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Original Articles

SOME COMMON INDIAN BIRDS.

No. 28. THE WEAVER-BIRD OR BAYA (*PLOCEUS PHILIPPINUS*).

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 Tailor-bird has already afforded us an example of admirable nest-building and the Weaver-bird has equal claims for admission to our circle of bird friends, which, so far as this series is concerned, must be strictly limited. We may, however, at once note a point of contrast between the two. The Tailor-bird makes every effort to escape its enemies by concealing its nest between leaves sewn together; the Weaver-bird, on the other hand, positively flaunts its nesting arrangements before our eyes and in many parts of India its nests—whole colonies of them, indeed—form conspicuous objects of the country-side. In some places scores of these nests may be seen, freely exposed to view, hanging from favourite trees, which are usually palms or *babuls* (*Acacia arabica*), trees which overhang water often being selected as it seems to be a *sine quâ non* that the situation considered suitable for suspending a Weaver-bird's nest should have no other tree directly underneath it which might afford access to enemies from below. For a nest swinging up aloft on the tip of a long slender palm-shaft is singularly inaccessible to most would-be marauders.

Although the nests are familiar enough, the bird which constructs them is less so. The Weaver-bird belongs to the large family of the Finches and at most times of the year looks very like a hen House-sparrow, being a small, thick-billed, reddish-brown bird. Towards the beginning of the Rains, however, the cock bird dons his breeding plumage, his head, neck and breast becoming a beautiful golden-yellow and his chin turning almost black.

With the onset of the Rains, nest-building commences, either a new nest being built or an old one, of the previous season, patched up and put into good repair. The process of patching up old nests, which are easily distinguishable by the difference in the colour of the grass, and building new ones can often be seen going on in the same tree. The nest itself is strongly woven with strips of leaves of grasses, plantain or palms, strips from leaves of wild species of *Saccharum* being used most commonly. These strips are prepared by the bird itself, which seizes a leaf in its beak and makes a notch at the edge near the base of the leaf; it then grips with its beak the edge of the leat above the notch and jerks its head away so as to tear off a strip along the edge of the leaf; by flying off with the end of this strip in its beak, the strip is usually pulled off along the length of the leaf; but sometimes, at the first effort, if the leaf is tough, the bird is pulled backwards and hangs suspended by the strip in its beak, so that several attempts have to be made to detach the strip required for nest building. Sometimes the bird bites a second notch on the edge above the first and at a distance allowing for the length of strip which it considers necessary. The strips thus collected are wound securely around the branch or leaf from which the nest is to be suspended and, as more strips are brought in, these are added, securely wound and plaited together, until there is formed a long stalk from which the nest proper is suspended. This stalk is usually about four or five inches long but may occasionally extend to as much as a foot. Having completed the suspensory stalk, the birds then expand its lower end into a bulb-shaped structure, which is usually about five and a half inches in diameter in one direction and four inches in the other. At this time, having determined where the egg-chamber is to be, the birds construct a strong transverse bar or loop, a little to one side of the centre of the chamber, this bar forming a division between the egg-chamber and the long tubular entrance. At this stage of construction the nest resembles an upturned basket, the loop representing the handle. Up to this point in the construction of the nest, both sexes have done the same kind of work in collecting fibre-strips and weaving these into the nest, but, when this loop has been completed, the female bird takes up her position on it, leaving the cock henceforth to procure more material for building and to work from the outside of the nest, whilst she works from the inside, both of them pushing and drawing in the fibres through the walls of the nest so that everything is plaited together smoothly. The little builders seem to enjoy themselves thoroughly, the cock bird especially being industrious, emitting a cry of delight each time that he brings in a beak-full of fibre and often bursting into song during the process of weaving material into the nest. The egg-chamber is now finished on one side of the loop and on the other side the walls of the nest are prolonged downwards into a long tubular entrance, about two inches in diameter internally, and usually about six inches long, but occasionally twice this length. The male bird often continues building on to this tubular entrance even after the eggs have been laid and are being incubated by the female. The lower end of the tubular entrance is loosely woven so as not to afford any firm support to enemies attempting to plunder the nest. The birds themselves when entering the nest close their wings and shoot perpendicularly upwards through the tube; it is marvellous how they can do this without running their heads through the top of the egg-chamber or even apparently shaking the nest. This tubular passage is used as an entrance to the nest by the parents whilst nest-building and incubation are proceeding; but, when the eggs have hatched, the food brought to the nestlings is passed in to them through small holes pierced through the sides of the egg-chamber. The presence of such holes is a sure sign that the eggs have hatched.

It will now be apparent what a hard nut has to be cracked by any would-be plunderer of the nest, which is placed high up out of reach of any non-climbing animals. Even a good climber, such as a squirrel, rat, snake or lizard, will find little to cling to on the tip of a palm-leaf and, arrived there, has to negotiate a distance of at least eighteen inches to reach the entrance to the nest, whilst the lower portion of the entrance-tube is too flimsily constructed to yield any foothold. Plainly visible, its inaccessibility is its sure defence and it can well defy most marauders.

There is still one point to be mentioned about these nests and that concerns the lumps of clay which are stuck onto them in odd places. Jerdon notes that he found in one nest about three ounces of clay in six different places. Many theories have been advanced in explanation, a very popular idea in India being that the bird uses these clay patches as *points d'appui* on which to stick glow-worms to illuminate the interior of its nest. A more probable explanation is that the clay is applied to balance the nest more correctly, to prevent it being blown about by every gust of wind and to keep it steady whilst the birds are entering and leaving it.

Two is the normal number of eggs laid but occasionally three or four are found. As many as ten have been noted, but, in cases where there are so many, they are probably the product of more than one bird. The eggs are usually found in July and August. They are pure white in colour, without any gloss, typically rather long ovals considerably pointed towards the smaller end, and measure about 20 by 15 millimetres.

The Baya is found throughout India and is now divided into four subspecies, which are the Baya (*Ploceus philippinus philippinus*) found in Ceylon and the greater part of India; Finn's Baya (*P. philippinus megarhynchus*), a local race found in the Himalayas about Nainital; the Eastern Baya (*P. philippinus passerinus*), found in the lower Himalayas and Hills in Bengal, Assam, North Burma and Siam; and the Malayan Baya (*P. philippinus infortunatus*) which occurs in the Malaya Peninsula and Siam, only entering our limits in Tenasserim. It is the typical race which is shown on our Plate. Besides the Baya, three other species of Weaver-birds are found in India, of which the Indian Striated Weaver-bird (*Ploceus manyar flaviceps*) has the feathers of the breast streaked longitudinally with black; this bird is not uncommon in localities in Northern India providing suitable rushy, reedy cover, in which the nests are placed, the nests being much like those of the Baya but without the long pensile support.

Like most of its relatives, the Weaver-bird is largely graminivorous, feeding on seeds of grass, paddy, millets, and weeds, but a certain proportion of insect food, mostly small beetles and caterpillars, is taken. It cannot be claimed as a useful bird, and during times of forest fires the nests sometimes burn through at the base and may then be blown, all ablaze, for hundreds of yards into areas which would otherwise escape from the fire.

Its feeding habits make it comparatively easy to keep the Baya as a cage-bird and it is often so kept, young birds being offered for sale in Calcutta during August. Given a large enough space, the Baya will weave its wonderful nest in confinement, but requires all the space for itself for, as Cunningham remarks, "they are very undesirable additions to any aviary containing other kinds of small birds, as they are very aggressive, and are possessed by a deeply-rooted desire to hammer in the skulls of their neighbours, which, as Abdur Rahman in his autobiography remarks of a Baluchi tribe of similar disposition, 'naturally causes disputes'".

Young Bayas are readily tamed and easily acquire tricks, such as threading beads, drawing up little buckets of water or of seed, or loading and firing off a toy cannon. Lockwood Kipling tells of one which flew up to a tree at the word of command, selected a flower or leaf, plucked it, and, returning, placed it daintily between its master's lips. There is no doubt that it is an intelligent bird and it is therefore a favourite cage-bird. In the Punjab a popular proverbial rhyme contrasts the house-building talents of the Weaver-bird with the helplessness of the shelterless monkey which cannot protect itself against the weather in spite of possessing human hands and feet. "This verse," says our informant, "is often quoted for the benefit of idle boys and girls who object to learn," much in the same way as the little busy bee is held up for infantile admiration in Western lands.

FUTURE DEVELOPMENT OF COTTON-GROWING IN INDIA.*

BY

B. C. BURT, M.B.E., B.Sc.,
Secretary, Indian Central Cotton Committee.

It is my privilege to-day to welcome the members of the Agricultural Section of the Science Congress, and to say how greatly I appreciate the honour of being allowed to preside over this Section. I trust that our meeting this year will maintain the high standard attained in previous years.

It has been a custom amongst my distinguished predecessors to select for the presidential address some general question connected with agricultural development. I propose to-day to depart from that precedent and to invite you to consider agricultural research in its relation to a particular crop, viz., cotton. My reasons for this are three: In the first place, much of my time in recent years has been devoted almost entirely to this crop. Secondly, in the Central Cotton Committee India now possesses a unique organization for the furtherance of the improvement of the cotton-growing industry; an organization, moreover, which not only is representative in character but which possesses funds of its own and thus able to provide the means for giving effect to many of its own recommendations. Thirdly, bearing in mind that agriculture is in the first place a business and in the second place an art, it occurs to me that it may be of no small profit to ignore momentarily the conventional division of science and to examine briefly the

* Presidential address at the Agricultural Section of the Indian Science Congress, Bangalore, 1924.

problems presented in attempting the improvement of a single crop. To agricultural improvement every pure science has contributed and will contribute in future. A science of agriculture can hardly be said to have arisen as yet, but the supreme importance of the scientific method in agricultural work is now realized. If the problems requiring solution lie on the borders of several pure sciences they are the more fascinating for that very reason, and, as in other branches of applied science, the thorough investigation of the economic side of our problem must be provided for.

The cotton-growing industry in India occupies a position which in many respects is unique. It is true that the area under cotton is much smaller than that under food crops, nevertheless India is the second cotton-growing country in the world. Further than this, approximately half of the cotton grown in India is converted into yarn and cloth in the country. Not only is India the leading cotton-spinning country in the East but she is the fifth cotton-spinning country in the world. But, though the cotton spinning and weaving industry is the most important in India, cotton is still one of our most important exports. Thus, in addition to the actual cotton-growers, no small proportion of the population is concerned with cotton trade or cotton manufacture, and, apart from the production of the essential food-grains, there is probably no other crop with which the welfare of the country is so intimately connected. As a principal constituent of clothing, especially of cheap clothing, cotton is of intense importance to the world generally and particularly to the agricultural classes of India and the East. The world position in regard to the production of this most important staple is at present extremely unsatisfactory. The prices of most agricultural products have now approached to pre-war values, but cotton, a raw material of outstanding importance, still stands at well over double pre-war prices. This position is liable to be intensified when the cotton mills of Europe attempt to attain pre-war production. At present, cotton mills throughout the world are working much below their full capacity, largely for the reason that high prices have limited consumption. Those high prices have been brought about chiefly by crop has been attributed to various factors. Enhanced cost of production and a rise in the cost of labour have undoubtedly been contributing causes, but the real cause has been the damage done by a single insect pest, the dreaded Mexican Boll-Weevil, which despite all efforts to check its advance has now spread throughout the American cotton belt. The areas sown with cotton in America during the last two years have been well above the average and the present area resulting from the stimulus of high prices is practically a record. But the yield per acre is again most unsatisfactory, and from an area of some 38 million acres, which a few years ago produced 16 million bales and even in unfavourable years has produced 13 million bales, only a crop of 10 million bales or so is now expected. At an optimistic estimate the average production of cotton in America has fallen by 2-3 million bales per annum, an amount equal to more than half of the total Indian crop. Despite years of patient scientific endeavour and the application of control measures on a scale which has never been attempted in any other country and at almost fabulous cost, no real solution of the difficulty has been found. Methods of poisoning, especially with calcium arsenate, have been developed which will reduce the loss but at considerable cost, and there seems little hope that this method of control can be universally applied. Even where it has been successful the expense has been great, amounting to anything from 1*d.* to 2½*d.* per lb. of the cotton produced. An even more serious consideration is that under weevil conditions cotton-growing threatens to become unprofitable in a considerable portion of the American cotton belt, thus suggesting further reduction in cotton production. The conclusion is obvious, viz., that unless other parts of the world can increase their production of cotton, especially of cotton of certain types, the clothing supply of the world will be restricted for years to come.

Increased cotton production in India has often been urged and is undoubtedly possible, but it is desirable to recognize frankly what our limitations are. India, in certain respects, is a fully developed country with a dense population and consequently with only limited opportunity for increasing the *area* under any particular crop. Direct increases in the cotton area have been possible in recent years by the extension of canal irrigation. The creation of canal colonies in the Punjab not only added 800,000 acres to the cotton area (and some 300,000 bales in yield), but has made possible the cultivation of half a million acres of long staple cotton. The Sukkur Barrage and canal scheme in Sind will probably enable an equally important advance to be made during the next ten years, but I must not dwell on this point as it forms the subject of a paper by Mr. Main. For the time being at any rate we have probably reached the limit of direct additions to the cotton-growing area. Any other additions must be at the expense of other crops. The area under cotton in India does respond directly to enhanced prices and has done so in recent years, but in many respects the cultivator is not a free agent. Not only does a dense population necessitate a large area under food crops and under fodder crops to support a large, though inefficient, cattle population, but the fact that holdings are small militates against the maximum area being devoted to the so-called commercial crops.

It is unnecessary in an assembly of agriculturists to lay stress on the need for rotations. It is now widely recognized that existing rotations in India are based in most cases on sound economic and practical considerations and are not readily disturbed. It is, therefore, to higher agricultural yields that we must look for the principal solution of our problem, not only higher cotton yields but better yields from all crops and a higher agricultural efficiency all round, thus releasing land for increased areas of revenue producing crops.

It is common knowledge that like other crops cotton is dependent largely on the vagaries of the monsoon. I should not have considered it necessary to refer to this but for the fact that the effect of the monsoon on the cotton area, as distinct from yield, is not always recognized. I am indebted to Dr. Leake, Director of Agriculture, United Provinces, for some figures which clearly illustrate this point. Approximately one-third of the cotton of the United Provinces is grown on canal irrigation, and he has shown that in recent years this area has been almost directly governed by the relation between the prices of cotton and wheat, the correlation factor being high and positive, viz., 0·57 (± 0·11). For the un-irrigated cotton area the contrary is the case, the area sown being almost directly determined by the nature of the monsoon prior to the middle of July, the correlation factor between rainfall prior to 15th July and the cotton area being 0·62 (± 0·11). If we except the canal-irrigated tracts of Northern India, a relation similar to the latter may be said to hold fairly generally. Fluctuations in area through conditions beyond the control of the grower must therefore be expected. The effect of the monsoon on yield is too well known to need emphasizing.

The problem before the Agricultural Departments, therefore, is not an increase in area but an increase in the profits obtainable from cotton production. Every advance in this direction tends to be reflected in the area and is directly reflected in production. It is necessary to state most clearly, however, that the mere increase in the quantity of cotton produced, though important in itself, is not the real objective. If India is to assist to her own profit in meeting the present world's shortage, it is essential that she should produce more of the type of cotton which the world requires. It has already been stated that India is the second cotton-producing country in the world. Her average cotton crop is approximately 5 million bales equivalent to 4 million American (500 lb.) bales as compared to an American crop of some 10 million bales. But 70 per cent. of her cotton is of so short a staple that it can only be used to a limited extent. The cotton spinning and weaving industries of the world have developed mainly on the basis of the type of cotton which America has supplied in the past, i.e., cotton of not less than $\frac{7}{8}''$ staple. At least 30 per cent. of the Indian cotton crop is of only $\frac{5}{8}''$ staple and 70 per cent. is below $\frac{7}{8}.''$ India exports well over a million bales annually of these very short staple cottons, and there is no indication that the world's spindles can use very much more of this quality. On the other hand, Indian mills absorb something like half of our average commercial crop, and out of the 2-2$\frac{1}{4}$ million bales which they use, over one million bales are of staple cotton, i.e., cotton of $\frac{7}{8}''$ and upwards. Of such cottons there is only a small margin estimated at an average of some 250,000–300,000 bales per year. Incidentally in certain years the imports of American cotton into India have been as high as 100,000 bales and there is a regular import of similar cotton from Africa.

In the past India has occasionally experienced difficulty in selling promptly the whole of her crop in a year of large production, e.g., when in 1919-20 an Indian crop of nearly 6 million bales coincided with a fair crop of American cotton, resulting in a carry-over on 31st August, 1920, of over a million bales in Bombay alone and exclusive of mill stocks. The crop in the following year fell below 4 million bales, thus relieving the situation. But it is clear that our percentage of short staple cotton is unhealthily high. It will be obvious that our ultimate objective should be to enable the Indian cotton cultivator to produce a cotton which will be freely competed for in the world's markets every year; at present this is not the case. At the present moment while American cotton is selling at some 20*d.* per lb., Indian short staple cotton is fetching only about nine annas per lb. I have dwelt on this question at some length because it has often been urged in the past, and from authoritative quarters, that India should produce more cotton whatever the quality may be. The truth appears to be that even with the present world's shortage there is only a limited demand for cotton of less than $\frac{7}{8}''$ in staple.

As is well-known, India at one time produced a larger proportion of stapled cottons than at present. Within recent history, for example, the Central Provinces and Berar grew chiefly Bani cotton (*G. indicum*) a cotton of one inch staple and over and one of the best of our indigenous cottons instead of the short staple cotton which now forms the bulk of the crop. The irony of the situation lies in the fact that it is largely the development of cotton spinning with modern machinery in the East which has led to the replacement of long by short staple cottons. Indian mills and China and Japan are by far the most important outlet for short staple cottons although the demand from the Continent is by no means unimportant.

Such cottons as Bani are characterized by a low ratio of fibre to seed and in most tracts by a relatively low yield per acre. Until cotton marketing in India reaches a much higher standard of perfection than we can foresee at present, only in very rare cases, if ever, could an Agricultural Department advise the substitution of a high quality cotton of low average yield for an existing variety of higher yield.

The ratio of cotton lint to seed or the ginning percentage, as it is commonly called, is also an extremely important though not the critical factor. In most parts of India the cultivator sells unginned cotton, i.e., *kapas*, and in consequence, so far as he is concerned, ginning percentage is only one of the commercial qualities of *kapas* and therefore capable of being set off by lint quality, provided that the necessary primary market facilities can be established. The ideal cotton for any tract would be one with growing period adapted to local climatic conditions, equal or superior in yield to the present varieties, equal to them in ginning percentage and with a staple of *at least* $\frac{7}{8}''$ and preferably over 1″. Such an ideal is not impracticable, but the difficulties to be overcome in its attainment vary greatly in different tracts. The three means at our disposal to securing this end are :—

(1) The isolation of the best unit species from the existing mixed crop.

(2) The use of an acclimatized exotic often involving irrigation facilities and, for complete success, involving the isolation of pure lines.

(3) Hybridization.

In those areas which already grow cottons of relatively long staple, the first method has already given excellent results. In the Tinnevelly tract the isolation of the Karunganni constituent from the crop has given a cotton of superior staple and better yield. The same is true of the Westerns and Northerns tracts. In South Gujarat the deterioration due to the invasion of this area by a short staple *herbaceum* cotton of high ginning percentage has been checked by the isolation and establishment, over practically the whole of the Surat District and a considerable portion of the

Baroda State, of a longer staple unit type. In Dharwar, success has been attained by the isolation of pure types from Kumpta and Dharwar-American cottons. The latter incidentally is an acclimatized exotic American of ancient origin.

The second method has met with conspicuous success in the Punjab and in Madras, in both cases a short staple cotton having been replaced by a long staple cotton. Punjab-American, which is now grown on half a million acres, is a selection from Upland American introduced originally into Bombay over fifty years ago. Cambodia cotton, now grown throughout the Coimbatore and parts of other districts in Madras, is an American type obtained from Indo-China. In both these cases success has been possible by the development of these cottons as an irrigated crop. The success of Cambodia is of particular interest as the irrigation is from wells, and the cultivation intensive, comparable with that given to garden crops.

In the Central Provinces and Berar and in the United Provinces where the existing cottons are of very short staple, the material for selecting a type of $\frac{7}{8}''$-1″ staple probably does not exist. With canal irrigation part of the United Provinces can grow an acclimatized Upland American cotton successfully, but in the greater part of the province a cotton of short vegetative period comparable with the existing *neglectum* type is an essential. The same appears to be true of the Central Provinces, Berar and the Khandesh Division of Bombay. In these tracts pure line selection has produced types more profitable to the grower, for the time being at any rate, than the previous mixture, but the real problem has not been solved. In such areas ultimate success will probably only be achieved by hybridization, although it is not possible to be too emphatic on this point.

It is by no means certain that we have yet reached a limit in the improvement of cotton by the study of the unit species contained in the present mixtures. The importance of such work cannot be over-rated, for it not only provides material for temporary advances in the desired direction, but is essential to a proper understanding of the material available even if the final solution can only be found by hybridization.

There are still some gaps in our knowledge of the inheritance and characters of cotton, particularly of those determining its commercial value. The work of Leake, and later of Kottur, Patel, Hilson and others, has done much to clear up many of the points which seemed obscure. But even now we are still ignorant of some of the factors determining the agricultural yield and as to whether there is anything in the nature of a linkage between staple length and the lint-seed ratio. Within any given agricultural variety there is undoubtedly a general tendency for long lint to be accompanied by a low proportion of lint and for short lint to be accompanied by a high ginning percentage. It is fairly clear that no complete linkage exists, but there are probably limitations on the extent to which the two can be combined. Fuller knowledge on this question is clearly of great importance.

Physiological research is also needed to elucidate the present low yield of many types of cotton, particularly in the black soil areas. No less is it needed to elucidate the causes for the loss of crop caused by bud and boll shedding. Preliminary work in Bombay and Madras has shown that the latter offers a most fruitful field of enquiry.

To multiply such instances would be tedious. The work of the Agricultural Departments has already added enormously to the profits of the cotton-grower, and if the problems which await solution before a further advance can be made demand time and patience, we can go forward with the knowledge that the scientific results achieved can undoubtedly be given effect to in the general cotton cultivation of the country through the organization which the Departments of Agriculture have built up.

It was my privilege last year to contribute a short paper to this section dealing with the necessity for technological research on raw materials with special reference to cotton. I was able to show then that the task of the agricultural investigator concerned with cotton improvement is in some respects rendered unnecessarily difficult by the lack of knowledge as to the precise qualities in cottons which are desired by the spinner, and by lack of facilities for testing new cottons.

Textile physics is a comparatively new branch of the subject, but has already led to very valuable results in England where investigations now being carried out to elucidate the constitution and character of the cotton fibre may eventually lead to marked and possibly revolutionary changes in spinning methods. There is a wide field for such work in India, especially if directed to the improvement of the raw material. I shall refer again to this subject later.

No less important than agricultural research and improvement is the improvement of cotton marketing, the object being to obtain for the grower the fullest possible price for the cotton he produces. The possibility of introducing certain improvements into general agricultural practice will depend largely on such market organization. It is not sufficient that the major markets are willing to pay enhanced prices for superior staple or for clean cotton. This premium must reach the grower. For this to be the case two conditions must be fulfilled. Firstly, many of the present gross forms of adulteration, resulting as they do in small profits to the middleman, out of all proportion to the loss caused to the producer and to the general economic loss to the country, must be stopped. Certain Indian cottons for many years have possessed an unenviable reputation on account of the mixing of different varieties much of which is deliberate and fraudulent mixing. Secondly, the organization of primary markets requires improvement to bring them into better touch with major markets and to give the grower a square deal. Nor can the major markets for Indian cotton be held to be entirely satisfactory. The classification adopted, based as it is on geographical distinctions and station names rather than on intrinsic quality, does not tend to the grower getting the full value of his cotton. Again, since the whole question of agricultural finance is involved, the possibility of developing co-operative methods of marketing may well be a critical factor. It will be seen, therefore, that the question of cotton improvement covers an extremely wide range both scientifically and commercially. Until comparatively recently the Agricultural Departments were left to deal with these various phases almost unaided.

As one of the results of the touring Cotton Committee of 1917-18, the Indian Central Cotton Committee was created in 1921 and permanently incorporated with funds of its own in 1923. This Committee consists of representatives of cotton growers, cotton traders, cotton spinners, cotton ginners, of the Agricultural Departments of the cotton-growing provinces, and representatives of the larger cotton-growing Indian States. The cotton cess, on which the Committee depends for its funds, at present produces some Rs. 9,00,000 per annum, the great portion of which is devoted to the furthering of research.

By means of research grants to Provincial Departments of Agriculture the Committee has been able to make provision for additional research on problems of general applicability. In the Bombay Presidency grants have been given for physiological research in connection with boll and bud shedding, research on cotton wilt, investigations in the methods of dealing with spotted cotton bollworm and for plant-breeding work on Upland cotton. In Madras, a grant has been given for special investigations on the *herbaceum* cottons of the Northerns tract and a further grant sanctioned for bio-chemical research on the causes of resistance and susceptibility to disease and the effect of environment on the staple.

In the Central Provinces, grants have been given to enable a more thorough study of the cottons of the province and for work on cotton wilt. In the United Provinces, a grant has been given for special investigations on the pink bollworm. In the Punjab, provision has been made for a special study of Upland American cottons under canal colony conditions. Other research schemes are under consideration. In addition, the Committee proposes to provide for a Central Agricultural Research Institute for cotton, to be situated in Central India, for both plant-breeding and physiological investigations.

I have already referred to the importance of technological research, and provision for this has been made in the Central Technological Laboratory, Bombay, which will shortly be completed. It is a matter for regret that Professor Turner, of the

Manchester College of Technology, who has recently been appointed Director of this research Laboratory, arrives in India just too late to be with us to-day. In the course of a few months we shall be able to offer agricultural investigators the fullest facilities for the testing of new cottons, and a start will be made on a general technological study of Indian cottons.

On the economic side, and in its capacity as an advisory Committee, the Central Cotton Committee has taken up actively the question of checking adulteration and the improvement of marketing at all stages. Certain of its recommendations for legislation have already been given effect to by Government and others are still under consideration. In particular the Cotton Transport Act passed a year ago enables any Local Government to prevent the importation into tracts growing superior cottons of inferior cottons for purposes of mixing. This Act is already in force in the Bombay Presidency.

Time does not permit of even a casual review of the Committee's various operations. But, apart from its more formal activities, its value as a common meeting ground for all sections of the cotton industry has already proved to be of the greatest value.

It will be seen that the Central Cotton Committee is trying to do for India the work which the Empire Cotton Growing Corporation is attempting for the British Empire as a whole, but with special reference to the newer cotton-growing countries. It marks a new departure in the development of Indian industries, for it is a body composed mainly of unofficials administering funds contributed by the cotton trade and industry for the improvement of that industry. It has initiated a well-balanced and adequately financed programme of research work and, during the two years of its existence, has made very important progress towards the solution of the many problems which the improvement of cotton-growing in India involves. Not only has the industry itself provided funds for its own improvement, but individual representatives of its various branches, gentlemen occupying important positions in the commercial world, have given unstintedly of their time and thought. Team work of this nature, where all interested in the improvement of cotton pull together, cannot fail to be of the greatest value. The Committee has fully justified the confidence which the Government of India and the Indian Legislature reposed in it when in January last the Committee was given a definite constitution and permanently incorporated by a special Act.

In conclusion, I would venture to remind you of the stress laid by two past Presidents of this Section on two important aspects of agricultural work. In 1918, Dr. Coleman urged the necessity for accuracy in agricultural investigations and for accurate field experiments. In 1921, Mr. Milligan drew attention to the many-sided nature of the problems with which the agricultural investigator is confronted and urged the desirability of more team work directed to the solution of a particular problem or group of problems. Not only in respect of the crop which we have been discussing but in regard to all agricultural investigations in India, there was perhaps never a time when these two maxims stood so much in need of emphasis. Now that every Agricultural Department is busily engaged in developing the successful results of earlier experimental work, there is no small danger that, during a period of financial stringency, the necessity of adequate provision for further research and experiment may be overlooked or discounted. On the other hand, the next advances in agricultural improvement may only be achieved after much patient and laborious investigation, for in many instances we have only just come to grips with the essential features of our major problems.

Superficial or inadequately conducted experiments are no more justifiable in applied science than in the pure sciences. Only by patient and co-ordinated effort are lasting results likely to be achieved.

PLATE IX.

THE JAMSHEDPUR ACTIVATED SLUDGE SEWAGE DISPOSAL WORKS.

BY

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AND

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WHEN the town of Jamshedpur or Sakchi, as it was then called, was first built, it was laid out to accommodate about 8,000 to 10,000 workmen, which were sufficient to supply the needs of the Tata Iron and Steel Works, as they were originally planned. With the extension of the Works the town has grown until there is a population of more than 50,000 situated near the Steel Works.

The sewage of the original town was disposed of in two septic tank installations which were quite adequate and entirely satisfactory. The effluent from these septic tanks ran down *nalas* and ultimately found its way into the rivers which embrace the town on two sides. The purification was so far complete that sewage contamination could only be traced a very short distance down from the points at which the effluents entered the rivers.

In the latter half of 1916, the Company realized that, in view of the expected extensions of the town and works, competent advice should be taken to ensure satisfactory drainage and sanitation of the town. For this purpose Lt.-Col. Clemesha, M.D., M.R.C.S., D.P.H., I.M.S., Sanitary Commissioner to the Government of India, was consulted and he made a report, in the course of which he advised that a new method of treating sewage, namely, the activated sludge process, had been discovered, and that it was more satisfactory than septic tanks for many reasons. In 1918, Dr. Gilbert J. Fowler, D.Sc., F.I.C., of the Indian Institute of Science, Bangalore, was consulted, and he explained the advantages offered by the activated sludge system of disposal inasmuch as it claimed to produce a clear non-putrefactive effluent and a sludge rich in nitrogen and free from any offensive odour and thus valuable as a fertilizer. At that time there was no activated sludge plant working in India and doubts were raised regarding the suitability of the process for this country. A series of laboratory experiments were inaugurated at Bangalore under the supervision of Dr. Fowler, who took an active part in the original experiments and in the original design of the activated sludge plant. These experiments clearly demonstrated the feasibility of working the process on a small scale, and it was decided to deal with the sewage of an additional part of the town, which had to be cared for immediately, in an activated sludge plant, which would form a practical disposal works for that part of the town, provided the process was a success, and an experimental station for determining the design of the enlarged plant necessary to take care of the whole town.

Conditions were such that it was necessary to pump the sewage either before or after it passed through the disposal works. A pumping station was, therefore, erected consisting of a well calculated to contain about 12 hours' flow of sewage, which would be a safeguard if there should be a temporary stoppage of the pumps, and designed to act as a grit catcher, and a pump chamber containing two stereophagus pumps delivering into a 7-in. cast iron rising main 6,214 feet long leading to the site selected for the disposal works. This site, which is on the summit of a ridge, was chosen because it commands for gravity irrigation an area of about 1,000 acres of arable land.

From the gaugings made in existing sewers and surface drains it was estimated that the quantity of sewage to be dealt with daily would be 120,000 gallons from some 3,000 persons. The activated sludge plant was constructed to designs prepared by Activated Sludge, Ltd., nominally capable of handling up to 150,000 gallons per day, for 3,000 persons at 50 gallons per head. It consists of three aeration tanks, all leading out of and back into a bye-pass channel, a settling tank, a sludge re-aeration tank and blower house

containing two blowers. The total capacity of the tanks is 150,000 gallons. When serving 3,000 persons, therefore, the tank capacity is about 2 c.ft. per head.

The tanks are constructed of masonry work and are built above ground-level, as both the effluent and sludge are used for irrigation, and it was desirable to retain as much "head" as possible. The bottom of the settling tank is hopper-shaped and below ground-level. From the bottom of the hopper an air-lift leads into the re-aeration tank. The incoming sewage is admitted at the point where the re-aerated sludge falls into the head of the bye-pass channel. By means of the bye-pass channel the aeration tanks can be used all three together, or either one or two can be isolated. The tank works only on a continuous-flow system, the amount of effluent overflowing at the end depending on the amount of fresh sewage pumped in.

When working at the rate of 150,000 gallons per day and when there is approximately 20 per cent. of sludge accumulated in the tank the detention period is about 5 hours.

The air equipment consists of two rotary blowers which were intended to be driven by electric motors, but owing to delay in obtaining current, are driven temporarily by an oil engine and a portable steam engine. The air is distributed by means of cast iron pipes laid on the walls leading to diffusers supplied by the Activated Sludge Co. The diffusers are laid in shallow troughs in the bottom of the aeration and re-aeration tanks.

The plant was first put into operation towards the end of November 1921. The characteristic activated sludge action was visible in the tank at the end of 24 hours, and after 48 hours' aeration the sludge could be distinctly settled out in a bottle leaving a clear effluent with the following analysis in parts per 100,000 :—

	F. S. N.	Alb. N	Nitrite	Nitrate	Cl	Sludge
0 hrs.	0·744	0·216	nil	nil	2·0	nil
24 ,, ...	0·860	0·186	nil	f. traces	2·1	f. traces
48 ,, ...	0·912	0·108	f. traces	0·01	2·1	distinct

Various difficulties and defects, which were only to be expected in the first plant of the kind to be set to work in India, appeared from time to time. These were dealt with as they appeared and the plant settled down to a satisfactory running after 2 or 3 months. In October 1922, the plant was unavoidably shut down over a month owing to outside causes. Before starting it up again the opportunity was taken to remodel certain parts with the result that the capacity of the plant has been increased to over 200,000 gallons per day.

As a method of purifying sewage the plant has been extremely successful. It has not given rise to any nuisance and has consistently turned out a non-putrefactive effluent. Typical analyses are as follows :—

Crude sewage analysis.

Parts per 100,000.

O_2 abs. in 4 hrs.	F. S. N.	Alb. N	Nitrate	Nitrate	Cl	Kjeldhal (N)
11·26 ..	1·6068	0·420	nil	nil	3·2	3·22
11·26 ..	1·8852	1·980	nil	nil	3·5	9·24
13·80 ..	2·6656	2·100	nil	nil	4·0	9·80

Analysis of effluent.

Parts per 100,000.

O_2 abs. in 4 hrs.	F. S. N.	Alb. N	Nitrite	Nitrate	Cl	Kjeldhal (N)
0·68 ..	1·014	0·120	nil	0·008	2·6	6·3
0·64 ..	1·301	0·105	f. traces	0·006	2·6	[illegible]
0·70 ..	1·440	0·125	0·02	0·007	2·4	[illegible]

Analysis of sludge dried in the sun.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture ..	6·0	9·08	6·9	4·86	1·00	4·84
Organic matter ..	72·5	70·52	69·8	72·08	75·78	62·52
Ash (mineral matter)	21·5	20·40	23·2	23·05	23·21	32·63
Nitrogen by Kjeldhal	7·6	8·88 / 9·13	7·84	8·73	8·62	6·18
	P_2O_5 = 1·35 P_2O_5 = 1·66 P_2O_5 = 1·59	K_2O = 0·25 per cent. Ether soluble matter = 5·5 per cent.				

During one period of accurate observation the number of persons served was 6,000. The flow of sewage was 150,000 gallons per day. The dilution of the sewage was, therefore, 25 gallons per head per day, and the cubic capacity of the tank 1·3 c.ft. per head. With the plant working under these conditions, an entirely satisfactory non-putrefactive effluent was obtained, and a sludge which could be handled without difficulty. At times the flow of sewage has risen as high as 240,000 gallons per day and the population served may have been as high as 8,000, though this is uncertain. When the flow is as great as this, the settling tank capacity is not sufficient to bring down all the sludge, and light particles are to be seen in the effluent, but no trouble has yet arisen on this account. Ever since the plant was put into operation the whole of the effluent and sludge produced by the plant has been absorbed in the farm lands.

Some experiments were made on drying the sludge in the sun. It was found to dry very well on turf provided the depth of the sludge layer did not exceed 3 in. Drying on sand was found unsuitable because although the sludge dried more rapidly, it penetrated the upper layers of the sand which became incorporated with it, thereby lowering the percentage of nitrogen per volume of dry sludge. A 3 in. layer of sludge on turf dries to spadable condition within 6 hours, and within 24 hours it is quite dry in flakes, which can easily be handled. In thin layers it will dry well on a cement floor. The sludge dried in the laboratory both on turf and on the cement surface of a roof, and kept in a stoppered bottle from last year, shows so far no sign of deterioration or of any offensive smell.

The sludge that has been used in cultivation and incorporated in the soil has not so far created any nuisance in the locality.

In addition to the success in purifying sewage, the use of the effluent and sludge for irrigation and fertilizing land has been very successful. Several acres of land which are in the nature of hard gravel (known as moorum) and which were rejected by all the indigenous cultivators as totally barren are slowly changing their texture by constant irrigation with sludge. Organic humus and nitrogen are being supplied by the sludge, and in one particular plot four crops, namely, oats, maize, beans and cabbages, were raised within the period of one year. The yield and growth of various crops such as maize, beans, sugarcane, oats, and market vegetables, such as cabbages, cauli-flowers, brinjals, peas and other varieties, have been quite satisfactory. The sugarcane was grown on good paddy land, the yield being as follows :—

Class of cane	Weight per acre	No. of canes per acre
	lb.	
J 247 (thin)	120,000	51,900
New Guinea 22 (thick)	108,000	27,600
New Guinea 15 (thick)	76,160	15,300

These results were obtained over an area of a little over three acres and may therefore be accepted as practical.

A series of experiments was made to compare the efficiency of sludge as a fertilizer with other natural and artificial fertilizers. A piece of the barren land referred to above was selected and was divided into 10 plots, each of $\frac{1}{40}$th acre.

Five of these plots were irrigated with water supplied from the town mains; the other five with activated sludge effluent. The plots were manured as shown below. The activated sludge being liquid was distributed by making small channels in the plots. The sludge was dry in a little over 24 hours and when quite dry was mixed with the soil by ploughing. During these operations there was no nuisance of any kind. In plot 8 the sludge was applied on 7th December, 1922, and in plot 7 on 9th December, 1922. Cowdung and ammonium sulphate used in other plots were applied on 9th December, 1922. As it was late in the season, it was decided not to attempt to grow any crop to its full yield of grain and straw but to be content with green fodder crop. On 16th December, 2½ lb. of oats were sown in each plot.

Within a week the seeds germinated, approximately equally in all the plots. In the third week of January, plots 7 and 8 were looking best of all. No. 1 by this time was very poor. In the second week of February, No. 7 had such a heavy growth that it was thought advisable to cut the plots and conclude the experiments, but before a decision was reached a hailstorm on 10th February, 1923, made it necessary to cut immediately. Results are indicated in the tabular statement given below.

It is worth noting that the mere addition of inorganic nitrogen in plots 2 and 9 did not help the plants as much as the inorganic nitrogen combined with organic manure did in plot 3. This is in agreement with the experiments at Rothamsted farm. Plot 6 is very interesting. It was not manured deliberately in any way, but only irrigated with activated sludge effluent. The most probable explanation is that some sludge, which may have been sticking to the sides of the main irrigation channel, was picked up and carried to the plot by the effluent. Comparing plots 7, 8 and also 6 if the assumption is true, it appears that the activated sludge is easily available to the plants and the more it is added (provided the toxic point is not reached) the better the result. This should be borne in mind when the correct proportion of seed for growing green fodder is being considered. It appears probable that if the quantity of seed in plots 7 and 8 were reduced to half, the individual plants would have thriven better and the ultimate yield would have been as good.

A comparison of the amount of "dry matter" added to plots 7, 8 and 10 is interesting. In plot 7 it is 50 lb. given in 1,000 gallons of sludge. In plot 8 it is only 10 lb. given in 500 gallons of sludge. (The sludge on the latter day happened to contain more moisture and therefore less "dry matter" per unit volume.) In plot 10 it is 560 lb. The farmyard manure in plot 10 has given a fine yield, but it is less than that of plot 8, where there was only one-fourth of the nitrogen and one-fifty-sixth of the weight of dry matter. This fact would become of great importance if the sludge is ever dried and sold as manure, for the cost of bringing it to the site would be comparatively small.

The experiments are only those of one season, and the figures are those for small plots, $\frac{1}{40}$th of an acre; but combined with the visible results on the cultivation of some thirty acres, and the satisfactory character and analyses of the effluent from the sanitary point of view, they clearly indicate that the activated sludge system is remarkably well suited to Indian conditions both as a method of sewage purification and as a means of producing a valuable fertilizer.

In order to arrive at some comparison between the cost of sewage disposal by this method and by the method of septic tanks and filters comparative estimates have been made. The activated sludge plant without the prime movers for the blowers costs Rs. 22,100. Such machinery as was available has been adopted for the service, and not being properly proportionate to this work cannot run as economically as the plant should be running. Supposing power was available at a distance of 2,000 ft., the electric wiring and machinery would cost about Rs. 12,500, making a total of Rs. 34,600. The cost of running charges for motors, blowers and all necessary attention to the activated sludge tank would come to about Rs. 2,200 per annum, with power at 2 annas per unit. An alternative method would be to use small oil engines to drive the blowers, the capital cost of which would be about Rs. 6,000, making a total capital cost of Rs. 28,100. The running costs would then be about Rs. 7,000 per annum.

The capital cost of a septic tank and filter installation to turn out an effluent of approximately the same quality would be about Rs. 37,000 and the cost of annual maintenance would be about Rs. 3,200. The annual cost of running the activated sludge plant, if cheap electric current is not available, therefore, is rather more than double the cost of the septic tank and filter plant, but the crops produced by the effluent and sludge of the activated sludge plant will be at least Rs. 4,000 more valuable than the crops produced by the effluent of the septic tank and filters.

For a plant of this size, therefore, it appears that the capital cost and net cost of maintenance are approximately equal. This does not consider any cost of land. The septic tank and filter installation will require an area five times as large as the activated sludge plant.

Experiments with oats manured in different ways.

Plot No.	Area of each plot	Manure per plot	Added nitrogen in lb. per plot	Irrigation	Observation	Height in inches	Yield in lb. per plot of green fodder	Yield in lb. per acre	Yield in units per acre
1	$\frac{1}{40}$ acre	No manure	nil	Water	Growing in thin patches of pale green colour.	14	29 (25-2-1923)*	1,160	1·0
2	Do.	7 lb. ammonium sulphate	1·4	Do.	Do.	16	62 (25-2-1923)	2,480	2·1
3	Do.	Cowdung 140 lb.; ammonium sulphate 3½ lb.	1·4	Do.	Growing well in thick patches of both pale and dark green colour.	17	336 (15-2-1923)	13,440	11·6
4	Do.	Cowdung 280 lb.	1·4	Do.	Growing well like No. 3.	19	194 (14-2-1923)	7,760	6·7
5	Do.	Cowdung 560 lb.	2·8	Do.	Do.	24	222·5 (14-2-1923)	8,900	7·7
6	Do.	No manure	nil	A. S. effluent	Growing well with dark green colour.	21	360·5 (13-2-1923)	14,420	12·4
7	Do.	Activated sludge 1,000 gals.; 50 lb. dry matter	3·5	Do.	Growing very thick with dark green colour, roots deprived of light.	30	762 (13-2-1923)	30,480	26·3
8	Do.	Activated sludge 500 gals.; 10 lb. dry matter	0·7	Do.	Growing thickly with dark green colour, roots deprived of light.	31	449 (12-2-1923)	17,960	15·5
9	Do.	Ammonium sulphate 7 lb.	1·4	Do.	Growing in thin patches.	23	128 (12-2-1923)	5,120	4·4
10	Do.	Cowdung 560 lb.	2·8	Do.	Growing well with dark green colour.	32	410 (12-2-1923)	16,400	14·1

* Date of cutting.

NOTE ON DISEASES OF SHEEP.*

BY

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THIS subject has been suggested for discussion at the Conference, not because the writer has had much experience of sheep diseases, but because he believes that there is a large annual loss of sheep and wool, at any rate in parts of India, much of which could be prevented if (1) more veterinary medical aid were available, (2) the sheep owners would avail themselves of it, and (3) the usual methods of disease control adopted in more advanced countries could be applied.

According to the census of 1914, the number of sheep in the Punjab was $4\frac{1}{2}$ millions; this number had decreased to 4 millions according to the 1919 census. In spite of the very poor grazing usually available in the plains of the Punjab, the number seems extraordinarily small. In the Cape Colony, not much larger than the Punjab, for example, there were over 16 million sheep in 1921.

The small number and decrease may be partly accounted for by extension of canals and consequent decrease in grazing areas, but it seems reasonable to assume that heavy casualties are at least partly responsible. I think our discussion on diseases will support this view.

In passing, with a view to emphasizing the case for more attention for sheep diseases, I would like to point out that sheep in many parts of India, certainly in the Punjab, are valuable animals. They carry wool which has oscillated in value during the past few years between 4 annas and 12 annas per lb. If properly looked after they yield about 4 lb. of wool per year. Assuming 4 million sheep yield only 2 lb. per head at 6 annas per lb., the value is

* Submitted to the Second Meeting of Veterinary Officers in India, Calcutta, 1923.

30 lakhs of rupees per year. The amount could be doubled if we could control skin diseases.

Mutton in most Punjab cities is now about 6 annas per lb. Punjab sheep in decent condition average about 40 lb. of mutton, so that even at 4 annas per lb. a sheep is worth Rs. 10 to the butcher. If the sheep are well looked after and fed, the mutton is of good quality.

The sheep could easily be graded up to yield much more than 40 lb., but even at Rs. 10 each loss from disease soon runs into large sums of money. The writer has not been able to discover any statistics from which he can give any estimate of the loss by disease. Putting it at the very low estimate of 5 per cent. (it is probably nearer 50), deaths from disease in the Punjab would be 200,000. If half could be prevented, a saving to the province of 10 lakhs of rupees would result.

Internal parasites. So far as the writer's experience goes, the most important disease, or rather parasitic infection of sheep in the Punjab, is infection by *Hæmonchus contortus*, commonly known as the stomach wire worm. Certainly the flock on the Hissar farm has suffered more from this parasite than from any other; this has happened in spite of the fact that Hissar is one of the driest districts in India, the average annual rainfall being under 14 inches. Long periods of drought are common; for example, from 5th August, 1920, till 10th June, 1921, the rainfall amounted to less than one-tenth of an inch. Such conditions must be very uncongenial to the parasite, yet it was found in the stomachs of sheep, the deaths of which were attributed to pneumonia in May and June 1921.

No doubt the presence of canals accounts for its surviving in Hissar. But if it can flourish in Hissar under such adverse conditions, how much more common must it be in other parts of the province and of India where conditions are favourable? Statistics of casualties on the Hissar farm, attributed to the parasite, have not been given, as we invariably treat the flocks as soon as we discover the parasite and they would give no indication of mortality under usual conditions in India. The writer hopes, so far as this farm is concerned, eventually to get rid of the parasite altogether, by treatment on the lines recommended by the Union of South Africa Veterinary Department.

Several drugs and methods of administration are recommended by the South African authorities. Copper sulphate in solution is the drug the writer generally uses. He has not found it difficult to train men to drench the sheep without untoward results.

In South Africa, *Hæmonchus contortus* is said to cause more losses among sheep and goats than any other internal parasite. The Veterinary Department there has done a great deal of work in connection with it, and has published many valuable papers on it in the "South African Journal of Agriculture."

The next most common parasite at Hissar is *Œsophagostomum columbianum*, the cause of the so-called nodular disease of the intestines of sheep. Considerable losses are attributed to this parasite in South Africa. It is not believed to be the cause of much loss to country-bred sheep in the Punjab. However, pure merinos imported from Australia to Hissar suffered very severely from it, and many died from it. The writer often found portions of the colon almost completely occluded by it. However, very severe lesions were also found in sheep which undoubtedly died from other causes.

During the last four years the average number of sheep on the Hissar farm has been 500 ewes, 15 rams, and about 300 weaned lambs. During this time only one or two deaths have been attributed to this parasite. The worm, however, can generally be found if searched for at post-mortem examination.

As regards internal parasites, any besides the above two are not of any economic importance in the dry parts of the Punjab.

The alimentary canals of sheep are, however, fine fields for the parasitologist in the wet and riverine tracts. Colonels Walker and Baldrey writing in the now defunct "Journal of Tropical Veterinary Science" both mention several parasites found by them while investigating a disease locally known as "Gillar." This disease appears to be a veritable scourge. Ninety per cent. of sheep in affected areas are said to become infected, and 90 per cent. of animals attacked die. Neither of the above investigators came to any definite conclusions as to which parasite was the cause of the disease, but both mention the finding of *Hæmonchus contortus* which is capable of causing most of the symptoms described.

Fluke is a source of heavy losses in the Himalayas and foot-hills. No case has hitherto occurred in Hissar, but the question whether there is any danger of this disease being spread by the agency of canals is worth inquiring into.

External parasites. The only one that has given much trouble at Hissar is the scab parasite. The one or two outbreaks which occurred were, however, speedily stamped out by the usual dipping methods.

There seems to be some difference of opinion as to the prevalence of scab in India. In addition to the outbreaks at Hissar, the writer has several times seen scabby sheep in the neighbourhood. Mr. Cattell, when Superintendent, Civil Veterinary Department, Baluchistan, reported that it was very prevalent there.

Dr. Mollison, first Inspector-General of Agriculture in India, who was much interested in live stock generally, and wrote a volume on stock breeding for his Text-book of Indian Agriculture, however, writes as if he thought the disease was non-existent in the Bombay Presidency, and considering how largely sheep scab looms in the veterinary and agricultural literature of most other countries, it certainly seems to have received very little attention in this. It is hoped that discussion in this conference may add to our knowledge as regards its prevalence. Possibly the fact that Indian sheep are usually shorn twice, and sometimes three times, annually may play some part in checking the spread of the disease. Any way as we know that the disease does exist in India and realize the losses of and preventive measures adopted by other countries, it would probably pay India to adopt similar measures. But the Veterinary Department and the Police are not in the present state of their organization capable of supervising and enforcing such regulations as are enforced in other countries.

Larvæ of *Œstrus ovis* are common in sheep all over the country. Irritation due to them may cause loss of condition, but they are not of much economic importance.

Blow fly maggots in wet seasons are a source of very serious loss. Even at Hissar, when we get any rain in the monsoon period, sheep require a good deal of attention if they are to be kept free from maggots.

Microbic diseases. So far as the Hissar farm is concerned, pneumonia has caused far more deaths than any other disease. Pneumonia is a veritable scourge of young lambs in the cold weather, and generally seems connected in some way with malnutrition. For example, in young lambs, deaths are practically confined to the months of January and February. In these months grazing is generally scanty and the time for grazing is short, and ewes have very little milk. The lambs die at about 3 weeks old. Deaths cease abruptly in March, when the days get longer and grazing on canal banks, etc., improves. In older animals also outbreaks of pneumonia have always been seen at times when grazing was short, and the sheep in poor condition. Changing to better pasture or stall-feeding have proved the best method of treatment. I should like to note in passing that change of grazing and also changing the folds, if the sheep are folded or taken in at night, is generally worth trying if one is called to deal with any obscure outbreak in sheep.

As regards young lambs dying in January and February, a simple way to deal with the problem is to arrange to have no births in the cold weather. Since the Indian custom of running rams with ewes all the year round was given up, losses in young lambs at the Hissar farm have been reduced to practically nil. Soon after the writer joined the farm, out of 90 lambs born in December, January and February, 71 died of pneumonia.

Anthrax is also the cause of a good deal of mortality in sheep. The bad reputation of East Indian wool at home tends to support this theory. Personally the writer has not had much experience of anthrax in sheep, as the Hissar farm was entirely free from this disease from the date the Civil Veterinary Department took it over in 1899 till 1920. In the cold weather of 1920-21 an outbreak of this disease in cattle was accompanied by a few deaths in sheep. One might suppose that under certain circumstances very serious casualties must sometimes occur. A full discussion on this subject has, however, been provided for under another head in our agenda.

Foot-and-mouth disease is very common in sheep in the Punjab, but as a rule seems even milder in indigenous sheep than cattle. It is, however, a very serious disease in sheep imported from countries free from the disease. Pure merinos suffer very severely, and several have died from this disease at Hissar. Mouth lesions were the most severe, with the tongues often so much swollen that they could not be retained in the animals' mouths.

Although a case of *sheep pox* has not come under the writer's notice, it is a common disease in India. Imported merinos in an outbreak at Hissar, before I joined the farm, suffered severely.

Foot rot is another disease from which losses are serious in some parts of India.

Rinderpest. Several outbreaks of rinderpest in sheep have been recorded in India, but the writer has never seen a case and personally believes that Indian sheep are highly immune. While he was at Muktesar, Holmes failed to infect two sheep experimentally. There were outbreaks on the Hissar farm in cattle in 1914, 1917, 1918 and 1920. The 1917 outbreak was particularly severe and the infection was present on the farm for 9 months; by that time nearly all the sheep in the farm were half or three-quarter bred merinos. One flock was running with and grazing with affected cattle, but no sheep was ever attacked. Most reported outbreaks in India are probably cases of wrong diagnosis by the Veterinary Assistants and are generally parasitic infections in reality.

The writer does not pretend to have mentioned all the diseases of sheep in India, or even in the Punjab. He claims to have mentioned some of the most important, and that losses due to them must cost this country many lakhs of rupees. He thinks it very striking in reviewing this list which was made without any view to that end, how peculiarly suitable the conditions are for veterinary medical intervention. Wire worm, for example, is one of the few internal parasites we can reach with drugs. Over 5 million doses of their wire worm remedy were issued in 1921 by the Union of

South Africa Veterinary Department. Losses from many other parasitic affections could be diminished if more advice from our department were available and we could find listeners. I do not claim that Indian owners drive their sheep to graze in swamps, just because they like to have them die as some people seem sometimes to assume. In fact, the swamp is often the only place, at least in the Punjab, where there is anything to graze. Propaganda work and advice on such subjects are, however, very urgently necessary.

Losses from external parasites are likewise amenable to treatment, although it is doubtful if much can really be done to check scab without compulsory dipping.

We are, however, discussing legislation in connection with the control of disease under a separate head in our agenda. Personally, the writer does not think legislation is of much use unless it can be given effect to, and doubts if the average Veterinary Assistant could be trusted to supervise dipping. He once had it severely impressed on himself that a picked Veterinary Inspector from another province could not be so entrusted.

The same remarks apply in a lesser degree to other diseases. Losses from pneumonia in famine times will always be heavy in areas subject to fodder famine, but it is certain that a great saving would result, if ewes were not bred to lamb in the cold weather.

There is a crying need for more Veterinary Education, both of the general public and the Indian graduate, in such economic problems. We want men who are not only capable of dipping a scabby sheep but can also effectively preach the futility of dipping one sheep in a flock or one flock in an area.

COIMBATORE SUGARCANE SEEDLING 232 AT BIROWLIE.

MILL TRIALS OF COIMBATORE SUGARCANE SEEDLINGS 232 AND 233.

BY

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In a previous article entitled "Mill Trials of Selected Coimbatore Seedlings" published in this Journal (Vol. XVIII, Part III), the present writer has fully described the nature of the testing work on cane being done and the method of cane growing followed at Pusa and the importance of the factory tests which are arranged for, with a view to obtain reliable data for the guidance both of the sugar industry and the cane growers. It is, therefore, not proposed to repeat the details given there. Suffice it to say that by the method of short planting successfully adopted at Pusa, two new varieties, Co 232 and Co 233, were rapidly multiplied, and three acres under the former and one acre under the latter were put down in February 1923. The crop was grown in a rather sandy field at Birowlie (Plate X) about two miles away from Pusa, which was rented for the purpose. As usual, the cane was planted in February according to the Pusa method described in the article already referred to and was cut on the 18th December. Half a ton of castor cake per acre was given at the time of planting and a dressing of another half ton given at the break of the rains. The canes were grown without irrigation but they stood the hot weather remarkably well. Unfortunately the rainfall of 1923 was most disappointing in this part of North Bihar, only 26 inches of rain being registered against an average of 45 inches. Even then while the local cane *Bhurli* suffered badly, these canes gave a fair yield. While these canes grew well, the deficiency in rainfall was extremely marked when it came to the actual tonnage weight. The canes grew to a good height but failed to swell to the normal extent in an average year, and it is perfectly evident that, however well a cane may withstand drought, actual tonnage is linked to the rainfall. In North Bihar, cane is grown without irrigation and any great deficiency in the rainfall, such as occurred this year, is bound to be shown in the yield, however strong the cane may be. Three hundred and sixty maunds * stripped cane per acre was obtained in the case of Co 232, while Co 233 yielded only 220 maunds. The whole crop was practically free from any insect pest or fungus disease. It was evident that Co 233 is not able to withstand such conditions, and further tests on this cane will be discontinued.

Both Co 232 and Co 233 are seedlings of the same parents—P. O. J. 213 and Katha (a Punjab cane)— but they vary in a number of characters. Co 232 is a straight growing and early ripening cane with fair vigour and good habit, but it has not been found to tiller so well as Co 213 or Co 210. It is too early yet to pronounce definitely regarding this cane owing to the abnormality of the season in this part of Bihar. As it is highly important to have an early cane to replace Co 214 if the latter shows signs of deterioration or tends to emphasize its present twisted habit in the cultivators' fields, the writer has again put down three acres of this cane in 1924 with a view to find out whether, in point of tonnage, it comes up to the standard of Co 214, i.e., to at least 20 tons per acre. Co 232 is an early cane of erect growth and if it proves a good tonnage cane in a normal season, it can be used to supersede Co 214, but at present no definite decision can be arrived at on this point. It is necessary to emphasize that the great desideratum of the white sugar tract in India is an early cane with a fair tonnage. Growers will not take up a cane, however early, which is much inferior to Co 213 or Co 210 in tonnage, and factories do not want a cane the juice of which shows low purity.

To return to the mill trials. As mentioned above, both these canes are early ripening, and the short rainfall undoubtedly hastened their maturity. It was, however, unfortunately not possible to arrange for a mill trial till the 19th of December when they were

* 1 maund = 82·28 lb.

put through the Champaran Sugar Factory at Barrah—such delay always militates against a really early ripening cane—and by the time they were crushed both canes were over-ripe. The following are the results of the mill trial:—

I

	Cane mds.	Sugar per cent. on cane	Fibre per cent. on cane
Co 232 ..	932	12·65	15·55
Co 233 ..	148	10·35	17·13

II

Analysis of first juice.

	Brix	Purity
Co 232	21·00	77·61
Co 233	20·00	69·50

III

Analysis of mixed juice.

	Cane mds.	Brix	Sugar	Purity
Co 232 ..	716	19·20	14·20	73·95
Co 233 ..	121	16·00	10·49	65·56

It will be seen that Co 232 is better in the mill than Co 233, but even Co 232 does not in these results show itself to be very desirable from the factory point of view; while the Brix of the first juice was 21, the purity was only 77, and the percentage of fibre, 15·5, is higher than the mills like.

To sum up. The result of this year's experiment has been to prove that in Co 232 we have a fairly tall, straight growing cane with the character of early ripening and a good sucrose content.

It now remains to find out whether in a normal season it will yield about 600 maunds of stripped cane per acre, and whether healthy well-grown cane of this variety when subjected to a mill trial when fully mature shows better purity. It has already been mentioned above that much of the cane supplied to the factory was over-ripe, and hence the analytical results require further confirmation by comparison with the results obtained with a crop grown under normal conditions of rainfall and crushed at the right time. It is proposed to have such a test carried out in November next along with further tests of other canes.

In conclusion, the writer wishes to express his obligations to Messrs. Begg, Sutherland & Co., Cawnpore, not only for financing this experiment but also for allowing the mill trial to be carried out at their factory, and to Mr. Noel Deerr, Sugar Technologist, for valuable assistance rendered in connection with these mill trials.

NOTES ON MAINTENANCE RATIONS.*

BY

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IN 1914, Murray[1] published an account of a method by which the maintenance rations for oxen of varying weights might be accurately ascertained. The following notes are to a large extent based on his work.

A feeding standard is formulated when the amount of food that an animal of 1,000 lb. body weight requires for specific purpose, irrespective of its actual size, is reduced to terms of digestible nutrients. In the same way we can express a feeding standard by stating that an animal of like weight and for an identical purpose requires that quantity of food which will yield a given amount of available energy. Both are the same feeding standard expressed in different terms. The common method of stating feeding standards is per 1,000 lb. body weight, and it is likely to be inferred from this that the requirements of animals of increasing and decreasing weights can be calculated by the rule of three; that such is not the case will be proved later.

That the food requirements of animals are not proportional to their mass has long been an established fact, and the historical notes given by Lusk[2] and others are not without interest.

Sarrus and Rameaux (1839) stated that since the loss of heat in animals must be proportional to their surface area, therefore the heat production must be proportional to the same unit.

Bergmann (1843) suggested that the food requirements of animals are not proportional to their mass, but he gave no experimental data to support his statement.

* Paper read at the joint meeting of the Sections of Agriculture and Botany, Indian Science Congress, Lucknow, 1923. A summary of this paper has been included in *Pusa Agri. Res. Inst. Bull.* 150.

[1] *Chem. of Cattle Feeding and Dairying.*

[2] *Jour. Amer. Med. Asso.*, **77**, p. 250, 1921.

Regnault and Reiset (1849) wrote :—" The consumption of oxygen absorbed varies greatly in different animals per unit of body weight. It is ten times greater in sparrows than in chickens. Since the different species have the same body temperature and the smaller ones present a relatively larger area to environmental air, they experience a substantial cooling effect, and it becomes necessary that the sources of heat production operate more energetically and that respiration increases."

Bidder and Schmidt (1852) made the following statement which is thoroughly modern in its conception : " The extent of the respiration, like every other component of the metabolism process, is to be regarded as a function of one variable, the food taken, and one constant, a distinctly typical metabolism (Respirationsgrösse) which varies with the age and sex of the individual. This factor characterizes every animal of a given race, size, age and sex. It is just as constant and characteristic as the anatomic structure and corresponding mechanical arrangements of the body. It is in the main determined by the heat consumption in the organism: that is to say, the replacement quota for the heat lost to the body through radiation and conduction to the environment in a given unit of time. It may, therefore, be used to determine this, or in case the factor of heat loss is known, one can deduce the extent of the metabolism. This typical metabolism...... is that of the fasting animal. It must be nearly the same in animals having the same body volume, surface and temperature : the larger the body surface, the body volume and temperature remain constant, or the higher the body temperature, with surface and volume constant, the higher will be the metabolism as determined by the laws of static heat. Of course a sharp mathematical treatment of the phenomenon can be thought of only after very numerous and experimental determinations on animals of most varied form, size and temperature."

Bergmann (1853) again suggested that the food requirements of animals were not proportional to their mass.

Müntz (1873) reopened the question, but it was not until six years later that any definite progressive movement took place.

Meeh published in 1879 a formula for calculating the surface rea. This formula assumed that the surface was a function of ie $\frac{2}{3}$rd power of the volume. Since animals contain the same aterials, weight may be substituted for volume. The result ius obtained was multiplied by a constant K which expressed the lationship of weight in kilograms to surface area in square meters or a given species.

Rübner was the first investigator to apply exact calculation this problem. In 1883, he gave the results of his detailed quantitive study and announced that dogs varying in weight from 3 to 0 kilograms produced the same number of calories per square meter f body surface, though per kilogram of body substance the eat production was 88 calories in the smallest dog and only 6 calories in the largest one. He remarks:—"Large and mall dogs do not metabolise different quantities of food because heir cells are differently organized, but because the cooling influences n the skin excite the cells to activity." Rübner at a later date ealized that the level of basal metabolism could not be caused by he influence of cooling on the body. As the result of his experiental work Rübner formulated a law governing the relationship etween mass and surface area; he established definitely that when he mass is increased 9·75 times, the surface area of the body is nly increased 4·43 times; therefore, we find that animals of tenfold ass have only about 4·7 times the body surface.

Richet (1885) almost simultaneously made a like discovery, hich fully confirmed Rübner's work. He showed that a cat, a abbit and a goose, all of similar weights, produced approximately he same amount of heat. He stated that in future one should xpress all calorimetric observations in terms of surface area and not 1 weight.

Sondén and Tigerstedt (1895) pointed out that the heat producion in children during the period of adolescence was relatively igher per square meter of surface area than in the adult.

E. Voit (1901) published the results of his studies on the applicaion of Rübner's law to other species than dogs. His experiments ere carried out on man, rabbits, swine, geese and hens, and he found that the law was approximately true for all these species. About the same time Oppenheimer showed that the law also holds good for infants.

Dreyer, Ray and Walker (1912-13) found that the surface area, blood volume and cross sections of the aorta and trachea are all proportional to the $\frac{2}{3}$ power of the weight.

Carl Voit's conclusion that the mass of the cells and their power to oxidize materials determines the height of the metabolism was confirmed by Moulton[1] (1916). This worker found that the surface area was a two-third power function of the total body nitrogen of beef cattle and therefore of the protoplasmic mass.

The principle embodied in Rübner's law, which is that the basal metabolism is a simple function of the body surface, has been disputed by Benedict[2] and Dreyer[3], and, as Boothby and Sandiford[4] have recently pointed out, such objections in a strict sense are quite valid. Nevertheless, as Means and Woodwell[5] state, in a broader sense Rübner's law has never been disproved, and while it may be true that the basal metabolism is not strictly proportional to nor perhaps determined by the surface area, the fact remains that it is more nearly proportional to this area than to any one factor so far discovered.

A large animal, for example, one of 1,000 lb. body weight, has relatively a smaller extent of body surface exposed than an animal of 100 lb., and consequently the loss of heat per unit of mass is greater in the smaller animal. The following illustration may help to make this point clear: a cubic foot of water weighs 62·3 lb. and has a surface area of 6 square feet: while a cube of water 2 feet on the side would weigh 500 lb. and has a surface area 24 square feet only, i.e., while the area has increased only 4 times, the mass has increased slightly over eight times.

The amount of heat actually radiated from the skin is considerable but at the same time variable. In warm weather an animal

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[1] *Jour. Bio. Chem.*, **24**, p. 299, 1916.

[2] *Boston Med. and Surg. Jour.*, **182**, p. 243, 1915.

[3] *Lancet*, 1920, p. 289.

[4] *Basal Metabolic Rate Determination*, 1920.

[5] *Arch. Int. Med.*, **27**, p. 608, 1921.

loses less heat than in cold weather. Among the factors causing loss of heat other than variations in the atmospheric temperature are exposure to cold winds, rain and snow and the effects from clipping the coats of animals, etc. Exposure to any of the conditions such as are detailed above bring about a loss of heat in the attempt to maintain the body temperature, and if this is to be satisfactorily accomplished more food will have to be consumed. If the food supplied is inadequate for this purpose then the body tissues are oxidized to make good the insufficiency of the food, the result being made manifest by loss of weight and condition. At the same time it must be remembered that while warmth and shelter lead to a saving of food, too high a temperature which may eventually lead to a loss of appetite is not advisable.

By the term maintenance ration one implies the food requirements of an animal sufficient for its maintenance in a state of so called rest, i.e., in a state of tissue equilibrium, where it achieves no gain in body mass, nor performs work on its environment. It is obvious that this state is merely one of apparent rest for certain systems of tissues; for example, the heart must perform actual work unremittingly while the animal organism survives. It is most important to keep this conception in mind, for the requirements of the animal in a state of maintenance are wholly different, both in quantity and character, from those necessary for various classes of production. In a ration supplied solely for maintenance purposes, the essential requirements are of the following order :—

(1) " Fuel " to maintain a constant level of body temperature, and provide the energy required by the systems which function unremittingly for the performance of their work.

(2) " Repair material " in the form of nitrogenous " organic " material to replace the worn out tissue substance, and " inorganic " salts to replace the small but continuously excreted quantities of these necessary products in animal metabolism.

With regard to the second of these desiderata it has been calculated that 0·5 lb. of digestible protein is a sufficient amount of nitrogenous organic material to provide in the maintenance ration of an ox of 1,000 lb. body weight. However, it has been pointed out by numerous workers that it is not advisable to feed protein at the minimum experimentally estimated rate. McCollum and Simmonds[1] state that certain phenomena observed by them in the course of feeding experiments, when animals were given quantities of food essentials estimated to be adequate but only slightly above the minimum requirements in protein, could be attributed to a considerable lowering of the animal vitality. Although the following observations refer to productive ration, it may be recalled that Haecker showed that the resistance diminishes if an animal is kept for long periods on a low protein intake. Reid Hunt also showed that restriction of diet played a most important part in the variation in resistance offered by animals to certain toxic substances. Munk was also of the opinion that a restricted protein intake definitely diminished the powers of resistance of animals. In the course of an interesting paper on the relation of the necessary intake for growth and maintenance, Aron cites a paper of Waters in which he showed that if a restricted diet were given to calves although limited growth took place the flesh remained "veal" whilst that of the control animals of the same age became "beef." Briefly, it can be stated that, while it is possible to maintain animals in a satisfactory state of health for relatively short periods, it has not yet been satisfactorily proved that by these means their condition can be maintained for extended periods.

The potential energy of a feeding stuff is measured by the amount of heat developed by oxidization. The usual methods of expressing this are as small calories (*c*), kilo calories (C), or therms (T). In the method described by Murray the kilo-pound unit is used (kt.), and it is that amount of heat which is required to raise the temperature of 1,000 lb. of water one degree centigrade.

The total fuel value of a foodstuff which is obtained by burning the substance in a calorimeter does not indicate the true nutrient

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[1] *Jour. Bio. Chem.*, **32**, p. 347, 1917.

value of the material under investigation. A certain amount of the foodstuff when fed to the animals always remains unoxidized, while other portions are only partially oxidized. The unoxidized and partially oxidized fractions of a foodstuff which are excreted in the fæces and the urine have to be deducted from the total fuel value obtained in the calorimeter when estimating the available or metabolisable energy of a given sample of food.

Murray gives the following factors for calculating the available or metabolisable energy or static value of the different feeding stuffs : —

Pure digestible nutrients	*Factors*
Protein	4·93
Fat of oilcakes	9·40
Fat of cereals and pulses	9·00
Fat of hay and straw	8·50
Starch and cellulose	3·76

The maintenance ration for an ox weighing 1,000 lb. is based by Murray on Wolff's standard which allows :—

	lb.
Digestible crude protein	0·75
Digestible crude fat	0·15
Digestible nitrogen-free extract and digestible crude fibre ..	8·00

The above reduced to terms of available energy contains 35·04 kt.; a reduction of 0·01 lb. of the digestible nitrogen-free extract and digestible crude fibre gives an energy value of 35·00 kt.; this figure will be used for calculating the requirements of oxen of varying weights : —

Digestible crude protein	0·75 × 4·93 = 3·69
Digestible crude fat	0·15 × 8·50 = 1·27
Digestible nitrogen-free extract and digestible crude fibre	7·99 × 3·76 = 30·04
	35·00 kt.

(The reason for using the factor 8·50 for the fat is due to the fact that the maintenance portion of most rations is made up of roughages.)

If the food requirements of animals of varying weights were in strict proportion to their live weight, and it be taken that an animal of 1,000 lb. live weight requires 35·00 kt. for maintenance purposes only, then an animal of 1 lb. would require (35 ÷ 1,000) and for one of x pounds the formula would be $x\ (35 \div 1{,}000)$. We have seen however, from the studies of Rübner and E. Voit that the food requirements of animals of varying weights are not proportional to their weight; therefore, the simple formula given above must be discarded.

It has been proved that animals of tenfold mass have approximately about five times the radiating surface; this, taken together with other facts of a similar kind, would indicate that their food requirements will bear a like relationship. The simple formula given above must therefore be amended to: when the body weight x is less than 1,000 lb. something must be added to the proportional amount and when greater something must be deducted. Another way of expressing the above conclusion is to state that when the mass is increased tenfold the food should be increased only five times and vice versa.

Working with the above data Murray deduced the following formula by which it is possible to calculate the maintenance requirements of oxen of any given weight: –

$$\log E = 0{\cdot}7 \log M - 0{\cdot}556$$

E is the amount of available energy (kt.) of the food required and M is the live weight of the animal in pounds.

The above standard given by Murray has been objected to by many authorities on the ground that it is higher than is absolutely necessary. Most of the present-day standards are based on what is known as the "Modified Wolff-Lehmann Standard" which gives the requirements of an ox of 1,000 lb. live weight as: –

	lb.
Total dry matter	17·0
Digestible crude protein	0·7
Digestible crude fat	0·1
Digestible nitrogen-free extract and digestible crude fibre	7·0

The available energy value (kt.) of the above ration using Murray's factors being 30·62 kt., the formula for calculating the requirements of animals of varying weights is as follows: –

$$\log E = 0{\cdot}7 \log M - 0{\cdot}6139$$

Larson and Putney give a table showing the food requirements of animals varying in body weight from 800 lb. to 1,600 lb. according to Haecker whose standard follows the line of strict proportion as regards the digestible crude protein, and the digestible nitrogen-free extract and digestible crude fibre. This according to either of the other standards gives too low a ration for animals under 1,000 lb. body weight and too great an allowance for animals weighing over 1,000 lb. when compared with the "Modified Wolff-Lehmann Standard."

Table I has been prepared to show the available energy requirements of animals of varying weights according to "Murray's Standard," the "Modified Wolff-Lehmann's Standard" and "Haecker's Standard." The formulæ used being: –

Wolff's Standard	$\log E = 0{\cdot}7 \log M - 0{\cdot}5558$
Modified Wolff-Lehmann's Standard	$\log E = 0{\cdot}7 \log M - 0{\cdot}6139$

Haecker's rations have been calculated by the aid of Murray's factors.

The following additional formulæ have been worked out by which it is possible to calculate the quantity of total dry matter and of the different digestible nutrients required by animals of various weights according to either Murray's or the Modified Wolff-Lehmann's Standard.

Requirements.	*Wolff's Standard.*
Total dry matter ..	$\log A = 0{\cdot}7 \log M - 0{\cdot}8563$
Digestible crude protein	$\log B = 0{\cdot}7 \log M - 2{\cdot}2249$
Digestible crude fat ..	$\log C = 0{\cdot}7 \log M - 2{\cdot}9238$
Digestible nitrogen-free extract Digestible crude fibre ..	$\log D = 0{\cdot}7 \log M - 1{\cdot}1974$

Requirements.	*Modified Wolff-Lehmann's Standard.*
Total dry matter ..	$\log A = 0{\cdot}7 \log M - 0{\cdot}8696$
Digestible crude protein	$\log B = 0{\cdot}7 \log M - 2{\cdot}2549$
Digestible crude fat ..	$\log C = 0{\cdot}7 \log M - 3{\cdot}1000$
Digestible nitrogen-free extract Digestible crude fibre ..	$\log D = 0{\cdot}7 \log M - 1{\cdot}2549$

The simple formulæ given below are for those who are not familiar with logarithms. They provide a ready means for estimating the requirements of animals of varying weights provided the available energy or kt. requirements are known for the weight of the animals to be fed.

Requirements	*Wolff's.*	*Modified Wolff-Lehmann's*
Total dry matter	= E ÷ 2	E ÷ 1·8
Digestible crude protein	= E ÷ 46·7	E ÷ 43·74
Digestible crude fat	= E ÷ 233·4	E ÷ 306·2
Digestible nitrogen-free extract } Digestible crude fibre }	= E ÷ 4·3805	E ÷ 4·374

Table II shows the requirements of animals for maintenance purposes only of total dry matter and the different digestible nutrients. The figures given under Murray and Modified Wolff-Lehmann have been calculated by the logarithm formulæ given above, those under Haecker are as given by Larson and Putney.

The formulæ given throughout these notes have been based on data obtained from experiments carried out on European and American cattle. How far the figures so obtained can be successfully applied to Indian cattle-feeding problems can only be satisfactorily settled after a considerable number of prolonged feeding experiments have been carried out.

It may be found that while the Modified Wolff-Lehmann Standard will answer for oxen, Murray's Standard will have to be closely followed for buffaloes. The tables given in this paper have been compiled with the hope that they may prove of some service to workers on nutrition problems in India.

It is necessary to bear in mind that all feeding standards are simply averages and approximations. The tables given are for guidance only; to use them as infallible prescriptions not to be varied under any circumstances whatsoever is to invite disaster. While a ration may be chemically correct, it may be practically wrong. In such cases it is necessary to study the idiosyncrasy of the animal concerned, to endeavour to trace the factor or factors that are acting in such a manner that the animal in question is proving an exception to the general rule and not to condemn blindly the chemists' work.

According to Murray, the formula given for oxen is also correct for horses so that the available energy figures given in Table I can be used for this species also. Linton, however, has objected to Murray's maintenance rations for horses on the ground that they are excessively high. Further it should be noted that the formula $\log E = 0{\cdot}7 \log M - 0{\cdot}556$ does not apply to sheep, the maintenance ration formula for this class of animal being $\log E = 0{\cdot}7 \log M - 0{\cdot}8$. If the maintenance rations for sheep were to be calculated by the oxen formula, an animal weighing 100 lb. would require that quantity of food which would yield 6·93 kt. of available energy, whereas it is known that an animal of this weight requires considerably less, the amount being 4 to 4·5 kt. according to the texture of the wool.

TABLE I.

Body weight	Available Energy Requirements		
	Wolff's Standard	Modified Wolff-Lehmann Standard	Haecker Standard
lb.	kt.	kt.	kt.
100 ..	6·93	6·06	....
150 ..	9·21	8·09	....
200 ..	11·34	9·92	....
250 ..	13·26	11·60	....
300 ..	15·07	13·18	....
350 ..	16·79	14·69	....
400 ..	18·43	16·16	....
450 ..	20·02	17·51	....
500 ..	21·54	18·86	....
550 ..	23·03	20·15	....
600 ..	24·48	21·42	....
650 ..	25·89	22·67	....
700 ..	27·27	23·85	....
750 ..	28·63	25·03	....
800 ..	29·94	26·19	24·49
850 ..	31·24	27·33	25·98
900 ..	32·52	28·44	27·55
950 ..	33·77	29·54	29·04
1,000 ..	35·00	30·62	30·62
1,050 ..	36·22	31·66	32·10
1,100 ..	37·42	32·73	33·68
1,150 ..	38·60	33·77	35·09
1,200 ..	39·77	34·97	36·74
1,250 ..	40·93	35·80	38·13
1,300 ..	42·08	36·89	39·80
1,350 ..	43·19	37·79	41·29
1,400 ..	44·30	38·76	42·85
1,450 ..	45·40	39·72	44·40
1,500 ..	46·49	40·67	45·93
1,550 ..	47·57	41·62	47·42
1,600 ..	48·64	42·55	48·99
1,650 ..	49·71	43·48	....
1,700 ..	50·75	44·39	....
1,750 ..	51·80	45·31	....
1,800 ..	52·93	46·22	....
1,850 ..	53·86	47·11	....
1,900 ..	54·78	47·99	....
1,950 ..	55·88	48·78	....
2,000 ..	56·87	49·75	....

Table II.

WOLFF'S

Body weight lb.	Total dry matter lb.	Digestible nutrients: Crude protein lb.	Crude fat lb.	Nitrogen-free extract and crude fibre lb.
	A	B	C	D
100	3·4	0·148	0·029	1·58
150	4·6	0·197	0·039	2·10
200	5·6	0·243	0·048	2·59
250	6·6	0·284	0·056	3·02
300	7·5	0·322	0·064	3·43
350	8·3	0·359	0·071	3·83
400	9·2	0·395	0·078	4·20
450	10·0	0·428	0·085	4·56
500	10·7	0·461	0·092	4·92
550	11·5	0·493	0·098	5·25
600	12·2	0·524	0·106	5·58
650	12·9	0·555	0·110	5·91
700	13·6	0·584	0·116	6·22
750	14·3	0·616	0·122	6·53
800	14·9	0·641	0·128	6·83
850	15·6	0·669	0·133	7·12
900	16·2	0·696	0·139	7·42
950	16·8	0·723	0·144	7·70
1,000	17·5	0·750	0·150	7·99
1,050	18·1	0·776	0·155	8·26
1,100	18·7	0·801	0·160	8·54
1,150	19·3	0·827	0·165	8·81
1,200	19·8	0·852	0·170	9·08
1,250	20·4	0·877	0·175	9·34
1,300	21·0	0·901	0·180	9·60
1,350	21·5	0·925	0·185	9·88
1,400	22·1	0·949	0·189	10·11
1,450	22·7	0·972	0·194	10·36
1,500	23·2	0·996	0·199	10·61
1,550	23·7	0·020	0·203	10·86
1,600	24·3	1·042	0·208	11·10
1,650	24·8	1·065	0·212	11·34
1,700	25·3	1·087	0·217	11·58
1,750	25·8	1·110	0·221	11·82
1,800	26·4	1·132	0·226	12·06
1,850	26·9	1·154	0·230	12·29
1,900	27·4	1·176	0·235	12·52
1,950	27·9	1·198	0·239	12·76
2,000	28·4	1·218	0·243	12·98

MODIFIED WOLFF-LEHMANN'S

100 . ..	3·3	0·138	0·019	1·38
150 . ..	4·5	0·184	0·026	1·84
200	5·5	0·227	0·032	2·27
250	6·4	0·265	0·037	2·65
300 .. .	7·3	0·300	0·043	3·00
350 . .	8·1	0·325	0·047	3·25
400 . ..	8·9	0·368	0·052	3·58
450 ..	9·7	0·400	0·057	4·00

TABLE II.—*concld.*

MODIFIED WOLFF-LEHMANN'S

Body weight lb.	Total dry matter lb.	Digestible nutrients: Crude protein lb.	Crude fat lb.	Nitrogen-free extract and crude fibre lb.
	A	B	C	D
500	10·4	0·431	0·061	4·31
550	11·1	0·460	0·065	4·60
600	11·8	0·489	0·069	4·89
650	12·5	0·518	0·074	5·18
700	13·2	0·545	0·077	5·45
750	13·9	0·572	0·081	5·72
800	14·5	0·598	0·085	5·98
850	15·1	0·624	0·089	6·24
900	15·7	0·650	0·092	6·50
950	16·4	0·675	0·096	6·75
1,000	17·0	0·700	0·100	7·00
1,050	17·5	0·724	0·103	7·24
1,100	18·1	0·748	0·106	7·48
1,150	18·7	0·772	0·110	7·72
1,200	19·3	0·805	0·113	8·05
1,250	19·8	0·818	0·116	8·18
1,300	20·4	0·841	0·119	8·41
1,350	20·9	0·861	0·123	8·61
1,400	21·5	0·885	0·126	8·85
1,450	22·0	0·908	0·129	9·08
1,500	22·5	0·929	0·132	9·29
1,550	23·1	0·951	0·135	9·51
1,600	23·6	0·972	0·138	9·72
1,650	24·1	0·994	0·141	9·94
1,700	24·7	1·014	0·144	10·14
1,750	25·1	1·036	0·147	10·36
1,800	25·6	1·056	0·150	10·56
1,850	26·1	1·076	0·153	10·76
1,900	26·6	1·104	0·156	11·04
1,950	27·1	1·118	0·159	11·18
2,000	27·6	1·137	0·162	11·37

HAECKER'S

800	....	0·560	0·08	5·60
850	....	0·595	0·08	5·95
900	....	0·630	0·09	6·30
1,000	....	0·700	0·10	7·00
1,050	....	0·735	0·10	7·35
1,100	....	0·770	0·11	7·70
1,150	....	0·805	0·11	8·05
1,200	....	0·840	0·12	8·40
1,250	....	0·875	0·12	8·75
1,300	....	0·910	0·13	9·10
1,350	....	0·945	0·13	9·45
1,400	....	0·980	0·14	9·80
1,450	....	1·015	0·14	10·15
1,500	....	1·050	0·15	10·50
1,550	....	1·085	0·15	10·85
1,600	....	1·120	0·16	11·20

THE FRUIT MOTH PROBLEM IN THE NORTHERN CIRCARS.*

BY

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FOR the past three years there have been complaints in the Northern portion of the Madras Presidency from certain taluks of the Kistna District as to a heavy fall of fruits in pomegranates, oranges and sweet limes during the months of July to August. Investigations carried out during 1923 and the previous years show that the fall is due mainly to three species of Noctuid moths (*Ophideres materna*, Linn.; *Ophideres fullonica*, Linn.; and *Anua coronata*, Fabr.) which visit the trees at night and puncture the ripening fruits with their powerful file-like proboscides. They not only suck the juice but also induce a rotting of the pulp as they provide entrance for bacteria which ultimately cause the fruit fall. On actual experiment, it was found that a single moth could drill 15 to 20 holes into a sweet pomegranate in one night. The number of punctures in oranges and mangoes are far less on account of the ready availability of the fruit juices. Sour pomegranates and sour limes are not affected. The pomelo has too thick a rind to be penetrated by the sucking organs of these moths.†

Visits to the affected area were somewhat too late in 1921 to enable one to study the whole problem thoroughly, but during 1922 observations made in August shed a certain amount of light as to the nocturnal habits of the perpetrators of the damage. A trial was made in reference to the possibility of destroying the moths

* Paper read before the Agricultural Section of the Indian Science Congress, Bangalore, 1924.

† Pomelos have been reported to be damaged severely by these moths in the Bombay Presidency (*Proc. Third Entl. Meeting*, p. 86). [T. B. F.]

by attracting them to traps of poisoned molasses, flavoured with fruit essences, such as those of the orange, lime and pine-apple. The pine-apple essence was found to be decidedly in favour with the moths. Several dozens of moths were found feeding on the bait and some of these were caught and caged and found to succumb in 24 to 48 hours, thus establishing the possible efficacy of poison-baiting. Due to the disappearance of the moths during the second week in August 1922, these very interesting sets of experiments had necessarily to be postponed.

The question was again taken up in earnest in June–August 1923. There were several points to be discovered both in regard to the life-cycle of the pests and their attraction to poisoned scented molasses baits in preference to the fruits on the trees. Investigations were started in the village of Mathimuthanagudem lying in a submontane tract, 40 miles from Ellore, Kistna District. In June-July, after considerable effort, the breeding places of many of the major visitants to fruits were discovered and an early campaign was instituted against one of the larval foodplants, *Tinospora cordifolia* (Fam. Menispermaceæ) known as "Tippa-tiga" in Telugu, which breeds the major pest *Ophideres materna*. This is a creeper which grows mostly among thick and neglected hedgerows and among clumps of vegetation in the midst of the cultivated area. The creeper does not affect forest areas. Besides this, *Cocculus hirsutus* (Fam. Menispermaceæ) and *Combretum ovalifolium* (Fam. Combretaceæ) are two more weeds on which *Ophideres fullonica* and *Anua coronata* breed respectively. The campaign against these foodplants was started on the 24th June, and by the 9th July the bulk of the weeds referred to had been cleared from the village precincts. Four to five hundred caterpillars of fruit moths were taken from the creepers and most of them reared out into moths in cages. Since the few moths that in nature survive from probably the previous season's brood begin to breed towards the end of June, a campaign against the larval foodplants at this time may be calculated to ensure the destruction of hundreds of caterpillars which, if allowed to turn into moths, would damage every fruit in the orchard. As a result of endeavours made to find out the egg-laying capacity of the moths, two females were found to lay a total of 302 eggs spread over 13 days in captivity. Nevertheless, when compared with that of other moths of the same group, this figure does not by any means represent the maximum capacity of the moths in nature.

In 1923, as a result of the campaign, no moths had appeared in the orchards till the end of the first week in August, thus tiding over the period in which a severe loss is sustained year by year. But, due to the indifference of the orchardist who did not attend to a thorough removal of the weeds, a second brood of caterpillars would appear to have developed early in August, leading to the emergence of a large number of moths and consequently to a considerable amount of fruit fall later on. In contrast to this gardener, another orchardist, who had taken pains to remove the fruit-moth-breeding weeds in another orchard some 20 miles off, wrote on 17th September, 1923 :—" I have cleared to some extent the *Tippa-tiga* (*Tinospora cordifolia*) and *Yethala-tiga* (*Combretum ovalifolium*) but it was not possible to destroy them all at once, as they were found to sprout up again, but still in our gardens, we had not much loss on account of the insects. . . . . . . I can now definitely say that from the time you came here and advised me on the clearing of the weeds, there had been no loss in my garden due to the ravages of the insects." The foregoing facts show that a *raiyat* who had not cared to understand or to connect the existence of particular weeds with the periodical appearance of fruit moths and thereby had omitted to eradicate them in the vicinity of his orchard suffered a heavy loss, whereas another *raiyat* in a different village, acting under advice, had profited by the removal of the weeds.

Apart from the poison baiting of fruit visiting moths which is yet in an experimental stage, there is thus a direct method whereby the axe may be laid at the root of the whole trouble, namely, the thorough eradication of the foodplants on which these fruit pests breed, illustrating the old, old adage, " Prevention is better than cure."

Selected Articles

THE TEACHING OF AGRICULTURE.*

BY

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I CANNOT help feeling that the object of my remarks is still somewhat in a tentative condition, and it may be better if I reserve a formal exposition of the subject so that all I have to say may be regarded by way of stimulus and suggestion rather than a direction to a particular action that I should like to see taken. This must be the case with all good teaching. The teacher has to work out a method, that method may not be a good one for universal adoption, but if a man has worked it out for himself and is keen, the very fact of his keenness may make that method an extremely profitable one.

CLOSER CONSIDERATION OF THE METHOD OF TEACHING.

What I have to bring before you is this, put broadly, that the actual method of our teaching, whether we teach inside the college or the farm institute or whether we teach in the county, requires more consideration than it ordinarily gets. We all of us in this country begin teaching agriculture in a thoroughly haphazard amateurish fashion. We go to college and later on when we leave, we find ourselves put in front of a class and required to teach on our own account. I think most people's experience would be similar to mine; no one gave me a hint or suggestion of what methods to follow—I floundered about and tried one method after another.

* Substance of an address given at the Agricultural Education Association at Aberystwyth

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Many scientific and technical men have a certain scorn for what generally may be called the art of exposition, whether in speech or writing. In writing I have often occasion to deplore the style and quality of the written matter that is put out. In teaching I have from time to time listened to lectures and classroom instruction, and I do think the teaching might be enormously improved if the men thought a little more about this matter of teaching as an art in itself, independent of the material that is to be set forth, an art which has a code of rules and laws of its own. I do not want to lay down methods at this moment. Every man will think out his own method, but I do want to plead for a consideration of the method itself as something worth thinking about, something by which the work—whether it is in classroom or lecture room—can be made more effective. I want you to take it that teaching is not a process into which you drop quite naturally, that it only involves the doling out of so much information to be got up by the class, whereby all the teacher can be expected to do will have been accomplished. If that were the case, if there were nothing in the functions of the teacher but to hand out a certain amount of knowledge, why have any oral teaching at all? Why not content oneself with books, or with some kind of organization like the correspondence college? The organization of a correspondence college, for example, can show the student exactly what he ought to read, it can set him papers, mark and comment on them. The way these colleges flourish proves that they can be effective in promoting the acquisition of knowledge for examination purposes. In fact one must take it that the very existence of these correspondence colleges on a large scale points out that there is a defect in the ordinary teaching given in the country. If the oral teaching were of the right kind, the correspondence college, which gets its results and could not live if it did not get its results, would go out of existence.

To give an illustration of what I mean; you are all familiar with one of the very commonest forms of classroom teaching in University or University College—the lecturer who practically dictates to his students a certain text which he has prepared. The lecturer prepares very carefully his lecture as a résumé of a particular section of the subject and delivers this from the platform so that every student may take it down verbatim and get it accurately transcribed into a notebook. That form of instruction is very popular, especially amongst students. It supplies them with a short cut to knowledge; it absolves them from the necessity of reading anything other than their notes. They need not buy text-books; still less need they compare the different views of other people on the subject, and they regard this as a very profitable form of instruction. If they get up the notes which the professor has given them they expect to be able to pass the required examination. One knows the type of lecture notebook which is produced in that way, and I believe in some of the Universities it has considerable financial value. That always reminds me of a story of a Cambridge undergraduate in the time of a very famous coach known as Big Smith. The undergraduate had just come into residence and was taking counsel with some senior friends as to what course to pursue, should he read for Honours or a Pass. He asked what was the difference between a Tripos and a Poll degree. The old hand replied "if you go for the Tripos you go to Brown, of Trinity, and he tells you what he thinks about it; then you go to Jones, of Jesus, and he tells you what he thinks about it: then you go to Tomkinson, of Caius, and he tells you what some other Johnny thinks. If you take a Poll you go to Big Smith and he tells you what it *is*." That is the attitude of the typical undergraduate; he wants positive knowledge delivered to him in neat little packets ready to be handed over the examination counter. I submit, however, that the teaching of that kind will eventually be replaced by the gramophone. It would be cheaper to the University to replace such professors by gramophones.

Of course there is the converse of the process, where the lecturer refuses to allow his students to take a note at all. That was my own practice in the later days of my actual teaching career. I was asking my students for their attention; I did not want them to divert their attention by taking notes. The object of my lecture was to impart a point of view and to get my students to apprehend the principles of the subject. So far as notes went, it was my practice to issue a typescript at the end of the lecture, which contained subject headings, tables and diagrams, and references to the text-books indicating where details of the matters dealt with could be found. I do not say mine was the right way but it was an attempt to teach, whereas the other way is only an attempt to supply information. I throw out that as an illustration; the point I want to make is that the mere process of teaching does require thinking about.

On the other side, let us take the outside lecture, the lecture that every college or institute teacher is required to give from time to time to audiences in villages and country centres. As a rule the preliminaries are organized for him; he walks into the place and is rather apt to suppose that if he delivers the lecture and the people do not leave the room in too large quantities during the process, that his method is good. If the audience falls off during the lecture course, he blames the organization.

But we have to ask ourselves whether the lecture method is suited to the village audiences at all, whether the type of teaching we have to do in the counties has not got to start from an entirely different point of view. I want to suggest that the prime effort of the extra-mural teacher must be in some way to drag the members of the audience into the fray themselves. They must be led to become active participators in the process of education. You have not much time in dealing with an audience of that description; you are running over the whole of agriculture, perhaps in six lectures and you only have time for stimulus. The technique of the process by which you can get your pupils to read and work for themselves does require a good deal of consideration. Put yourself the question, "How am I to get my audiences to help themselves? I, in charge, can only help people, I cannot teach them; I can only point out the lines upon which they can teach themselves."

How we can improve our methods of teaching.

I take these as illustrations of the kind of subject I should like to see discussed, the methods of teaching inside and outside the college, how, by thinking for ourselves, we can improve our own methods. I want specifically to suggest the question of how the subject of agriculture itself ought to be treated in our colleges and farm institutes, etc., because there I can see perhaps the greatest opening for better technique and indeed for some considerable reconstruction of our aims in teaching agriculture.

I think we are inheritors in this country of rather a mistaken tradition. I know quite well 30 years ago when colleges began to start in Great Britain for the teaching of agriculture, the general idea of their founders was that agriculture could be regarded as an assembly of applied sciences. There was chemistry, botany, zoology, geology and so forth, all sciences throwing light upon the growing of crops and the feeding of animals. If we first taught these sciences to agricultural students and then the application of those sciences to agriculture, we were teaching agriculture. You may remember that the first Cambridge diploma did not proceed further than that. It was content with an examination in applied sciences and treated agriculture itself as one of those rather mechanical extras which are pursued in practical life but which should hardly concern the university. So I think we were given a set towards the treatment of agriculture as just an assembly of applied sciences, and it was conceived that we could bring out a farmer by grounding the youth thoroughly in chemistry, botany, zoology and so forth.

Now agriculture is a subject *sui generis*, something quite distinct from an applied science; it has its own technique and methods and its own fundamental science, which is neither chemistry, botany nor zoology, nor anything of the kind popularly termed science. It is accountancy which lies at the basis of the teaching of agriculture, and as pure chemistry is the grammar of the agricultural chemist and botany of the agricultural botanist so is accountancy the grammar fundamental in the instruction of the farmer.

The object of our teaching.

If we start off with that somewhat one-sided statement we shall get a little nearer to what is the right form of teaching. Let us begin by asking ourselves what we are after when we are dealing with the young men in an agricultural college. What is our object;

what are we going to try and turn out? I think it is agreed that we are not thinking of turning out teachers, officials or that kind of man; we are thinking really of turning out a thoroughly equipped farmer and we want to ask ourselves what we mean by that a thoroughly equipped farmer under modern conditions, and how we can help to ensure that type of man by education. We know well the old farmer who has no education behind him; he tells the teacher that no one can learn farming in a classroom and that he has no opinion whatever of book farmers. The answer is not easy, but I think we can remove that kind of reproach if we take our teaching of agriculture from a somewhat different angle. What he means is that success in farming depends upon a number of qualities which are personal and many of which are only obtained by experience. If a man has no will or determination, if he lacks a certain firmness about making a bargain, of course he cannot become a successful farmer—and none of the efforts of the educator are directed towards giving these qualities.

Still, putting aside these inborn faculties and the essential matter of experience, what does characterize a good farmer as distinct from a bad farmer? We can sum it up in one word management. The good farmer not only knows what work has to be done, what good work is, the technique of growing his crops and breeding cattle, etc., but he knows how most effectively to dispose of the staff of labour that he has on that particular land. His job as farmer is a manager. The agricultural college is dealing mainly with men who are going to be managers of labour, directors of other people's work. They are not going to do manual work themselves, except perhaps in their younger days, but in the main they are going to be heads and not hands.

Developing the idea of management.

When you turn to compare the successful with the unsuccessful farmer you will probably find in a great many cases that the question of financial success depends upon this disposal of labour more than anything else. We may sum up the object of the agricultural college as the training of managers. That being the case, what I want to submit to you is that we must direct our teaching to that end.

Suppose we turn to one of the most successful text-books on agriculture that we have in England, the late Professor Fream's — almost the only widely distributed text-book that has been written in English on agriculture —do you find that point of view, management, set out from the beginning of the book to the end? There may be an odd chapter or two about it, but in the main the book is concerned with the description of the materials of the farmer. You are told how to discriminate between fescues and poas, hop trefoil and yellow clover — just the kind of things that are so much taught and learned by the agricultural student and so heartily despised by the old type of farmer. The old farmer is wrong; you cannot know too much of anything. None of these descriptive points are without their value, only they cannot replace the other things, the vital study of the economics of a farm and its management. That is the point that I want to bring forward in these remarks.

The teaching of agriculture as I have seen it, and I speak from experience, is far too much a mere matter of description. It may not even be descriptive of the kind of farm the teacher knows himself, it may be a discussion on the old systems of farming. It is not unknown that men continue to teach the East of Scotland form of agriculture as described in Stephens' "Book of the Farm" as the only method of successful farming. It may have had little to do with the farming that was going on round about the college, having been worked out on a different rotation and for a different soil and climate. Let us have done with this purely descriptive teaching of agriculture.

The teaching of agriculture should be to an increasing degree a matter of personal experience, and it should be in every district largely based upon what is going on round about the college. It should begin as a description, so far as it is descriptive, of the farming practice amongst the people the student comes from; that is the first thing; let us localize our teaching. In this way the teacher can introduce the element of personal investigation; he begins by finding out what the people round about are doing, that will lead him to comparisons of their methods with other people's methods. He can fall back on the standard system of his text-book, compare it with the local system and discuss the difference that he finds between the two. The critical faculty is brought into play.

But we must go a step further if we have in view management, so that the student, when he leaves college and begins to work on his own account, shall be in a position to be critical of the work that he gets done, and not merely in the hands of his foreman or bailiff. We must not be content merely with describing. We must ask ourselves about each of the processes, how many men, how many horses, how much time, what will it cost step by step, and criticise these costs in the light of the results. Here the real critical process comes into play. The agricultural teacher dealing with, say, the potato crop, should have acquired for himself, by direct observation, a picture of the practice of a successful potato grower under certain conditions. He has followed the crop through, he has found out the number of men at work and the amount they did, and he is in a position to sum up the costs. That alone is a description which may be a great help to a student later on. But if he can set alongside that a description of the methods of two other equally good farmers and in different districts with the details of the alternative operations, the number of men on the job and the costs, I should think he is entering his students in the art of being managers. That is the first step. It has not got to end there.

After the teacher has been through the raising of crops and the treatment of livestock as individual operations, he has got to get his students into a perception of how a really good farmer schemes out his work from week to week, and how, given a certain staff at his disposal, he uses them to the best advantage. From my own observation of practical farming there lies the difference between the successful and the bad farmer—the way in which a good farmer has his work planned out and with a given staff always is ready to throw in his strength at the right moment. Of course you cannot teach that but you can awaken the student very much to the necessity of thinking it out for himself.

It is in that connection the college farm is going to be most useful for the purpose of the teacher. The college farm should be run as a practical business proposition which is illustrating management and which is a text-book of the teacher in the lessons he is giving. Every student should keep an exact diary week by week of the operations that go on on the college farm, and it should be a diary with full details. It does not record "March 15th, sowing barley on the 10-acre field." No, he says "sowing barley on the 10-acre field; wheat stubble ploughed in November, wanted more frosts, a little stale on top and wet below." Then should follow the operations, the horses and men to each and the time taken. Further, the teacher should be giving the actual cash transactions from week to week. The teacher taking his class on Monday morning will say "our business during this week is so and so. I propose the men shall do so and so," and he shows them how he has schemed out the use of his staff during the week and the alternative in case the weather is unfavourable. It is in this way we can make our agriculture itself scientific, and not merely descriptive of accessory scientific facts which may be of value but which are of secondary importance compared with the question of management.

When we get on to the second and third year of teaching we have to consider broader economic questions; the reason for this or that branch of the business, why we are producing milk, why we are fattening bullocks, etc. We can begin with a consideration of the policy of the college farm, for it is the one which is close at hand, the one about which the teacher has the most details. But neighbouring farmers are generally willing to help the college by disclosing enough of their accounts to give the teacher materials for the discussion of policy. Now this means that agricultural teaching should be founded upon a system of cost accounting. The future of efficient management depends fundamentally upon a good book-keeping system to begin with, and the constant use of that book-keeping to check operating costs, so I think that the student must be inducted early into the point of view of cost accounting.

We are apt sometimes to assume that we can describe the right method of farming. I do not think there is a right method of *farming, there is only a best compromise to adopt under given* circumstances as regards soil, climate, markets, etc. The teacher's object should be to get the student into a critical way of examining other people's work so that eventually he will pass on to criticise his own work. The machinery for this is only to be supplied by a sound system of costing. Therefore the teacher of agriculture should investigate costs for himself so as to establish a comparative system of teaching, comparing A's methods with B's methods and discussing with his class how relatively they arrive at the same ends though one may cost a little more. He is then in a position to criticise the whole conduct of particular farms, always with the management in view, and the results in cash as the fundamental test of the rightness or otherwise of the operation.

I do not think I need say anything more. I could have elaborated, but I rather want to throw out these suggestions for you to turn over for yourselves and see if they will not strike on your box and modify the methods by which you teach. I am convinced that if you think about these points of the technique of teaching, you can make your work more effective.

KIKUYU GRASS (*PENNISETUM CLANDESTINUM*, CHIOV.).*

BY

O. STAPF.

IN 1911, Mr. J. Burtt-Davy received from Mr. David Forbes of Athole, Amsterdam, Transvaal, a single root of peculiar grass which he had collected on the shores of Lake Naivasha, Kikuyu, whilst hunting there, the grass having attracted his attention by the partiality which the wild game showed for it. The root was transplanted in one of the plots of the Botanical Station at Groenkloof, Pretoria, and soon established itself.[1] It has since flowered there regularly every year, but not seeded, the original plant and its descendants being apparently all functionally female.[2] In "The Farmer's Weekly" of March 23rd, 1917, Mr. H. A. Melle published a fuller account of the grass as it presented itself under cultivation, the greater part of which is reproduced here.

"Kikuyu grass (*Pennisetum longistylum*), says Mr. Melle, is a perennial, running grass, and like the 'kweek' forms a dense turf. It has branching, leafy stems. The leaves are flat and spreading. Kikuyu has numerous stout rhizomes, as thick as a lead-pencil, and by the growth of these a single plant may cover an area of several square yards. If grown in a vicinity where there is not much moisture it will make very little top-growth, but will send out shoots and spread along the ground and establish itself firmly. But in the presence of moisture it will put on top-growth.

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* Reprinted from *Kew Bull.*, 1921, p. 85.

[1] A preliminary note announcing the introduction of the grass was published in the *Report on the Department of Agriculture, Union of South Africa*, 1910-1911, p. 241. Here also appears the name Kikuyu grass for the first time.

[2] A short article by Mr. Burtt-Davy in the *Agricultural Journal of South Africa*, II (1915), pp. 146-147, describes the experience gained with this grass in the Transvaal by them, and deals with its uses and disadvantages. It also states the circumstances of its introduction, and that with some reserve it had been referred at Kew to *Pennisetum longistylum*.

I have seen it grow $2\frac{1}{2}$ to 3 ft. high. As yet it has not been observed to set seed in South Africa although it flowers regularly at the Groenkloof Botanical Station every summer.

Kikuyu is a summer grass, but will remain green until the first severe frost and will start growing again long before the veld grasses. *At the time of writing our mealies have been scorched by frost and the veld grasses have become coarse and dry ; whereas the Kikuyu is still putting on growth and is beautifully green and succulent.* Its drought-resistant qualities have proved to be equal if not better than any of the other grasses.

Kikuyu may be considered as essentially a pasture grass. In districts where the rainfall is over 30 inches it might be possible to get two or three cuttings a season. What number of plants it can carry per acre has not been ascertained, but it will probably carry more than any other grass owing to its dense and rapid growth, combined with its resistance to eradication. If a sod of this grass be taken up, a few rhizomes (underground shoots) are always left in the ground ; these in two weeks' time will send out green leaves and soon re-establish themselves.

As Kikuyu can only be propagated by roots or runners, the initial cost of establishing a pasture would be more than other grasses that bear seed. This, however, is compensated for by the fact that when it has been put in, provided there is sufficient moisture in the soil to start it growing, it will take care of itself. There is, moreover, no fear of it becoming choked by weeds. Although Kikuyu is such a hardy and vigorous grass, it would be advisable to well prepare the ground previous to planting as it will then strike immediately and have an advantage over any undesirable plant.

(*a*) *Palatability.* I can say with every assurance that Kikuyu is one of the most palatable grasses. All stock eat it greedily and will leave most grasses to get to it. If stock are allowed on a patch of Kikuyu it will be seen that they will graze contentedly, and when they have had their fill they like to lie down on it, for the Kikuyu forming such a dense turf provides a very comfortable rest.

(*b*) *Chemical analysis.* From the following table kindly supplied by the Division of Chemistry, it will be seen that Kikuyu is one of our most nutritious grasses :—

Air-dried material	Moisture	Protein	Carbohydrates	Fat (ether extract)	Crude fibre	Ash	Containing true protein	Nitrogen	Albuminoid nitrogen
Kikuyu grass ..	8·29	12·36	35·06	1·70	33·08	9·42	8·31	1·977	1·330
Guinea grass (*Panicum maximum*) ..	8·02	9·03	28·63	1·68	40·54	12·10	7·09	1·445	1·134
Warm baths grass (*Digitaria* sp.) ..	10·94	8·33	25·22	1·72	34·56	9·23	6·13	1·333	0·980
Vinger grass ..	6·93	8·12	33·94	1·68	39·68	9·65	5·51	1·299	0·882
Blauwzaad grass (*Eragrostis* sp.)	7·91	6·58	43·78	1·80	34·50	5·43	5·43	1·053	0·868

Kikuyu grows well on any kind of soil but thrives best on moist vlei soil. We have it growing on alluvial vlei, on heavy clay loam, on gravel clay, on red loam, and poor impoverished stiff clay. On all these it is doing remarkably well. It is also known to do remarkably well on sandy soils.

Like all other grasses Kikuyu has also its disadvantages, and amongst these the chief are :—

(1) It is a summer grass as it does not remain green throughout the winter, unless watered and not subjected to frost.

(2) As it does not appear to form seed in this country, the only means of propagating it is by runners, hence freight, which involves additional expense. And it may happen that when it reaches its destination the ground prepared for it may not have sufficient moisture to start it growing. Although this is enumerated as a disadvantage it may also be considered as an advantage; yielding no seed there is no fear of it establishing itself voluntarily in an adjoining field.

(3) Being such a hardy and persistent grower when once established, it will be very difficult to eradicate. We have a good

illustration of this on the Station. About a month ago we disposed of large quantities of Kikuyu and the patch from which we took the grass three weeks ago was apparently quite clean but now is beautifully green and almost covered with Kikuyu.

(4) Kikuyu is so aggressive that no other plant can grow with it. This is a great advantage because when planted on the veld it will establish itself against any of our veld grasses of minor feeding value.

(5) There is a likelihood of a Kikuyu pasture becoming sod-bound and if this should happen, the field should be disked and ploughed or harrowed.

(6) It is only natural that a plant of such vigorous growth as Kikuyu would soon impoverish the soil.

Kikuyu responds generously to manure, for where there are animal droppings on a patch it will be noticed the grass grows there higher than anywhere else.

Lawns have been grown from this grass around the laboratories of the Botanical Division and on the terraces of the Union Buildings, Pretoria. The bright, light green colour of the foliage forms a lovely setting for ornamental gardening. It will also make an excellent field lawn as it forms a dense, soft and springy turf when closely grazed or clipped.

On account of its ability to grow on practically any type of soil and its creeping characteristics, it should be an excellent soil binder, on dam walls, on sandy soils and on eroding slopes and dongas.

Then again it can be recommended as a grass for planting in a poultry-run. Fowls seem very fond of the leaves, and owing to its aggressive nature it can withstand the ravages of the fowls' scratching, etc.

As Kikuyu is easily propagated by cuttings, it may be either planted by cuttings or "roots." Our practice is to take the grass out in sod, then cut it up into pieces about 3 in. square and plant it out 6 ft. by 6 ft., or 6 ft. distant between the rows and 3 ft. distant in the rows. Our results have shown that when planted 6 ft. by 6 ft. on fairly good soil, it covers the ground in a single season.

Kikuyu being a summer grass the best time of planting is during the spring and summer rains, but it can be planted as late as April when the frosts do not occur before May.

In order to recover the cost of preparing the ground for Kikuyu it is possible after the last cultivation of mealies to put down Kikuyu between the rows."

Subsequently an attempt was made to introduce the grass into Mashonaland. The success seems to have been complete, as may be seen from the following note in the *Rhodesia Agricultural Journal*, XV (1918), p. 327.

"As late sa a year ago it was mentioned in an article in the *Rhodesia Agricultural Journal* (June 1917) that, despite all efforts up to then, no pasture grass had been discovered suitable for Rhodesia which formed a thick bottom and might prove useful for grazing purposes. Since that date, however, our trials with Kikuyu grass (*Pennisetum longistylum*) on the prevailing red soils of Mashonaland have shown that this grass adapts itself perfectly to local conditions, and fulfils all the expectations that have been aroused from reports concerning its behaviour in the Union. The first lot of roots introduced by the Department of Agriculture were obtained from the Potchefstroom experiment farm in March 1917. Through delays, these arrived in a seemingly dead condition, and after a preliminary soaking were planted out. Practically no rain fell after planting, yet by December 1917, considerable growth had been made and the runners became the source of our principal propagation plots. A further lot of slips were imported from Natal in December 1917, and were planted out one foot apart each way. The resulting plot as it appeared in June 1918 is shown in the accompanying illustration. The slips soon covered the ground entirely, and the growth was so vigorous that the paths and adjoining beds were invaded. The spreading power of this grass is one of its most remarkable features, and not only does it spread along the surface of the ground, but its runners penetrate downwards to a considerable depth in the course of a single season, making its hold upon the ground very firm, and rendering it hardy against tramping.

In view of its known excellent feeding qualities, its vigour and its adaptability to Rhodesia, it can be confidently recommended. It is expected that slips in limited quantities will be available for distribution during the coming season."

When in 1915 the first very meagre specimens of the grass reached Kew from Pretoria they were recognized as identical with some fragments of a *Pennisetum* which in 1906 had been received from Mr. A. Linton among pieces of *Cynodon Dactylon* collected at " Linoru " (evidently meant for Lamoru, the first railway station west of Kikuyu). Both were then considered to be probably stunted and very much reduced forms of *Pennisetum longistylum*, a conception corresponding more or less to Leeke's treatment of the plant as a var. *clandestina* of the same species " congrua—et cum forma normali evidenter consanguinea." However, after the accession of better material from East Africa, and the experience gained in the Transvaal, namely, that improved conditions did not affect the peculiar structure of the grass, it became evident that the extreme reduction of the inflorescence and the stunted condition of the vegetative parts were not casual features impressed on the plant by an especially unfavourable habitat, but fixed and perfectly definite characters of specific rank. This was also the conclusion Pilger came to when describing the grass which he had from Lamoru (collected by G. Scheffler in 1909), as a new species, *Pennisetum inclusum* (in *Engler's Jahrb.*, XV, p. 209). Further search in the literature on *Pennisetum*, however, showed that Pilger had been forestalled by Chiovenda who had already in 1903 (*Annuar. Ist. Bot. Roma*, VIII, p. 41) accorded the grass the status of a species, taking up an unpublished name of Hochstetter's " clandestinum " as nomen specificum. Chiovenda's species was based on a specimen of Schimper's, 2084 (no locality stated), which is not represented in the collection at Kew and the British Museum at London, nor was the species itself recorded in the *Index Kewensis*. Chiovenda's description, however, and his figure leave no doubt as to the identity of the plant. Thus the Kikuyu grass will have to be known under the name proposed by him, namely, *Pennisetum clandestinum* Hochst. ex Chiov.

1 and 2, Flowering branches in the female (1) and male stages (from Lamorn, Scheffler, 294). 3 and 4, A flowering (3) and a barren (4) shoot (Groenkloof Botanical Station: cult). 5, A whole inflorescence of a female plant (Groenkloof). 6, Upper glume. 7 and 8, Valves of lower (7) and upper (8) floret. 9, Valvule of upper floret. 10, Rudimentary stamens and ovary of a female plant. 11, Part of a cross section (including midrib) of a

The two most striking features of *Pennisetum clandestinum* (*see* Figs. 1 and 2 on p. 421) are its stunted growth and proclivity to the formation of very vigorous runners, and the extreme reduction of the inflorescence and its inclusion in the top sheath. In habit it resembles strong specimens of *Cynodon Dactylon* to a remarkable degree, so much so that barren specimens of both may be all but indistinguishable. The anatomical differences are, however, obvious, as will be seen from the cross sections shown on p. 421 (Figs. 11 and 12). Grown in good and well-watered soil it throws up barren stems up to 30 cm. (according to Melle, l. c., even 1 m.) high with elongated internodes (up to 7 cm.) and long slender blades (up to over 20 cm. by 3–4 mm.), whilst the flowering shoots seem to remain short (5–6 cm.) even under such favourable conditions (Figs. 3 and 4). The reduction of the inflorescence (Fig. 5) affects not only the number of spikelets (2–4), but also the involucral bristles which are short, the longest not surpassing three-quarters the length of the spikelet, delicate and eplumose and have evidently lost their function; further, the glumes, the lower of which is quite suppressed, whilst the upper is merely a small nerveless or almost nerveless scale; the lower floret which is reduced to its valve and finally the stamens which are occasionally arrested, the flowers becoming thereby functionally female (Figs. 6–10). The valves share the relatively great number of nerves (11–14) with those of *P. longistylum*, but they are narrower, longer, thinner and in the lower part almost devoid of chlorophyll—no doubt in response to their concealed position. The genetic derivation of *P. clandestinum* from *P. longistylum* is obvious, but the power of reversion to its ancestral type seems to have been lost. The reduction of the inflorescences to so few spikelets—and of these sometimes a portion only fertile—must mean poor seeding, a loss amply balanced by the vigour of the vegetative reproduction of the grass by runners and stolons. The area of *P. clandestinum* extends from Eritrea to Mt. Elgon and the highland of West Usambara. *P. longistylum* on the other hand is so far only known from Northern Abyssinia, and the adjoining parts of the Italian colony of Eritrea.

The following is a description of the grass.

Pennisetum clandestinum, Hochst. ex Chiov. in *Annuar. Ist. Bot. Roma*, VIII, 41, t.v., fig. 2 (1903). A hermaphrodite or sometimes unisexual low creeping closely matting perennial with creeping rhizome and slender stolons with very short internodes, throwing up single or more often fascicled short stout branches, the underground portion of which is densely covered with downwards more or less decayed leaf-sheaths. Culms (over-ground stems and branches) very short, often hardly raised above the ground or growing out into long rooting runners appressed to the ground and copiously branching to the right and left with the branches short, stout, closely sheathed and shortly ascending (*see* note on cultivated specimens below). Leaf-sheaths closely imbricate, mostly 1·2–1·6 cm. long, very rarely longer, almost membranous, very pale, then turning brown, distinctly nerved, glabrous or sparingly and shortly hirsute; ligules reduced to a densely ciliate rim; blades spreading, linear, gradually passing into the sheath, tapering to a subobtuse point, 1·25–5 cm. by 3–4 mm. (flattened out), tightly folded, then opening out, subsucculent, more or less glaucous, glabrous or sparingly and shortly hirsute, rough on the margins and the subcarinate midrib towards the tip, otherwise smooth, midrib slender, prominent below, primary lateral nerves 2–3, more or less differentiated below only. Inflorescence reduced to a cluster of 4–2 (mostly 3, rarely 1) spikelets, subsessile and enclosed for the greater part in the uppermost leaf-sheath, the terminal spikelet shortly pedicelled, the others sessile, each spikelet supported by an involucre of delicate bristles; bristles of the terminal involucre up to 15, very unequally long, the longest and strongest about ¾ the length of the spikelets, of the lateral involucres similar but much fewer and only on the outer side of the spikelet. Spikelets bisexual or functionally unisexual, slender, linear-lanceolate, 1–1·75 rarely 2 cm. long, glabrous, whitish below, greenish upwards. Lower glume suppressed, upper ovate to ovate-rotundate, subobtuse, up to 2 mm. long, hyaline, obscurely few-nerved. Lower floret reduced to its valve, this lanceolate, long tapering, subacute, as long as the spikelet, thinly membranous, 11–9 nerved. Upper floret ⚥ and markedly protogynous or functionally ♀ with rudimentary stamens; valve very similar to that of the lower floret, but slightly shorter; valvule linear-lanceolate, long acuminate, very thin, 4–2-nerved. Lodicules 0. Stamens ⚥ with very long protruding filaments (up to over 25 mm. long) and dangling anthers, 5–7 mm. long, of the ♀ much reduced with linear-subulate filaments slightly exceeding the ovary and empty anthers, 3 mm. long which remain permanently enclosed in the floret. Ovary obversely pear-shaped, attenuated into the long-exserted filiform style which is up to 3 cm. long, simple or shortly 2-fid and finely plumose from below the middle upwards. Grain (almost mature) dorsally compressed oblong-elliptic in outline, over 2 mm. by 1 mm. long, brown; hilum punctiform, black (Figs. 1–11, p. 421). *P. longistylum* (?) Stapf ex Burtt-Davy in *Agricultural Journal, South Africa*, II (1915), 147. *P. l.* var. *clandestina*, Leeke, *Untersuch. Abstamm. u. Heimat d. Negerhirse*. 23 (1907); Chiov. in *Annuar. Ist. Bot. Roma*, VIII, 319 (1908). *P. inclusum*, Pilger in *Engl. Bot. Jahrb.*, XLV, 209 (1910). *Cynodon Dactylon*, Schweinf. in *Bull. Herb. Boiss.*, II, App. II, 31 (1894), not Pers.

Distribution. Eritrea. Okule Cusai; by the Dégra stream near Saganeiti, *Schweinfurth* 1257 (barren)! Abyssinia; Samen; Sabra District, Selenka, on dry spots in wet meadows, 2750 m., and at Debra Eski, in dry grassy places, 2870 m., *Schimper* 398! Schoa, Ankober, *Roth* 62! Uganda; Mount Elgon, common on open ground in the bamboo zone, 2600 m., *Dummer* 3614! British East Africa; near Lamoru, *Linton* 215! and near the same place in low bush at 3000 m., *Scheffler* 294! Nairobi, *Dowson* 185! Tanganyika Territory: West Usambara 1600 m., *Eichinger* 3294.

Melle (*see* above) has pointed out that Kikuyu grass in the presence of water will put on top-growth and attain to a height of 2½–3 ft. A specimen from the Groenkloof Botanical Station (H. D. Agr. 19059) shows such a drawn up shoot (Fig. 4). It is about 1 ft. long, with 11 or 12 leaves and the 6th and 7th internodes measure 5 and 6·5 cm. respectively; the corresponding sheaths are roughly of the same length, whilst their blades measure 18 and 23 cm. respectively, by about 5 mm. when unfolded. The accompanying flowering specimens stand 5 cm. above the ground, with about 7 leaves and blades 3–7 cm. long.

The flowers are as in all the allied species protogynous (Figs. 1, 2). Reduction to a functionally female condition is characteristic of all the cultivated specimens from the Transvaal as far as I have been able to examine them, and it also occurs in those collected by Roth at Ankober; but whilst the anthers of the cultivated specimens were quite devoid of pollen, those from Ankober contained beside some empty pollen grains numerous pollen-mother-cells which had not got beyond the stage of division and were loosely scattered through the anther which had dehisced.

THE MEASURABLE CHARACTERS OF RAW COTTON.*

THE DETERMINATION OF AREA OF CROSS SECTION AND HAIR WEIGHT PER CENTIMETRE.

BY

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INTRODUCTION.

IN comparing different types of cotton it is necessary to evaluate as accurately as possible all characters which are capable of exact measurement. The properties of a yarn depend ultimately on the properties of the single hairs, so that it is important to study the latter in detail. It should be possible from the knowledge gained to predict the behaviour of the raw material in spinning and manufacture, in terms of single-hair properties. This paper supplies data on two of these properties, namely, the mean area of cross section of single hairs, and mean hair weight per centimetre of length.

METHODS.

Sampling. The determination of the mean value of any measurable character in a sample of cotton involves a preliminary study of sampling, since the accuracy of the mean may depend largely on the extent to which the sample is truly representative. It has been shown that groups of thin-walled hairs occur in patches on normal seeds, and that a whole seed may be characterized by thin-walled hairs, if death of the hairs from various causes has taken place before completion of secondary thickening. Balls (*Develop-*

* Reprinted from *Journ. Text. Inst.*, XIV, 12.

ment and Properties of Raw Cotton) has calculated the number of hairs per seed on some Egyptian cottons to be about 8,000. Assuming this number to be approximately accurate for our purpose, there will be, in a given sample of cotton, many groups containing 100 to 8,000 thin-walled hairs scattered sporadically through the sample. Where the size of sample for the determination of any single hair property consists of only a few hundred hairs, it is of great importance to have the thin-walled hairs randomly distributed through the mass. Probably the only accurate way is to select the sample hair by hair from a large number of places, the disadvantage of this system being the amount of time consumed and the eye-strain devolving on the worker. The method adopted in obtaining the results in this paper consisted in collecting a small sample from the amount of material available, and then mixing thoroughly on the draw frame of the Balls sledge sorter.

Cutting sections. For the measurement of area of cross section it is necessary to cut sections from a large number of randomly selected hairs. In practice, half the sample mixed in the draw frame was used for the determination of hair weight per centimetre and the other half for the sections. The latter portion was combed until the hairs were approximately parallel, and a bunch of a few hundred hairs was bound round a wire frame, immersed in alcohol for two minutes to drive out air bubbles, and then transferred to water. An aqueous solution of gelatin, so concentrated as to be quite stiff when cold, was heated over a water bath until fluid. The frame was then placed in a tube and sufficient of the liquid gelatin poured in to cover it completely. The tube and contents were placed for three hours in a warm oven, so that the gelatin remained liquid, and the frame was then immersed in a mixture of 5 per cent. formalin (40 per cent.) and 95 per cent. alcohol, in order to harden the gelatin adhering to the cotton. It was left in the hardening solution for several hours, preferably overnight, and finally placed in absolute alcohol for a few minutes to complete the hardening. The cotton was then cut away from the frame, embedded in vaseline-paraffin, and sections were cut with a hand microtome, and mounted in glycerin-jelly.

For the determination of area of cross section the hairs were drawn on paper at a known magnification, either by use of a micros-cope and camera lucida, or the projection apparatus. The paper drawings were cut out and weighed, the weight being corrected by means of that of a sheet of standard paper.

RESULTS.

Area of cross section. The area of 20 cross sections was chosen as a unit of convenient size, and the results for 50 groups of 20 obtained for the following cottons :—

(*a*) Trinidad native (T. N. 2), (*b*) U. S. 12–16 (coarse Sea Island), (*c*) Texas (Upland).

The mean area of 20 cross sections was also obtained for Peruvian and for a coarse Peruvian-American hybrid, in each case on 600 sections.

The results are set out in Table I.

TABLE I.

Frequency arrays of areas of cross section of groups of 20 hairs in units of 100 square μ.

Type ..	..	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
U. S. 12–16	..	1	3	7	17	6	5	9	1											
T. N. 2 ..	..	2	..	3	4	6	17	11	1	3	1	1								
Texas ..	..										2	1	5	5	9	16	6	3	1	2

Two further cottons with still greater areas of cross section were worked with. The complete results are summarized below :—

Type		Mean area of cross section of 20 hairs	Probable error	Co-efficient of variability	Probable error of one result
U. S. 12–16	..	29	±0·30	10·5	±32·8 per cent.
T. N. 2 ..	..	32	±0·35	11·5	±34·6 ,, ,,
Texas ..	..	49	±0·37	7·9	±23·9 ,, ,,
Peruvian ..	..	54 on 600	cross sections		
Peruvian hybrid	..	58 ,,	,, ,,		

With the type which showed the greatest probable error, it was normally sufficient to obtain the area of cross section of 132, or say, 140 hairs taken at random, when the maximum probable error of the arithmetic mean was about 3 per cent.

The above results are probably fairly accurate for comparative purposes, but it must not be supposed that they represent the actual areas of cross section, since it is known from a variety of miscellaneous observations that an unknown amount of expansion takes place when a section of a hair is cut, owing to the release of internal tensions. A section cut from one part of a hair may expand more than another section cut from a different part of the hair. Further, the amount of expansion may vary with wall thickness from hair to hair, a hair with thick wall expanding more than one with a thin wall. A rough analogy is provided by a compressed sponge enclosed by a skin ; if a thin section is cut, expansion will take place. From this it will be seen that the determination of the true area of cross section is an almost insuperable problem. Bearing in mind the error involved in the above determinations, it is probable that they are of value (Balls, loc. cit.) for such purposes as the comparison of fineness of various cottons, though the more important quality—degree of variability from hair to hair—would be hidden unless each area of cross section were measured separately, a long and arduous task.

Hair weight per centimetre. It has been pointed out by Balls (loc. cit.) that "although the measurements of this characteristic are not of direct use to the commercial growers or users of cotton as they stand, it is quite possible that some simple, indirect or mechanical method of obtaining the measurements may be devised, and knowledge of them be turned to utilitarian account. The four components which could affect the weight of a lint hair are its length, the thickness of its wall, the density of the cellulose of which the wall is composed, its diameter, and its moisture content........ In general ...... the weight of a hair will depend on its diameter and the thickness of its wall."

Balls made some measurements of this character by cutting uniform lengths out of the middles of samples of hairs, and showed that the ratio, fibre weight : breaking load, had a value ranging from 2·60 to 3·26, and concluded that the breaking load of a hair is largely determined by its weight, i.e., by the thickness of the cell wall. According to the same author, the probable error of *hair weight determinations is high, presumably owing to the* sampling difficulty.

Estimations of hair weight per centimetre have been made on the same five cottons, for which data on area of cross section have already been presented. The sample, after having been put in sliver form by passing through the draw frame used in connection with the sledge sorter, was combed and reduced to a group of hairs of convenient mass. A bunch of centimetre pieces was cut from the middle of the bunch with a cutter consisting of two safety razor blades one centimetre apart. Groups of 40 hairs were then weighed separately on a micro-balance, and the results plotted as a frequency curve. The results are presented in Table II.

TABLE II.

Frequency arrays of weights of groups of 40 hairs in milligrams.

	Weights (milligrams)												Mean
Type	0·048	0·053	0·058	0·063	0·068	0·073	0·078	0·083	0·088	0·093	0·098	0·103	
U. S. 12-16	1	9	17	11	11	1							0·061 ± 0·005
T. N. 2 ..	2	5	14	21	7	1							0·061 ± 0·005
Texas ..							1	4	20	15	9	1	0·091 ± 0·005
Peruvian ..	(on 600 hairs)												0·110
Peruvian hybrid ..	(on 1,000 hairs)												0·10

From these results it may be calculated that from 80 to 160 hairs are necessary in order that the probable error of the arithmetic mean shall be about 3 per cent. The assumption is involved that other cottons will not be more variable in respect of the distribution of weights of groups of 40 hairs.

The apparent density of cotton. By the usual accepted methods of determination, the density of cotton is 1·53 to 1·50. Using the data obtained for area of cross section and hair weight per centimetre, the apparent density can be calculated. A preliminary series of observations gave figures for apparent density of 1·0 to 1·2, which indicated that the structure of the cotton hair is porous and not continuous, a conclusion which many botanical workers had already reached on other grounds. It is better to use specific volume instead of density, however, as the amount of pore space can then be expressed as a percentage.

In an Indian cotton, Bharat *kapas*, the specific volume is 0·63 c.c. per gram, using the accepted density figure of 1·50. Actually by calculation from hair weight per centimetre and area of cross section, it is 0·88 c.c. per gram. Thus 0·25 c.c. or 30 per cent. of the volume is pore space. The question thus arises whether different cottons vary in pore space. Determinations for four cottons of widely different degrees of fineness are placed below :—

Type	Apparent density	Specific volume	Pore space, per cent.
T. N. 2	0·97	1·03	37
C. S. 12 - 16 ..	1·05	0·95	32
Texas	0·93	1·07	39
Peruvian hybrid ..	0·91	1·10	41

It will be seen that the pore space varies from 32 per cent. to 41 per cent., and the variation may either be significant or due to a working error. The area of cross section has already been stated to be too large, owing to the unknown expansion which takes place when the hair is cut, and there seems to be no way of finding out whether the expansion is greater for a coarse cotton than a fine. Greater expansion on the part of the coarse cottons would result in a lower apparent density and a higher specific volume. Bearing in mind, however, the working error, the provisional conclusion may be stated that the finer the cotton, that is, the lower the area of cross section, the greater the apparent density and the lower the porosity.

Work on bleached cottons would show whether the variations in porosity observed are related to differences in dyeing properties, but such differences would be most easily detected by actual dyeing experiments.

SUMMARY.

1. The necessity for quantitative investigations on the properties of single hairs is emphasized, and methods for the evaluation of mean area of cross section and hair weight per centimetre are described.

2. To obtain a mean value subject to a maximum probable error of not more than 3 per cent. of the mean entails great care in sampling, and the following minimum number of observations :—

140 for area of cross section,

80 to 160 for hair weight per centimetre.

3. Data on area of cross section and hair weight per centimetre are presented for five cottons, but the existence of an unknown amount of expansion when the hair is cut renders the figures for area of cross section of doubtful value except for comparative purposes.

4. Calculations of specific volume, apparent density, and porosity of four cottons show that the amount of pore space varies from 32 per cent. to 41 per cent. and, in general, the amount of pore space increases with the coarseness of the cotton.

Notes

IRRIGATION AND INTERCULTIVATION.

FOR some years the writer has been considerably interested in the conflict between irrigation and intercultivation of crops. In any irrigation scheme the general slope of the land must be sufficient for the water in canals and feeding channels to flow steadily; but the surface of each plot to be irrigated must be almost level: so that, in practice, either expensive grading is necessary or the plots are small because of the numerous contour ails necessary to hold the water approximately at the same depth all over the plot. Usually a compromise between the two is arrived at, but almost always the individual plots are too small to allow of intercultivation of the growing crop by bullock-drawn implements. It is generally agreed that heavy irrigation followed by cultivation, at longer intervals, is better practice than applying the same amount of water in smaller doses at shorter intervals: but, with the usual systems of irrigation, only hand cultivation is possible and this is very expensive and generally badly done; so in practice it is very often omitted and, instead, more water is given when the soil looks dry. Water is probably generally cheaper than hand labour.

Intercultivation by cattle connotes turning space at the ends of the rows and a certain minimum length of rows to keep the time occupied in turning as against that employed in actual cultivation at a reasonably low figure. The turning space may not be entirely wasted from cultivation as a catch crop may be sown when the main crop is too large for further cultivation. Probably from these points of view 10 chains is a convenient minimum length of plot.

The matter is further complicated in the cultivation of drained lands in Chota Nagpur for sugarcane by the fact that we want the lands sufficiently sloped for free surface drainage in the monsoon.

If the slope is sufficient for really good surface drainage, there will be heavy wash if the furrows are too long. In practice a slope of 6 to 9 inches in 100 feet and furrows about 10 chains long seems satisfactory, and of course the steeper the slope the shorter the furrows.

These furrows are usually irrigated by turning into one the stream from whatever is the water supply and letting it flow till it looks as if it will reach the other end. Then that furrow is closed and the stream turned into the next, and so on. A coolie is required to turn the stream from one furrow to the next and watch for bursts in the furrows, etc. Often, on land where the furrows are ill-defined or shallow, two or three coolies are kept busy keeping the stream in its proper furrow. Scouring, exposure of cane setts and waste of water seem inevitable if the supply of water is at all ample.

A system of automatic irrigation is mentioned in the "Agricultural Journal of India" (Vol. XIX, Part II) and more fully described in the Bulletin of the Hawaiian Sugar Planters' Association on "The Irrigation of Sugarcane in Hawaii," and the writer has been experimenting with the adoption of the principle in some of his cane irrigation. The field in which the attempts were made is 22 acres, 11 chains long and 2 chains wide with a slope of about 9 inches per 100 feet, not yet uniform, and the cane is newly planted in furrows running the length of the field and 4 feet apart. The water supply is at present free flow from a tank above, through 2 inches pipe running full. Formerly by running the whole flow into successive single furrows we irrigated 10 furrows per day. Two coolies were kept busy controlling the water, setts were exposed, some scouring occurred and the furrows were dry enough to cultivate on the second day after watering.

Now we have made furrows across the end of the rows at the high end of the field with their boundary ails horizontal. Each furrow commands 8 lines of cane. A little water was run into the first cross furrow and then 8 pipes (uncut country tile pipes of 2 inches mouth) were placed in the ail next the cane, all exactly at water level, and the supply pipe was opened. As the cross furrow filled, a trickle of water flowed through each pipe and seeped, rather than flowed, along the cane row. The whole was then left to look after itself. Occasionally the jemadar, *gur*-making in the next plot, wandered over; and if he saw the flow of water in one furrow lagging behind the others lowered its pipe a little. In the evening the water had seeped to the end of the 8 rows of cane, and judging by the side seepage into the ridges each line had a very thorough irrigation. There was no scouring or exposure of setts, no coolies had been employed except for an hour in the morning starting up, and the furrows were not dry enough to cultivate till the third day after watering, when a good cultivation was given. Most of the setts have germinated and the next irrigation 17 days later found the soil very damp 3 inches below the surface.

Of course there are probably various drawbacks. For instance, the actual amount of water seeping into the soil probably varies largely at the two ends of the furrow, and it may be difficult to get heavy irrigations on to the land by this method. Increasing the period of flow into the furrows and adjusting it so that it just reaches the far end without serious overflowing would help both. But there is almost certainly an optimum length of furrow for any particular slope and texture of soil. It seems likely, however, that, working on some such system as this, we can effect a reasonable compromise between irrigation and cultivation, not only for young cane but for other crops grown in lines such as cotton and vegetables, and incidentally make better use of our available supply of water and economize considerably in hand labour. [A. P. Cliff.]

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A GALL-FORMING THRIPS ON *CALYCOPTERIS FLORIBUNDA*: *AUSTROTHRIPS COCHINCHINENSIS*.*

The writer had occasion to visit the Taliparamba Pepper Farm, Malabar, in May 1923 and later on in September-October 1923, and in the course of an examination of the various wild plants on the farm he came across certain characteristic galls on one of

* Note read at the Zoological Section of the Indian Science Congress, Bangalore, 1924.

the wild plants there, viz., *Calycopteris floribunda* (Nat. Ord. Combretaceæ). This plant is a small shrub generally growing into a bush and is said also to put forth long branches in favourable places whereby it climbs trees like a twiner. The plant goes under the local name of "Pullani" in Malayalam. The galls are when full-formed rather large structures reaching a length of two to two and a half inches, generally roughly elliptical in outline, somewhat flattened, but with the surface deeply wrinkled and convoluted. They were generally found formed at the axils of the leaves. A close examination revealed the fact that the gall was in reality a bag-like structure and that they invariably showed the presence inside of numerous specimens of a small black thrips in different stages of development—little elongate oval whitish eggs, the pale greyish larvæ, and the mature black adults. In very old specimens abundant signs of the attack of a Pyralid caterpillar (not reared) were noticeable.

During the second visit in September-October 1923, the writer met with numerous examples of the galls in the incipient stages of growth. An examination of such young galls—which were noted in various stages of development—and a careful dissection of those structures have induced him to come to certain conclusions as to the nature and origin of those extraordinary structures, which it is the object of this paper to point out.

These galls are almost invariably axillary in their position—being almost always found borne at the axils of the leaves; a terminal position, though it may occur, is rather uncommon. In the older galls the tissues are so overgrown and malformed that it is not easy to say which part of the healthy plant the gall represents. It looks more like a malformed fruit than anything else. In the earlier stages, however, evidences are more clear as to what it really is. In the half-formed ones the swelling is distinct and is borne on a stalk which it is easy to recognize as the stem of the young shoot. At the tip of the gall the rudiments of the young leaves of the shoot are clearly recognizable. The gall itself is a hollow structure communicating with the outside by a small hole between the leaf rudiments at the tip and is lined inside by a hairy epithelium (?)

as in the case of the surface skin of the young shoot. This hollow structure is invariably peopled by varying numbers of the adult thrips and in addition contains numerous eggs and young ones of the same thrips. In instances of still earlier stages of development, the gall is but slightly formed, but is still a sort of hollow stalk in which 2 or 3 thrips are busy laying eggs and rearing their offspring. In a few cases very young buds in which an adult thrips was insinuating itself between the young rudiments of the leaves at the tip were also noticed. From these observations it appears to the writer to be clear that when fresh shoots are put forth by the plant after the monsoon, the adult thrips come out of their places of hiding inside old galls and go in search of young shoots. They crawl between the leaf rudiments at the tip, and reach the growing bud in which they appear to attack the meristematic tissues in such a way that while the central part ceases to grow, the sides begin to lengthen and ultimately cause the formation of a pocket-like structure at the tip of the growing shoot. The gall is therefore a bud or shoot gall—in which the development of the growing point is checked and a hollow outgrowth is formed carrying at the tip the leaf rudiments. The colony of thrips lives inside these hollow galls, breeds and increases.

The situation is often complicated by the fact that a Cecidomyiid maggot also causes blister-like galls in the young leaves of this plant and such galls are also found on the walls of these Thripid galls.

These galls were called "Fruits" by the people about Taliparamba and are known to have medicinal properties, being used in preparations for skin diseases by the local physicians.

These galls were found by Mr. T. V. Ramakrishna Ayyar at Mundakayam and Tenmalai in Travancore and reported to be used similarly for skin troubles, and were recently collected by Mr. J. A. Muliyil from Gurpur in S. Kanara District, and it is probable that this thrips will be found throughout the West Coast.

The writer is indebted to Prof. H. Karny, Zoological Museum, Buitenzorg, for his kind identification of these thrips. He described this species from specimens collected in South Siam and Cochin-China. [Y. RAMACHANDRA RAO.]

FIRST PLANT BREEDERS' CONFERENCE, BOMBAY.

In the Bombay Presidency, plant breeding as a separate activity of the Agricultural Department has of recent years greatly increased in importance and in personnel. It was felt that the time was now ripe for a conference of all those engaged in this branch of scientific work, and accordingly the First Plant Breeders' Conference met at the College of Agriculture, Poona, on April 14, 15 and 16, 1924.

The members of the conference were thirty-one in all, and included the Plant Breeding Expert and his graduate staff, the Cotton Breeders, the men specializing in the breeding of rice, sorghum, wheat, tobacco, and inferior millets, the Horticulturist and his staff, and the Economic Botanist and his staff. Dr. W. Burns, Principal of the College of Agriculture, presided throughout the gathering. Dr. H. H. Mann, Director of Agriculture, Bombay Presidency, opened the proceedings with an address emphasizing the need for severe scientific treatment of our problems and the success hitherto achieved. A variety of papers were presented and discussed, the most important and most discussed subject being the interpretation of the results of field experiments. The recent work[1] of Faulkner, Sarkar, Parnell and Leslie Lord was freely cited in this connection, and much illuminating original information was supplied from the work of the members of the conference. Work done on special crops was reported and criticised, certain methods of standardizing methods and measurements were agreed on, and a recommendation made that the meeting should be an annual fixture and the next meeting be held in Surat. The social side was not neglected, the members entering into the college games and also entertaining to tea Dr. and Mrs. Mann who were about to proceed on leave.

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FIGHTING THE BOLL-WEEVIL: RENEWED AMERICAN CAMPAIGN.

A SPECIAL correspondent in Washington writes in "The Times Imperial and Foreign Trade and Engineering Supplement."

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[1] *Agri. Jour. India*, XIV, 5; XVIII, 3; XVIII, 5; XIX, 1.

No. 304:

Stabilization of cotton production through the control of the boll-weevil is the object of an aggressive movement just launched by the combined business interests of the United States, as represented in the Chamber of Commerce of the United States. The drive against the boll-weevil will be conducted under the auspices of the National Chamber's Agricultural Bureau, in co-operation with 130 local chambers of commerce in the cotton belt.

In a statement announcing the movement the National Chamber pointed out that "a steady decline in the production of cotton, accompanied by an increase in the price of the American staple, has been reflected in increasing activity on the part of the foreign Governments to develop potential cotton areas outside the United States, as well as in a slackening of demand for finished mill products. Students of the situation are asking whether at the present rate of production of cotton in the United States the world demand for the raw product can be met unless new cotton areas are brought into play. While we do not believe that there is any immediate danger of the United States losing its position of dominance in the world cotton markets, yet we are convinced that the situation demands more aggressive efforts to stabilize production."

The National Chamber will supply local chambers of commerce in the cotton belt with information for use in the campaign, including the following:

(1) Facts and figures showing the trend of world supply and of demand for raw cotton;
(2) Material indicating the part played by export cotton in the preservation of the national trade balance;
(3) A survey of the possibilities of increased production of cotton in foreign lands;
(4) Data showing the steadily increasing consumption of American cotton by our own mills, with the proportionate falling-off in our cotton exports.

Information concerning the methods of weevil control and the manner of applying them and the work that is being done by banks and commercial organizations to stimulate the movement will be distributed, and the Agricultural Bureau will act, as far as possible, as a clearing-house for all member organizations. The Bureau is now devising a plan for organized stalk-destruction in the autumn.

SIX MILLION BALES LOST YEARLY.

In furtherance of the movement, Mr. Julius H. Barnes, President of the National Chamber, has just issued a statement dealing with the present cotton situation from a number of important angles. Mr. Barnes's statement, which showed that in 1923 the United States exported 13 per cent. less cotton than in 1922 and 37·8 per cent. less than the pre-war average, aroused the business interests of the country to the importance of the campaign. It was further shown by Mr. Barnes that the boll-weevil now is preventing production to the extent of about 6,000,000 bales a year. He added that this falling-off of exports of an item which played so important a part in the maintenance of the American trade balance was a matter of national concern.

On the important subject of the boll-weevil Mr. Barnes's statement says :

This insect, though it became established on our side of the Rio Grande River in 1892, did not seriously curtail production of cotton before 1914. This is explained by the fact that increased production of cotton in the area which up to that time was not infested by the weevil offset the damage wrought in the area occupied by the pest. However, since 1914 the real blight of the insect has been felt. In that year we made our record yield of 16,000,000 bales. Since then production steadily has decreased in spite of increased acreage. Between 1896 and 1914 the average per acre yield of cotton in this country was 188 lb. ; between 1915 and 1923 this yield shrunk to an average of 155 lb.

REMEDY FOR THE PEST.

We do not agree with the British report that there is no real remedy for the boll-weevil. After many years of painstaking research which has given us more scientific data on the boll-weevil than perhaps on any other insect, there has been evolved a method by which cotton can be produced in spite of the invader.

Briefly summarized, this method calls first for maintenance of soil fertility in order to secure a high normal production, and the use of early maturing varieties of cotton and intensive cultivation so that maturity of the fibre may be brought about in the shortest possible time, thus to win the annual race against the weevil. These methods are absolutely essential for a maximum yield of cotton regardless of the weevil, but in addition to and in conjunction with these the use of an arsenical poison has been demonstrated to yield most encouraging results.

In October 1923, at the call of the Louisiana State Bankers' Association, there was held in New Orleans a convention for the purpose of organizing more aggressive action against the weevil. This convention premised its deliberations upon the fact that cotton production in America not only is a national problem but an international problem as well. Out of this convention arose the National Boll-Weevil Control Association, which has been put on a relatively permanent basis for the purpose of utilizing all possible agencies in the task of awakening industry as well as agriculture to the importance of stabilizing cotton production through more effective weevil control. This organization is furnishing chambers of commerce, banks, and other organizations and individuals with the A B C of boll-weevil control methods as finally agreed upon by both this association and the Association of Southern Agricultural Workers, which made a careful study of the various control measures now in use.

Because of the interdependence of agriculture and industry it is the common privilege of both these great groups to strive for stabilization of cotton production in this country. It is of vital concern to the banking interests of the East no less than to those in the South that cotton shall retain its place among the foremost items of export contributing to our American trade balance.

Such opportunities to drive home the necessity for better weevil control as lie within reach of chambers of commerce, bankers' and manufacturers' associations, and other groups should be seized upon and made the most of. The Chamber of Commerce of the United States has taken due cognizance of this national problem, and through it the Agricultural Bureau has planned an aggressive campaign which may aid in placing American cotton beyond the danger of losing its dominant position in the world market. Not as an independent organization but through the hearty co-operation of its member organizations throughout the cotton belt, the National Chamber hopes to render agriculture and industry this aid.

Mr. Barnes also pointed out that in the United States the labour problem was one great limiting factor in the possibilities of extending the cotton area. When it was remembered that, as compared with corn, the amount of labour required for the production of an acre of cotton was 107 hours as against 18 hours, and that 68 per cent. of the labour in producing cotton fell before the time of harvest, it would be seen what an item this was.

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A TREE-PLANTING MACHINE.

ATTENTION is drawn in the February (1924) Number of "South African Journal of Industries" to a recent invention designed to facilitate the planting of trees. It is known as the Duivel Tree-Planter, and the principle on which it works is that of taking up the rich nursery soil around the young tree, with the tree in the centre, and planting the whole in the position which the tree is to occupy permanently. The roots are thus left undisturbed, and the tree suffers nothing from its change of position. The removal is accomplished by means of a cylinder which is placed around the tree and pushed down into the soil. By this means a young tree can be removed with a block of soil round its roots nine inches deep and nine inches in diameter. The cylinder is then planted in the designed spot and withdrawn. It is claimed that a young tree can be planted out with the Duivel machine in the hottest sun at any season of the year without suffering any serious setback. [*Jour. Royal Soc. Arts*, No. 3729.]

COTTON GROWING IN AUSTRALIA.

We have received the following for publication:—

An authoritative article dealing with the present position of cotton-growing in Australia and the possibility of the Dominion becoming an important source of supply is published in the current issue of the "Bulletin of the Imperial Institute" (XXI, 4). The author, Mr. W. H. Johnson, who was at one time Director of Agriculture in the Southern Provinces, Nigeria, recently paid a visit to Australia to report on the suitability of different parts of the country for cotton cultivation.

In 1788, Governor Philip brought cotton-seed from South America to plant in Sydney, and since then many attempts have been made to grow cotton in Australia. The first bale of cotton exported from the Dominion was produced in Queensland in 1852. With the help of premiums paid by the Government and the high prices ruling as a result of the American Civil War, production increased and, in 1871, shipments from Queensland amounted to 2,602,100 lb. Subsequently, the industry declined, and, with the exception of a slight revival in 1890, remained practically dormant until the last few years. Considerable interest has now been again aroused. The Queensland Government are encouraging the growth of the industry by providing cotton-seed free of charge for planting purposes, and by paying farmers a guaranteed price for seed-cotton; assistance is also being rendered by the British Cotton Growing Association. In 1922, an area of 7,000 acres were planted with cotton in Queensland and the yield of seed-cotton by the end of August had amounted to over $3\frac{3}{4}$ million lb. Mr. Johnson discusses the problems confronting the planter in the various regions where cotton-growing has been proposed and concludes that the soil and climatic conditions in large portions of Queensland, Northern New South Wales, North-West Australia, and in the Irrigation Settlements of Victoria, New South Wales and South Australia, are well adapted for cotton cultivation, but carefully conducted trials will be necessary to decide whether the crop can be grown profitably on a large commercial scale.

COTTON-WILT: A SEED-BORNE DISEASE.

THE following is a summary of a paper by Mr. John A. Elliott in the *Jour. of Agri. Res.*, XXIII, 5:—

The cotton wilt organism, *Fusarium vasinfectum*, Atk., was isolated from strongly surface-sterilized cotton-seed, indicating that the organism is at times carried on the inside of the seed-coat. The pathogenicity of the organism was proved by inoculation experiments. Artificially inoculated seed carried the viable organism on the seed lint for at least five months. The wilt disease was introduced into wilt-free soil by means of artificially infected seed. It is recommended that badly infected fields be rejected as a source of seed for planting.

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RESTRICTIONS ON IMPORT OF PLANTS FROM INDIA INTO SCOTLAND.

IN amplification of Notification No. 360, dated 29th February, 1924 (*Agri. Jour. India*, XIX, 3, p. 327), it is notified by the Government of India in the Department of Education, Health and Lands (No. 825, dated 12th June, 1924) that a Destructive Insects and Pests Order has also been passed by the Board of Agriculture for Scotland, dated 23rd June, 1922, the terms of which are the same as the Destructive Insects and Pests Orders made by the Agricultural Departments of England, Northern Ireland and the Irish Free State. The arrangements published in the above Notification which have been made in India for the inspection and certification of plant consignments intended for export to England, Wales, Northern Ireland and the Irish Free State will also be applicable to plant consignments intended for export to Scotland, the original of the certificate covering which should be forwarded by the exporter to the Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

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

His Majesty the King-Emperor's Birthday Honours List contains the following names which will be of interest to the Agricultural Department :

Knighthood. The Hon'ble Mr. M. S. D. Butler, C.B., C.I.E., C.V.O., C.B.E., I.C.S., President, Council of State.

C.S.I. Mr. Frank Noyce, C.B.E., I.C.S., Secretary to Government, Development Department, Madras.

Rao Bahadur. Mr. Pandurang Chimnaji Patil, M.Sc., L.Ag., Deputy Director of Agriculture, South Central Division, Bombay.

Rai Sahib. Babu Srish Chandra Banarji, F.C.S., Offg. Assistant Agricultural Chemist, United Provinces.

Babu Haridas Banarji, Head Assistant, Office of the Director of Agriculture, Bengal.

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Mr. J. W. Bhore, C.I.E., C.B.E., I.C.S. (Madras), has been appointed Secretary to the Government of India, Department of Education, Health and Lands, *vice* Sir Montagu Butler appointed President of the Council of State.

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Mr. M. S. A. Hydari, I.C.S. (Madras), has been appointed to officiate as Under-Secretary to the Government of India, Department of Education, Health and Lands.

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Dr. W. H. Harrison, D. Sc., has been appointed to officiate as Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa, *vice* Dr. D. Clouston, C. I. E., granted leave for 3 months and 25 days. Dr. W. McRae officiates as Joint Director of the Institute and Mr. J. N. Mukerjee as Imperial Agricultural Chemist.

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Mr. M. Wynne Sayer, B.A., Secretary, Sugar Bureau, Pusa, has been appointed to officiate as Imperial Agriculturist from 5th June, 1924, *vice* Mr. G. S. Henderson on other duty. Mr. Arjan Singh officiated as Imperial Agriculturist from 14th April to 4th June, 1924.

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Mr. E. J. Bruen, Deputy Director of Agriculture for Animal Breeding, Bombay, has been appointed to officiate as Imperial Dairy Expert, Bangalore, *vice* Mr. W. Smith granted leave for six months from 25th April, 1924.

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Mr. T. F. Main, B.Sc., Deputy Director of Agriculture, Bombay has been appointed to officiate as Director of Agriculture, *vice* Dr. Harold H. Mann granted leave for six months.

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Dr. W. Burns, D.Sc., Economic Botanist to Government, Bombay, has been confirmed in his appointment as Principal, Agricultural College, Poona.

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On the retirement of Mr. J. B. Knight, M.Sc., from 19th April 1924, Mr. B. S. Patel, B.Ag., N.D.A., N.D.D., has been appointed Professor of Agriculture, Agricultural College, Poona.

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Mr. B. S. Patel, B.Ag., N.D.A., N.D.D., Professor of Agriculture, Agricultural College, Poona, has been appointed to officiate as Deputy Director of Agriculture for Animal Breeding, Bombay, *vice* Mr. E. J. Bruen on other duty.

MR. V. G. GOKHALE, L.AG., Deputy Director of Agriculture, Bombay, has been appointed to officiate as Professor of Agriculture, Agricultural College, Poona, *vice* Mr. B. S. Patel on other duty.

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MR. M. K. PAWAR, B.AG., has been appointed to officiate as Deputy Director of Agriculture, Konkan, *vice* Mr. V. G. Gokhale on other duty.

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RAO SAHEB BHIMBHAI M. DESAI has been appointed to act as Deputy Director of Agriculture in the Indian Agricultural Service, Bombay, from 19th April, 1924, the date of retirement of Mr. J. B. Knight.

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MR. T. GILBERT, B.A., Deputy Director of Agriculture, Sind, has been granted combined leave for 15 months and 7 days from 1st September, 1924.

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MR. W. M. SCHUTTE, A.M.I.M.E., M.R.A.S.E., Agricultural Engineer to Government, Bombay, has been granted leave on average pay for six months from 1st July, 1924.

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MR. C. S. PATEL, B.AG., has been appointed to act as Deputy Director of Agriculture, North Central Division, Bombay, *vice* Mr. W. J. Jenkins granted leave.

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MR. F. R. PARNELL, M.A., Government Economic Botanist, Madras, has been permitted to retire from the Indian Agricultural Service from the date of expiry of leave granted to him.

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MR. B. VISWANATH, Officiating Government Agricultural Chemist, Madras, has been admitted a Fellow of the Institute of Chemistry in London (F. I. C.), as a result of examinations held a few months ago.

Mr. D. Anand Rao, B.Sc., Deputy Director of Agriculture, Madras, and Rao Saheb T. S. Venkatraman, B.A., Government Sugarcane Expert, Coimbatore, have been confirmed in the Indian Agricultural Service from 10th June, 1924. Mr. Anand Rao was on leave for one month from 1st June, 1924.

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Mr. C. Tadulinga Mudaliyar, F.L.S., who has been promoted to the Indian Agricultural Service from 3rd September, 1923, has been appointed Lecturing and Systematic Botanist, Agricultural College, Coimbatore.

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Mr. F. Ware, M.R.C.V.S., Chief Superintendent, Civil Veterinary Department, Madras, has been granted an extension of leave on half average pay for 14 months and 12 days from 11th October, 1924, in lieu of study leave for 4 months previously granted to him.

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Mr. T. J. Hurley, M.R.C.V.S., Officer in charge of the First Circle, Civil Veterinary Department, Madras, has been appointed to officiate as Professor of Surgery, Madras Veterinary College, from 1st July, 1924, *vice* Mr. P. T. Saunders on other duty.

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Mr. P. T. Saunders, M.R.C.V.S., Professor of Surgery, Madras Veterinary College, has been appointed to officiate as Professor of Pathology and Bacteriology, *vice* Mr. V. Krishnamurthi Ayyar deputed to the Imperial Bacteriological Laboratory, Muktesar, for training.

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In modification of a previous notification, Mr. A. C. Dobbs, B.A., Director of Agriculture, Bihar and Orissa, has been granted leave on average pay from 28th April to 25th October, 1924.

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The services of Dr. H. M. Leake, Sc.D., M.A., Director of Agriculture, United Provinces, on deputation under the Government of Soudan, have been replaced at the disposal of the Government of the United Provinces from 21st May, 1924. He has been granted leave on average pay for three months from the date of reversion.

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MR. C. P. MAYADAS, M.A., B.Sc., Principal, Agricultural College, Cawnpore, was on leave on average pay from 18th April to 1st June, 1924, Mr. P. B. Richards officiating.

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SYAID MUHAMMAD RAZA HUSAIN has been appointed to officiate in the Indian Agricultural Service as Deputy Director of Agriculture in charge of Cattle Breeding Operations, United Provinces, from 15th May, 1924, *vice* Mr. C. H. Parr granted leave.

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MR. T. A. MILLER BROWNLIE, C.E., M.I.M.E., Agricultural Engineer to Government, Punjab, and Offg. Principal, Punjab Agricultural College, Lyallpur, has been granted leave on average pay for four months from 1st June, 1924.

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SARDAR SAHIB KHARAK SINGH, M.A., Associate Professor of Agriculture, Punjab Agricultural College, Lyallpur, has been granted leave on average pay for two months from 21st May, 1924.

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MR. MUHAMMAD ABDULLAH has been appointed to officiate as Deputy Director of Agriculture, Gurdaspur Circle, Punjab, *vice* Malik Sultan Ali granted leave.

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COLONEL G. K. WALKER, C.I.E., O.B.E., F.R.C.V.S., Principal of the Punjab Veterinary College, Lahore, has been granted leave on average pay for 2 months and 27 days from 3rd April, 1924, combined with the college vacation, Mr. W. Taylor, M.R.C.V.S., officiating.

On return from leave, Mr. Leslie Lord, B.A., Deputy Director of Agriculture, Burma, has been posted to the charge of the Northern Circle with headquarters at Mandalay.

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On relief by Mr. Leslie Lord, Mr. W. M. Clarke, M.B.E., B.Sc., has been appointed Professor of Agriculture, Agricultural College, Mandalay.

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Dr. S. K. Mitra, M.Sc., Ph.D., has been confirmed in the Indian Agricultural Service and in his appointment as Economic Botanist, Assam, from 28th February, 1924.

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Mr. J. N. Chakravarty, B.A., M.S.A., M.R.A.S., Deputy Director of Agriculture, Assam, has been granted leave on average pay for one month from 1st June, 1924. Srijut L. Barthakur officiating.

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In consequence of certain vacancies caused by the retirement of nominated members, the following have been nominated to be members of the Indian Central Cotton Committee, Bombay :—

Mr. B. F. Madan to represent Co-operative Banking.

Mr. H. T. Conville to represent the Punjab Cotton Growing Industry.

Mr. R. C. Broadfoot to represent the Madras Agricultural Department.

Mr. G. Z. Meli, to represent the Chamber of Commerce, Tuticorin.

Reviews

Practical Botany.—By Diwan Bahadur K. Rangachari, M.A., L.T. (Madras: Superintendent, Government Press.)

We cordially welcome this book which is the third of the publications recently contributed by the author to the study of Indian botany. It is prepared from the material handled by the author and his colleagues for the exercises which were taught to successive batches of students of the Agricultural College and Research Institute at Coimbatore. The book, which is divided into three sections dealing with Morphology, Physiology and Cryptogams, quite appropriately forms a valuable laboratory supplement to the author's excellent "Manual of Elementary Botany for India."

We have read over the book with great interest and find it to be an extremely useful guide to the students of practical botany, even of advanced classes, and it is more so to the teachers and demonstrator. The selection and preparation of plant materials and objects leaves nothing to be desired. There are appropriate illustrations in the three sections and some good microphotographs are also reproduced. The latter are extremely useful. Their value would have been further enhanced had they been supplied with explanatory references by pointed lines to the contents. This want is more particularly felt in the case of Figs. 1, 5, 11. In the portion on physiology, one would expect to see more illustrations. There are none of the latter to explain experiments of photosynthesis. Such were specially necessary for experiments 7, 9, 5(*b*).

The four appendices, giving a list of apparatus, micro-technique, etc., provide all detailed information that may be needed for fitting up a botanical laboratory that will serve the purpose of the teacher and the taught.

The author's method of treatment of the subject discloses his appreciation of the difficulties of the students and his consequent endeavour to make the instructions clear at each step. As the student progresses in the study of practical botany as presented in this book, more and more interest in the study is awakened in him to pursue the subject. The writer's aim mentioned by him in the preface—of not compelling the student to discover things for himself but of *helping* him by giving clear instructions and guidance—has been very well accomplished.

The book is a valuable addition to the literature on Indian botany and we commend without hesitation this book to students and to teachers. [G. B. P.]

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Some Studies in Bio-Chemistry.—By Some Students of DR. GILBERT FOWLER, D.Sc. Pp. 197. Illus. (Bangalore: The Phœnix Printing House.)

THIS publication is a collection of 26 short articles and studies in industrial and bio-chemistry, dedicated to Dr. Fowler on the eve of his retirement from the chair of bio-chemistry at the Indian Institute of Science, by the authors, some of his former students.

The range of subjects discussed is very wide, including, as it does, problems connected with such raw materials and products of industry as acetone, alcohol, fibres, lac, manures, edible oils, leather and tannery products, and gives the reader a slight idea of the number and variety of problems connected with industry in India, the solution of which cannot be expected to be found without the work of bacteriologists and bio-chemists. [J. H. W.]

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. The Soil and its Management, by Merritt F. Miller. Pp. vi+386. (Boston and London: Ginn & Co.) Price, 7*s*. 6*d*. net.
2. Beasts of an Indian Village: A popular account of the Common Back-boned Animals of an Indian Village, by Douglas Dewar. Pp. viii+132+9 plates. (London, Bombay, Calcutta and Madras: Oxford University Press). Price, 4*s*. 6*d*. net.
3. Farm Equipment for Mechanical Power. by Frank N. G. Kranich. Pp. xv+405. (London: Macmillan & Co., Ltd.) Price, 12*s*. 6*d*. net.
4. The Production of Field Crops: A Text-book of Agronomy. Pp. 514. (London and New York: McGraw-Hill Publishing Co.) Price, 17*s*. 6*d*.
5. Butterflies of India, by Chas B. Antram, F.E.S. Pp. xvi+226+412 figs. (Calcutta and Simla: Thacker, Spink & Co.) Price, Rs. 30.
6. Economic History of American Agriculture, by Prof. E. L. Bogart. Pp. x+173. (London: Longmans, Green & Co.) Price, 6*s*. net.
7. Manuring of Grass Land for Hay, by Winifred E. Brenchley. Pp. viii+146. (London: Longmans, Green & Co.) Price, 12*s*. 6*d*. net.
8. Grassland Farming, Pastures and Leys, by W. J. Malden. Pp. xxiv+314. (London: Ernest Benn, Ltd.) Price, 30*s*. net.
9. Quantitative Agricultural Analysis, by E. G. Mahin and R. H. Carr. (International Chemical Series.) Pp. xiii+329. (London: McGraw-Hill Publishing Co.) Price, 13*s*. 9*d*.

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

Memoirs.

1. Studies in Indian Tobaccos. No. 4. Parthenocarpy and Parthenogenesis in the varieties of *Nicotiana Tabacum* L. var. *Cuba* and var. *Mirodato*, by Gabrielle L. C. Howard, M.A., and Kashi Ram. No. 5. The Inheritance of Characters in *Nicotiana rustica* L., by Gabrielle L. C. Howard, M.A. (Botanical Series, Vol. XIII, No. 1.) Price, Rs. 2 or 2*s*. 9*d*.
2. The Wilt Disease of Safflower, by S. D. Joshi, B.Sc. (Botanical Series, Vol. XIII, No. 2.) Price, R. 1 or 1*s*. 6*d*.

Bulletin.

3. The External Morphology and Bionomics of the Commonest Indian Tick (*Hyalomma ægyptium*), by Mohammad Sharif, M.A., F.R.M.S. (Pusa Bulletin No. 152.) Price, R. 1.

Report.

4. Report of the Proceedings of the Fifth Entomological Meeting, held at Pusa from 5th to 10th February, 1923. Price, Rs. 9-8.