

(3) This check in the early season is chiefly due to the work of the spotted bollworm (*Earias*). The pink bollworm appears later in the season, but is not a serious danger at the time we are now considering.

* The actual examinations were made by Mr. T. N. Jhaveri, Assistant Entomologist, to whom our thanks are due.

If these conclusions are correct, then the checking of the spotted bollworm is the most important thing to be done to increase the outturn of cotton in Lower Gujarat. So far efforts in this direction have taken three lines, and we will now review what has been done in these directions and its general value. These three methods are—

(a) To grow a trap crop along with cotton, and then remove this crop and destroy it. The trap crop usually employed has been *bhindi* (*Hibiscus esculentus*) or ladies-finger.

(b) To destroy the earlier broods of the bollworm by removing the top shoots of the cotton plants.

(c) To catch the paired moths when they are dormant, that is to say in the early morning and in the evening.

When the first of these methods was tried, namely, the growth of *bhindi* as a trap crop, the following observations were made. The attack of the pest was first noticed at the beginning of September. From that time onward till the first week in October, after which the trap crop was removed, fifty-six pounds of *bhindi* fruits were removed, from which 744 worms were killed. During the same time 899 worms were obtained from the top shoots of the cotton crop immediately surrounding. In the trap crop the heaviest infestation was found when the harvest was finishing in the beginning of October, and at that time the attack on the cotton was less than in the *bhindi*. It will thus be seen that the trap crop was not so attractive as to prevent attack of the cotton while it was present, though it had a greater proportion of attack than the main crop.

On the other hand, the moths themselves were not at their maximum until after the trap crop had been removed. In 1920, a campaign to kill the paired moths (as per method (c) above) was made from October to the middle of December and the number so killed was as follows:—

| | |
|---|---|
| September .. .. .. | 9 pairs |
| October 1st to 23rd .. .. | 21 pairs |
| October 24th to 31st .. .. | 235 pairs |
| Total October .. .. .. | 256 pairs |
| November .. .. .. | 579 pairs |
| December 1st to 16th .. .. | 177 pairs |

While searching for the paired moths, all punctured flower-buds, flowers, and immature fruits which were found on the cotton and on the trap crop were removed and the worms destroyed. The number of worms so removed and destroyed was as follows:—

*Number of worms removed and destroyed.*

| | From trap crop | From cotton | Total |
|---|---|---|---|
| September .. .. .. | 185 | 474 | 659 |
| October first week .. .. | 559 | 425 | 984 |
| October 8th to 31st .. .. | .. | 261 | 261 |
| November 1st to 19th .. .. | .. | 1,234 | 1,234 |
| November 20th to December 16th .. | .. | 282 | 282 |

The figures furnish a good indication of the severity of the attack.

It is clear, therefore, that the system hitherto in vogue of sowing a trap crop with the cotton and removing the *bhindi* pods as they mature is almost useless, as the maximum attack occurs after the *bhindi* is removed. Even when the trap crop is present, there is still a large amount of attack on the cotton, and as a means of removing the early broods of the bollworm and so *preventing* the serious attack of the cotton, the method definitely fails. Whether there is a possibility of *checking* the attack, by having successive crops of *bhindi*, is not yet clear and has not been tested.

With regard to the second suggested method of check, it may be noted that, up to the third week of October, the attack of the bollworm was chiefly on the young growing shoots of the plant, either on the petioles of the leaves or on the flower-buds. After that date, it occurred equally on all kinds of immature fruit forms. Now, from the previous table, it will be seen that the maximum emergence of moths takes place from the last week in October and through November. Thus the removal of the top shoots of the young plants will not be effective unless all or nearly all such shoots are removed, for the bollworm moth has the habit of depositing its very numerous eggs singly in a large number of places. Its life-cycle takes about a month, so that the eggs deposited near the end of September will give the moths which produce the very heavy broods of moths at the end of October. Inasmuch as it is impossible to remove all or even a large proportion of the growing shoots of the plants at the end of September or in early October when the cotton is making its growth, the method seems definitely to fail and has, in fact, produced little advantage in practice.

The advantage of using all the above mentioned methods on a single area of cotton, that is to say, the growing of a trap crop (*bhindi*) among the cotton, the nipping off top shoots in the early season, and the destruction of moths in the morning and evening, was tested by noting the percentage of diseased and healthy flowers opening each day on a fully treated area and on an adjoining untreated area during two weeks at the most important part of the season. The results are as follows:—

| | Percentage of attack | |
|---|---|---|
| | Treated area | Untreated area |
| | Per cent. | Per cent. |
| November 20 .. .. .. | 9·5 | 17·1 |
| " 21 .. .. .. | 10·7 | 16·3 |
| " 22 .. .. .. | 12·6 | 15·0 |
| " 23 .. .. .. | 8·0 | 15·6 |
| Average .. .. .. | 10·2 | 15·6 |
| December 7 .. .. .. | 3·3 | 4·7 |
| " 8 .. .. .. | 1·9 | 6·4 |
| " 9 .. .. .. | 2·7 | 4·9 |
| " 10 .. .. .. | 1·0 | 3·0 |
| Average .. .. .. | 2·2 | 4·7 |

The real benefit obtained by the application of all these methods was tested by comparing the percentage of success of flowers from flower-buds, and of bolls from flowers, in the general area of the farm in 1920-21 and 1921-22, with the success on an area where all the methods were tried in 1922-23. With two pure strains the figures were as follows:—

| | Percentage of success | |
|---|---|---|
| | Strain "1A Long Boll" | Strain "1027 A.L.F." |
| 1. Flower-buds to flowers— | | |
| 1920–21 .. .. | 39·3 | 36·5 |
| 1921–22 .. .. | 39·7 | 44·1 |
| 1922–23 .. .. | 30·0 | 33·9 |
| 2. Flowers to bolls— | | |
| 1920–21 .. .. | 38·0 | 36·0 |
| 1921–22 .. .. | 32·0 | 38·5 |
| 1922–23 .. .. | 35·6 | 36·0 |

That the pest gets a check suddenly from 5th of December and onward can be judged from the following table showing the percentage of diseased bolls from flowers opening in different weeks in two of the strains in 1922.

| | Strain "1A Long Boll" | Strain "1027 A.L.F." |
|---|---|---|
| | Per cent. | Per cent. |
| From bolls, up to 5-12-22 .. | 70·0 | 73·6 |
| 6th to 12th December .. .. | 51·7 | 56·2 |
| 13th to 19th December .. .. | 37·5 | 48·1 |
| 20th to 26th December .. .. | 28·2 | 39·1 |
| 27th December and onwards .. | 15·7 | 36·0 |

In short, there is apparently a distinct effect of the measures used, but the remaining attack is so great that, as practical effective measures, they are not worth the cost and trouble involved.

The amount of attack remaining is so great as to ensure full infestation of the crop in the later stages. The absence of greater effect would seem probably to be due to the fact that a single pair of moths can produce an enormous amount of infestation owing to their method of depositing the eggs singly in many separate places, so that a smaller number of moths left undetected may and will probably lead to almost a maximum amount of damage later in the season.

The figures above noted do, however, show one very striking fact, namely, the sudden and very large reduction in the proportion of diseased flowers between the third week in November and the second week in December. This is coincident with the sudden appearance at the end of November or beginning of December of worms heavily parasitized with a small wasp, *Microbracon lefroyi*, which is also very active in the Punjab. In the latter part of November, in fact, worms were found in numbers in a moribund condition. Several of the larvæ of the wasp responsible for the parasitism were found on each worm and the full-grown insect emerged after ten days, following eight days' pupation. The natural supposition would be that this parasite, whose appearance coincides with a sudden fall in the percentage of attack, is probably the cause of the sudden reduction in the amount of infection. There is as yet no proof that this is the case, but the substantial failure of other methods of reducing the severity of attack would lead one to look upon the cultivation of this parasite as the most promising method of dealing with the pest in Gujarat.

# SOME ASPECTS OF LARGE ESTATE FARMING IN THE PUNJAB.*

BY

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THE Punjab Government when colonizing the Lower Bari Doab tract allotted certain large size grants of land on lease for specific purposes. The following are the main grants being worked at present :—

| Area in acres | Lessee | Purpose |
|---|---|---|
| 21,000 | Military Farms Department .. | To produce fodder for the Army. |
| 7,000 | Col. Cole .. | Horse breeding conditions—roughly one breeding mare per square of 25 acres to be kept. |
| 7,000 | Major Venrenen .. | |
| 2,000 | Hon. S. Jogendra Singh | Steam cultivation. |
| 2,000 to 4,000 | Ch. Jehangir Khan .. | Cattle breeding—a definite number of breeding cows kept per square. |
| | Ch. Allahadad Khan and others (five in all) | |
| 3,000 | Mr. Couville .. | Seed production for the Agricultural Department. |
| 7,000 | British Cotton Growing Association .. | To encourage staple cotton growing, test varieties, establish a buying agency for long staple cotton, etc. |

A total of about 60,000 acres has thus been allotted—this corresponds to ½ per cent. only of the irrigated tract of 12 million acres in the Punjab and less than ¼ per cent. of the cultivated area of the province. All these farms with the exception of that of the Hon. S. Jogendra Singh are worked on the tenant system and *batai*, i.e., the tenant gets half the produce and the landlord half;

* Paper read at the Indian Science Congress, Bangalore, 1924.

the water rate and land revenue and taxes which total about Rs. 9 per acre being paid half by the landlord and half by the tenant.

The great bulk of the irrigated colonies has been allotted to small farmers who hold from one to five squares, i.e., from 25 to 125 acres. The conditions of the leases of the large estates mentioned above are much stricter and more severe in every way than those granted to the small cultivator.

The writer has been managing the B. C. G. A. estate at Khanewal for the last three years. A few of the ways in which this estate especially, and others incidentally, benefit the country are noted below.

### Supervising staff.

Owing to the areas being large it is possible to engage qualified men from the Lyallpur College, where the writer worked for 12 years, as assistants. The Association employs at present five graduates or diplomates of the college, besides an honours graduate just recruited from home, whose qualifications in botany it is hoped to utilize to supplement and help the work of the Agricultural Department.

### Cultivation of cotton.

Special attention is given to the cultivation of cotton. About 1,800 acres of irrigated cotton are grown annually. The average yield last year for 1,300 acres of American cotton was 12 maunds of 82$\frac{2}{7}$ lb. per acre and for *desi* cotton 15$\frac{3}{4}$ standard maunds. No other large or even small estate in the Punjab can point to such results. The yields in the present season* are expected to be at least equally good, as judged from pickings so far received and the general condition of the crop. The general method of cotton cultivation at the farm is as follows :—

The land in the colonies is divided into squares of 25 acres, five acres each way and numbered from 1 to 25. Each line of five acres in a square is divided into two, thus giving ten units of 2$\frac{1}{2}$ acres in each square. Three such lines per square are generally

* Final yields for 1923-24 are: American 14 maunds per acre on 1,400 acres and *desi* 15·1 maunds on 600 acres.

put down to cotton. These are always together and are continued in the next square, so that a line 2½ acres wide may often stretch for ten or even more squares. This enables the irrigation water to be concentrated on these blocks and on the adjoining fodder block, the fallow areas not being touched. This leads to economy and concentration of water, and is a big factor in securing the best result from the water available. Had cotton been sown in odd acres all over a square, much water would be wasted in being taken along various channels, of which comparatively little use was made. The same thing applies, of course, to wheat and other crops, which are also concentrated in blocks.

During the latter part of March and early April, experience shows that excess of water is available in the canals. Use is made of this by giving land prepared for cotton double *rauni*, i.e., two waterings before sowing. This secures good tilth and a well supplied subsoil water reserve. After sowing, the crop gets no further water for from six to ten weeks, and has thus an opportunity to develop deep roots, and to get well into the soil, thus insuring better resistance to drought, should water supply be short later on.

If rain falls after sowing, the crust is immediately broken by means of the " bar harrow " which is very popular on the estate. All cotton is sown in lines either two feet apart (*desi* cotton) or three feet for American. The crop is intercultured as often as possible and especially after irrigation. Generally from four to six intercultures are given. It may be mentioned that the usual system of cotton sowing in the Punjab is broadcast, and no interculture is possible with that system. The native plough is actually run through the crop, even when it has been broadcasted, but observation shows much damage is thus done to young plants, especially of American cotton, and such fields are characterized by plentiful weeds, which cannot flourish except at the expense of the cotton crop.

As cultivation is done on a large scale, uniformity throughout the farm is rapidly attained. Instructions are given out from week to week and day to day as to what operations are to be performed and what crops require watering, etc. In this work the Lambardars (headmen) appointed from among the tenants, and by them, give invaluable assistance. There has been no slowness in appreciating the value of system and control, for, after all, the tenant gets half the produce while the supervising staff, implements, etc., fall entirely on the estate or landlord.

### Buying agency.

Again, assistance is given in selling produce, for which a premium over the ordinary market qualities is always available. In order to facilitate the securing of best prices for cotton the Association has established its own buying agency and tenants' cotton is bought at premiums over the market rate. Other large zemindars who sell to the Association and can produce uniform quality cotton also receive premiums.

### Pure seed.

Great attention is paid to the supply of pure seed. Sufficient to sow a lakh of acres of cotton was supplied either to the Agricultural Department, or direct to the cultivators last season. Similarly as regards wheat as much seed as is wanted can be supplied at market rates.

### Assistance to Agricultural Department.

In order to facilitate the work of the Agricultural Department, large scale tests of varieties are carried out by growing types alongside one another and recording yields separately. It is hoped thus to secure early results as to the value of new varieties (constantly being produced by the department) when tested under ordinary conditions away from Government farms.

### Report to Government.

A report is sent each year to Government on the value of the Punjab-American cotton in Liverpool and Lancashire, thus tending to keep the grower in touch with the value of long staple cotton as compared to *desi*.

## POWER CULTIVATION.

Among other lines of work being started is investigation of power cultivation, whether from tractors or steam, as compared to tenant farming. As large tracts will shortly be coming under cultivation for the first time, both in the Punjab and Sind, and as, under present conditions, settling and colonizing a new tract is slow work, after the completion of a canal, it is hoped very important economic results will be worked out. It is very probable, as far as existing evidence goes, that assistance during the first years of colonization will materially reduce the project costs estimated for such canals as the Sutlej Valley in the Punjab and the Sukkur Barrage in Sind.

A very instructive experiment in tractor cultivation is in progress on Major Venrenen's estate where 2,000 acres are being managed in this way, with apparently very successful results. A great many problems, however, still remain to be solved, especially as regards comparison of tractors and steam cultivation.

A feature of most of the estates is the well planned villages, roads, trees and wells put up by the lessees for their tenants and labourers—whose prosperity and contentment must be considered in all successful estate management.

# CARBON DIOXIDE IN SOIL GASES.*

BY

JATINDRA NATH MUKERJEE, B.A., B.Sc.,
*First Assistant to the Imperial Agricultural Chemist.*

It must have been observed by many that fruit trees do no grow so well on plots which are never weeded out, as on those which are kept free from weeds by surface cultivation. This fac is demonstrated in the botanical orchard at Pusa, where there ar three plots, one of which has been grassed down, one kept cultivated and a third which has been grassed but provided with trenche (1½ ft. wide and 2 ft. deep, filled with gravel) between rows of trees Although all the three plots were planted at the same time, frui trees grown on the cultivated plot are quite vigorous and are fa superior to those on the other two plots, while those grown on th trenched grassed plot are slightly better than those on the grassed plot without trenches. The trees on the grassed plot are not onl of very poor and stunted growth, but some of them are actuall dead. This fact was brought to the notice of the Chemical Sectio at Pusa about four years ago, and an investigation was at onc commenced.

During the first year 1919, attention was confined only to th periodical examination of the $CO_2$ content of the soil gases fron these three plots. The method adopted for the collection of soi gas samples and the determinations of their $CO_2$ content was quit simple. For each determination about 10 litres of soil gases wer aspirated through a Reiset's apparatus connected at one end, b means of capillary tube and a tap, to a brass tube driven insid the soil and at the other end to a 15-litre aspirator bottle. Th

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* Paper read at the Indian Science Congress, Lucknow, 1923.

Reiset's apparatus contained a measured volume of baryta water, the strength of which was determined before and after aspiration of the soil gas by titration against standard acid and the titration differences gave the data for calculating the amount of $CO_2$ contained in the soil gas.

The results for 1919 (Table I) show that the proportion of $CO_2$ has been considerably higher in the grassed plot than in the cultivated plot; the trenched grassed plot results being intermediate

TABLE I.

| Months during which soil gas was examined | PLOT No. 1 GRASSED DOWN | | | PLOT No. 2 GRASSED BUT PARTIALLY AERATED BY TRENCHES | | | PLOT No. 3 SURFACE CULTIVATED | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1919 % $CO_2$ | 1920 % $CO_2$ | 1921 % $CO_2$ | 1919 % $CO_2$ | 1920 % $CO_2$ | 1921 % $CO_2$ | 1919 % $CO_2$ | 1920 % $CO_2$ | 1921 % $CO_2$ |
| January .. | 0·444 | 0·342 | 0·375 | 0·312 | 0·250 | 0·294 | 0·269 | 0·186 | 0·247 |
| February | 0·472 | 0·382 | 0·331 | 0·320 | 0·342 | 0·282 | 0·253 | 0·238 | 0·248 |
| March .. | 0·427 | 0·457 | 0·315 | 0·223 | 0·383 | 0·302 | 0·197 | 0·236 | 0·233 |
| April .. | 0·454 | 0·367 | 0·514 | 0·262 | 0·321 | 0·430 | 0·203 | 0·222 | 0·315 |
| May .. | 0·271 | 0·385 | 0·374 | 0·257 | 0·315 | 0·322 | 0·133 | 0·235 | 0·277 |
| June .. | 0·341 | 0·544 | 0·148 | 0·274 | 0·524 | 0·421 | 0·249 | 0·275 | 0·296 |
| July .. | 1·540 | 1·113 | 1·421 | 1·090 | 0·906 | 1·219 | 0·304 | 0·334 | 0·378 |
| August .. | 1·590 | 2·036 | 2·280 | 0·836 | 0·993 | 1·648 | 0·401 | 0·307 | 0·542 |
| September | 1·908 | 2·212 | 1·620 | 0·931 | 1·167 | 1·206 | 0·450 | 0·341 | 0·442 |
| October .. | 1·297 | 1·545 | 1·268 | 0·602 | 0·718 | 0·805 | 0·365 | 0·291 | 0·300 |
| November | 0·853 | 0·647 | 0·873 | 0·456 | 0·420 | 0·513 | 0·261 | 0·254 | 0·264 |
| December | 0·398 | 0·441 | 0·669 | 0·327 | 0·341 | 0·373 | 0·219 | 0·277 | 0·273 |

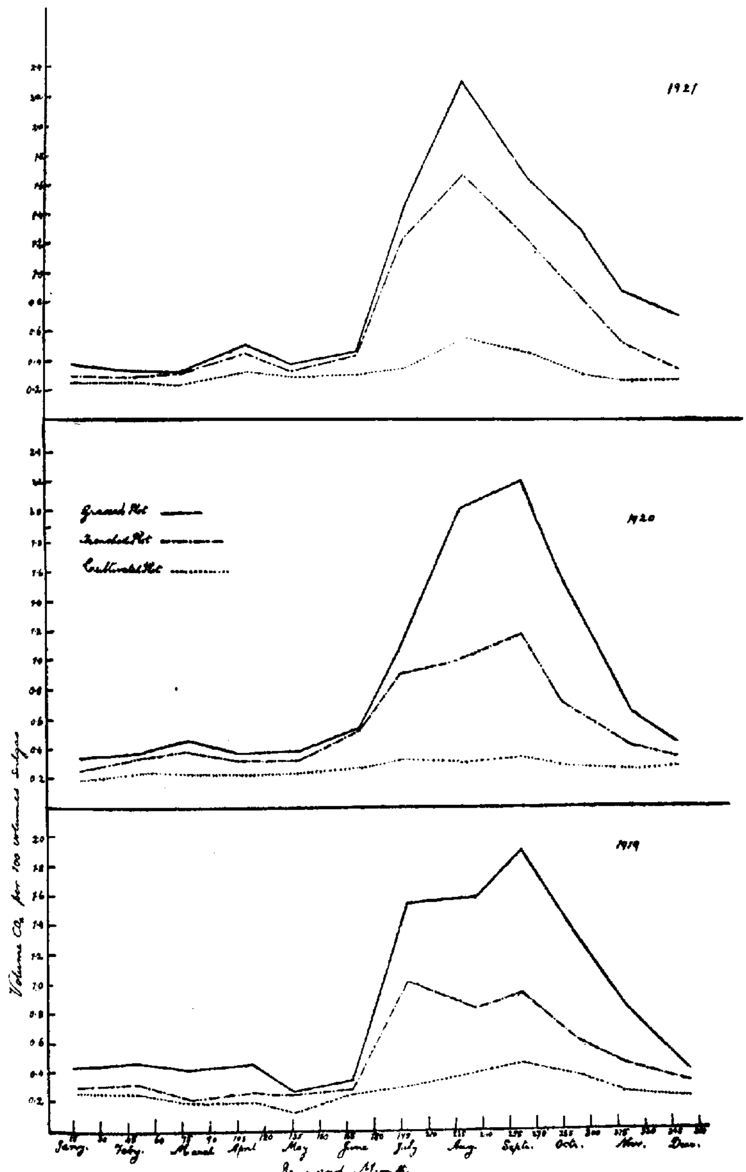
in character. During the first six months of the year, the carbon dioxide in the soil gas of the grassed and trenched plots varied between 0·50 and 0·25 per cent. and that in the cultivated plot between 0·30 and 0·15 per cent. The $CO_2$ was at its lowest in all the three plots during May when the weather was very hot and dry. Immediately after the commencement of the monsoon, the $CO_2$ in all the three plots suddenly rose and continued increasing till it reached its maximum point between August and September. In the grassed plot, the figure rose to about 2 per cent., in the trenched plot to about 1 per cent. and in the cultivated plot to about 0·45 per cent. $CO_2$. With the ceasing of the rainfall in October, the $CO_2$ content decreased until in December it fell to 0·4, 0·3 and 0·2 per cent. respectively. These rises and falls were most pronounced in the grassed plot and less marked in the trenched plot, whereas the variation in the cultivated plot was only slight (Chart I). Chart I shows the seasonal variation in the $CO_2$ content of the soil gas from three plots.

In the following years 1920 and 1921, the periodical examinations of the $CO_2$ content of the soil gases from the three plots were continued. The results obtained during these years were quite analogous to those obtained in 1919, as will be evident from Table I giving the values obtained during three years 1919 to 1921. The soil atmosphere of the grassed plot is uniformly much richer in $CO_2$ than that of the cultivated plot, and this difference is most marked during monsoon months.

The rise and fall of the $CO_2$ content of the soil gas could not be correlated with the rise and fall of subsoil water level. An attempt was made to determine the $CO_2$ contents in the gases below a depth of 10 ft. from the surface, in September 1921, when the water level stood highest. The $CO_2$ content at this depth approximately worked out to 1·3 per cent. when the corresponding $CO_2$ content below 1 ft. was 1·62 per cent. The very great increase in the $CO_2$ content of the grassed plot during the monsoon month would seem to be associated with the presence of moisture in the soil at 1 ft. depth, and the explanation of a few abnormal figures obtained in March 1920 and April 1921 is to be found in this; on both these occasions, there had been some rain about four or five days previous to the examination of soil gas and consequently there had been an appreciable increase in the $CO_2$ content of the soil gas from the grassed plot.

In order to confirm the conclusion that the formation of increased amount of $CO_2$ in the soil gas of the grassed plot is due to the presence of moisture, two plots of ground were selected in the

CHART I.


1921
1920
1919
Jany.
Feby.
March
April
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Days and Months

pot culture house compound, both of which were kept grassed over, but, of which, one was irrigated throughout the hot season, the other remaining under normal conditions. Before commencing the experiments, the $CO_2$ content was determined and found to be 0·474 per cent. in No. 1 and 0·492 per cent. in No. 2. The results obtained subsequent to commencing the irrigation of Plot No. 1 were as follows:—

TABLE II.

| Date | Plot I Irrigated | Plot II Unirrigated |
|---|---|---|
| April 7th .. .. .. | 0·984 | 0·441 |
| „ 12th .. .. .. | 0·864 | 0·410 |
| „ 24th .. .. .. | 1·000 | 0·435 |
| May 8th .. .. .. | 1·002 | 0·364 |
| „ 20th .. .. .. | 0·819 | 0·335 |
| June 2nd .. .. .. | 0·779 | 0·349 |

It may, therefore, be taken as clearly demonstrated that the effect of keeping plots grassed over is to enormously increase the $CO_2$ content of the soil gas during periods of rainfall and that the presence of moisture is the determining factor.

Examination of moisture content of the soil up to a depth of 18 inches, in all the three plots, throughout the year (Table III) showed that, during April and May, the moisture content of the soil at 1 ft. to 1 ft. 6 in. in the grassed plot goes down to about 1 per cent., in the trenched plot to about 1·3 per cent. and in the cultivated plot only to about 5·5 per cent. It is, therefore, evident that the soil in the grassed plot becomes so depleted of moisture that a large proportion of grass roots die during hot weather. Consequently during the monsoon, conditions are favourable to a rapid decomposition of the organic detritus introduced into the soil from the roots of the grass, carbon dioxide being one of the products of this decomposition.

Brown and Escombe[1] found that the response, which all the species of flowering plants make, to a slight increase in the amount

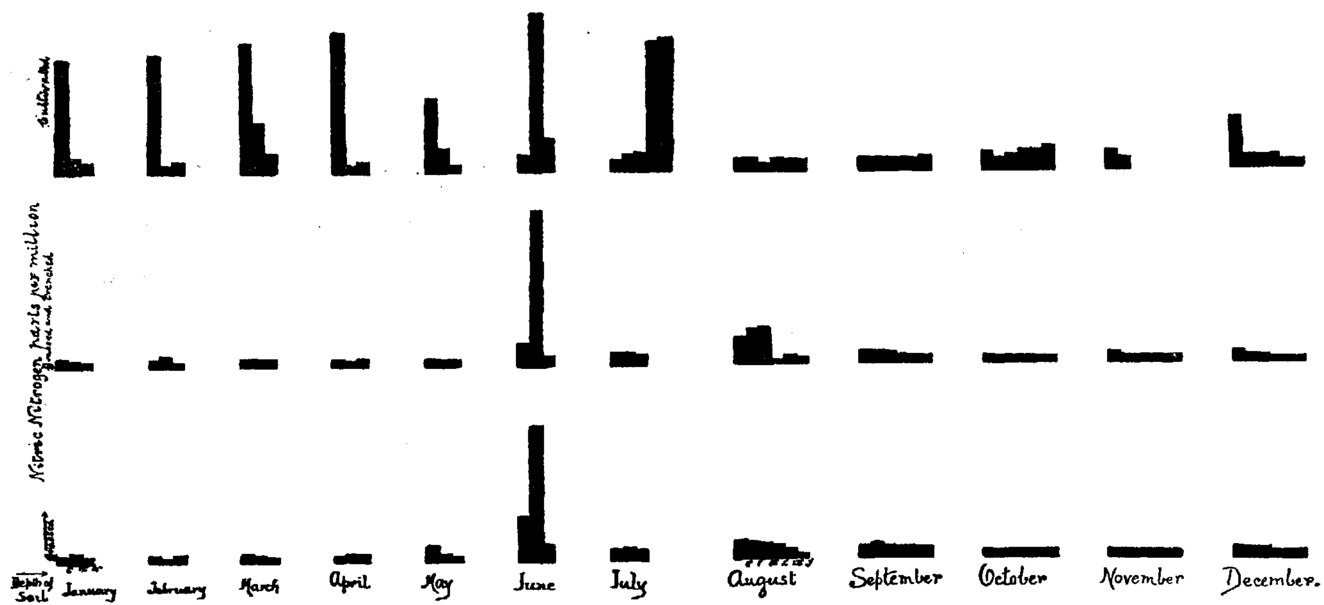
[1] *Royal Soc. Proc.*, **76**, p. 351, 1905.

of $CO_2$ is in a direction altogether unfavourable to their growth and reproduction, and that a comparatively sudden increase of $CO_2$ in the air to the extent of but 2 to 3 times the present amount would result in the speedy destruction of nearly all flowering plants. Cannon[1], while carrying on a series of experiments, in which the roots of *Prosopis velutina* and of *Opuntia versicolor* were exposed to an atmosphere of (1) pure $CO_2$, (2) atmospheric air, so diluted with $CO_2$ that a mixture containing 5 to 25 per cent. oxygen resulted, found that there is retardation of growth with increasing amounts of $CO_2$ and that the roots of both *Prosopis* and *Opuntia* can maintain only a feeble growth rate in an atmosphere containing as little as 5 per cent. oxygen, but that root growth in both species stops in pure $CO_2$. As the action of excess of $CO_2$ in the soil in retarding plant growth has been demonstrated by Cannon and several other observers, this factor must be looked upon as one of the causes of the poor growth of the trees in the grassed plot of the botanical area. Another important factor is the great reduction in the moisture content of the grassed plot during the dry season.

From a determination of the soil nitrate content of these plots, in every six inches, down to 1 ft. 6 in. (Table III), it was found that, during January to May, the soil nitrate content of the grassed and trenched plots varied between 0·3 and 0·4 parts nitric nitrogen per million soil, whereas in the cultivated plot, the figures varied between 4 and 5 parts per million soil. In June, immediately after the commencement of the monsoon, nitrification commenced in the grassed and trenched plots also and the nitrate contents in these were similar to that in the cultivated one. During the next three months (July to September), the nitrate in most cases moved downwards in all the three plots. After the close of the monsoon, while the grassed and trenched plot did not show any rise in the nitrate content beyond 0·4 parts nitric nitrogen per million soil, the cultivated one showed a gradual rise in the nitrate content, till in December it attained about 2 parts per million on the surface. Chart II shows the variation in the soil nitrate content of the three

[1] *Science*, N. S., 44, p. 761, 1916.

CHART II.


Nitric Nitrogen parts per million
Depth of Soil
January
February
March
April
May
June
July
August
September
October
November
December.

plots down to 1 ft. 6 in. from January to July and down to 3 ft. from August to December.

## TABLE III.

*Moisture and soil nitrate.*

| Months | Plot No. 1, grassed | | | | | |
|---|---|---|---|---|---|---|
| | Moisture % | | | Soil nitrate—nitrogen parts per million soil | | |
| | 0″–6″ | 6″–12″ | 12″–18″ | 0″–6″ | 6″–12″ | 12″–18″ |
| January .. .. | 2·60 | 4·92 | 3·68 | 0·310 | 0·400 | 0·236 |
| February .. .. | 1·68 | 3·96 | 2·94 | 0·307 | 0·237 | 0·319 |
| March .. .. | 1·64 | 2·85 | 2·63 | 0·383 | 0·311 | 0·233 |
| April .. .. | 3·52 | 1·32 | 1·68 | 0·235 | 0·305 | 0·307 |
| May .. .. | 1·09 | 1·76 | 1·06 | 0·609 | 0·307 | 0·228 |
| June .. .. | 13·63 | 11·15 | 1·84 | 1·265 | 4·884 | 0·615 |
| July .. .. | 13·70 | 15·90 | 11·50 | 0·452 | 0·466 | 0·439 |
| August .. .. | 19·31 | 21·16 | 19·65 | 0·688 | 0·607 | 0·593 |
| September .. | 14·28 | 15·21 | 14·14 | 0·456 | 0·555 | 0·455 |
| October .. .. | 15·79 | 14·76 | 12·55 | 0·373 | 0·367 | 0·356 |
| November.. .. | 11·56 | 11·58 | 9·29 | 0·351 | 0·351 | 0·340 |
| December .. | 6·88 | 8·11 | 7·68 | 0·411 | 0·418 | 0·416 |

| Months | Plot No. 2, grassed but trenched | | | | | |
|---|---|---|---|---|---|---|
| | Moisture % | | | Soil nitrate—nitrogen parts per million soil | | |
| | 0″–6″ | 6″–12″ | 12″–18″ | 0″–6″ | 6″–12″ | 12″–18″ |
| January .. .. | 2·68 | 3·68 | 3·11 | 0·388 | 0·315 | 0·234 |
| February .. .. | 4·52 | 8·05 | 8·25 | 0·318 | 0·418 | 0·251 |
| March .. .. | 2·24 | 2·17 | 1·99 | 0·309 | 0·309 | 0·308 |
| April .. .. | 5·74 | 2·24 | 1·68 | 0·243 | 0·232 | 0·300 |
| May .. .. | 1·36 | 1·27 | 1·31 | 0·306 | 0·305 | 0·305 |
| June .. .. | 14·10 | 11·50 | 2·66 | 0·819 | 5·613 | 0·388 |
| July .. .. | 15·70 | 15·00 | 11·50 | 0·466 | 0·466 | 0·439 |
| August .. .. | 19·46 | 18·80 | 16·80 | 0·986 | 1·269 | 1·326 |
| September .. | 15·18 | 15·68 | 14·03 | 0·462 | 0·466 | 0·455 |
| October .. .. | 11·25 | 12·22 | 10·04 | 0·350 | 0·354 | 0·343 |
| November.. .. | 6·59 | 8·61 | 7·36 | 0·410 | 0·337 | 0·331 |
| December .. | 7·95 | 10·08 | 12·08 | 0·417 | 0·334 | 0·354 |

TABLE III—*concld.*

*Moisture and soil nitrate.*

| Months | Plot No. 3, cultivated | | | | | |
|---|---|---|---|---|---|---|
| | Moisture % | | | Soil nitrate—nitrogen parts per million soil | | |
| | 0″–6″ | 6″–12″ | 12″–18″ | 0″–6″ | 6″–12″ | 12″–18″ |
| January .. .. | 6·74 | 9·92 | 9·20 | 4·102 | 0·600 | 0·428 |
| February .. .. | 6·27 | 9·93 | 8·63 | 4·239 | 0·343 | 0·421 |
| March .. .. | 4·49 | 7·68 | 8·83 | 4·614 | 1·828 | 0·760 |
| April .. .. | 4·39 | 5·81 | 5·39 | 5·087 | 0·324 | 0·403 |
| May .. .. | 3·67 | 8·49 | 7·63 | 2·760 | 0·924 | 0·332 |
| June .. .. | 22·05 | 15·56 | 10·15 | 0·616 | 5·762 | 1·204 |
| July .. .. | 14·30 | 15·70 | 14·90 | 0·452 | 0·652 | 0·745 |
| August .. .. | 17·34 | 16·69 | 14·27 | 0·477 | 0·477 | 0·365 |
| September .. | 12·43 | 14·66 | 15·97 | 0·533 | 0·459 | 0·468 |
| October .. .. | 9·34 | 12·51 | 11·67 | 0·749 | 0·513 | 0·610 |
| November.. .. | 7·76 | 9·77 | 11·11 | 0·750 | 0·513 | .. |
| December .. | 7·99 | 12·81 | 13·31 | 1·840 | 0·447 | 0·450 |

Investigations into the moisture and soil nitrate contents of the grassed and cultivated plots, thus, further explained the effect of grass in retarding the plant growth. Apart from its effect in increasing the $CO_2$ content, which has a deleterious effect on the plant root, it depletes the soil so considerably of its moisture and nitrate content during dry weather, that normal growth is completely checked and plants sometimes die as well.

# NOTES ON COTTON WILT IN THE SOUTHERN MARATHA COUNTRY.

BY

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THE wilting of cotton plants at some stage of their growth occurs all over the Southern Maratha Country, and is familiar to practically every cultivator. It is usually attributed either to insects or to the well known *Fusarium* wilt fungus residing in the soil, and carried by soil infection. The loss from wilting caused by insects is insignificant at present, but that generally ascribed to the fungus is very great, though its extent has never been accurately determined. Observations, moreover, indicate that this latter is extending, and the recent tendency of cultivators to grow cotton after cotton, without any rotation, seems favourable to its extension. It is possible, therefore, that the trouble will become far more serious in the future than it is at present. Steps are already in hand for the breeding of wilt-resistant types of Kumpta cotton at Dharwar, and the present note is intended to give some of the interesting results already obtained in that direction.

The literature on Indian cotton wilt is very scanty, and so far as the fungus which is said to be the immediate cause of it is considered, the article by Ajrekar and Bal in a recent number of this Journal[1] is almost the only piece of published information on the subject. The American publications regarding cotton wilt seem to deal with an entirely different fungus from that described by these as well as by other workers in this country. This seems

[1] *Agri. Jour. India*, XVI, p. 598.

likely, for American cotton, which is extensively grown in Dharwar, does not seem to suffer from this form of wilt even when grown in badly infested wilt areas, and the same is true for Buri, another cotton of American origin, in the Central Provinces. The same also seems true for all American cottons except Sea Island cotton, whose immunity is doubtful.

### VARIATIONS IN THE SUSCEPTIBILITY OF INDIAN COTTONS.

On the Dharwar farm, which is extremely badly infested with wilt, a large number of different types of Indian cottons are grown, but all of them have, under the farm conditions, proved themselves susceptible to the disease. The susceptibility varies, however, very much with the different cottons. Attention was first called to this difference by the apparently abnormal susceptibility of Broach cotton, which suffered much more than others, but, later on, Goghari, another cotton, proved still worse. The relative susceptibility of different types when grown on adjoining plots affected with wilt, but not artificially infected, was as follows :—

| *Cotton variety* | *Percentage of wilted plants* |
|---|---|
| 1. Goghari (*Gossypium herbaceum*) .. .. | 46 |
| 2. Broach (*Gossypium herbaceum*) .. .. | 32 |
| 3. Jari (*Gossypium neglectum*) .. .. | 23 |
| 4. Bani (*Gossypium indicum*) .. .. | 15 |
| 5. Comilla (*Gossypium cernuum*) .. .. | 12 |
| 6. Kumpta (the local cotton) (*Gossypium herbaceum*) | 8 |

These figures only give a very rough idea of the relative degree of susceptibility as, in the absence of special thorough infection, the soil is not uniformly liable to cause the disease. It became necessary, therefore, to infect a small piece of land with the cotton wilt fungus specially raised for the purpose. The culture was mixed thoroughly with farmyard manure, and evenly spread over the plot, and on this a number of different strains of the local Kumpta cotton with two other strains of supposed greater wilt resistance were grown. The percentage of attack was as follows :—

| *Strain or variety of cotton* | *Percentage of wilted plants* |
|---|---|
| 1. Kumpta (local mixed type) .. .. | 22·3 |
| 2. Dharwar No. 3 (selection from local Kumpta) .. | 55·1 |
| 3. Dharwar No. 4 (selection from Kumpta-Goghari cross) .. .. .. .. | 55·4 |
| 4. Dharwar No. 5 (Ditto) .. .. | 72·1 |
| 5. Rosea (a selection from *Gossypium neglectum*) .. | 34·5 |
| 6. Wagale (a strain of Burmese cotton or *Gossypium obtusifolium*) .. .. .. | 4·7 |

The difference in susceptibility is very striking. The strains of the cross between Goghari and Kumpta seem to retain the susceptibility of the latter. A pure strain isolated at Dharwar from the Burmese cotton known as Wagale proved almost entirely resistant. The experiment is interesting from another point of view. The local Kumpta cotton is a mixture of many strains, and of these some are very much more immune to wilt than others. The relative position of the local mixture and one of such selections is given above; that of two others is as follows :—

| *Strain or variety of cotton* | *Percentage of wilted plants* |
|---|---|
| 1. Kumpta (local mixed type) .. .. | 22·3 |
| 2. Dharwar No. 1 (selection from local Kumpta) .. | 38·3 |
| 3. Dharwar No. 2 (Ditto) .. .. | 5·6 |

The difference between these two strains is remarkable. Dharwar No. 1, though in every other way a desirable cotton, is evidently very susceptible to wilt, while Dharwar No. 2 is almost as resistant as any type tried.

We have thus two strains so immune to wilt disease that they may fairly form a basis for breeding with the object of getting a much more resistant cotton than any in use at present. These are the strains of Wagale isolated at Dharwar, and our own selection from Kumpta which has been termed Dharwar No. 2.[1] Wagale is most unsuitable in every other way as a cotton for the Southern Maratha Country, but may well form the basis for a cross with Dharwar No. 1, which is otherwise the best of our improved types.

### Effect of selection of pure strains.

For some years experiments have now been continued with the object of isolating resistant plants from plots composed of pure strains of cotton. Accordingly plants were selected, which were free from wilt, in a highly infected plot of Dharwar No. 1, and the seed from them grown. So far no appreciable progress has been made in this direction during the past three years and the progeny of the resistant plants seems equally susceptible with those from the ordinary seed of the strain.

### Effect of locality on wilt resistance.

There are a number of types of cotton which have a reputation for wilt resistance in their own areas, and seeds of two of these having been obtained have been grown side by side with the other types in the specially infected plot. These two were Rozi, from Nadiad in Upper Gujarat, a type of *Gossypium obtusifolium*, and Bishnur Jari from Akola in the Central Provinces, a variety of *Gossypium neglectum*. They gave results as follows at Dharwar:—

| *Strain or variety of cotton* | *Percentage of wilted plants* |
|---|---|
| Rozi.. .. .. .. .. | 82·0 |
| Bishnur Jari .. .. .. .. | 56·1 |

Both the cottons suffered very badly. As regards Bishnur Jari, there seems no doubt about its resistant nature in the Central

[1] Kottur. Kumpta Cotton and its Improvement. *Mem. Dept. Agri. India, Bot. Ser.*, X, p. 262.

Provinces. The writer has seen this cotton at Akola where it withstood the attack in a remarkable manner. But it failed to maintain its character at Dharwar, and this difference in its behaviour may be due to differences in the active exciting cause at the two places, or merely to differences in the environment under which it is grown. As to which of these is the reason of the differing behaviour, there is at present no evidence.

# RICE GROWING IN THE KONKAN WITHOUT TRANSPLANTING.

BY

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THE growing of transplanted rice is a very laborious operation, and the difficulty and expense of transplanting is by far the most serious element in the production of the crop. It has, however, been generally supposed that by no other method can equal yields of rice be obtained as by transplanting, and though no definite experiments confirming this have been made, yet the supposition has been so constantly repeated that it is almost universally believed. If, however, the operation of transplanting could be eliminated, without loss of yield, a very great advantage would be obtained both to the grower and to the consumer, as in this case the price of rice would undoubtedly be reduced. With this in view I have conducted experiments at Bassein, for five successive years, in which the seeds were sown directly in the field by means of a regular field marker illustrated below, thus allowing of adequate weeding between the rows, and proper puddling at the same time.

The operations on the land by the writer's method of cultivation are as follows :—

(1) Ploughing of the land immediately after the previous rice crop.

(2) Re-ploughing of the land, and preparation for sowing in February or March.

(3) Sowing seeds before the rains in May or June by means of a marker allowing for square sowing.

(4) As soon as the seed has germinated and the lines of plants become visible, the field is weeded in both directions by a special weeder.

(5) When the water begins to stand in the field the weeder is again used to puddle the land.

(6) The number of plants in each hill is thinned as necessary and the plants obtained are used to fill any gaps in the field.

The ordinary method with transplanting is so well known that there is no need to describe it.

The actual records of the expenditure incurred in one experiment out of many are as follows :—

*Sowing without transplanting.*

| | Cost per acre Rs. | A. | P. |
|---|---|---|---|
| (1) Ploughing on October 26th .. .. .. <br> (2) Second ploughing on December 29th .. .. | 1 | 8 | 0 |
| (3) Marking and sowing on May 27th .. .. | 2 | 13 | 0 |
| Seed used 68 lb. per acre .. .. .. | 2 | 0 | 0 |
| (4) Rain fell on June 7th, and seed germinated by June 12th. Weedings were given on June 24th, and on July 10th, 11th and 12th .. .. .. | 10 | 8 | 0 |
| (5) Gaps were filled on July 12th .. .. .. | 1 | 2 | 0 |
| (6) Manure used .. .. .. .. | 3 | 0 | 0 |

The total cost was thus Rs. 20-15-0 per acre, excluding the cost of harvesting which was the same in both cases. The yield obtained was

| | | |
|---|---|---|
| Grain (páddy) .. .. .. | 2,820 | lb. per acre. |
| Straw .. .. .. .. | 5,288 | " " " |

*Sowing with transplanting.*

| | Cost per acre Rs. | A. | P. |
|---|---|---|---|
| (1) Ploughing in October and December .. .. | 1 | 8 | 0 |
| (2) Preparing seed-bed (one-tenth acre) including ploughing, *rab* material and sowing .. .. .. | 25 | 8 | 6 |
| (3) Seed used (40 lb.) and weeding of seed-bed .. .. | 1 | 6 | 0 |
| (4) Preparing of field for transplanting .. .. | 1 | 1 | 0 |
| (5) Lifting and transplanting (July 13th and 14th) .. | 9 | 8 | 0 |
| (6) Weeding by hand (August 13th) .. .. .. | 2 | 9 | 0 |

The total cost is therefore Rs. 41-8-6 per acre, excluding, as before, the cost of harvesting. The yield obtained was :—

| | | |
|---|---|---|
| Grain (paddy) .. .. .. | 2,610 | lb. per acre. |
| Straw .. .. .. .. | 4,252 | " " " |

The results obtained in this experiment, which is merely representative of a number of experiments which have been done at

Bassein, at Alibag, and in cultivators' fields, would indicate considerable promise in the direction of growing rice without transplanting in the Konkan. They are being followed up and more complete results will shortly be available.

The special implements I use in the method described are two :—

1. *Field marker and planter* (Fig. 1). This is a wooden roller with a circumference of ten to twelve inches, in which square holes

FIG. 1. Field marker and planter.

are made to take pointed wooden pegs seven inches in length. The arrangement will be clearly seen in the illustration. The implement is rolled in the manner shown, leaving holes in which the seeds can be sown regularly, just as in the ordinary process of dibbling; only much more quickly. There is no difficulty in joining two or three rollers together (each being six feet long) and so sowing a breadth of twelve or eighteen feet at one time.

2. *Weeder* (Fig. 2). This is a wooden implement very similar in appearance to a light country plough (see right hand

side of the figure). It consists of a wooden pole about four feet long, having one end fitted with a cross piece projecting six inches on each side to serve as a handle for pulling, and the other attached to a handle, and a little over three feet long, fitted at the base with a short leg ten inches long, which forms the working part in the

Fig. 2. Weeder.

soil. The two sections of the implement are strengthened with cross-stays where necessary. The base section is fitted with an adjustable and reversible blade. In this form it requires two men to work it as shown, one pulling and the other pushing in the paddle between the rows of rice.

This weeder is also made to be used by a single man, and then consists of a wooden pole about four feet long, with the steel blade fixed at one end and a handle at the other, as shown on the left of the illustration. This is worked alternately backward and forward by the man using it.

# Selected Articles

## THE DEVELOPMENT OF AGRICULTURE IN INDIA.*

BY

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AGRICULTURE is admittedly our largest industry in India and furnishes practically all the material for the food and clothing of the people as a whole as well as raw materials for the larger part of our manufacturing industries; over the greater part of India it is in a backward state at present and therefore offers great scope for development on scientific lines. The value of the land, buildings, stock, implements, etc., which form the capital of the landholders of this country, must run into thousands of crores of rupees: the value of that could almost certainly be doubled by the application of science to practice. The scope for improvement is so great that the cost to Government of maintaining an efficient Department of Agriculture should be insignificant as compared with the value of the results which such a department would in course of time produce. Rapid progress will necessarily be slow owing to the apathy and ignorance of the people themselves. It is the bounden duty of Government therefore to provide the driving power; in no other way can it be provided. In India an intelligent appreciation of the value of research and of scientific methods hardly exists outside Government departments; very few of our public men who voice the sentiments of the people are personally interested in the development of agriculture, and our practical agriculturists are not sufficiently well educated to be able to express their views clearly, or to

* Reprinted from "The Indian Empire—Trade and Commerce Survey, 1923-24" Supplement to the *Times of India Illus. Weekly*, 4th July, 1923.

give a scientific department the backing it requires and deserves. India is placed at a disadvantage in this respect as compared with England, for example, with its large number of up-to-date "gentlemen" farmers, many of whom have studied the theory and practice of scientific agriculture at Universities and Agricultural Colleges. These farmers themselves conduct experiments with the assistance of the large staff of scientific advisers employed by the Ministry of Agriculture, the Universities and Colleges; they keep in touch with every new development in agriculture by subscribing for scientific periodicals, and play an important part in moulding the policy of Government. Living as they do in a scientific atmosphere, they appreciate the value of science and give the scientist the backing he needs.

### The application of science.

The standard of cultivation in India to-day closely resembles that which obtained in England two centuries ago, when the wooden plough, since relegated to the museums as a relic of the past, was the tillage implement in common use. Such land as was under cultivation in England at that time gave very poor yields, and for want of efficient implements and draught power very large areas were never cropped. The agricultural unit in England at this time was the village with its scattered holdings, common grazing grounds, half starved cattle, and poor crops resulting from bad cultivation—all of which are characteristic of most parts of India at the present day. Wars and more especially the Napoleonic wars, the rapid development of manufacturing industries in urban centres, the consequent increase in the urban population and the decrease in the population of rural areas all helped to force up wages and the cost of farm produce. High prices, coupled with a rise in the cost of labour, stimulated the use of labour-saving appliances and the production of larger acreage yields; and the open field system of scattered holdings with its bad cultivation which resulted therefrom gave way slowly before economic pressure. In England the leading "gentlemen" farmers were the first to adopt the more intensive methods of farming demanded by the times. Holdings were consolidated and fenced, and the cultivation of turnips, clover and other new crops which were to revolutionize farming was taken up on a large scale. There was as yet no science of agriculture which could be applied to the solution of its manifold problems. Men like Jethro Tull, Bekewell, Lord Townsend and Young, though not themselves scientists in our sense of the term, possessed the scientific habit of mind which they brought to bear on the agricultural problems of the day, and thus prepared the way for scientists who about the middle of the nineteenth century did so much for the development of English agriculture. As a result of the war of 1914-18 scientific enquiry in all branches of agriculture has been stimulated afresh in England. Statesmen and the public generally now realize the paramount importance of scientific investigation and of providing for the endowment of work connected with the development of agriculture on a scale commensurate with its great importance. They see, as they never did before, that the countries which have made the greatest progress and which obtain from the soil the highest return are those which have developed their research institutions.

### AN ECONOMIC REVOLUTION.

The introduction of improved implements and machinery, of better seed and cattle and of manures and crop rotations which followed in the wake of scientific investigation revolutionized agriculture in the West, and has in about a century and a half enabled the English farmer to double the outturn of his crops, to drain and bring under cultivation large areas of waste land, to improve his methods of cultivation generally, and to make much larger profits. The increased productiveness of the land effected was all in the interests not only of the cultivator, but of the average citizen, helping as it did to keep down the cost of living at a time when our population was fast increasing. It was in the interests of the nation, too, in enabling it to hold its position in the markets of the world; but for the development of agriculture it would have been impossible for England to feed the hundreds of thousands of urban workers employed in her factories, and she could never have developed her great manufacturing industries. If India desires to develop her main industry—agriculture—it can be done in the same way as it has been and still is being done in England and other advanced countries, namely, by employing highly qualified investigators to show the way, and by disseminating the results of their work among the cultivators.

History repeats itself; the economic conditions which obtain in India to-day resemble in many respects those which led to the development of more intensive farming in England in the eighteenth century. The price of farm produce has risen very much: industries other than agriculture are drawing labourers from rural to manufacturing centres, and there has been a general rise in wages. If he is to take full advantage of the new situation thus created, the landholder in this country will have to follow the example of the English farmer by adopting more intensive methods of cultivation involving the use of labour-saving machinery, of manures, and of better methods of cultivation generally. There are many indications that he is beginning to do so, the pity is that he is not as yet sufficiently well educated to take much part in moulding the policy of his Government. His supposed views are generally represented by men who live in towns and who are not practical agriculturists. This class of politician has within the last two years somewhat weakened the driving power of the Executive Government and progress is thereby being retarded.

The landholder in this, country unlike the English farmer of a century and a half ago, is in the fortunate position of having at his back a body of agricultural scientists who have, by research and experiment, produced results which should be of the greatest value if applied. Much has already been done to improve the cattle and the staple crops of the country by selection and hybridization, and the financial results therefrom have been most striking. To take but one example, namely cotton, the area now being sown in India every year with improved varieties probably exceeds 2,000,000 acres, and the increased profits therefrom, calculated on the basis of an increase of Rs. 10 per acre, must be somewhere in the neighbourhood of two crores of rupees annually. There is no reason, however, why the increased profit on the cultivation of this crop should not be raised to twenty-three crores of rupees a year; for the total area under cotton is over 23,000,000 acres. In one province alone, namely, the Central Provinces, the introduction of a selected cotton is reckoned to have increased the annual value of the cotton crop by at least 70 lakhs of rupees which covers the annual expenditure on the working of the Department of Agriculture seven times over. For the improvement of other important crops, such as rice, wheat, *juar* (*Sorghum vulgare*), oil seeds and jute, there is also great scope for improvement, and much has already been done in that direction. It is no exaggeration to say that the value of crops in this country could be increased by hundreds of crores, by merely substituting improved strains of seed for the inferior low-yielding varieties at present grown.

## CATTLE-BREEDING.

In India where the bullock is the draught animal in common use and where milk products are common articles in the dietary of the people, cattle-breeding is of enormous importance. Poor draught cattle result in bad cultivation; bad cultivation results in poor outturns of grain for the cultivator and of fodder for his cattle; this again results in an impoverished cultivator and in weak and therefore inefficient draught bullocks. How to break this vicious circle is one of the most difficult problems facing the scientific investigator and Indian farmer to-day; for the standard of cultivation possible is largely dependent on the quality of the draught bullocks available. The introduction of improved implements on a large scale would be practicable if there were bullocks sufficiently strong to work them. The position, however, is by no means hopeless. Cattle in India to-day are probably but little, if any, inferior to those which were found in England in the middle of the eighteenth century. By better breeding and feeding English breeds have since that time been improved out of all resemblance to their progenitors. The improved breeds evolved have gained a world-wide fame, and England has become the world's principal stud farm. In the middle of the eighteenth century we read that cows in England were such poor milkers that they did not produce enough milk to feed their calves, and that an average cow could be purchased for £3 or Rs. 45 in Indian money. By selection and cross-breeding, cows of some of our English breeds now yield 40 seers of milk daily and are worth at least Rs. 750. Most cows of Indian breeds are such poor milkers that it does not pay to keep them for dairy purposes; the average cow when in full milk seldom gives more than 6 lb. of milk per day. By selection and crossing the quality of breeds both for milk and draught purposes has, on Government farms, been greatly improved, and what is being done to-day on Government farms will be done in 20 years or less by enterprising cattle-owners in this country. A herd of Montgomery cows on the farm of the Pusa Research Institute has within 10 years been improved to such an extent by selection that their average daily milk yield per cow has increased from 5½ to 9 lb. per day, including dry periods during which no milk was given. This improvement should add at least 40 rupees to the value of each animal: but the improvement effected by cross-breeding is still more striking, the average yield from the Pusa Ayrshire-Montgomery crosses on the same basis of calculation being 15 lb. per day. The improvement effected on some of the breeding farms managed by Provincial Governments where draught breeds are kept is also worthy of note. The animals bred thereon are much larger and stronger than those reared in villages under existing conditions, and they are probably worth at least Rs. 40 more per head. Taking into account the fact that there are about 14½ crores of animals in India, it is evident that there is enormous scope for adding to their value by better breeding and feeding.

## Agricultural implements.

The Indian cultivator is working at a great disadvantage owing to the inefficiency of his agricultural appliances. His tillage implements are so light and small that they do not kill out weeds effectively; nor can they be used for ploughing under weeds and other forms of leaf manure when that is necessary. Of all the implements in common use in India the country plough or *nagar*, as it is commonly called, is perhaps the most inefficient. It may be described as a piece of wood shod with an iron point which constitutes the share. It is fitted with a wooden pole and is usually drawn by one pair of bullocks. Having no breast it stirs the soil without inverting it, and having no cutting parts it does not eradicate weeds. The argument advanced against the introduction of iron ploughs and other improved implements is that they are generally heavier to pull than those in common use, and are not, therefore, suitable for the draught cattle of this country. The improved implements are, however, appreciably lighter in draught as a rule than those which they are replacing. The M. S. N. plough so popular in rice tracts weighs 34 lb. and can be drawn by a pair of very small bullocks.

Ploughs of the Rajah and Punjab types which have found favour in the Gangetic valley are not too heavy for one pair of ordinary bullocks.

In black cotton soil tracts, improved iron ploughs have become very popular; thousands are now being sold there every year and some cultivators have of late years taken to the system of ploughing land on hire with Turnwrest ploughs after completing their work on their own farms. Another plough, which has done exceptionally well in this tract, is the Sabul which is specially suitable for ploughing cotton land in the dry season. An important feature of the Sabul plough is that it is equipped with a share having a renewable and adjustable bar point made from a specially prepared high carbon steel. The plough weighs 145 lb. and does better work when drawn by two pairs of bullocks than the heavy *desi* plough which requires three pairs.

Landholders are beginning to realize that it pays to eradicate from their fields perennial weeds such as *dub* (*Cynodon dactylon*) and *kunda* (*Andropogon punctatum*) which in badly tilled fields compete year after year with their staple crops for the limited amount of moisture and plant food available in the soil. The loss in yield due to the growth of weeds in cultivated fields must in the aggregate be colossal, more especially in tracts where *kharif* crops are mainly grown. But even in *rabi* tracts, where wheat and gram are the principal staples, the loss in yield every year due to the low standard of cultivation and to the perennial crop of weeds resulting therefrom is enormous. *Kans* grass (*Saccharum spontaneum*), one of the most obnoxious of these weeds, has got thoroughly established over large areas in Central India, the Central Provinces and Bundelkhand in the United Provinces. This weed has a stoloniferous root which branches freely at a depth of about 7 or 8 inches from the surface. It is found in the best wheat soils which retain moisture in the hot weather and many hundreds of thousands of acres of such land have gone out of cultivation in consequence. Much of this area has lain fallow since the famines of 1896 and 1900; but in addition to this fallow area, there are many hundreds of thousands of acres in which *kans* competes year after year with the wheat, gram and other *rabi* crops grown, the yields of which are thereby greatly reduced. After each famine the draught power of the village is reduced, for many bullocks die of partial starvation and the strength of the remainder is reduced owing to the same cause. For want of sufficient bullock power the weed gets the upper hand and the land is allowed to lie fallow thereafter. Such is the fate of the patient plodding tiller of the soil in India to-day where the bullock supplies the motive power. In a famine year unfortunately the quantity of food by the bullock required to produce the energy needed is not forthcoming. The Settlement Officer of Saugor District in the north of the Central Provinces says that the area under *kans* in that district alone amounted in 1916 to about 180,000 acres or 15 per cent. of the cropped area. We may take it that landholders in *kans*-infested tracts are losing at least Rs. 30 an acre annually by allowing any such land to lie fallow.

### Tackling the Weeds.

To reclaim *kans* land by means of the ordinary implements used in the villages is almost impossible, except when the weed is tackled in its early stages by more or less continuous ploughing, and even then it is extremely difficult to accomplish. Small areas of *kans* have been eradicated by means of both the Sabul and the Turn-wrest ploughs worked to a depth of 7 or 8 inches. With the inferior bullocks available in the wheat tract it is difficult, however, for the ordinary cultivator to use these ploughs in the dry weather when the soil is dry and hard; and *kans* cannot be killed by ploughing during the rains. The introduction of the motor tractor may perhaps solve the difficulty. The cost per acre of ploughing clean land with tractors is about Rs. 20, including interest and depreciation: in stiff soil badly infested with *kans* the indications are that the cost will be about Rs. 30. But even at Rs. 30 it will pay the owner very handsomely to have such land brought under cultivation, seeing that one crop should about cover the cost of reclamation. When tractors are used, the land can be ploughed in the dry weather in which case the roots of the weed are killed by being exposed to the sun and dry air.

From experiments already carried out it would appear that over 90 per cent. of the roots are killed by one ploughing. Enterprising landholders at times eradicate small areas of *kans* by manual labour, in which case the cost of hand digging amounts to Rs. 80 an acre. In a test carried out on the College Farm, Nagpur, it was found that when employed for eradicating *kans* a tractor did as much work per day as 16 pairs of bullocks, and as much as 288 men when employed in removing the roots by digging.

On the strength of information obtained from these and other experiments, the Government of the Central Provinces has agreed to give loans under the Land Improvement Loans Act to cultivators desirous of eradicating *kans* and other perennial weeds from their fields, and the Department of Agriculture is now working tractors lent by an enterprising Bombay firm ploughing weedy land for cultivators at a fixed acreage rate. Syndicates or private firms will, it is hoped, take up this important line of work in course of time. It requires no great stretch of imagination to understand the potential value of mechanical power if used for converting such fallow areas into productive land.

## Use of tractors.

There is a good deal of controversy as to the respective merits of steam cable sets and motor tractors. Into this controversy I do not wish to enter; suffice it to say that the former would probably prove the more efficient for work in the *kans*-infested areas already referred to. Their initial cost is, on the other hand, so high that there is little chance of their being tested by Government in these days of financial stringency. The tractor is being tried because it is much less costly: it can, moreover, be used with advantage not only for ploughing and cultivating land, but for driving stationary machines such as cotton gins, pumps, flour mills and fodder cutters. As at present designed, the tractors tried are not sufficiently strong and fool-proof for Indian conditions, and much difficulty has been experienced in some provinces in keeping them in good running order. Workshops where repairs can be executed are few and very far between, and all the agents in this country have not yet realized the paramount importance of keeping a large supply of spares in stock. Still the fact remains that under specific conditions and with intelligent use the tractor is a farm-power unit of great possibilities in tracts where the draught power at present available is inadequate. There are on the market at the present time more than 50 makes of tractors varying to some extent in type. They may be roughly classified as wheeled types and caterpillar types.

Tractors of the caterpillar type are well suited for after-cultivation work; their weight is distributed over a much larger area than that of wheeled tractors, and they do not therefore pack the soil so much. They can for the same reason be worked on land which is too wet for wheeled tractors. Another advantage claimed for this type is that they are very suitable for work in small fields as they can be turned in a small space. For ploughing hard land there is little to choose between the two types; but it may be claimed for the wheeled types that there are no tracks to be renewed every second year or so, and that the cost of upkeep is, therefore, less. For stationary work both kinds are equally suitable. Both types suffer in the hands of careless drivers from over-heating and many break-downs are due to this cause alone; for it is extremely difficult at present to get in this country properly trained mechanics, and to put a tractor in the hands of a man of the cooly class, even after he has been trained to drive it, is to court disaster. This and other difficulties will, however, gradually disappear with the advent of facilities for training mechanics.

The improvement of draught cattle, the introduction of better implements and the use of mechanical power will enable the cultivator to perform his tillage operation under optimum conditions; poor yields are often due in no small measure to the land being ploughed badly or too late. The wheat grower, for example, who harvests his crop in March spends weeks in treading out the grain under the feet of his bullocks and in separating it from the chaff. Given a good threshing machine and winnower, this work could be done in as many days. So much time is spent over each operation at present that ploughing for the next crop has often to be put off till the rains. Over a greater part of the wheat tract, the monsoon breaks about the middle of June, and in years of heavy and continuous rainfall the breaks are so short that the area ploughed before the close of the monsoon is small. With the abrupt cessation of the monsoon, the soil rapidly dries and becomes too hard for ploughing with the country plough. The seed has thus to be sown in a badly prepared seed-bed. Ploughing with improved ploughs in the hot weather has, in some parts of India, increased the yield very largely. Land ploughed before the rains break absorbs much more of the rainfall than unploughed land. Ploughing provides for the better aeration of the soil, too, and thereby stimulates bacterial action in the formation of nitrates. Ploughing thus done under optimum conditions provides for the succeeding *rabi* crop a store of moisture and nitrogen.

## Demand for improved implements.

The introduction of improved tillage implements has opened up a vista of great possibilities for the agriculture of this country. The efficiency of these implements is largely due to their having been designed by the trained engineers of certain firms working in collaboration with agricultural experts in India. Many of the improved ploughs thus introduced have met a felt want. Machines for harvesting crops, for cleaning grain and for chopping fodder have yet to be evolved. A reaping machine suited for cutting *juar* would be a boon; such a reaper should be high-geared and should have a short cut of from three to four feet. The fingers of the knife bar and the knife itself should be strong and the sheaf board long enough to support the stalks which are usually six or seven feet long and about three-quarters of an inch in diameter. For wheat mowers there is already a small demand which is likely to increase, as the cost of labour, more especially at harvest time, is rising.

For fodder cutters a fair demand already exists. In *juar*-growing tracts about one-fifth of the stalk is wasted when fed whole to cattle, as they refuse to eat the coarse ends unless they are cut into small pieces. The high price of these machines prevents all but well-to-do cultivators from buying them.

For winnowers, too, a demand already exists; but the prices charged for imported machines are so high that cultivators cannot afford to purchase them. The winnowers made in India by village carpenters are less expensive, but at the same time less durable. The sale of these inferior country-made imitations of imported machines is no doubt detrimental to the trade in agricultural machinery generally; but the solution of the difficulty is in the hands of the big manufacturer. To create a demand, they must be prepared to supply India with her requirements at reasonable prices.

The method in vogue in India of treading out the corn with the muzzled ox is a slow and primitive process. The need of improved machinery is becoming more evident every year. Threshers driven by oil engines are now being used on Government farms and will no doubt find favour among cultivators in course of time. One objection to their use is that they do not break up the straw into small pieces. This objection, however, is not a very serious one, perhaps, seeing that this can be done later by means of a separate fodder cutter.

The demand for improved iron cane mills of the three-roller type and capable of being worked by a pair of bullocks is very great. Most of these bullock-driven mills give about 10 per cent. more juice than the *desi* mill which they are fast replacing. Their introduction must be adding lakhs of rupees every year to the profits of cane cultivation in India; for there are now hundreds of thousands of them in use. It is a pity that no firm in England has specialized in the manufacture of bullock-driven cane mills; for the workmanship of those turned out in India is generally poor. The mills turned out by the Nahan foundry in the Punjab are an exception to the rule, and the demand for the mills made there exceeds the supply. A small all-iron cane mill capable of crushing half a ton of cane per day when worked by a pair of bullocks would find a ready market in this country if offered for sale at Rs. 200 or less.

### Fencing against animals.

Wild and domesticated animals do a great deal of damage to crops in India. Wire fencing is used on a small scale only, and the result is that stray cattle in the villages as well as antelope, wild pigs, jackals, etc., rob the cultivator of the fruits of his labour. Of the wild animals to be considered in this case, the wild pig is perhaps the most destructive. Being a nocturnal feeder he lies hidden during the day in the jungle or grass-covered wastes which are often many miles from the crops, on which he feeds. The cultivator sometimes constructs a fence of thorns or bamboos round the field he wishes to protect, but as all such fences are more or less inefficient, it is customary for him to keep also a watcher in the fenced fields at night. The wild yells of this watcher on the approach of "grunters" are generally sufficient to scare them away; but at times, Homer-like he nods and the pigs break in and steal. In the morning the owner of the field finds that his crop has been very materially damaged and his profits for the year thereby reduced. Patent pig-proof woven wire fencing has been introduced in some provinces with good results. The demand for this type of fencing wire is likely to increase very largely.

The whole field of Indian agriculture still bristles with unsolved problems; but in a short article it is possible to deal only with a few of the outstanding ones. The activities of Provincial Departments of Agriculture extend over a wide field and improvements are being introduced which are both adding to the wealth of the cultivator and fitting him for further progress. The great task of reconstruction is well worth all the brains and energy which can be put into it; for on the development of agriculture depends not only the prosperity of India's many millions of agriculturists, but to a great extent the lot of those engaged in other industries, too. Increased crop production will help to banish famine and poverty from the land and to bring us nearer the realization of our desire, namely, to make India "a garden ringing with cheerful and contented life, with smiling fields and food in plenty."

## METHODS ADOPTED IN AUSTRALIA FOR DISINFECTING COTTON-SEED.*

FOR some time past the Victorian Department of Agriculture, acting through the Government Plant Pathologist, Mr. C. C. Brittlebank, and Mr. D. B. Adam, B.AG.SC., has been engaged upon a series of experiments, having for their object the cleansing of cotton-seed from parasitic attachments tending to promote disease. In this country, where a resolute endeavour is now being made for the cultivation of cotton on a commercial scale, it is thought to be of the greatest importance to prevent the planting of contaminated seed in order to ensure healthy and profitable stock. Doubtless the effort is beset with much difficulty. Whereas in the laboratory it may be comparatively easy to strip the seed operated on from every trace of infection, to do so on the bulk of seed used in the ordinary process of cotton planting would be a troublesome and expensive task. From the report of Messrs. Brittlebank and Adam the following statement is taken.

The cotton plant, *Gossypium* sp., is liable to a variety of diseases. Some are caused by fungi, the spores of which are carried on the lint remaining on the seed after ginning. Black rot, or cotton wilt, caused by the fungus *Fusarium vasinfectum* E. F. S. and anthracnose of the boll and stem caused by the fungus *Glomerella gossypii* Edg. are examples of two serious diseases which are spread by this method. Neither of these diseases has been reported as occurring in Australia. There, however, is a possibility of their being found in Queensland, where cotton has been grown for about 50 years. As no effort to prevent the introduction of disease in the original seed samples was made, that State must be considered a possible source of infection. All seed brought from there should,

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* Reprinted from *Tex. Recorder*, XLI, No. 486.

therefore, be subjected to the same disinfection and treatment as any imported from overseas. On account of the dryness of the adhering lint, it is difficult to effectively soak the usual sample of cotton-seed in any disinfectant. It is necessary to remove the lint. The concentrated sulphuric acid method of treatment is an efficient and cheap way of delinting cotton-seed. The seed is placed in a wooden or earthenware vessel, and then covered with commercial sulphuric acid for from ten to fifteen minutes, being stirred constantly with a wooden ladle. The seed can be removed in an earthenware vessel with a sieve bottom. The same sulphuric acid may be used for treating several lots of seeds. The treated seed is then washed in running water for 20 minutes and allowed to drain. For complete disinfection the seeds may afterwards be placed in corrosive sublimate (1—1,000) for 15 minutes, and at the end of that time allowed to dry. Experiments in the use of this process have been made in the laboratory of the Department of Agriculture in Victoria. Some have been designed to test the effect of the treatment on the germination of the seed and the condition of the young plants. Other experiments have been carried out to test the effect of immersion in sulphuric acid for varying periods of time.

### The Effect on Germination.

Two samples of 100 seeds each were taken. One was treated for 15 minutes with sulphuric acid and then washed for 20 minutes and germinated. The other sample was not treated. Of the treated seed 88 per cent. has germinated in three days, and in four days 93 per cent., which was the total germination. The growth was clean and vigorous. Of the untreated seed 86 per cent. germinated in four days, and 90 per cent. in six days, which also was the total germination. The growth of these plants was not as vigorous as that of those from the treated seed. Many treated seeds were grown in pots. Of the plants to be used for inoculation experiments none failed to germinate; all gave clean, healthy, vigorous plants. Some of the plants grown from untreated seed were sickly and apparently affected with disease. A suspension obtained by soaking untreated seed was used to inoculate agar plates. Among the numerous fungi found, a *Fusarium* was isolated. This was used for inoculation experiments with results, details of which are given below :—

(*a*) Some clean cotton-seeds were planted. Eleven days after they showed above ground, they were infected with spores from an agar culture placed on the soil around each plant. In four days all the plants were affected.

(*b*) Soil was sterilized in an autoclave at 110°C. for two hours. Cotton-seed was treated with sulphuric acid for 15 minutes, washed for 20 minutes, and sown in four pots with this sterilized soil. Five seeds were sown in each pot.

| Treatment | Number germinating | REMARKS |
|---|---|---|
| (*a*) 1. Seeds infected from culture .. | .. | .... |
| 2. " " " " .. | 2 | Spores formed on primary leaves. |
| (*b*) 3. Seeds infected with spores .. | 1 | .... |
| 4. " " " " .. | 1 | .... |

The exact species of *Fusarium* has not been definitely fixed. In acute cases it has entirely prevented the germination of the seed.

### THE EFFECT OF VARYING THE TIME OF IMMERSION IN SULPHURIC ACID.

Small bottles, each containing 100 seeds with sufficient sulphuric acid to cover them, were used. After the period of immersion and washing, the seeds were placed in damp blotting paper and incubated at 75°F. The first examination took place four day afterwards, the final examination two days later with the following results :—

| Time of immersion | First germination | Final germination | REMARKS |
|---|---|---|---|
| Minutes | Percentage | Percentage | |
| 0 .. .. | 86 | 90 | The plants were more vigorous and cleaner than those from untreated seed. |
| 15 .. .. | 88 | 93 | |
| 20 .. .. | 86 | 90 | |
| 25 .. .. | 84 | 87 | |
| 30 .. .. | 92 | 94 | |
| 35 .. .. | 80 | 85 | |
| 40 .. .. | 84 | 86 | |
| 45 .. .. | 92 | 95 | |
| 60 .. .. | 83 | 86 | |
| 75 .. .. | 88 | 91 | |
| 90 .. .. | 91 | 93 | |
| 120 .. .. | 88 | 89 | |
| 240 .. .. | 90 | 94 | |

From this table it may be seen that prolonged immersion of four hours did not affect the germinating capacity. Some seedlings from treated seed have been grown in pots and have given perfectly healthy plants and bolls. To test whether seeds could be killed with sulphuric acid, some seeds were left in concentrated acid for twenty and forty hours respectively, and afterwards washed. Germinations of 91 and even 92 per cent. were obtained. With the former, a good clean, healthy growth resulted. In the second case, many of the young plants were malformed. The sulphuric acid had decomposed the pericarp, and had begun to attack the cotyledons, or subsequent primary leaves.

It is doubtful whether any of these plants would have grown much further than the seedling stage. From the data given, there seems to be little danger from too long immersion within reasonable limits. It was thought to be advisable to test the effect of treating seed with sulphuric acid for varying periods, then washing, drying, and allowing to stand for a week, and this was done. The results obtained are given below. Seeds germinated at 75°F.

| Time immersed | | Germination |
|---|---|---|
| Minutes | | Percentage |
| 15 | .. | 94 |
| 30 | .. | 92 |
| 45 | .. | 94 |
| 60 | .. | 90 |
| Check | .. | 90 |

This shows that a delay of one week after immersion and before planting has no effect on germination. When sulphuric acid and water are mixed great heat is rapidly developed. Under some conditions this may do so with explosive activity, hence sulphuric acid must always be used with care. After treatment with sulphuric acid and subsequent draining, the seed should be placed in a large volume of running water. An experiment was conducted by adding a small quantity of water to treated seed; the temperature rose to 180°F., but with the addition of more water it soon fell. Subsequent experiments showed that seed held in hot water at 180°F. for five minutes failed absolutely to germinate. At 160°F. for five minutes, of two samples, 46 and 41 per cent., respectively, germinated. The necessity for care in handling sulphuric acid cannot be too strongly impressed upon those unacquainted with its strength. If it comes in contact with the hands it will burn them, and any splashed on clothes will damage them.

## SUMMARY.

(1) The spores of many serious diseases are borne in the lint attached to the seed.

(2) The lint is most conveniently removed by sulphuric acid.

(3) The necessity for treatment of all imported samples is shown by the isolation of a pathogenic *Fusarium* from an imported cotton-seed sample. Its pathogenicity has been demonstrated.

(4) Immersion up to four hours has no effect on the capability of the seed to germinate.

(5) Finally, the seed after immersion in sulphuric acid should be washed in a large volume of running water.

The report of the Government pathologist and his collaborator ends at this point.

One of the most striking exhibitions seen during the course of these experiments was the strong vitality of cotton-seed under circumstances that might have been presumed to be completely destructive. On the other hand, it was proved that the seed is very sensitive to a comparatively small increase of temperature and is injured by it.

The purification of cotton-seed as a provision against the spread of disease is unquestionably a work of necessity and importance, and to carry it out on a scale commensurate with the planting of large areas seems to invite the attention of the mechanical engineer in co-operation with the chemist and pathologist.

## THE IRRIGATION OF THE SUGARCANE IN HAWAII.*

IRRIGATION in the sugarcane fields in the Hawaiian Islands is not confined to those parts on the western side where the rainfall is insufficient for the growth of the cane to maturity, but extends throughout the planted area, especially in Kauai, Oahu and Maui. Although the local practice of irrigation has turned out to be a very costly proceeding when compared with that in other parts of the world, it is found to be a very paying proposition, and the plantations are not only concerned with the tapping of rivers and the storage of the rainfall and bringing these supplies on to their fields, but this supply is supplemented by immense pumping plants by which the underground water supplies are brought to the surface and similarly utilized. And so convinced are the planters of the profitableness of this line of development that, besides the investment of large sums of money in canals and pumps, the labour allocated to the leading of the water on to the fields has become the dominant item in the balance sheet of those estates which use this means of increasing their outturn of sugar. In addition to all this, they are spending large sums of money on reafforestation, in order to keep up the supplies of soil water and to utilize to the best advantage the natural rainfall of these favoured islands.

A full study of the whole subject has been made by W. P. Alexander and is presented in a thesis "in partial fulfilment of the requirements for the degree of Master of Science in the University of Hawaii," and this has now been published by the Hawaiian Sugar Planters' Association in pamphlet form.[1] This pamphlet deals with the whole accumulated literature of the subject (73 papers) and is compressed into 109 pages, with 63 illustrations and numerous tables. As the author has himself done much useful research on the subject and leaves no part of the field untouched, the paper is

* Reprinted from *Int. Sug. Jour.*, XXV, pp. 401–408.

[1] "The Irrigation of Sugarcane in Hawaii." Experiment Station of the Hawaiian Sugar Planters' Association, Honolulu, 1923.

an extremely valuable one. It is well and clearly written, although in parts the desire for compression has made it a little difficult to follow, and one would in some places have wished for a more generous treatment as regards explanatory remarks.

The thesis commences with a brief introduction of a general and historical character (10 pages), and this is followed by a detailed review of irrigation practices, continuing with summaries of the various lines of research which have been followed by the different workers in the field from the commencement, and concluding with a detailed local bibliography of the subject. To give an idea of the treatment and the relative development of the different sections, these are given below with the number of pages in brackets devoted to each : After the introduction follows a brief statement of the standard method of distribution of water in the field (2), and an important discussion of the application of water, including the most recent variations from this method (33). Then the following are dealt with in briefer summaries: Duty of water (5), Conservation of water (13), Soil moisture studies (6), Economical distribution and optimum application (9), Time element in irrigation practice (7), Saline irrigation (2), and Application of fertilizer in irrigation water (2). Owing to the great mass of material brought together, it is somewhat difficult to review the paper, but the present article endeavours to lay out before our readers the salient features of this great problem, and this is to a certain extent rendered more easy by the recent publication in this Journal[1] of a description of the more recent advances in economizing the labour involved.

For the production of profitable crops of sugarcane, over 50 per cent. of the fields in the Hawaiian Islands are almost entirely dependent on irrigation, and the tonnage from this proportion of the area under cane exceeds two-thirds of the total sugar output. This will be readily understood from the subjoined figures of the irrigated and unirrigated areas under cane in the four sugarcane growing islands. In Kauai 40,036 acres are devoted to sugarcane cultivation, 95·66 per cent. of which are irrigated : the figures for

[1] *Int. Sug. Jour.*, XXV, pp. 180–184.

Oahu are 40,352 and 98·25, and for Maui 50,906 and 89·52; while, on the other hand, there are 93,126 acres of cane land in Hawaii, only 6·97 per cent. of which are dependent on artificial watering.

Irrigation has been used in the local sugar industry from its start. The first project was carried out in Maui in 1878, when water was diverted from the rainy eastern slopes seventeen miles across to the arid western side: this was completed at a cost of $80,000. It was immediately followed by a large project carried out by the Hawaiian Commercial and Sugar Company for the irrigation of the central Maui plains, and from this beginning an irrigation system has developed which has cost some $4,000,000, the latest addition being the great Wailoa ditch delivering 140 millions of gallons at an elevation of 1,100 ft. and costing $1,500,000; this aqueduct the author regards as the largest in the world. An enumeration follows of the chief projects for the storage and delivery of rainfall water on similar lines throughout the islands, mountains being tunnelled, valleys bridged and syphons erected for the negotiating of the irregularities of the mountainous country to be traversed. Besides these projects, steps have been taken to tap underground water supplies which would otherwise be wasted, and a number of immense pumping stations have been installed, the machinery alone of which has cost some $6,000,000. The electrification of the latter has recently been undertaken as it has been proved to be by far the most economical method of lifting the water. Altogether, the 24 plantations on which irrigation is employed have invested something like $17,000,000, while close on 100,000 acres of forest land are owned and set apart for the conservation of the water supplies.

It is estimated that in Oahu 2,500 millions of gallons of water are pumped every month from artesian sources for the sugar plantations. For the maintenance of this supply, assuming that there are 300 days in the year used for pumping, it is necessary for 25,000 millions of gallons to enter the underground system every year. The proportion of watershed is considered to be twice that of the cane area served, and thus 100 inches of rainfall a year must find its way from the forests into the subsoil. The conservation and replanting of the remnant of the natural forests of the islands, which have been deplorably devastated for many years past, has thus become a matter of supreme importance to the planters, and is, in fact, receiving marked attention from the Hawaiian Sugar Planters' Association, which is working hand in hand with the Government and the individual planters themselves.

The cost of irrigation per acre and per ton of sugar is set forth for the crop of 1914 in a table, in which the averages work out as follows: cost per acre $67·91, per ton cane $1·42, percentage of labour employed on irrigation to total labour in getting the crop to the mill 62·97. These figures are then compared with those obtained from Porto Rico and Cuba, although irrigation in the latter island is to be regarded as in a purely experimental stage. In 18 Porto Rican plantations the cost of irrigation per acre is given as $15·76 and that per ton of cane $0·63, while the figures for the four Cuban estates are $2·18 and $0·08 respectively. From these details it is obvious that in Hawaii the profitable production of sugar is subordinated to the intelligent use of irrigation. With this idea in his mind, the author of the thesis aims at a stimulation of research in this direction and devotes his attention chiefly to the means by which the heavy costs of applying the water to the fields may be reduced to a minimum.

The standard irrigation practice in Hawaii is concisely described by means of a diagram here reproduced (Fig. 1). The elements thereof, once the water has been brought to the plantation, consist of a series of water channels of different calibre and arrangement. These are, in succession, as follows: main supply ditches, running along the higher contour lines and therefore more or less level; straight ditches more or less at right angles to them, that is, running down the slope; level ditches again running along the contour lines and 200–300 ft. apart; watercourses, small improvised channels down the slope leading the water to the furrows, the latter lying more or less across the slope of the land, 30 to 35 ft. long and about 5 ft. apart. The adaptability of this scheme to all kinds of topography has made its practice almost universal. But, as will be seen, there are numerous small deviations according to the conditions, The method of supplying the water does not greatly vary, but the actual practice depends on a great number of special local

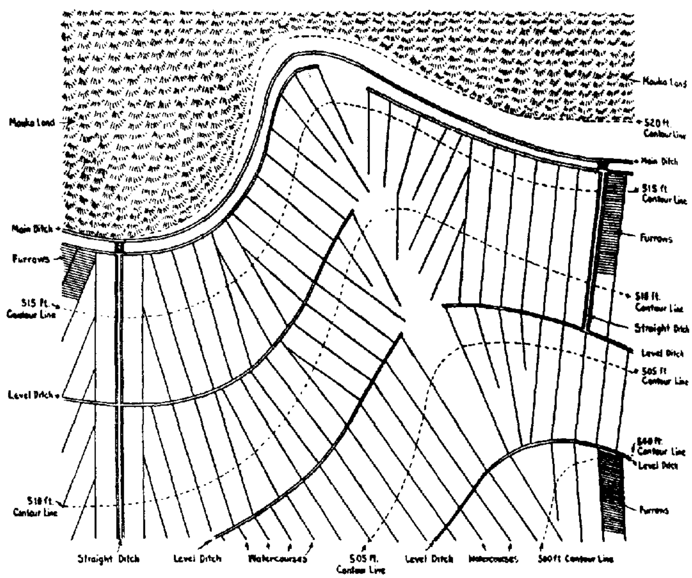


FIG. 1. Diagram of the Hawaiian furrow system.

circumstances. Such are the nature of the supply, whether steady or fluctuating, and its sufficiency for maintaining the supply all the year round; the occurrence of freshets with only a limited water storage capacity; whether the cost of pumping as supplemental is found to be profitable; the necessity of over-irrigation because of salinity; the labour available and its skill and the nature of the supervision required; the texture of the soil, whether light or heavy, rocky or smooth; the presence of coral below, retention of moisture and drainage facility; the condition of the field, whether the furrows are shallow or deep, and the condition of the watercourses; the slope and regularity of the contour; the kind of cane grown, its habit, whether erect or recumbent, light or heavy yielding, the amount of trash produced, whether plant cane or ratoons, hilled or unhilled; the periods of irrigation and the relation of these to weeds, the possibility of applying fertilizers in the irrigation water, and so forth.

In the standard practice every row is irrigated separately from one side only of a watercourse (Fig. 2), and this is considered the best method by the managers of the largest and most successful plantations. The two-way system, as described by Maxwell, gives water to the furrows from both sides of a watercourse at the same time; it is said to be economical of water, but even land is required. Every other row irrigation is an emergency method for hilled-up cane, the alternate rows being filled up with trash; it saves time and weeding and is a big help when water is scarce. Percolation is found to be sufficient to keep the soil moist, but the ultimate yield of canes is deficient.

Cutting lines is the name given to another method, in which one outlet of the watercourse irrigates a number of furrows in succession, as follows: When the water reaches the end of the first furrow, the ridge between it and the next below is cut across, so that the water enters the latter and flows back again towards the watercourse, and by repeating the operation a number of furrows can be dealt with by one opening from the watercourse. In one form or another this deviation from the standard is used by 16 out of 26 plantations, but only after the first two or three months. It is useful for holding back the water of freshets with little natural storage capacity, or for flooding after a dry spell when heavy rains occur. The first furrow, of course, gets too much water and the method is inapplicable to porous soils. When the water is short, single line irrigation is reverted to.

The Ewa or Renton system (Fig. 3) is a combination of the two-way and cutting line systems and saves labour, as well as land, because half the usual number of watercourses with their banks are available for cane growth. In 1914 by the old method one man was able to irrigate 8·29 acres in a day, but in 1916 by this system a single labourer was found to be able to attend to 13·35 acres. The system has been in use on the Ewa plantation for 20 years, but it is only practised on three plantations. The chief objection is that lands are usually too steep and that too much soil would be washed away, but it has much to recommend it in the saving of labour.

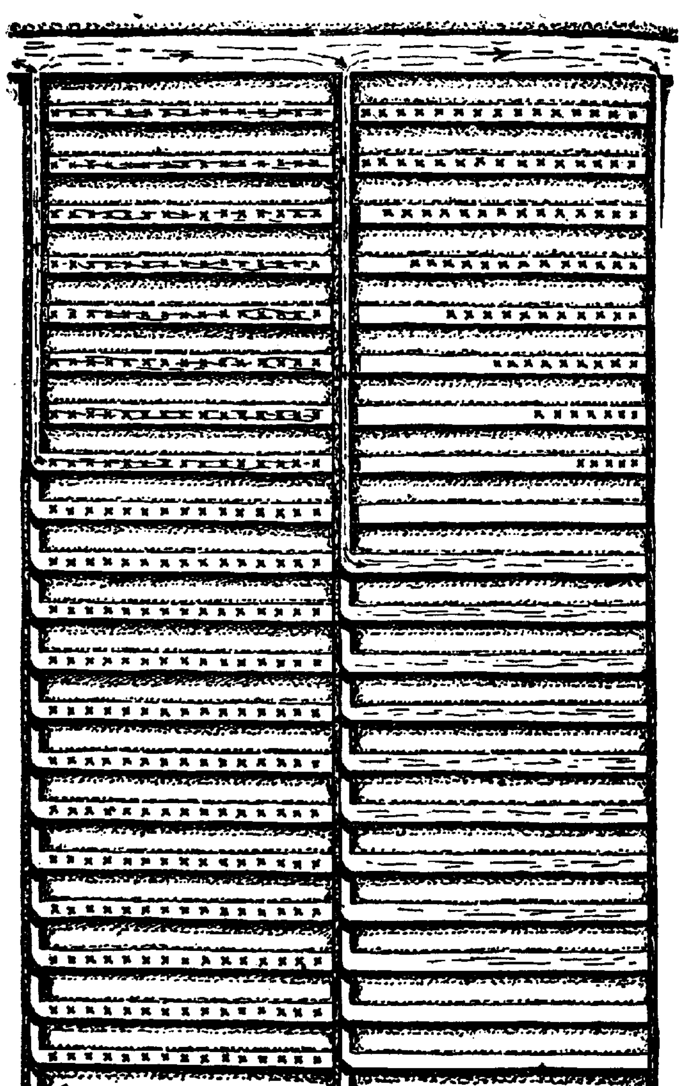

FIG. 2. Hawaiian furrow system.

An enlarged sketch of the actual layout from level ditch to furrow, showing the arrangement of watercourses and furrows when each row of 35 ft. is irrigated separately. There are between 40 and 70 furrows to one watercourse, depending on the field and plantation practice. The crosses signify the position of the cane plants in the furrows.

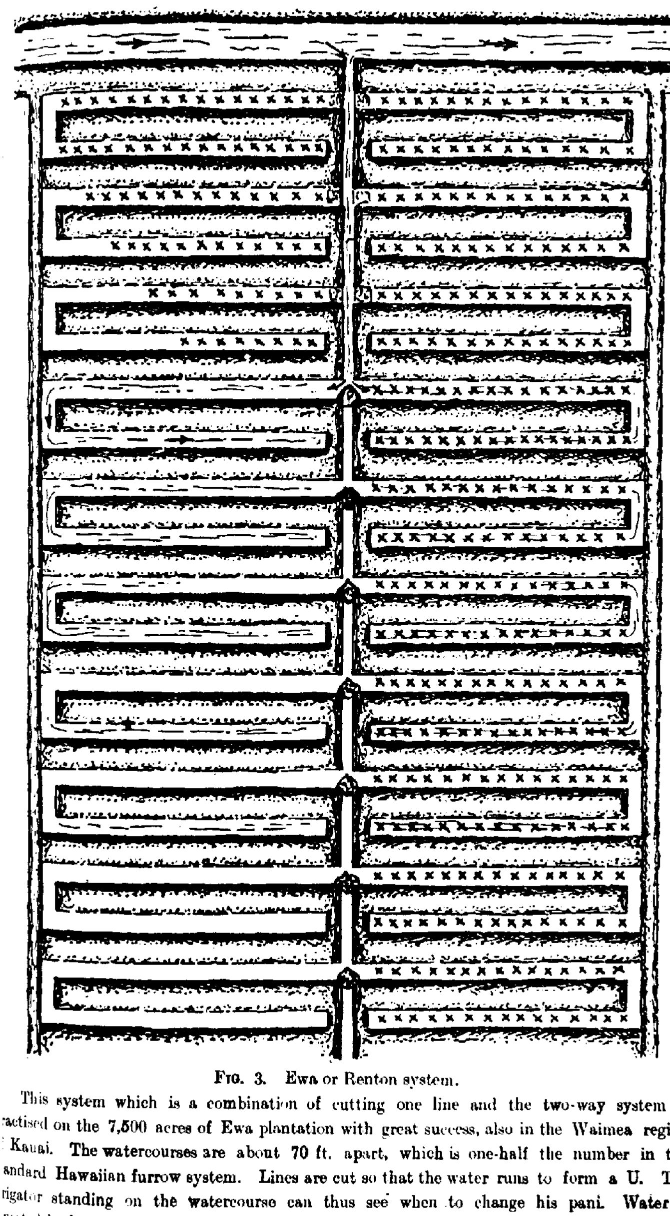

FIG. 3. Ewa or Renton system.

This system which is a combination of cutting one line and the two-way system is ractised on the 7,500 acres of Ewa plantation with great success, also in the Waimea region Kauai. The watercourses are about 70 ft. apart, which is one-half the number in the andard Hawaiian furrow system. Lines are cut so that the water runs to form a U. The rigator standing on the watercourse can thus see when to change his pani. Water is verted both to left and right hand sides of the watercourse at the same time.

Grove farm standard system. Here there are three changes in the method during the growth of the crop; the watercourses are 50 ft. apart and the level ditches 300 to 400. Single furrow irrigation is practised for the first three to four months. Then three successive ridges are cut, so that each opening of the watercourse irrigates four furrows; the furrows are thus divided into blocks of four. When the canes are six to eight months old, that is in the spring, the blocks are enlarged, so that 20 to 30 furrows are served by one outlet from the watercourse, and one man can irrigate 5·6 acres in a day. The chief advantage is that the whole plantation can be irrigated in a few days, and this is especially useful where freshets with limited storage occur.

Flooding is not considered practicable as a rule because of the waste of water. It is only possible when the shortage of labour is acute, as was the case in the 1920 Oahu strike. These are the chief variations given of the standard practice of irrigation in the islands. But, with the field thus prepared, the increasing paucity of labour in 1921 induced various planters to think out new methods whose main aim was to save labour, sometimes at a certain cost of efficiency. Labour has become a limiting factor, and a number of novel and ingenious methods have been evolved which are classed together by the author under the heading New Methods. Of these the main idea is to make irrigation as far as possible automatic, and in a recent number of this Journal[1] three methods classed under Kilauea Automatic Irrigation by the author have been described, namely, the Modified Orchard system, the Hillside or Huli-Huli system and Old Ratoons laid down to the standard system but converted to the automatic. The Baldwin Flume system, also automatic, was described at the same time. These systems are one and all of great ingenuity and significance, and the reader is referred to our reference to them for the details. There remain two other systems to complete the number described by the author.

No watercourse system, or simply furrows 200 ft. long between two adjacent level ditches. Renton devised the system and gave it

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[1] *Int Sug. Jour., ibid.*

over to the author to carry out. About 10 furrows can be irrigated at the same time, and the method is at present purely experimental; if the flow is found to be too rapid, it may be readily checked by the insertion of low dams along the furrows at the necessary intervals. The method has received careful study and a table records soil moisture determinations at different distances along the furrows.

Waipio system. This is automatic and is being conducted under the auspices of the Hawaiian Sugar Planters' Association on their sub-station at Waipio. The level ditches are 20 furrows from one another and the furrows are 30 ft. long and must be level. To consolidate the soil and thus prevent washing, the first two or three irrigations are according to the standard method. Then the ridges are cut to 15 ft. lengths, these cuts alternating in successive ridges down the slope. The bottoms of all the cuts must be at the same level, and 3 in. above the bottom of the furrow; the cuts are protected by a mulch of trash or better of paper laid over their lowest part to prevent washing. The whole system is made automatic by outlet boxes in the level ditch, and a gate is placed in the latter between each set of furrows served.

This part of the paper concludes with an experiment conducted by the author at Ewa, in which three systems were compared during nine months in 1921, in a uniform, level field of H 109 plant canes of very vigorous growth. It was one year old at the start when it had approximately 50 tons of cane to the acre; at the time of the last irrigation the weight of cane was estimated as at least 95 tons to the acre. The methods compared were the Ewa system already described, semi-flooding, which was merely an adaptation of the latter whereby, instead of four furrows, 20 to 24 were irrigated at one time, and ordinary cutting of the lines and the resulting zigzag flow of water through the furrows. The latter gave a very slow movement of water, because of the small slope and heavy growth of canes, but no difficulty was experienced with it. The labour saved by the Ewa system was very satisfactory when compared with that of the standard practice, and labour was also saved by the zigzag method. Stripping of the canes, however, could only be done by the irrigator in the Ewa system and the cost of this operation, which had to be done by an extra man owing to the lack of time, has to be added to the irrigation cost in the other two.

Duty of water. This is the water required to bring the crop to maturity and to obtain the optimum growth. A considerable number of papers have been issued on this subject, but unfortunately there is no uniformity in the standards used, and the canes were grown under very different conditions. The author thinks that, considering the importance of the subject, the information obtainable in Hawaii is very meagre. A summary history of the experiments is given, the results having been converted into comparable figures, and 16 of them have been tabulated. Where possible some of these have been averaged, but in the bulk of them this was not feasible. The following averages are extracted from the table :—

1. Acre-ft. required to bring the crop to maturity, 19·13.
2. Gallons of water per acre to bring the crop to maturity (not so convenient for irrigators but universally adopted in the islands), 6,205,888.
3. Yield of sugar per acre, 6·66 tons.
4. Tons of water to one ton of sugar (although frequently used this is not a recognized standard), 3,898.
5. Tons of sugar from a million gallons of water (safe and more scientific), 1·091.
6. Gallons of water applied per acre per day (deduced from column 2, with 460 days' irrigation for crop), 13,941.
7. Acres covered by one million gallons of water in 24 hours (said to be 100 but the average in the table is), 75·15.

" Verrett's tabulation of the amount of water used at Waipio for the crop of 1921 is 5·9 acre-in. (presumably per irrigation), producing 9·85 tons of sugar, or 2,140 tons of water per ton of sugar. The average interval between irrigations was 20 days, being longer in winter and shorter in summer."

Allen at Waipio experimented for $4\frac{1}{2}$ years on the duty of water on short ratoon crops (12 months ?) and obtained the following results :—

1. Average yield per acre of tons of cane, 36·91, of tons of sugar, 4·46.
2. Water used per acre, in gallons, 2,479,858, in acre-ft., 7·613.
3. Water used per ton of cane, 69,020 gallons or 0·21[illegible] acre-ft.
4. Water used per ton of sugar, 582,870 gallons, or 1·789 acre-ft.
5. Lb. of water used for 1 lb. of sugar, 2,421.

*(To be continued.)*

# Notes

## A POTENTIALLY USEFUL DIAGNOSTIC CHARACTER IN RAPE.

A FEW plants of rape of a very distinctive yellow green colour somewhat like that of *taramira* without any " bloom " were found in a field at Ranchi some years ago. The variety has been grown at Sabour and has shown very much less contamination by crossing than was expected.

Crosses with the ordinary types are very easily picked out by their more bluish colour and " bloom."

The seed is yellow and somewhat smaller than that of the corresponding normal type. The type seems to be no less vigorous than the common types.

This note is published because such a distinctive character may be of use to those who are working on cruciferous oil-seeds, if only as a means of readily estimating the amount of crossing that takes place under different field conditions. Small samples of seed will be supplied to officers of the Indian Agricultural Service on application to the Economic Botanist, Sabour, Bhagalpur. [A. C. DOBBS.]

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## AMERICAN COTTON SITUATION.

THE September 1923 issue of the " International Cotton Bulletin " (the official organ of the International Federation of Master Cotton Spinners' and Manufacturers' Association, Manchester) contains a series of interesting articles on the American cotton situation by Messrs. A. S. Pearse and Arthur Foster who have just returned from a tour of the American cotton belt. The first of these " The future of U. S. A. cotton production " gives some startling figures of the present cost of producing cotton in various States. For instance, in Mississippi 30 cents. per lb. for short staple (i.e., $\frac{7}{8}''$—1″) and 35 cents. for $1\frac{1}{8}''$ cotton, in North Carolina 25 cents., in Central Texas 20 cents. are given as the minimum profitable prices *to the farmer*. In 1918, the U. S. A. Department of Agriculture estimated the cost of production to be 22 cents. in Georgia, 32 in Alabama, $25\frac{1}{2}$ in South Carolina and $21\frac{1}{2}$ in Texas. Owing to the ravages of the boll-weevil and army worm, it is stated that in some parts of Georgia cotton would no longer pay even at 60 cents. or in Mississippi at 40 cents. Even allowing for exaggeration, the authors consider that, under boll-weevil conditions and with a shortage of labour, cotton production in some States has ceased to be economic, that only in Texas and Oklahoma there is a probability of maintaining and increasing production. They consider that there is every possibility that American cotton production will fall to little more than half of pre-war figures and that this would barely supply American mills.

Certainly a 11-million-bale crop from the record area of 38 million acres this year, or say 145 lb. per acre, gives no cause for optimism when compared with 13 million from a similar area in 1920-21, 16 million from the same area in 1914-15 and 15 million in 1911-12 from 36 million acres.

It is estimated that of 38 million acres planted only $1\frac{1}{2}$ million acres were treated with calcium arsenate.

A second article describes the cotton-growers' co-operative movement in the United States of America to which a reference was made in the March (1923) Number of this Journal.

Another article describes in somewhat more detail than any previous publication the organization and methods of the Cotton Crop Reporting Board. The "Bureau reports" have come in for considerable criticism of recent years though at one time held up as a model to the rest of the world. The article describes the reports as very thoroughly prepared "as the result of an analysis of the opinions of the state of the crop on a given date of many thousand peoples." The weak point still is, as always, that the cotton area is only *actually* determined decennially and that for forecast purposes both the area and the yield have to be estimated. That this is possible at all is due to fortnightly returns of cotton actually ginned and pressed being available. [B. C. BURT.]

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## MOSAIC DISEASE.

WHAT scientists declare to be the greatest discovery of the century in the field of plant diseases was announced at the annual meeting of the American Association for the Advancement of Science, which was held at Cambridge, Mass., early in the year.

The declaration was made after reports prepared by Prof. Ray Nelson of the Michigan Agricultural College, Dr. L. O. Kunkel of the Hawaiian Experiment Station, and H. H. McKinney of the University of Wisconsin had been read before the association. In their reports these scientists announced that, during the past year, they had discovered the organisms which cause the "mosaic disease" in various plants and they substantiated their finding by displaying photographs of these organisms actually at work.

### IMPORTANT TO SUGAR INDUSTRY.

While this discovery is of great import to all plant pathologists, it is of special interest to those who are concerned with the study of the diseases of the sugar-beet and sugarcane, for the reason that the mosaic disease is increasing every year and it is estimated that it results in the loss of tens of thousands of dollars' worth of sugar plants annually.

For many years plant pathologists have been searching for the cause of the mosaic disease, on the theory that if they could find the organisms they could devise means of controlling the disease. With the finding and photographing of these organisms accomplished, the mystery of the disease has been revealed.

The organism is described as having a long spindle-shaped body with whip-like hairs (cilia) at each end. They are considered as belonging to the most primitive forms of animal life, the protozoa. They are less than one hundred-thousandth of an inch thick and from ten to twenty times as long. They attack the cell in its most vital spot, the nucleus. Some of them have been found actually coiled about the cell nucleus.

### Specimens found in potatoes.

While it is true that scientists have believed for some time that the mosaic organisms belonged to the animal kingdom, no one was able, until recently, to prove this a fact, nor had anyone been successful in observing the organisms actually engaged in their depredations. Prof. Nelson reported that he had found the organisms by cutting thin sections of the inner part of infected potato stems and examining them under a high-powered microscope.

It has also been found that there are various kinds of these organisms, each preying on particular sort of plant. The organisms discovered by Prof. Nelson are those that infest beans, sugar-beets, clover, tomatoes and potatoes. These creatures are similar to the trypanosome, the cause of the sleeping sickness which kills man and beast in Africa.

Dr. Kunkel and H. H. McKinney announced the discovery of the parasites that cause the mosaic disease in corn and wheat plants. It was found that these organisms belong to the class known as amœba and are similar to the organisms causing malaria and yellow fever in man, which are transmitted from man to man by the mosquito.

While it is too early to announce the measures to be taken in the control of these organisms, it is the belief of many prominent botanical pathologists that their discovery may be the beginning of a new era in the treatment and cure of many plant diseases.

*" A factor to which too little attention has heretofore been paid in surveying crop conditions and prospects in Cuba is the mosaic disease of sugarcane, which by reason of its widespread existence and increasing dispersion seems to have reached a point where it deserves consideration along with the rainfall and weather conditions in general. Just how much territory in Cuba has been invaded by this disease, and to what extent, has never been

* This and subsequent paragraphs are taken from *Facts about Sugar*, XVII, 2.

determined by an accurate survey, although it has been known to exist in several parts of the island for a number of years. The reasons for this lack of attention to what, in other countries, has been recognized as one of the most serious menaces to successful cane agriculture have been various, but the principal ones have been the abundant crops of the past few years, the reluctance on the part of the managements of certain estates to admit the occurrence of the disease on their properties or to recognize its importance, and the desire of the Department of Agriculture to wash its hands of a problem too big for it to attack successfully.

"In Porto Rico the disease has been regarded as the worst scourge known in the cane fields and energetic measures, which give every promise of being successful, have been undertaken for its control. In Hawaii it has been held in check by the planting system employed and the practice of a rigid selection of seed cane. In Java its importance has long been acknowledged and control measures employed.

CUBAN CONDITIONS FAVOUR SPREAD.

"Cuban conditions and field practice are particularly favourable to the spread of the disease, as replanting is infrequent on good soils and, especially in recent years, the principle of selection of seed cane has been the reverse of that employed in the other countries mentioned, the best cane being sent to the mill and that of poorer quality saved for planting. This practice, combined with lack of information on the part of the field management of estates, has been the cause of extensive planting of seed cane affected by the disease, every stalk of which produces a diseased stool. As the ill effects are not at once visible to the eye, entire diseased fields have passed unnoticed, and only a comparative analysis would show the extent of the resulting losses.

"Recently there have been signs of a partial awakening among estate managements to the serious nature of the situation produced by former neglect, and a growth of interest in the means of combating the disease. Although individual estates, by proper measures, can rid their own fields of the disease, its complete eradication is something that can only be accomplished by co-operation among the mills to this end and by unflagging effort. Further attention to this serious factor in the industry will be given as new information on the subject is forthcoming." [*Cuba Review*, XXI, 10.]

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## LODGING OF SUGARCANE: MEANS OF PREVENTION.

It is not generally appreciated that the lodging of sugarcane in the fields has other consequences than the extra difficulties in cutting, handling and milling badly fallen cane. When a stalk of cane falls or is blown down, its growth is checked and the quality and yield of juice suffer appreciably. The difference between fallen and standing cane at the time of cutting will show up clearly if the two are harvested and worked up separately, as is illustrated by the following figures given by Geerts in *Java Archief* No. 22, 1923. The cane in question was D 152 grown in Godeo.

| | Brix | Sugar % | Purity % | White sugar % |
|---|---|---|---|---|
| | | *Standing cane.* | | |
| Base .. .. | 19·11 | 17·81 | 93·25 | 17·29 |
| Middle .. | 19·91 | 18·55 | 93·22 | 18·01 |
| Top .. .. | 17·90 | 15·40 | 85·98 | 14·39 |
| | | *Fallen cane.* | | |
| Base .. .. | 16·32 | 14·02 | 85·95 | 13·09 |
| Middle .. | 17·50 | 15·89 | 90 74 | 15·23 |
| Top .. .. | 15·38 | 12·26 | 79·61 | 11·00 |

### Losses due to lodging.

The average purity of the standing cane was 91·15 per cent. and the sugar content 17·31 per cent., that of the fallen was 85·87 and 14·10 per cent., respectively. This sufficiently indicates that lodging on any extensive scale has more serious consequences than annoyance in handling and milling. Moreover, the average weight of the fallen canes is smaller.

The causes of lodging are many and various, but for the most part are referable to definite factors. When whole fields are blown down by heavy winds there is, of course, no doubt as to the cause, but when, in the absence of such accidents, the percentage of fallen cane varies from one field to another or in different parts of the same field the predisposing causes are less obvious and it has required much observation and experiment to deduce the underlying factors.

One cause is a predisposition of the cane itself, i.e., some varieties of cane are more predisposed to lodge than others. The variety 100 POJ, for example, is one which lodges badly, whereas EK 2 and D 152 show much less tendency in this direction.

Another cause is connected with climatic and moisture conditions. If during the earlier period of its growth the cane is not well supplied with moisture, it is liable to develop a spindling stalk, and if at a later period the moisture conditions improve, the cane develops a heavy top growth and the tendency to lodge is greatly increased.

A third cause is irrational fertilizing of cane fields. Lodging is always more frequent in heavily fertilized plots. The application of fertilizer, of course, increases the yield, but if the tendency to lodge is trebled or quadrupled, as, from experiments quoted by Geerts, often occurs, the resulting depreciation of the lodged cane may considerably discount the benefit of the added fertilizer. On naturally rich ground application of fertilizer may even result in a smaller total yield of cane as well as a poorer yield of juice.

## Measures to prevent lodging.

The measures to be taken against lodging are, first, the selection of a variety little disposed to this trouble especially for rich, wet soils.

The method of planting is not without influence. Shallow planting, as practised under the plough system in Java, results in much stooling and more fallen cane than is observed in the "raynoso" system. Suckering the cane and planting wider apart results in stockier growth and smaller tendency to lodge.

The control of lodging by judicious fertilizing is more uncertain and requires long observation and some experimenting on different soils to learn their peculiarities. Strong land should not be given as heavy applications as poor soil.

Some writers have advocated tying together stalks in opposite rows. This is more or less effective, but costly and productive of bent cane which is not easy to transport or feed to the mill. A more serious objection is that the tops of the cane are crowded together, which has an unfavourable effect on the rendement. Other measures that have been proposed are stripping some of the lower leaves of the young cane or the cutting off the top of the cane about 2½ inches above the upper node. Such measures check the growth of the cane and where they diminish lodging they also diminish yields and profits. [*Facts about Sugar*, XVII, 15.]

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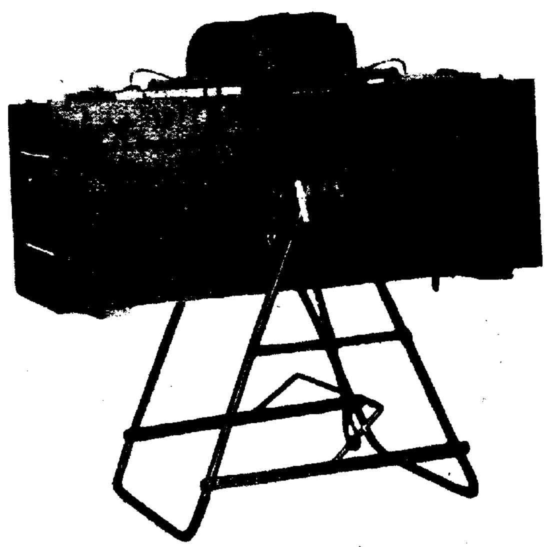
## AN EFFECTIVE WHEAT PICKLING MACHINE.

WE often hear of bunt in wheat crops, the seed of which is supposed to have been effectively pickled. Nevertheless, if the pickle has been used at the right strength, and if each wheat grain has been thoroughly "wetted" by it, apart from occasional soil re-infection, there should be little or no bunt in the crop.

Frequently in my opinion, lack of success in pickling is to be attributed to the way with which the pickle is applied rather than to the nature or strength of the pickle itself. Thus, merely dipping a wheat-butt into a cask containing pickle, and leaving it there for a few minutes, does not in any way insure that each grain is thoroughly "wetted" by the pickle. As a matter of fact the surface of the grain is more or less greasy in character, and water seems to slip over it readily or to adhere to it loosely in the form of numerous minute air bubbles beneath which the surface remains dry. Hence, many a spore of bunt escapes contact with the pickle and lives to germinate later on in the field in contact with the grain.

It is these facts which, in my opinion, render floor pickling more effective than the various mechanical methods hitherto recommended. Unfortunately, it is a long and laborious process



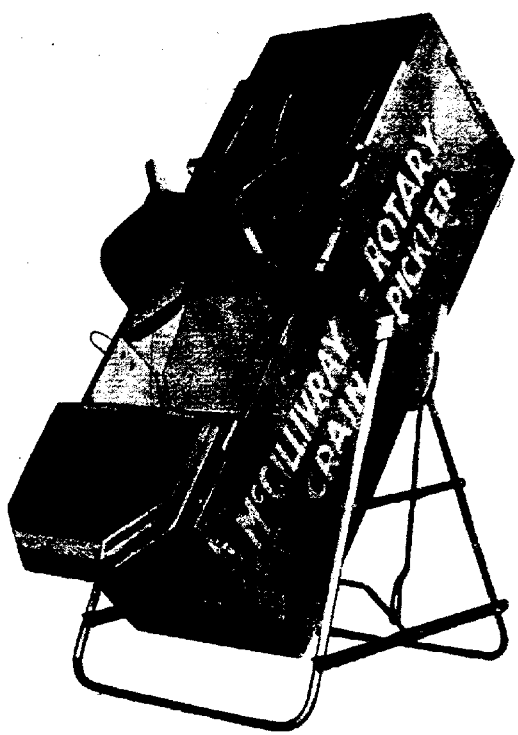
No. 1.

which we would willingly avoid if we could. Personally, for many years I have held the opinion that if floor pickling was ever to be effectively superseded it would be by some form or other of a rotary pickling machine. On the suggestion of Mr. H. J. Apps, we endeavoured to use for the purpose an old rectangular butterchurn, which, although quite effective from the point of view of the distribution of the pickle, was too slow for general purposes.

Quite recently, however, I have come across a new type of rotary pickler, the invention of a South-Eastern farmer—Mr. J.

McGillivray—which appears to me to have solved pickling difficulties very effectively.

It consists of a long, rectangular, watertight, wooden box, divided into three compartments by two sloping brass screens,

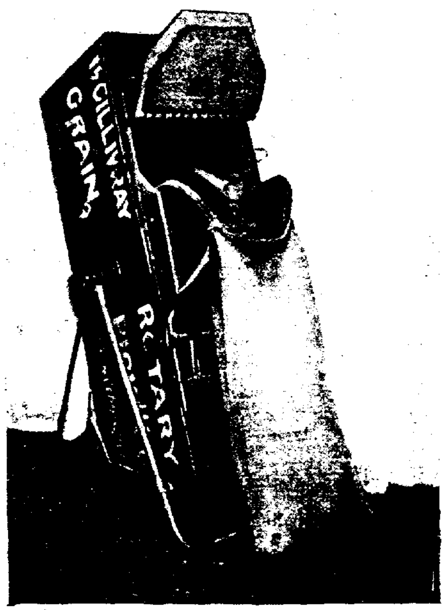



No. 2.

one of which is shown in illustration herewith. The box is mounted on a triangular iron frame around which it rotates freely. An ingenious lever-stop arrangement enables one to place the box in the various positions indicated in the illustrations.

The pickler is adapted to pickle one bag at a time, one half being placed in one compartment and the other in the opposite one.

When filling the pickler the box is brought to position 2; the doorway is thrown back and from $2\frac{1}{2}$ to 3 gallons of 1 per cent.




No. 3.

bluestone pickle should be poured into it. I indicate this quantity because in our experience it takes $2\frac{1}{2}$ gallons of solution to floor pickle effectively one bag of wheat; a slight excess of solution will do no harm. Half a bag of wheat should then be emptied into the open compartment, and the door closed down. The box should then be reversed and a second half bag emptied into the opposite compartment. The box should then be made to rotate slowly around its axis; a slight push will bring this about. As the box rotates the grain will be thrown violently against its sides and b brought effectively in contact with the pickle. Four or five minutes' rotation should suffice for the purpose.

The box is then brought to position 3, the trap door opened and the grain made to slide into a bag attached beneath the central lip. It is then reversed and the grain from the opposite compartment emptied out in the same way.

The whole mechanism is exceedingly simple and should, in my opinion, prove very effective for pickling wheat either with solutions of bluestone or formalin, or even with a dry powder like copper carbonate. [ARTHUR J. PERKINS in *Jour. Dept. Agri. South Australia*, XXVII, No. 1.]

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## NEW OFFICIAL UNIVERSAL STANDARDS FOR AMERICAN COTTON.

A RECENT Bulletin issued by the United States of America Department of Agriculture describes the new American official cotton standards, and the following abstract explains the variations from the previous American standards :—

### 1. *Establishment and replacement of the official cotton standards of the United States.*

Section 9 of the United States Cotton Futures Act, approved August 18, 1914, and re-enacted August 11, 1916, confers upon the Secretary of Agriculture the authority to establish standards of cotton by which its quality or value may be judged or determined, including its grade, length of staple, strength of staple, colour, and other qualities, properties, and conditions, and to change or replace the same from time to time. Notice must now be given at least one year in advance of the effective date of any change or replacement of the standards that have been established under the Act.

### 2. *Grades and colours of American upland cotton.*

Standards for nine white grades of American Upland cotton were established and promulgated by public notice of the Secretary of Agriculture on December 15, 1914, as follows: Middling Fair, Strict Good Middling, Good Middling, Strict Middling, Middling, Strict Low Middling, Low Middling, Strict Good Ordinary, and Good Ordinary.

By order of the Secretary of Agriculture, dated January 28, 1916, standards for colour in the various grades of American Upland cotton were established as follows: Good Middling Yellow Tinged, Strict Middling Yellow Tinged, Middling Yellow Tinged, Strict Low Middling Yellow Tinged, Low Middling Yellow Tinged, Good Middling Yellow Stained, Good Middling Blue Stained, Strict Middling Blue Stained, and Middling Blue Stained.

On August 12, 1916, by reason of the re-enactment of the United States Cotton Futures Act on the preceding day, the same standards for grades and colours of American Upland cotton were re-established without change.

No change has been made in these standards for American Upland cotton from the date of their original establishment until July 26, 1922, when an order was issued by the Secretary of Agriculture, effective August 1, 1923, making certain changes in the existing standards including the method of designating the grades and colours. These changes are designed solely to provide a more satisfactory classification of cotton already within the range of the present standards.

In the white grades the changes are not considerable and the new standards represent the nine grades for which the standards were originally established. The most noticeable changes are in Middling Fair and Strict Good Middling, which in the new boxes are somewhat less creamy and admit a trifle more leaf. The reason for this change is that in the old standards for these grades too large a proportion of creamy cotton was allowed in relation to the lower boxes. Great care has been taken to graduate all of the new boxes so that the steps between the grades shall be as nearly equal as practicable.

The extension of the boll-weevil depredations into practically all sections of the Cotton Belt has caused the greater part of the American crop to show some slight discoloration, known as boll-weevil spots. The new white standards provide for such colour in the white grades, but do not contain as much heavy spot as bales 3 and 11 of Strict Low Middling, 7 of Low Middling, 5, 6, 8 and 9 of Strict Good Ordinary, or 3 and 7 of Good Ordinary of the old standards.

(NOTE. For an explanation of the system of arranging and designating the type samples in the boxes of the Official Cotton Standards of the United States see Service and Regulatory Announcements No. 6 of the Office of Markets and Rural Organization.)

The old standards for yellow tinged cotton have never received the complete recognition of the cotton trade. The new standards, being much lighter in colour, are designed to conform more closely to American trade ideas.

One important objection to the old standards as a whole, brought forward by the trade, was the lack of specific designation for cotton intermediate in colour between the practical forms. This complaint was recognized as having considerable merit, especially in view of the wide differences in the values of the grades which have prevailed in recent years. The new standards, therefore, provide for a more exact classification of cotton the colour of which is lighter or deeper, as the case may be, than that shown in the practical forms without multiplication of the practical forms and the attendant increase of expense.

The numerical method of grade designation for cotton which was introduced in the American, Egyptian and Sea Island standards has been extended to the standards for American Upland cotton, in keeping with the general policy of the Bureau of Agricultural Economics (formerly the Bureau of Markets) to employ numbers for the grades of all commodities for which it has established standards, assigning No. 1 to the highest commercial grade and succeeding numbers to lower grades in order. Inasmuch as the standards for the white grades govern in all determinations of preparation, leaf trash, and other foreign material, while the standards for colour determine only the ranges of colour under the respective designations without reference to other considerations, the colour standards are denoted by descriptive words affixed to the grade numbers. Examples of the use of each designation are found in the table given below. The use of the full grade nomenclature, however, is continued in addition to the numerical designations.

| **Blue Stained** | *Gray* | **Standards for grades of Upland cotton white** | *Spotted* | **Yellow Tinged** | *Light Stained* | **Yellow Stained** |
|---|---|---|---|---|---|---|
| | | **1 or M.F.** | | | | |
| | | **2 or S.G.M.** | | *2 T.* | | |
| **3 B.** | *3 G.* | **3 or G.M.** | *3 Sp.* | **3 T.** | *3 L.S.* | **3 S.** |
| **4 B.** | *4 G.* | **4 or S.M.** | *4 Sp.* | **4 T.** | *4 L.S.* | **4 S.** |
| **5 B.** | *5 G.* | **5 or M.** | *5 Sp.* | **5 T.** | *5 L.S.* | **5 S.** |
| | | **6 or S.L.M.** | *6 Sp.* | **6 T.** | | |
| | | **7 or L.M.** | *7 Sp.* | **7 T.** | | |
| | | **8 or S.G.O.** | | | | |
| | | **9 or G.O.** | | | | |

Symbols in **heavy type** denote grades and colours for which practical forms of the Official Cotton Standards are prepared. Symbols in *italics* represent the designations of cotton which in colour is between practical forms of the same grades.

The grades shown above the horizontal line are deliverable on future contracts made in accordance with Section 5 of the United States Cotton Futures Act. Those below the line are untenderable on such future contracts.

[*Service and Regulatory Announcements of the Bureau of Agricultural Economics*, No. 72, 1922.]

The following abstract from the *Textile Mercury* shows the correspondence of the new American standards with the Liverpool standards :—

" The Manchester Cotton Association has received the following cable from the delegates at Washington stating that the European delegates have carefully compared the new American standards with the Liverpool standards in Washington and consider standard grades as follows :—

American Strict Good Middling=Liverpool Middling Fair.

American Good Middling=Liverpool Fully Good Middling.

American Strict Middling=Liverpool Good Middling.

American Middling=Liverpool Fully Middling.

American Strict Low Middling=Liverpool Fully Low Middling to Middling.

American Low Middling=Liverpool Low Middling to Fully Low Middling.

American Strict Good Ordinary=Liverpool Fully Good Ordinary to Low Middling.

American Good Ordinary=Liverpool Good Ordinary to Fully Good Ordinary.

"The delegates consider the standards satisfactory and even running. The standards have been made up from compressed cotton, but owing to the cotton not touching the box lid the standards have an uncompressed appearance."

There has been considerable controversy about the changes in standards, and the American standpoint is well explained in the article by Mr. Brand, reproduced in the January Number of this Journal (XIX, 1, 1924).

As a result of the deputation sent by the Liverpool Cotton Association to America, an agreement now appears to have been reached on most of the points at issue. It is understood that the American Government has agreed to supply the American standards to the Liverpool and Manchester Cotton Exchanges, and a compromise has been reached in regard to the difficult question of arbitrations. Under the Act passed recently the Washington arbitration will be final. This was strongly objected to by the Liverpool Cotton Association as it meant the overriding of their arbitrations. On the other hand, American opinion considered it essential that sellers should be able to obtain an official classification of their cotton in America and no longer be dependent on arbitrations carried out abroad against standards with which they are not familiar. From the cable reports it now appears clear that the Liverpool Cotton Association's arbitrations based on the new American standards will be recognized as authoritative. [B. C. BURT.]

## COTTON RESEARCH.

THROUGH the courtesy of the British Cotton Industry Research Association, the Secretary of the Indian Central Cotton Committee has sent the following abstracts for publication :—

### BOLL-WEEVIL TRAP.

An apparatus for protecting seeds and crops from insects and particularly for destroying boll-weevils on cotton consists of a cage-like device carrying a number of radial rods provided with down-turned bristles, wires or strings. This cage travels over the crop on an over-head wire. It is provided with conical passages to afford ready access for insects to the interior where strips of material soaked in sticky poisonous substance having an odour attractive to insects are suspended. The insects fall into a tank in the form of a drawer which can be filled with water or paraffin as desired. A lamp may be fitted within the cage. The rods on the outside of the cage may be coated with adhesive. The hanging strings engage the top of the crop and disturb the insects thereon. [*E. P.* 199867. J. SMITH-ROSS.]

### COTTON DISEASES IN WEST AFRICA.

Short descriptions, with illustrations, are given of the cotton diseases met with in West and South-West Africa. The diseases and the causative organisms include— angular leaf spot (*B. malvacearum*), wilt (*Neocosmospora vasinfecta*), anthracnose (*Glomerella gossypii*), sore shin (*Pythium debaryanum ?*), a "rust" (*Uredo gossypii*), and two less serious pests characterized by spotting and shedding of the leaves (*Ramularia areola* and *Mycosphaerella gossypina*). [*Text. Mercury*, 1923, **69**, 206-207. R. SWAINSON-HALL.]

### FUMIGATION OF COTTON-SEED.

Cotton-seed badly infested with pink boll-worm is completely disinfected by exposing it to chloropicrin, to the extent of 30 c.c. per cubic metre, for 24 hours. The germinating power of the seed is unaffected. [*Expt. Sta. Rec.*, 1923, **49**, 154; from *Agron. Colon.*, 1922, **7**, 249-253. P. VAYSSIERE.]

## DIMENSIONS OF STARCH GRAINS.

Using a high-power microscope equipped with a micrometer eye-piece, the authors have determined the sizes of the starch grains in seven typical flour samples. It was found that the starch grains could be grouped in two classes, those having diameters of 7 microns or less and those having diameters of 8 microns or more. The percentage of starch grains of different sizes in each sample of flour was ascertained. The results indicate a relationship between sizes of grains and strength of flours. The greater the percentage of small grains the stronger the flour. [*Ind. Eng. Chem.*, 1923, **15**, 1050-1051. J. H. BUCHANAN and G. G. NAUDAIN.]

## GOSSYPOL TOXICITY.

Pepsin and trypsin digest casein and the globulin of the cotton-seed to very nearly the same extent and at practically the same rate through an extended period. The addition to the protein of 1 per cent. of its weight of the toxic principle, gossypol, present in cotton-seed kernels to the extent of 1·5 to somewhat more than 5 per cent. of the estimated protein content, interferes markedly with the digestion in vitro of the cotton-seed globulin by pepsin and trypsin, and by pepsin alone, as well as the digestion of casein by pepsin and trypsin. The incomplete digestion (83 per cent.) by animals of the protein content of cotton-seed press-cake preparations is tentatively explained as an inhibitive effect of gossypol. [*Jour. Biol. Chem.*, 1923, **56**, 501–511. D. B. JONES and H. C. WATERMAN.]

## ADVANTAGES OF HEAVY SEEDS.

Water culture experiments with peas and barley are described which were designed to show the effect of weight of seed on the resulting crop. The results indicate that there is a steady rise in the dry weight of the plants as the initial weight of the seed increases, whether the food supply is limited or abundant. The "efficiency index" (rate of increase per day), however, falls gradually as the weight of the seed rises, so that the initial advantage accruing from heavy seed might be lost with prolonged periods of growth.

With annual crops, harvesting occurs before this point of equilibrium is reached. [*Ann. Appl. Biol.*, 1923, **10**, 223–240. WINIFRED E. BRENCHLEY.]

### CAUSES OF MILDEW.

A general article and discussion describing some of the causes of mildew in cotton cloth. [*Jour. Man. Col. of Tech. Text. Soc.*, 1923, **13**, 20–25. P. BEAN.]

### ADSORPTION.

After a short general review of the main theoretical and practical details of adsorption or sorption the author describes the two chief theories which are at present under discussion, one of which is based on a consideration of the compressed or condensed condition in which a gas will exist if brought within the zone of attraction of a solid, and the other on the conception of the unimolecular layer. Brief reference is made to some of the practical applications of a knowledge of sorption. [*Jour. Soc. Dyers*, 1923, 39, 233–238. J. W. MCBAIN.]

### DESCRIPTION OF COTTON GIN.

In a process for the removal of the residual hairs retained by cotton-seed after ginning, or for the removal of hairs from the decorticated hulls of cotton-seed or other fibre-bearing material, the heavily-loaded seeds are segregated from the hairless or lightly covered seeds at any stage of the process, and subjected to a further defibrating operation. The segregator, which is separate and distinct from the defibrating machine, comprises a shallow dish formed with a central compartment with a sloping floor roughened or coated with abrading material. The dish is suspended from a support and subjected to a wobbling or shaking movement. The seeds are fed to the outer compartment, and those with little or no fibre gravitate to the bottom of the mass and fall through an opening with a closing shutter, in the floor of the outer compartment above a shoot leading to a conveyer; the more heavily-loaded seeds tend to collect at the upper level of the mass and pass through opening in the wall and floor of the central compartment to be returned to the defibrating machine. [*E. P.* 198561. E. C. DE SEGUNDO.]

VIABILITY OF COTTON-SEED.

The fungus which is responsible for cotton anthracnose, and which infects the cotton-seed, is completely destroyed by heating the thoroughly dried seed in a vacuum or any inert atmosphere, such as nitrogen, to prevent oxidation of the fats and proteins, after which the seed will endure the temperature of boiling water for hours without affecting its vitality. Seed so treated has a much higher percentage germination than untreated seed. [*Science*, 1923, **57**, 741-742. G. F. LIPSCOMB and G. L. CORLEY.]

## PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

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MR. S. MILLIGAN, M.A., B.Sc., Agricultural Adviser to the Government of India, and Director, Agricultural Research Institute, Pusa, has been granted leave for six months on average pay from 1st March, 1924, Dr. D. Clouston, C.I.E., officiating.

***

THE services of MR. G. S. HENDERSON, N.D.A., N.D.D., Imperial Agriculturist, Pusa, have been placed at the disposal of the Government of Bihar and Orissa to officiate as Director of Agriculture, during the absence on leave of Mr. A. C. Dobbs.

***

DR. F. J. F. SHAW, D.Sc., Second Imperial Mycologist, Pusa, has been granted leave on average pay for six months from 15th March, 1924.

***

MR. RUDOLPH D. ANSTEAD, M.A., has been confirmed as Director of Agriculture, Madras, from 22nd December, 1923.

***

MR. A. C. EDMONDS, B.A., Deputy Director of Agriculture, I Circle, Madras, has been granted combined leave for nine months from 4th March, 1924, Mr. K. T. Alwa being placed in charge.

***

MR. F. T. T. NEWLAND, Government Agricultural Engineer, Madras, has been granted leave on average pay for one month and two days from 16th March, 1924.

***

DR. R. V. NORRIS, D.Sc., M.Sc., F.I.C., who retires from the Indian Agricultural Service, has been appointed Professor of Bio-Chemistry in the Indian Institute of Science, Bangalore.

Mr. B. Ramayya, B.Sc., has been appointed to act as Deputy Director of Agriculture, II Circle, Madras.

***

Mr. W. J. Jenkins, Deputy Director of Agriculture, North Central Division, Bombay, has been granted combined leave for nine months from 1st May, 1924.

***

Mr. M. Carbery, M.A., B.Sc., Agricultural Chemist to the Government of Bengal, has been granted leave on average pay for six months from 11th March, 1924, Mr. G. B. Pal, M.Sc., officiating.

***

Mr. P. J. Kerr, M.R.C.V.S., Director, Civil Veterinary Department and Veterinary Adviser to the Government of Bengal, has been granted leave on average pay for eight months from 26th February, 1924.

***

Mr. R. T. Davis, M.R.C.V.S., Vice-Principal, Bengal Veterinary College, has been appointed to act as Director, Civil Veterinary Department, Bengal, during the absence, on leave, of Mr. P. J. Kerr or until further orders.

***

Maulvi Saiyid Sultan Ahmad, G.B.V.C., Lecturer, Bengal Veterinary College, has been appointed to act as Vice-Principal, Bengal Veterinary College, *vice* Mr. R. T. Davis.

***

On completion of their probationary period, the following officers are confirmed in the Indian Agricultural Service with effect from 1st December, 1923 :—

(1) Dr. P. E. Lander, M.A., D.Sc., Agricultural Chemist to Government, Punjab, Lyallpur.

(2) Mr. H. R. Stewart, A.R.C.Sc.I., D.I.C., N.D.A., Professor of Agriculture, Punjab Agricultural College, Lyallpur.

(3) MR. D. P. JOHNSTON, A.R.C.Sc.I., N.D.A., Deputy Director of Agriculture, Lyallpur.

***

MR. A. MCKERRAL, M.A., B.Sc., has been confirmed as Director of Agriculture, Burma, from 26th November, 1923.

***

MR. J. CHARLTON, M.Sc., A.I.C., Agricultural Chemist, Burma, has been appointed Principal of the Mandalay Agricultural College, in addition to his own duties, from 1st December, 1923.

***

MR. F. J. PLYMEN, A.C.G.I., Agricultural Chemist to Government, has been appointed to officiate as Director of Agriculture, Central Provinces, *vice* Dr. Clouston on other duty.

***

DR. H. E. ANNETT, D.Sc., has been appointed to officiate as Agricultural Chemist to Government, Central Provinces, *vice* Mr. Plymen on other duty.

***

MR. W. YOUNGMAN, B.Sc., Economic Botanist to Government, Central Provinces, has been appointed Economic Botanist for Cotton from 1st November, 1923.

***

MR. JEHANGIR FARDUNJI DASTUR, M.Sc., D.I.C., Mycologist to Government, Central Provinces, has been appointed to hold charge of the post of Second Economic Botanist, in addition to his own duties, from 1st November, 1923.

***

MR. H. HORSMAN, Director, Swadeshi Cotton Mills Company, Limited, Cawnpore, has been nominated by the Upper India Chamber of Commerce, Cawnpore, to be a member of the Indian Central Cotton Committee, *vice* Mr. A. Horsman, resigned.

MR. F. G. TRAVERS, of Messrs. Gill & Co., Bombay, has been nominated by the Karachi Chamber of Commerce to be a member of the Indian Central Cotton Committee, *vice* Mr. H. C. Short, resigned.

***

THE Thirteenth Meeting of the Board of Agriculture in India was held at Bangalore in the Daly Memorial Hall from 21st to 26th January, 1924. This was the first occasion on which the Board met in an Indian State. His Highness the Maharaja of Mysore evinced his deep interest in its deliberations by graciously consenting to preside at its opening meeting. His Highness, who was accompanied by Their Excellencies the Resident and the Dewan and other high officials and notables of the State, in welcoming the Board, delivered a most inspiring speech which was highly appreciated by all who had the pleasure of listening to it. The Board was attended by 41 members and 30 visitors. There were eleven subjects on the agenda, three of which relating to questions of cattle-breeding and animal husbandry were initially threshed out by a Cattle Conference held simultaneously with the Board. A detailed account of the meeting, together with a photograph of the Board, will be issued in the next number of the Journal.

# Review

**The Empire Cotton Growing Review** (London: A. & C. Black, Ltd.; Quarterly—Annual subscription 5 shillings), the official organ of the Empire Cotton Growing Corporation, the first issue of which has been published with New Year, is a valuable addition to the growing literature on cotton. The Journal is intended not only to keep those interested informed of the activities of the Corporation, but also to publish information concerning cotton growing problems throughout the Empire, thus acting as a clearing house of intelligence collected from different Dominions and Colonies, and keeping Directors of Agriculture and others engaged in cotton growing in touch with development and experiments elsewhere. Statistics of the cotton crops of the world, together with their qualities and uses to which they are put, will form a regular feature of the Journal, and it is hoped to make it an instrument of giving both spinners and growers "a better knowledge of one another's lives, experiences, requirements and difficulties."

The first number, although, as explained, largely "historical and tentative," gives good promise of the fulfilment of the aims and objects with which the Journal has been started. After a short history of the formation and working of the British Cotton Growing Corporation, the place of honour has been given to an appreciation, by Dr. Lawrence Balls, of the late J. W. McConnel, the first Chairman of the Council of the Corporation, who, more than any other man, gave the cotton industry a new technical organization comparable with its existing industrial equipment. The Imperial College of Tropical Agriculture forms the subject of the next article from the pen of Sir Francis Watts, while of special interest to India is an excellent description of the working and programme of the Indian Central Cotton Committee by its energetic Secretary. Mr. Cecil Wood, who is doing important work for the Corporation in

Tanganyika, follows with an interesting paper on the prospects of cotton growing in this former German possession. There are two papers of purely scientific interest by L. H. Burd, one of which deals with the botanical work of the late William Robson, while the other records a sterile dwarf rogue in the Sea Island cotton. Cotton growing statistics are in the safe hands of Prof. John Todd. The issue winds up with " notes on current literature," which although not pretending to cover the whole ground of cotton literature, are by no means the least important feature of the Journal.

We commend this periodical to the notice of all interested in the development of cotton. [EDITOR.]

# Correspondence

## NATURAL CROSS-POLLINATION IN INDIAN LINSEED.

To THE EDITOR OF THE *Agricultural Journal of India.*

SIR,—Our attention has been drawn to a paper entitled "Linseed (*Linum usitatissimum*) hybrids" in the previous number of the *Agricultural Journal of India* (XIX, 1924, pp. 28-31) by Dr. R. J. D. Graham and Mr. S. C. Roy, in which it is stated that *the occurrence of natural cross-pollination of linseed has not previously been noted in India*. This statement is not correct. In October 1910 we published a paper—The economic significance of natural cross-fertilization in India—in the *Memoirs of the Department of Agriculture in India* (*Botanical Series*), III, 1910, pp. 281–330, in which the occurrence of natural cross-pollination in single plant cultures of linseed in India was for the first time recorded. This is referred to in the *Handbuch der landwirtschaflichen Pflanzenzüchtung*, Vol. III, 1922, p. 49. In December 1919, we published a further paper—Studies in the pollination of Indian crops I—in the *Memoirs of the Department of Agriculture in India* (*Botanical Series*), X, 1919, pp. 195–220, in which the results of our studies on the flowering and pollination (including the occurrence of natural cross-pollination) of Indian linseed are set out in great detail together with the necessary illustrations. Between 1916 and 1918 no less than 21 cases of natural cross-pollination between the unit species of Indian linseed were observed and investigated. These various publications appear to have escaped the notice of Messrs. Graham and Roy.

PUSA:
*9th January,* 1924.

Yours faithfully,
ALBERT HOWARD.
GABRIELLE L. C. HOWARD.

## NEW BOOKS

### ON AGRICULTURE AND ALLIED SUBJECTS

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1. Farm soil and its improvement, by Sir John Russell. Pp. 126 +37 plates. (London: Ernest Benn, Ltd.) Price, 7*s*. 6*d*. net.
2. The Micro-organisms of the Soil, by Sir John Russell and Members of the Biological Staff of the Rothamsted Experimental Station. Pp. vii+188. (London: Longmans, Green & Co.) Price, 7*s*. 6*d*. net.
3. The Foundations of Indian Agriculture, by H. Martin Leake, M.A., Sc.D. Second Edition. (Cambridge: W. Heffer and Sons.) Price, 7*s*. 6*d*. net.
4. Diseases of Crop Plants in the Lesser Antilles, by W. Nowell, D.I.C. Pp. 382+150 figs. (London: West India Committee.) Price, 12*s*. 6*d*. net.
5. Successful Spraying, and how to achieve it, by P. J. Fryer. Pp. 154. (London: Ernest Benn, Ltd.) Price, 7*s*. 6*d*. net.
6. Agricultural Implements, by G. H. Purvis. Pp. iv+110. (London: Ernest Benn, Ltd.) Price, 2*s*. 6*d*. net.
7. Vegetable Crops, by Homer C. Thompson, B.Sc. Pp. ix+478. (London: McGraw-Hill Publishing Co.) Price, 22*s*. 6*d*. net.
8. The Principles of Insect Control, by Robert A. Wardle and Philip Buckle. Pp. xvi+295. (London: Longmans, Green & Co.) Price, 20*s*. net.

THE following publications have been issued by the Imperial Department of Agriculture in India since our last issue:—

*Memoir.*

1. **Studies in Indian Oil Seeds, No. 2. Linseed, by Gabrielle L. C. Howard, M. A.; and Abdur Rahman Khan. (Botanical Series, Vol. XII, No. 4.) Price, R. 1-4 or 2*s*.**

*Bulletins.*

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