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THE INTRODUCTION OF IMPROVEMENTS INTO INDIAN AGRICULTURE.

By D. CLOUSTON, B.Sc.,

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Government has organized during the past few years a strong department for the scientific investigation of Indian agriculture, with the object of ascertaining the lines upon which improvement is practicable. A staff of specialists, highly trained in the agricultural sciences, is employed both in the Imperial and Provincial departments, whose research and experimental work have already shown that many important improvements can be effected. These results are placed before the public in the reports and other publications issued from time to time, but such literature fails to reach the mass of Indian cultivators. It is, therefore, an essential function of the department, no less important than scientific investigation, to devise methods whereby experimental results of proved value can be introduced into ordinary farming practice by the Indian cultivator. The methods to be employed in bringing experimental work of proved value to the notice of the cultivator, so as to secure its adoption in ordinary farming practice, will necessarily vary in different parts of India in accordance with the varying local conditions, such as the system of land tenure, the standard of farming attained by the cultivators, the social condition of the rural community and the like. It may be of interest to give an account of the methods that have been tried in the Central Provinces, and of the lessons learnt from the successes and failures that have resulted.

In the Central Provinces the villages are held by landowners, whose proprietorship is clearly recognized, though their rights of ownership are subject to the rights of occupancy of their tenants. Both proprietor and tenant are given security of tenure in the land, with the object of encouraging each to make the best possible use of it. This system has given a number of village proprietors who often cultivate large home-farms—intelligent farmers, who are willing to test improved methods and to lay out substantial capital sums, if they are convinced that an adequate return is likely to be secured. Amongst the tenantry there is also a sprinkling of men who cultivate large holdings and employ large capital: and such men are even more numerous in the rich province of Berar, where the *ryotwari* system of tenure prevails. The difficulties in introducing improvements are, therefore, not so great as in a tract where the land is parcelled out into minute holdings, and where the capital at the disposal of each holder is extremely limited, for there are numbers of cultivators ready to expend some hundreds of rupees upon a new implement, an improved method of cultivation or the like, provided they are convinced that the outlay will give a substantial return. The standard of farming attained in different parts of these Provinces varies considerably, but it is on the whole inferior to that of most other parts of India, so that there is much more scope for improvement than in provinces where cultivation has already reached a high level. In the Central Provinces, as a rule, land is plentiful and intensive cultivation is but little practised; in Berar, on the other hand, the great boom in the cotton trade has enormously increased the demand for land, with the result that grazing areas have been curtailed and the standard of cultivation has reached a much higher level. Good cultivators are found, as exceptions, among all the different castes. The best cultivators are the hereditary cultivating castes such as *Kunbis*, *Powars* and *Lodhis*. Contrasted with these may be mentioned such castes as *Gonds* and *Chamars*. The former live a contented but unenterprising life in the hilly jungle tracts of poor soil. Satisfied with a low standard of comfort, they are for the present so

inaccessible and primitive, as to be altogether outside the sphere of the department's influence. The *Chamars*, who form the bulk of the cultivators in the Chhattisgarh rice country, though inferior cultivators, enjoy a lazy and stoical content which is opposed to everything an agricultural department can teach in the way of progress. Contrasted with these again may be mentioned the educated Brahman cultivator of Berar who, after having made his fortune at a profession or trade, has purchased land on which he is anxious to experiment with anything from tree cottons to steam ploughs. The kind of improvements necessary, and the lines to be followed in introducing them among cultivators, can only be satisfactorily determined after studying all these conditions as they obtain in the different tracts. In the more backward parts, it is often some means of demonstrating better tillage methods that has to be considered; the Chhattisgarhi, for instance, has yet to learn the very elements of his art, *i.e.*, to cultivate his land properly, to conserve the manure already at his disposal, and to sow his crops efficiently. In more advanced tracts, on the other hand, what is necessary is to organize a system of seed farms from which supplies of pure and improved seed can be obtained, to introduce new and improved varieties of seeds, to teach definite but simple methods of preventing and remedying insect pests and of supplementing the present supply of manure. Every scheme for demonstrating the results of experimental work to the ordinary cultivator must, then, be based on a knowledge of the different tracts and of the people and their needs.

Wherever possible, our teaching should be in the concrete. This can best be done by means of demonstration farms. On these farms many experimental results of proved value can be demonstrated on a practical scale, so as to secure their application to the general practice of farmers. Experimental work should never be attempted on these farms; first experiment, and then demonstrate the results if they are of any practical value, should be the rule. To do this effectively, an experiment station has been located in each well-defined agricultural tract, and the

experimental programme is based on a knowledge of the agricultural requirements of the tract which it represents. The demonstration farm has an entirely different purpose, and serves as an object-lesson to induce the ordinary cultivator to incorporate into his farm practice the teaching of the station. No difficulty has been found in inducing a cultivator to lend a suitable piece of land. This should not be larger than the purpose demands and which the assistant in charge can efficiently manage; a small area carefully cultivated is much better than a larger area inefficiently managed. In some cases, with a thoroughly keen and efficient cultivator, it is safe to rely upon him to supply the bullocks, labour and other requirements, but in most cases it is much better for the assistant to be as independent as possible of local assistance and to supply him with his own bullocks and implements, and with funds to employ the requisite labour; otherwise the demonstration plot is apt to be neglected by the cultivator until the rest of his land has received his attention. An agreement is made with the cultivator for the use of his land, either by payment of a rent or by a share of the produce. Several demonstration farms started in these Provinces have failed to answer the purpose for which they were intended. In some cases they have failed, as they tried to demonstrate what remained to be proved, *e.g.*, that cotton and juar can be profitably grown in the rice tract. In other cases the failure was due to bad management, the assistant in charge having insufficient practical experience of cultivation, even if possessed of fair theoretical knowledge. This is the greatest difficulty that the department has to cope with at the present time; assistants are employed who have not been brought up on the land, and who are not, therefore, in sympathy with their work. Even when supervised by more highly qualified men, their work is not always satisfactory, for, not knowing when the simple cultural operations are properly performed, their supervision is futile. In the past, for lack of sufficient supervision, these men have been left to do things on their own initiative, and the result has been that under their management demonstration farms have

sometimes failed in their purpose owing to a small mistake in practical working. No assistant should be given a demonstration farm until it is certain that he has a thorough practical knowledge of the work entrusted to him. With more careful supervision and reliable experimental results to work upon, the demonstration farms started in Chhattisgarh last year proved successful. The objects aimed at were (1) to substitute the system of transplanting paddy for the present broadcast sowings, (2) to induce cultivators to utilize to the best advantage the irrigation water lately made available by the construction of Goverment reservoirs, (3) to grow a second crop after early and medium paddy, and (4) to demonstrate the method of eradicating *kans* grass by means of Ransome's turnwrest plough. A distinct measure of success has been achieved, and the malguzars and cultivators concerned, who at first were apathetic, are now most anxious that these farms should be continued in their villages for another year, so that they may learn still more of the new methods being taught by the agricultural department, whilst applications have been received from several villages to start similar farms. The department has thus gained their confidence in its desire to benefit them and in its power to do so. The outturns of paddy from the transplanted fields of the demonstration farms and from the adjoining fields of the cultivators, sown broadcast, are shown below :—

	Outturn of paddy in lbs. per acre.	
	Transplanted by the Department	Broadcasted by cultivators.
Jageshwar Farm	3,946	2,450
Jawaibandha Farm	1,690	600
Kholar Farm	2,880	1,272

Even this large increase due to transplanting does not fairly represent the total value of this demonstration work to the cultivators, for they also followed our example and irrigated their paddy for the first time this year. The cultivators of the villages concerned have thoroughly appreciated the value of these

farms, and the agricultural department has risen considerably in their estimation, so that this year we confidently hope that hundreds of acres will be transplanted where transplanting was unknown before, and this in a tract where the cultivators are notably lazy and slow to adopt improvements. They have already followed our example in transplanting small areas and in irrigating their wheat. The success of these farms was due to the fact that the scheme was carefully devised and the work efficiently supervised by a thoroughly practical superintendent under proper control. The results obtained appeal all the more to the cultivators, seeing that the manure and implements, with the exception of the turnwrest plough used for eradicating *kans*, were exactly the same as those used by themselves, so that the results are due to one varying factor in each case.

Seed farms and seed selection form a part of the work of the agricultural department which readily recommends itself to the cultivator. The cotton seed farms established in these Provinces have been successful. The cultivators recognize the advantage of using good seed, and a few have already started to imitate the seed farms in giving more attention to the cultivation of the plot intended for seed, to the spacing of the plants, to the selection of the seed and to the ginning of the cotton. They show, too, a preference for certain strains of seed. In one case the proprietor has taken into his regular employ the assistant who was in charge of the seed farm. After two or three years' careful supervision it will be possible to withdraw the agricultural assistants in charge of these farms, and to leave the owners to manage them as private seed farms. The department will still continue to supply the owners with selected seed for each year's sowing and to give them the benefit of its advice. The owners will be made to feel that they and the department are working in co-operation for the common weal. They will be requested to inspect the experimental stations from time to time and to see the whole scheme of seed selection carried on at these centres, while officers of the department will inspect and advise them in the management of their seed farms. In the course of a few

years it is not too much to expect that in these Provinces there will be several private seed farms where pure and improved cotton seed can be obtained, and where, too, the use of new manures and new varieties of cotton tested at the experiment stations can be demonstrated to neighbouring cultivators.

The agricultural stations themselves also serve the purpose of demonstrating to the ryots of the tract experimental work of proved value, including the use of improved agricultural machinery. The usefulness of a station in this respect depends very largely on the superintendent in charge. A practical man, who shows tact and sympathy in welcoming visitors, will induce many to come to the station. A visitor generally comes with the intention of seeing one particular experiment, or it may be one particular machine in which he is interested. It is advisable, therefore, to concentrate his attention on the results of one or two experiments in which he is specially interested, rather than to confound him by attempting to explain all the lines of work in progress. If, as a member of one of the District Agricultural Associations, he has been entrusted with one of the co-operative experiments being carried out by his association, he is anxious to compare the results of the station with his own, and he will often declare with some degree of pride that the crop at the station falls short of his own. This department always holds the meetings of the District Agricultural Association at the stations in the case of districts in which stations have been established. In other districts, such meetings will be held at a suitable demonstration or seed farm, wherever it is available. When the meetings are held at the stations, arrangements are made to work suitable foreign agricultural machinery and implements. The members are also shown such of the experimental series as are likely to be of some educational value to them. At other times leading cultivators, who have been paying special attention to one particular crop or manure, are asked to visit the station to compare their results with those obtained there. By paying attention to such points as these, much can be done to make an agricultural station popular, and to rouse the interest of the better class of cultivators in its work.

A Cattle-breeding Farm run by the Agricultural Department can also be made a most useful object-lesson in the improvement of a breed by selection. The cultivator recognizes that the scheme for the improvement of his animals is based on the same principle as that for the improvement of his seed, and that in each case the aim is to produce the best of its kind. The work of the Nagpur Cattle-breeding Farm is duly appreciated, and the demand for the loan of bulls far exceeds the supply available for distribution. On the other hand, the Hoshangabad Cattle-breeding Farm has not been so successful, because the stock is not of the best quality and of the exact stamp desired by the cultivators. It was started without sufficient enquiry into the local conditions and without sufficient effort to secure the right type of animal. Religious sentiment, combined with a knowledge of the fact that his cattle are deteriorating in quality, induces the ryot of the Central Provinces to look with favour on any scheme that makes for the improvement of his stock.

The demand for agricultural assistants as managers of Court of Wards estates affords another opportunity of bringing the results of the experimental work of the stations to the notice of cultivators. But as in the case of demonstration farms, it is essential to frame a complete scheme for such work, which the manager should not be allowed to exceed, to decide what improved methods of tillage, what manures, what system of seed selection and the like should be permitted with due regard to the local conditions. Here, again, the great difficulty is to secure competent candidates for such posts. In some cases the managers supplied for such estates by this department have proved unsatisfactory, being unpractical, lacking in initiative and therefore incapable of performing satisfactorily the duties of an independent charge. Their one idea is generally to imitate the experiment stations, particularly in purchasing foreign agricultural machinery at an extravagant cost. They lack the money-making instinct of the true farmer. In future this department will supervise the work of all its assistants thus employed, and advise them to follow the teaching of the stations only as far as it is applicable to estates run on commercial lines.

By exhibiting agricultural machinery and farm products at shows, fairs and exhibitions, the work of the department can be brought to the notice of a large body of cultivators who are not otherwise accessible. By combining popular lectures on the exhibits with practical demonstrations of each, much good work can be done. This requires to be arranged on a systematic plan in order to secure that the exhibits and lectures are suited to the tract served by the show. The exhibits of farm produce should be neatly arranged in sufficiently large quantities to allow of their being handled by interested parties. It must always be remembered that nine-tenths of the cultivators never read, and that their minds are not trained to assimilate abstract ideas. They are children of nature, and as such get all their impressions from the concrete. The exhibits should, therefore, be arranged so as to be an intelligible and instructive lesson to the ordinary illiterate ryot. The lecturer should, therefore, carry with him a small travelling museum of exhibits to illustrate his lecture. This department has started on these lines to prepare lectures and exhibits suitable for the different tracts. The more important shows and fairs of each tract will in future be attended by the superintendent of the station of that tract, or by some higher official. The superintendent will be supplied from head-quarters with a copy of the lectures that are to be delivered and the necessary museum of exhibits to illustrate the same. In the cotton tract the latter includes bolls of the different varieties of cotton recommended for the tract mounted on cardboard together with those of the varieties already grown locally; on a second sheet the lint is mounted so as to show their relative lengths; on a third is shown the life history of the stem borer and an actual plant killed by the same, with the help of which the lecturer will explain the remedies and methods of prevention. Cotton boll-worm and cotton wilt disease are similarly illustrated. The artificial manures recommended for cotton are also exhibited along with bags of uncleaned cotton to show the relative outturns of unmanured land and land to which these fertilizers have been applied. At exhibitions the exhibits would be more varied

and on a much larger scale, and many of the experiments that have given useful results at the stations can be graphically illustrated there by pot cultures.

Certain kinds of demonstration work can be effectively carried out by means of an itinerary staff. Here, again, the work is almost sure to prove futile unless precautions be taken to employ the right class of men for the work and to make all the arrangements beforehand, by fixing definite centres and definite dates for the demonstrations and by securing the assistance of the District Officer in intimating the same to the cultivators. Good work has been done on these lines by demonstrating the method of pickling juar to prevent smut. The assistants deliver short addresses at each centre, in which they explain the advantage of using this fungicide, and then proceed to give a practical demonstration of the method of applying it to the seed. Several cultivators are thoroughly taught the process, and are then given free of cost sufficient copper sulphate required to pickle the quantity of juar seed which each intends to sow. About 8 cwts. of copper sulphate were given out in this way last year or sufficient to pickle about 200,000 lbs. of seed. The department has successfully demonstrated this process for several years, and its advantages have been so fully recognized that it has become a regular practice in certain parts of the juar tract. Successful work on similar lines has been done by sending assistants on tour with selected new machines and implements, which we believe to be suitable for the tract. Here also it is necessary to frame a definite programme with fixed centres, such as large villages where bazars are held, where the assistant can stay and work his machines for some days, rather than wander about to a new village each day. In this way a considerable demand has arisen for some useful machines, such as winnowers and fodder-cutters. A register of purchasers should be maintained, and the department should ascertain from time to time whether the machine is working satisfactorily and should assist in effecting any necessary repairs. Failure has resulted in some cases, where the purchaser has not known how to work the machine properly, and

it is now the practice to try and induce a purchaser to send a man to the agricultural station to be taught the practical working of the implements that he desires to purchase. This is very necessary in the case of foreign ploughs, which are sometimes left useless in a village, not because the plough is unsuitable, but because the purchaser has not learnt the proper method of working it.

The school gardens should, to some extent, at least, be the means of bringing the young mind into touch with nature, and of arousing his interest in plant growth. Nature studies should form a fundamental part in the education of every child so as to teach him to observe closely and to reason accurately from data gained by observation. Nature study brings the child face to face with real things, and tends in this case to give his mind an intelligent bent towards cultivation and for the assimilation, later, of such useful scientific work as the stations may turn out for his farm practice. As the success of the scheme depends very largely on the teachers in charge, they are put through a six months' course at the Agricultural College, where they are taught the rudiments of theoretical agriculture in the class room and on the Nagpur Farm, sufficient to enable them to teach intelligently the agricultural lessons included in the School Readers. The system of elementary rural education has a most important bearing on the future of agricultural improvement.

An important departure was made six years ago by starting at the Nagpur Agricultural College a one year's course in practical agriculture for training the sons of farmers. The teaching is given in the vernacular, and is almost wholly practical work on the farm with a minimum of lectures and book-work. At the outset it was found very difficult to attract the right stamp of student, although scholarships were freely given by the District Councils. Some of the students were the sons of petty traders or officials who had failed in other attempts to earn a livelihood, who had no connection with, or liking for the land, but who hoped ultimately to get some employment and at least to be

supported in the meantime by scholarships. The importance of a careful selection of the students cannot be over-estimated. A few sons of cultivators were attracted with a real desire to learn something connected with their profession, and in such cases some measure of success has been secured, as was shown by an enquiry into the work that they were doing in their villages after they had left the College. One important lesson learned is, that it is most desirable to try and keep in touch with the students after they have finished their course, to encourage them to write and explain what they are trying, to advise them upon any difficulties that they experience, and to visit them in their homes when occasion offers. Some are the keenest members of their District Agricultural Association.

By personal intercourse between officers of the department and leading cultivators, much can be done to increase their confidence in the department and their interest in the work of the stations. Requests for information and advice should be encouraged in every possible way, for amidst much chaff there is often a little good grain. Everything possible should be done, also, to get District Officers to co-operate with the department in carrying out its demonstration work in the districts. If the department is doing its duty, there will be a large amount of unofficial correspondence between its officers and cultivators and the district staff.

The formation of agricultural associations has proved a most useful means of getting the best class of cultivators to co-operate with the department. In the Central Provinces the district is the best unit for which to form an association. Each district should have its own association, the members of which should be the leading cultivators, and a few Government officers who are keen on agricultural improvement, the District Officer being President. In forming such an association, considerable discretion is necessary in order to secure as members the right type of men from among the cultivating class. The men selected should be cultivators who take an intelligent interest in supervising their own cultivation and who are willing to undertake

actual tests of suggested improvements. They should be men of sufficient intelligence to understand simple instructions and to carry them out. The number of members should not be large, but each should be a willing worker and not merely a talker. The District Agricultural Associations started in these Provinces six years ago, have in most cases made satisfactory progress. Among the members will be found the most progressive farmers in each district, men who are anxious to learn and to experiment. The meetings, which are held twice a year to suit the *kharif* and *rabi* seasons, are attended by the Director or one of the Deputy Directors of Agriculture. The results of the past season's tests are discussed and a programme arranged for the next season's work. An officer of the Agricultural Department usually delivers an address describing such experimental work of the stations as may be of some practical use to the members. The members are asked to give their own experience on the particular subject dealt with. New manures and new varieties of seed recommended by the stations are distributed free of cost to the members willing to test them, and they are requested to report the results obtained at the next meeting of their association. To facilitate the writing of this report, forms are furnished, in which the member enters his observation as to the growth and yield of each variety tested, the increase due to the manures and the like. Leaflets written in the vernaculars, giving directions as to how the manure is to be applied and how to grow the crop that is to be tested, are also distributed. The members then carry out these experiments in their several villages. This kind of co-operative work has not yet had time to produce results of much value, but we believe that it may prove most useful as a means of demonstrating to the more backward cultivators the use of new methods, new varieties of seed and new manures; and the plots on which they are successful, in the case of trials with a new variety, may well become centres for the distribution of the seed to neighbouring cultivators. Indeed, the District Agricultural Associations have proved to be much the best means of distributing new and selected seed which

generally receives a fair trial by the members. An instance of successful work in this line is the introduction of the variety of early ripening *bajra* grown in the south of the Provinces to the northern districts, as it escapes the frost which sometimes causes great loss to the late ripening variety locally grown. Seed distribution has largely increased of late, and there is a large and increasing demand by cultivators for improved seed, which the department is endeavouring to meet.

An agricultural paper published in the vernacular can be made a most useful method of disseminating among its readers important experimental results obtained at the stations. It should be up to date, thoroughly practical, and should deal with the immediate needs and interests of the cultivator. It should contain popular statements of the work of the station, with directions to enable cultivators to apply them in their practical work on the farms. Purely scientific articles should never find a place in its pages, for the cultivator does not understand them. In editing such a paper for distribution among cultivators, the translation from English into the vernacular requires to be carefully made. If the work is left to a man who has not been brought up on the land, he often fails to give the meaning of the information which you wish to convey and, being ignorant of local agricultural terms, he gets over the difficulty to his own satisfaction by a free use of Sanskrit which is unintelligible to the villager. The language must be that of the people and not of the court. Such a paper can also be made a most useful medium for advertising improved strains of seed, agricultural machinery and other things for sale at the stations; while by introducing a "query and answer" column the readers are encouraged to ask the department for advice which, when given in this way, often saves the trouble of having to reply in the same strain to several different individuals. The Agricultural Gazette published monthly in Hindi, Marathi and English in these Provinces, has been a decided success. There are already 2,000 subscribers, but this is no measure of the circulation of its contents as, in villages in which only one Gazette is received, it

is the common practice for the *Paudit* of the same to read it aloud to his fellows. With the increasing number of persons taught to read and write, there is a great dearth of reading matter in the village, so that a monthly magazine is a real boon to many.

These in brief are the steps that are being taken to get the results of the stations' work incorporated into the general farm practice of the cultivator. What is required at present is steady work on these lines, perfecting them from time to time in accordance with the dictates of a fuller experience. The work is yet in its infancy and the difficulties in the way of rapid progress are great owing to the paucity and inefficiency of most of the existing agricultural assistants. The better prospects that are now offered to men entering the department should attract men of the right type who, having been brought up on the land, understand the needs of the cultivator and how to meet them; and who, moreover, inherit as by instinct a sense of the dignity of labour.

THE SUGARCANE BORERS OF BEHAR.*

By M. MACKENZIE,

Sniper, Hathwa.

AND

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Introductory.

Cane-growing as an industry has assumed great proportions in Behar during the past two or three years and has evidently come to stay. It is therefore of great importance that growers should know what pests attack sugarcane and how best to combat their depredations. Unfortunately, very little has been so far known on the subject, it being one to which apparently too little time has been devoted. It is hoped that the following remarks will have the effect of inducing others who are interested in cane growing to make further investigations.

It is proposed in this paper principally to give the result of certain observations of Cane Moth Borers in the District of Saran, with notes of their occurrence in Tirhut. The term 'Mothborer' is used to denote a caterpillar which bores in the tissues of the cane plant and which eventually becomes a moth. For the sake of convenience these insects are here separated into three different types, descriptive of their methods of attacking canes. See Plate XXI. They are :—

1. Shoot-borers, those which enter the cane by tunnelling downwards through the shoot or terminal bud.

* The greater part of this article is the work of Mr. Mackenzie, especially the account of the White Borer and the Green Borer. I have added the results of my work at Pusa and have prepared the illustrations.—H. M.-L.

2. Side-borers, those which enter the cane at the side.
3. Root-borers, those which bore into the roots of the cane.

1. SHOOT-BORERS.

Under this classification are two moths, the White Moth (*Scirpophaga auriflua*), the Black Spotted Moth (*S. monostigma*). Both are essentially white moths (Plate XX, Figs. 3, 5, 10), but the latter has a small black speck on each forewing. The hind end of the body is formed by a tuft of hair which is large in the female moth, and is either buff coloured, or the outer hairs are red, the inner buff. The White Moth is much more numerous and does much more damage than the Black Spotted Moth. The latter is not a serious pest in Behar like the former which there does great damage to sugarcane. In some seasons, favourable to the development of this insect, it is probable that at least 80 per cent. of the cane crop is affected by it. The cane, when affected, ceases to grow. The result is usually so serious that the cultivator should at once adopt remedial measures. In the case of these two particular pests, when a field is badly attacked, the cane has a general appearance of drying up owing to the top shoots, which are the portions attacked by the insect, having quite withered, forming what is known as "dead hearts." If a "dead heart" or withered shoot is pulled out by the hand, it is found quite rotted and has a most offensive smell. If looked at carefully, most probably a number of very small maggots, the larvæ of a very small fly, may be seen in the rotted portion. These are not the cause of the withering of the shoot and consequent damage to the cane. The cause must be sought lower down. Under the description of the "Caterpillar," the manner in which it operates will be described. We propose to discuss the life history of these shoot-borers in detail, beginning with the eggs.

Eggs.—The eggs of both moths are very similar in size, shape and appearance. They are elongate, oval and are usually laid in clusters of from sixty to eighty in number, most often on the under side of the fourth leaf from the top, although they may

be found on almost any leaf. The female moth, when depositing her eggs, covers each one in turn with some of the buff hairs from the anal tuft, the whole forming a compact cluster, buff in colour and measuring about a quarter of an inch long by an eighth of an inch in breadth. These eggmasses are not at all difficult to detect by one who knows where to look for them and what their general appearance is like. (Plate XX, Fig. 2.) The female, if disturbed during the process of depositing her eggs, will fly off to another leaf, continuing the egg-laying there, and this doubtless accounts for many of the clusters being smaller than others. As the result of observations during some years, it may be stated that the earliest eggs are laid on cane about the first week of March, preferably on young cane planted during the previous October, but also on older cane. Cane planted in January or February is generally too young to attract the moth at so early a stage, and it will generally be found that their attacks on such canes do not become general until the middle or end of March. The eggs usually take from eleven to twelve days to hatch out, as found by observations on moths kept in captivity. In captivity, the eggs are deposited on the second night after the emergence of the moth from its chrysalis. Such eggs laid on the night of 5th March hatched out in twelve days, and some laid on the 8th March in eleven days; therefore, the period of incubation is from ten to twelve days. The white Shoot-borer moth, *S. auriflua*, also affects *nuni* grass (*Saccharum ciliare*) and the eggs are also found in great numbers on a grassy reed which grows in rice *jheels*. This, of course, complicates enormously any remedial measures which might be taken for their extinction. It was found, in nearly all cases of eggs deposited on reeds in *jheels*, that minute parasitic wasps kept the pest within reasonable limits.

Caterpillar.—On the first day of emergence these are about $\frac{1}{12}$ of an inch in length, very active little insects with head and thorax shining black, a narrow whitish band between thorax and body above, body reddish brown studded with erect spines or hairs longer than the thickness of the body. On the second day they apparently shed their skins, the head and thorax became reddish

brown, the thorax and body a very pale green with dark dorsal line (pulsating heart), the hairs on the body were few and short, and the length of the larva about one-eighth of an inch. These observations were made from insects hatched in captivity, no observation being possible after the second day owing to their disappearance from the breeding cage. The young larvæ lose very little time after hatching, in boring into the unfurled leaves on terminal shoots of the cane stem; they eat their way through the shoot, the effect of which on the shoot is to produce a great number of small holes or, as they have been described, "shot holes." After penetrating the leaf, they burrow down until they reach the sappy portion of the cane stem from which point the real work of destruction commences. It is a remarkable fact that, although many of the young larvæ penetrate into the growing terminal shoot, only one insect is in possession by the time the sappy portion of the cane is reached. We do not know what happens to all the others, but it would seem reasonable to conclude that being less fortunate or less vigorous, they are forestalled in the race for the stem, and quit that particular shoot for other shoots close by. Probably during this dispersal, many are destroyed by predatory insects and birds, and no doubt parasitic insects also attack them, so that a small proportion of young larvæ survives to damage the cane. If every insect hatched from a cluster of eggs entered growing cane, the results would be dire indeed, for boring by this insect causes the upward growth to stop or the whole plant to die if it is not of vigorous growth. The boring insect eats its way downwards through at least three or four joints from the top or should the joints or nodes be very close together, as often happens, six or even seven internodes may be tunnelled. During this process of boring, a period of some 22 days has elapsed, and the larva meantime has acquired a length of about three quarters of an inch. The colour of the insect now is a dull creamy white, the intersegments and dorsal streak darker, with a few scattered hairs all over the body; the head is pale yellow. The boring stage in the life of the insect has now been about completed and it is time for it to enter into

the chrysalid stage. With this object it bores at right angles to the original tunnel until it reaches the bark of the cane from which it cuts out a circular section about the size of a No. 2 shot. This section it attaches again to the hole by a gummy substance from its mouth; thus a cover or door is formed through which the perfect insect can later on emerge, and a protection is provided against the inroads of ants or other dangerous insects. During the active period of the borer's life and while boring down into the cane, it covers its retreat with the "frass" or excreted portions of the cane, but when nearing the final stage of its boring it retains a considerable length of the lower portion of its tunnel about twice its own length free from such ejections, and this portion it lines with a coating of silk. After having closed up the hole of exit it retires to the further end of the silk-lined chamber, spinning silken partitions at frequent intervals during its retreat, as many as ten or a dozen such being sometimes made. It is thus thoroughly safeguarded against outside danger, and transformation into a chrysalis begins. In this chamber it remains head down and towards the hole of exit, until the pupal stage is complete.

The larva, unlike that of the other moth-borers referred to later, if released from its burrow, is quite incapable of shifting for itself. It is unable to burrow into the ground or hide itself underneath clods on the surface of the soil, and cannot transfer itself to another cane: it is quite a harmless insect. Experiments made by placing it under loose soil in close proximity to a piece of cane have proved that it fails to enter the cane and will die where placed.

The effect of the operations of this borer on young canes is most disastrous. The shoot which has been attacked usually dies, as it is too young to withstand the shock. In old canes, on the other hand, the cane does not die, but all further growth of the sugar-producing stem is entirely stopped and the top six inches of the cane is quite unfit for crushing. The eyes or buds of this portion of the cane throw out long shoots which, must detract very considerably from its sugar-producing value. The existence

of these shoots is typical of a cane bored by the White Moth Borer, and the cane exhibits the appearance of having a tuft of green shoots at the top with the withered shoot or "dead heart" in the centre. (Plate XXII.)

Chrysalis.—The chrysalis under ordinary circumstances remains in a motionless state within the silk-lined chamber for a period of from ten to twelve days. The pupa of the male is much smaller than that of the female, the former measuring about half an inch, the latter about three-quarters of an inch. At the expiry of the period mentioned, the moth breaks through the chrysalis case and emerges from the cane. How it gets rid of the intervening partitions and finally makes its exit can only be conjectured as the moth has no apparatus for eating through them. Possibly it forces its way through or scratches through them with its forelegs. The emergence usually takes place about an hour after sunset. (Plate XX, Fig. 17.)

On first emerging, the moth is not perfectly formed, or the wings have still to open out, and probably for fully an hour the moth is unable to fly. Mating takes place the first night and eggs are laid on the second night.

The entire period occupied for one generation from egg to moth will thus be seen to be from about 45 to 50 days, and if we take the period of activity of the pest in cane as from 1st March to end of October or say middle of November, we shall not be far wrong in considering that there are from five to six generations of the moth during the year. Cane planted early in October had the caterpillar in it in November, but it was found that these caterpillars, instead of going through the usual transformation into the chrysalis, remained within the cane in a dormant state until the following February, when instead of going on feeding again they became chrysalides, and after the normal period of pupation emerged as moths to begin the fresh cycle of their existence. This is the normal method of hibernation, and in the ripening cane at Pusa not cut till January or February, abundance of dormant larvæ were found.

Remedies.—The planter is doubtless interested in the fact that the borers attack his cane, but his chief interest lies in preventing attacks by these insects. To prevent attack altogether is, so far as is known at present, quite impossible, but a very great deal can be done to mitigate the severity of the attack, if prompt measures are used at the commencement. These consist of capturing any moths found sitting about on the leaves, the hand picking of the egg clusters when the cane is about a foot to eighteen inches high and the rigid cutting out of "dead hearts." The egg clusters are really not difficult of detection, and a smart coolie can keep about two acres under check if he goes over this area daily until the cane becomes tall and leafy. The following history of a two-acre plot of *shamshu* cane planted on 29th October 1904 with a view to the observation of insect pests illustrates the beneficial results which can be obtained by egg-picking. The cane germinated freely, and was apparently free from all insect attack until on 9th February 1905 numbers of the White Shoot-Borer Moth were observed on the plants. The cane on account of the cold had previously made but little growth. Killing the moth by hand was at once resorted to, and daily for about ten days, hundreds of the moths were destroyed. At this time, egg clusters were noticed in considerable numbers and to cope with these, one small but sharp coolie boy was put in charge. This little fellow, working assiduously from morn till evening, had, at the end of each day's work, collected several buckets full of the eggs. The leaf on which the eggs were deposited was plucked and the portion on which the eggs were situated was placed in the pail. The results of the day's work were burnt in the evening. About a fortnight after the first moths were observed, indications of "dead hearts" became apparent, and the cutting out of these, at or below ground level, also came within the duty of our small coolie. These latter were collected in small heaps, and underwent the same treatment every evening as the eggs. Daily, from 24th February until the middle of April, the operation of egg-picking and cutting out of "dead hearts" went

on, until the canes became so tall and leafy that detecting either eggs or "dead hearts" became very difficult. Every cane seen to be affected was cut out and the appearance of the crop represented only a 30 per cent. germination. Often the old factory *Jemadar* pleaded for a cessation of what he considered to be sheer and wanton destruction on the part of the over-zealous *sahib*, but it soon became self-evident even to the happy-go-lucky native servant, that the cutting out had encouraged tillering, several shoots had sprung up where there was only one before. Throughout the following rains that particular plot was singularly free from "borer," and on 1st November was cut down to provide seed for November planting elsewhere. The weight of stripped and topped cane taken off this two-acre plot was 3·6 tons, of which only ·07 tons were rejected as being unfit for seed, all bored or otherwise injured portions being carefully eliminated. The remaining and adjacent portion of this field, some nine acres, was planted out with *shamshara* cane in the month of March under conditions of cultivation similar to the two acre plot, but there was no collecting of eggs or cutting out of "dead hearts." The outturn of stripped and topped cane was only 12·4 tons per acre as against 19·3 tons per acre from the experimental plot. There is no doubt that the treatment produced beneficial results.

"Dead hearts" in young cane can be cut out until the cane is about three feet high, afterwards it is difficult or impracticable to continue the work. The shoot should be cut at a point below where the "borer is at work; this is easily ascertained, for, if the cut is made above that point, the portion already bored will be quite apparent and the shoot should be cut lower down until it is certain that the borer has been cut off. The three chief methods then open to the cane cultivator are:—

First, killing of moths found resting on the cane plants.

Second, hand-picking of the egg clusters.

Third, cutting out of all "dead hearts."

The destruction of useless canes by burning is important as they may contain borers, but it is a wasteful practice to burn the

trash (dry leaves, etc) as this stuff does not harbour cane insect pests. It is better to use the trash as litter for cattle or put it in a compost pit.

There is one other point of importance respecting this pest; it spends the winter in the caterpillar state in the top of the cane, and such a cane can be known by the number of shoots that have grown out on each side at the top, forming a bunchy top. Where cane is being cut from November to February the destruction of these bunchy tops should be rigidly carried out since every one allowed to stand over till late in February may mean a moth hatched out; such tops may be fed to cattle, or chaffed up or put in a compost pit: they must never be allowed to lie in the field or be stacked, since the moths would then have no difficulty in hatching out and laying eggs. (The habits of *S. aurostigma* are so identical with that of *S. excipiens* that a separate description is not necessary.)

In addition to these remedies, nature has provided one which is the most beneficial of all. This is the attack of parasites on both eggs and larvæ. Were it not for the check imposed by these parasites, cane growing would be out of the question. Minute parasite wasps deposit their eggs in the eggs of the moth and in course of time, instead of young larvæ of boring moths being produced, perfect wasps emerge. Large parasitic wasps (*Braconida* and *Ichneumonida*) deposit their eggs in the bodies of the borer larvæ, and thus keep them in check.

The following suggestion was made in "Indian Insect Pests" in connection with the collecting of egg clusters. "These eggs should not be destroyed but be put in a tray or dish standing in a larger dish of water or into a tray with a gutter of water round the rim. The parasites hatch out and fly away; the caterpillars that hatch, die being unable to cross the water. In this way the parasite is not destroyed, but continues to do its good work in the canes."

1. SIDE-BORERS.

Four different species of Side-borers have been recorded, *viz.*, the common Moth-borer (*Chilo simplex*), the Gold-Fringed Moth-

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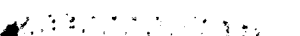

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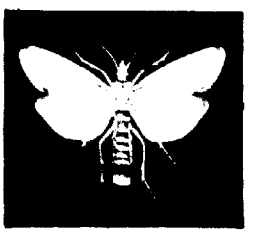

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borer (*Chilo auricilia*), the Pink Borer (*Nonagria uniformis*), the Green Borer (*Laccastia ablutella*). Of these, the first is usually greatly in excess of the second in numbers and the third not very plentiful, while the fourth is pretty common. Although none of these are so numerous as the Shoot-boring Moth already described, still they are a very real and deadly pest to cane.

The Moth-Borer.

(*Chilo simplex.*)

For all practical purposes a description of the mode of operation of this species will suffice for that of *Chilo auricilia*, as in so far as cane is concerned, their methods are identical.

Eggs. The eggs of both species have been found in the cane fields at Pusa but only in small number. (In captivity, both species have deposited their eggs freely, but this does not help us to discover them in the field: they occur freely on the cane leaves in Surat and Poona (Plate XX, Fig. 1c). The reader should consult the article on this pest in this Journal, Vol. I, no. 2, page 97.

Caterpillar. The young caterpillar, on emerging from the eggs, may enter the young cane shoots when from eighteen inches to two feet high either just above ground level or at any point higher up to within say a foot from the top of the shoot. In the former case it will tunnel its way upwards until it has consumed all the sappy portions of the stem when it will leave that and enter into an adjacent one. In the latter case it will bore down until it reaches the root stock and will pass from shoot to shoot until the period for its pupation arrives. At this stage it bores laterally, cutting a small round hole of exit in the rind which it completely closes up with a web of silk. It then retires within the burrow and undergoes the chrysalis stage. The hole of exit is always above ground level. *Chilo auricilia*, unlike other identified cane borers, allows others of its own species to occupy the same burrow, as many as three having been found in the same

tunnel. Later on when the cane grows taller, many separate burrows, occupied by different borers of this species, are frequently met with. The description given above refers to the cane in its earlier stage of growth and before defined nodes appear. In the earlier stages the boring results in a "dead heart" as in the case of *Scirpophaga auriflua*, and on plucking out the dried tip one can almost always tell by a casual examination of it which of the two borers have been at work. In the case of "*Chilo*" no punctures showing the entry of the insect will be found, whereas in the case of "*Scirpophaga*," as a rule, numerous small holes will be found showing where the young larva has penetrated into the growing tip prior to tunnelling its way down the stem. Later on, when nodes have appeared in the cane, the attacks of "*Chilo*" show no signs of a "dead heart," and it is likely that the progress of growth of the affected cane, although retarded, is not stopped.

The larvæ tunnel in the old canes in a very distinct fashion from that of *Scirpophaga*. It is not uncommon to find them in the shoot above the cane, feeding much in the same way as does *Scirpophaga*, not destroying the growing point or killing the shoot; in this case they frequently eat downwards, but they come in and out of the cane, eat round it, and do not behave in the same uniform manner that marks the *Scirpophaga* larva. More larvæ were found in the cane, in the internodes, at any point above ground; the larva eats into the cane, feeds inside and may destroy a few joints, or may come out and go in again elsewhere. It is common to find several holes made by one larva. When the larva becomes full fed (Plate XX, Fig. 15), it eats a hole to the outside, spins a few threads across and retires to transform to the pupa. (Plate XX, Fig. 16.)

Chrysalis.—The period occupied in the chrysalis stage is from ten to twelve days in cool weather, though only six to seven in hot weather. The moth emerges through the hole of exit previously prepared by the larva.

Moth. The moth is wholly nocturnal and does not rest openly on plants in the open, as does the White moth. It is

therefore practically never seen and will only be found if a light is placed in the field. (Plate XX, Fig. 4.)

Hibernation.—Normally hibernation occurs as a resting caterpillar or a chrysalis in cane or some other food plant. In Behar, the moth comes out late in February or early March and also in June. The caterpillar lives in rice, maize and various millets as well as in cane, and hibernates in any of these crops which may be standing. It is noticeable that when early maize is grown, enormous numbers of the caterpillars often occur in it, not boring in the stems but living in the green shoots or in the male flowers. From observations at Pusa, it is clear that the maize crop is very much more infested than is cane while the maize stands and this is probably the reason why this borer is so much less destructive than it is in Bombay for instance. There is much less loss to cane from this pest in Behar, and there is a much greater proportion of it in maize and similar crops, where it is not really very destructive.

Remedies. Until the eggs can be located, there is little use suggesting gathering them, so that the next best method is cutting out "dead hearts" and burning them in the early stages of the cane. Later on this cannot be done, without incurring very great loss of cane. To exterminate the pest altogether is absolutely out of one's power, for "*Chilo*" lives, moves and has its being as much in maize and jowar (*Sorghum vulgare*), etc., as in the cane. The fodder of these crops is stored in stacks, and in these the caterpillar which is hibernating, finds its home throughout the cold weather, emerging in great numbers as moths whenever the weather begins to get warm. It has been suggested, that burning the tops of the cane during the crushing season is beneficial as a remedy for "*Chilo*," but this cannot be, for "*Chilo*" is not found in the tops at that stage of the cane's existence.

Pink Borer.

(*Nonagria uniformis.*)

Another Side-borer which commits considerable damage is the caterpillar of a moth previously undescribed, to which the

name of *Nonagria uniformis* has been given by Mr. Dudgeon. This is the largest of all the cane borers referred to in this paper.

Eggs.—We have not discovered where the mother moth lays her eggs in a state of nature, although in captivity the eggs are freely deposited on the leaves of cane. In wheat and rice the eggs are laid in clusters on the leaves near the stem: they are round white eggs, not flattened as are the eggs of the ordinary borer.

Larva.—The caterpillar is most easily recognised by its colour: it is a smooth caterpillar, with few short hairs, a brown head and a distinctly pink tinge over the whole body. It grows to a length of 1½ inches and has no brown spots on it (Plate XX. Fig. 13) as has the caterpillar of the previous borer (*Chilo simplex*). The newly hatched caterpillar enters the young cane shoot or stem at or just above ground level, tunnelling its way upwards for a considerable distance, then returning to continue its burrow downwards, stopping short, however, at the point where the shoot springs from the parent sett. It follows this routine in several canes until it is fully fed, when it leaves its tunnel within the cane, and establishes itself between the cane stem and its outer sheathing leaf. In this position it weaves around itself a casing consisting of small portions of the cane finally shredded and minute pieces of the stem itself, which the insect gnaws into fine particles resembling sawdust. Within this casing it pupates. Although when actively feeding, each caterpillar appears to monopolize a stem to itself, several will congregate within the same sheathing leaf and pupate in close proximity to each other. We found larvæ of this moth as early as the 5th of May, and specimens were constantly found up to 27th August. Diligent search would probably determine that they operate much earlier and later than the dates given. They have been found in all varieties of cane grown in Behar.

Chrysalis.—The chrysalis stage covers a period of nine to ten days, the moth emerging at the upper end of the enveloping cane leaf. (Plate XX. Fig. 14.)

Though found in cane, this borer is far more frequent in other crops and it would be found abundantly in cane probably only when these were not grown. It is very abundant sometimes in rice in the late rains and early cold weather: in January the moth comes out and lays eggs on wheat, which is attacked freely in February. The insect then attacks the cane and has later been found in maize, jowar (*Sorghum vulgare*), other millets and guinea grass. Its period for attacking cane may then be a short one, where not much cane is grown in comparison with other crops, and its importance in cane is usually much less than its importance as a pest of wheat and rice.

Green Borer.

(*Leucania albistilla*.)

This is another Side-borer which was found in great numbers when the young cane was about three weeks to a month above the ground. It has been identified by Mr. Dudgeon as *Leucania albistilla*, Zell. We have not yet discovered where the moth lays its eggs, but specimens of the caterpillars were taken from the young canes continually from 1st April to 20th May.

The young caterpillar enters the cane shoot just below the surface of the ground, and first of all eats its way up the stem for about three inches and then tunnels down until it reaches the juncture of the stem with the planted cane, or should by this time the attacked stem be showing signs of joints, the larva will stop short at the first joint, and as a rule never penetrate through the joint. It then leaves that shoot and enters an adjacent one and goes on feeding for probably a period of three weeks. Larvæ about a week old were collected on the 1st of April. They became moths on the 22nd April. It is pretty safe to reckon 21 days for the larval stage and eight to nine days for the pupal. This borer leaves the cane and pupates in the ground: therefore it is difficult to determine when the latter stage is entered. The mature larva weaves in the ground a small round cocoon of silk

to the outside of which it attaches small particles of soil. This cocoon measures about $\frac{3}{8}$ of an inch and would be quite indiscernible to an ordinary observer. The usual "dead heart" is the sign that the cane has been attacked, and the only remedy so far known is cutting out the affected stems. The caterpillar is very active in its movements when out of the cane, and if left to itself, will, in a second or two, disappear under the ground. It is bright green in colour (Plate XX, Fig. 11), and cannot be mistaken for any of the other known cane borers, and measures about $\frac{3}{4}$ of an inch. It would appear that the larvæ of *Isocratia abbatella* runs through only two generations in the year at least in cane, but further investigation on this point is required. During the greater part of May and from that time on to the 27th of August the larvæ remained in a lethargic state down in the roots of the cane. It was, therefore, concluded that they were passing through a period of dormancy. Specimens of the caterpillar were also kept in captivity in the cane roots dug from the field, and these remained in this dormant state, and as larvæ until the following February when they pupated and bred out into moths in March. No insect has been observed as parasitic on the green borer. This pest has only been observed in Behar in a cane called *Laugara*, which was imported from the United Provinces. Irrigation kills quite a large proportion of those which happen to be at the time, either feeding in the cane stem below the water level or in the ground, while passing from one cane stem into another.

3. ROOT-BORER

(POLYOCHA SACCHARELLA.)

Perhaps the most deadly of all the cane borers is one which attacks the roots. Most fortunately they do not appear to be numerous as either the White borer or the ordinary borer, but nevertheless this insect is responsible for a great amount of damage attributed to white ants and other causes. The body of this caterpillar is white with intersegmental rings darker, the head light brown—length from $\frac{3}{4}$" to 1". (Plate XX, Fig. 12)

This caterpillar, like that of the other cane borers, would appear to become active in cane from about the time the cane is three weeks to a month old, generally about the end of March or beginning of April. It is, of course, difficult to say with any degree of certainty, seeing that it confines its operations entirely to the roots of the cane, and consequently its attack is not detected so soon as that of the other borers. The earliest specimens were obtained on 24th April. From that period, right on throughout the hot weather and rains specimens were taken and all of them appeared to be actively operating on the cane roots. On 25th November specimens were collected which at the time had every appearance of hibernating and afterwards proved to be so; for they did not emerge as moths until 20th to 22nd of the following April, during the whole of which period they were not feeding. They commence their life by boring into the cane stem low down, from which point they pass into the roots, where they spend the remainder of their existence as larvæ. As many as eight of these borers have been taken from the roots of one root stock. The result of the attack of this pest is that in a great many cases the whole stool dries up, or at any rate has a stunted or shrivelled up appearance. When the larva is about to pupate, it generally selects a dried-up stem standing perhaps a few inches above ground and the dried-up terminal shoot of which has fallen off, up through which it burrows to the end; at this point it weaves a sort of dome or tube of silk to the outside of which it attaches portions of the frass (borings from the tunnelled stem). This dome stands up from the end of the stem about an inch to 1¼ inches, the top being closed. The larva then retires down into the roots and when in due course the moth emerges, it makes its way out by eating through the upper end of the dome.

The effect of a bad attack of root borer is to dry up the whole of the affected plant. From the period at which the attack commences, the shoots assume a sickly and stunted appearance and as a rule no canes are ever formed, but even should

they be, these will ultimately, and long before they are fit for the mill, entirely dry up. This borer has been found to be far more abundant in some localities than in others. In Pusa, newly planted canes have not been much attacked, but some thick canes, kept as ratoons, suffered very severely. This will readily be understood as the insects hibernate in the shoots and go on attacking the ratoons when the warm weather comes; as shoots are formed, they are destroyed and the work of this borer can usually be detected easily by digging up ratoon shoots that are not thriving and cutting into the underground parts of the shoots. It is unfortunately difficult to distinguish the work of this insect from that of the other root eating insects, notably the weevil and the cockchafer, which both attack cane below ground, unless one finds this caterpillar or its chrysalid habitation.

This borer is not yet known to attack anything but cane, and cane planters will do well to pay attention to it if they find shoots dying off, not as "dead hearts," but wholly and from some point below the soil. There is one important point in the treatment of this borer, and that is, to take up the stools of canes as soon as possible after the canes are cut and either put them in a real compost heap under several inches of earth or burn them outright. When canes are cut before the end of the cold weather, great numbers of root-borers can be destroyed in this way and even in the case of canes cut after February, it is very important and practically the only check.

In the above pages no less than seven distinct insects are referred to. We have refrained from describing moths in detail except in the case of the White borer, because to the ordinary observer, they are so extremely similar. The moths of the common moth-borer (*Chilo simplex*), of the Gold Fringed Borer (*Chilo auricilia*), of the Pink Borer (*Nonagria uniformis*), of the Root-Borer (*Polycha saccharella*), of the Green Borer (*Lucas ablutella*), are all the colour of a dry grass stem or a withered cane leaf: the differences between them are shown in the plates but, for the most part, their recognition depends on characters it is needless to give here. For the planter it is important

to be able to identify the caterpillars, and the following briefly summarises the important points:—

A green caterpillar found in the young canes in April, May, June, is the Green Borer (*Anerastia abbatella*). (Plate XX, Fig. 11.)

A pink caterpillar, found in either the young canes or in the jointed canes is the Pink Borer (*Nonagria uniformis*). (Plate XX, Fig. 13.)

A pure white caterpillar found below the soil level and boring in the underground parts of the shoots is the Root-Borer (*Polyocha saccharella*); it will be found from April to November. (Plate XX, Fig. 12.)

A pure white caterpillar found in the young shoots or in the top only of the jointed cane, and always destroying the apical growing point, is probably the White Borer (*Sciopepliaga exigua*), but may possibly be the Black-spotted Moth Borer (*S. maculigma*). As both work alike, it is immaterial. (Plate XX, Fig. 14.

Finally, a dirty white caterpillar, with either distinct brownish spots or with vague bands of dark colour, found in the young shoots, causing "dead hearts," or in the joints of the canes (not in the top shoot), is either the common borer (*Chilo simplex*) or the Gold Fringed Borer (*Chilo auricilia*): as both work alike and are distinct only in the moth stage, it is immaterial which it is (Plate XX, Fig. 15). The following table may help in summarising the matter clearly: it must not be taken too literally in the case, for instance, of Pink Borer in June.

	White Borer.	Moth Borer.	Green Borer.	Pink Borer.	Root Borer
January	Hibernating in top shoot of cane.	Hibernating.	Hibernating.	Moths out. Eggs laid on wheat.	Hibernate in soil or cane.
February				In wheat	"
March	First moths out. Commencement of first attack in young cane.	First moths out. "Dead hearts" in young cane.	First moths on	In wheat. Eggs on young canes.	In young canes below ground.
April	Causing "dead hearts" in young cane.	Causing "dead hearts" in young cane.	Causing "dead hearts" in young cane.	In young cane	
May	"	"	"	"	

	White Borer.	Moth Borer.	Green Borer.	Pink Borer.	Root Borer.
June	In top shoots of cane.	In cane and other crops if available.	Causing "dead hearts" in young cane.	In cane, guinea grass or other crops.	In [illegible] shoots below ground.
July	,,	In cane, maize, janera, etc	Hibernate as caterpillars in soil.	In cane, maize, etc.	,,
August	,,	,,	,,	In rice, cane, maize, etc.	,,
September	,,	,,	,,	In rice chiefly.	,,
October	,,	,,	,,	,,	,,
November	Hibernate as caterpillars in top shoots of cane.	Hibernate as caterpillars in cane, in stubble, in janera stalks, etc.	Hibernate as caterpillars in soil.	,,	Hibernate in soil or in cane shoots.
December	,,	,,	,,	Hibernation in rice stubble	Hibernate.

Conclusion.

We may shortly summarise the treatment of a cane crop in Behar as regards Moth borers, commencing with the planting and including some precautions necessary for other pests.

The plant cane having been cut into setts, the setts are rejected if bored, and if sound, are dipped into either Bordeaux mixture or a cold solution of copper sulphate (bluestone) in water. This checks white ants. The young canes are periodically gone over, all "dead hearts" cut out, all eggmasses collected; the former are destroyed by burning, by being chatted and fed to cattle or by burying in a compost heap; the latter are taken from the cane field and simply exposed where the parasitic flies can escape or are left in the field in a proper dish or tray surrounded with water. Cutting out "dead hearts" should continue till May or June, egg collecting as long as possible.

If possible, an early crop of maize should be grown to attract the common Moth Borer (*Chilo*), and if this is full of the caterpillars, it should be fed to cattle or treated in some manner that will destroy the caterpillars. When the cane is being cut, all "bushy tops" should be properly dealt with, as containing White Moth Borers: the rejected bored canes which are usually left on

MOTH BORERS IN THE CANE PLANT

field as worthless should be collected and properly destroyed; as soon as possible after cutting, all stumps should be taken and so dealt with that the Root-Borer will not be able to plete its life. At the same time, it is worth while making tain that the stacked fodder is not a source of danger by ding Moth borers (*Chilo*), and that the stacks are properly ered in so as to prevent the escape of the insects.

These are the only practical precautions that can be taken inst borers, and they are within the reach of every cane wer in Behar. If they are properly carried out, the great loss w sustained from borers will be reduced and the present low ld of cane per acre increased.

EXPLANATION OF PLATES.

PLATE XX.

Fig. 1 Eggmass of Moth Borer (*Chilo simplex*)
" 2. Eggmass of White Borer (*Scirpophaga auricilia*).
" 3 Black Spotted Moth (*Scirpophaga nivella stigma*)
" 4 Moth Borer (*Chilo simplex*)
" 5 White Moth Borer (*Scirpophaga auricilia*).
" 6 Moth of Pink Borer (*Nonagria uniformis*)
" 7 Moth of Root Borer (*Polycha saccharella*).
" 8 Moth of Green Borer (*Ancrastia ablutella*)
" 9 Moth of Pink Borer (*Nonagria uniformis*).
" 10 White Moth Borer (*Scirpophaga auricilia*).
" 11 Green Borer (*Ancrastia ablutella*)
" 12. Root Borer (*Polycha saccharella*)
" 13 Pink Borer (*Nonagria uniformis*)
" 14 White Borer (*Scirpophaga auricilia*)
" 15. Common Borer (*Chilo simplex*)
" 16 Pupa of Moth Borer (*Chilo simplex*)
" 17 " of White Borer (*Scirpophaga auricilia*)
" 18 " of Pink Borer (*Nonagria uniformis*).
" 19 " of Root-Borer (*Polycha saccharella*)

Plate XXI.

Diagram of Cane Plant, showing work of borers in red. 1. Above is the track of the White Borer through the growing point out to the side. 2, 3. The track of two Side-borers in the joints is shown below, these being the Common Borer and the Pink Borer. 4. The track of the Common Borer (*Chilo*) in a shoot, the growing point not specially attacked. 5. The Root-Borer in the soil level. 6. The Green Borer in a shoot going down to the soil level.

Plate XXII.

Bushy Tops of Cane, containing White Borers; these were cut in February and should have been fed to cattle at once.

PLATE XXII.

F. J. Bunchy Tops of Canes attacked by White Borer.

THE HAND MAIZE SHELLER.

By J. M. HAYMAN, D.V.S. (Montreal, Canada),

Deputy Director of Agriculture, U. P.

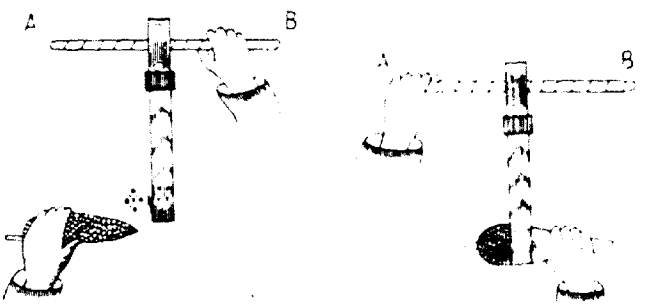
This is a small hand implement for removing the grain of maize from the cob. The principle of working is based on the motion of a screw. The idea originated from a spring which, if made to travel up a cob, will remove the grain by its free end. But the spring, owing to its want of expansion, cannot accommodate itself to the varying thickness of the cob throughout. Hence it became necessary to cut it in two and attach, in the form of a handle, a spring which would allow it to expand, at the same time retaining and improving its screw form. By gradual changes and improvements it assumed the shape shown on Plate XXIII, consisting of a wooden cross handle turning in the head of the implement two wood V-shaped springs, continuous with the head, and having at the other end the sheller in iron or brass. Externally appearing in the shape of two opposed hands, while the internal side of the opposing and somewhat bent fingers form a female screw set to a suitable pitch, so that when the point of the cob is applied to the sheller and the implement rotated by means of the cross handle, the screw grips the cob, and the sheller travels along it by reason of its screw arrangement, while the thumb of the hand removes the grain. The V-shaped wooden springs allow the hands to expand and accommodate the working of the sheller to the varying thickness of the cob. A ring at the base of the springs can be slipped forward in the case of extremely thin cobs, or if the springs should become weak with continual use, thus making it efficient again at once.

The method of working is as follows :—

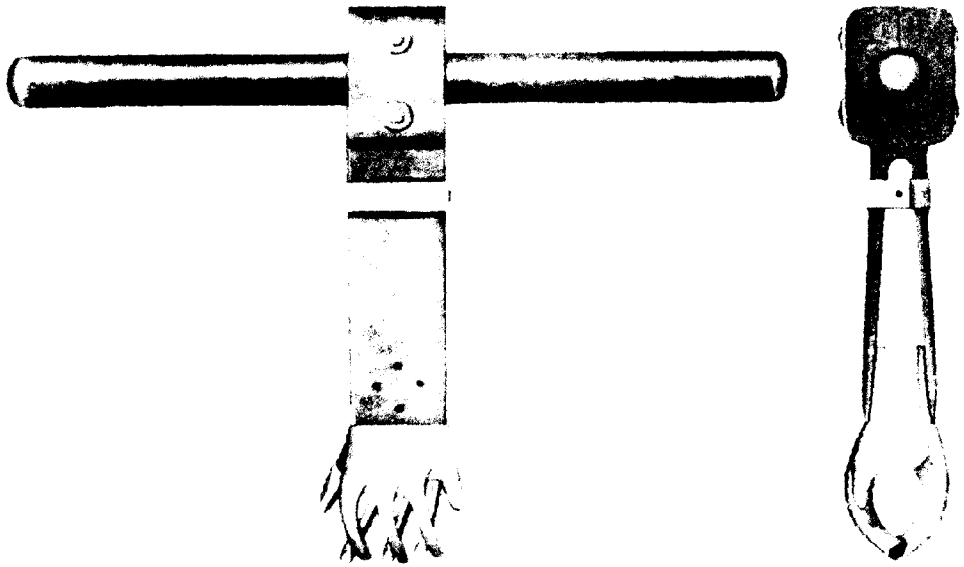
Grasp the cob at the thick end with the left-hand, then take hold of the handle (B) of sheller with the right-hand. Apply the thin end of cob to *. Then turn the sheller round and round. The thumb and fingers of the sheller will be found to remove the grain and at the same time the sheller travels along the cob. When the sheller has reached about the middle of the cob change hands, grasping the handle (A) of the sheller with the left-hand and the thin end of cob with the right. Then continue the revolving motion.

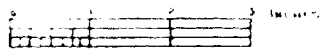
FIRST MOTION.

SECOND MOTION.



The sheller varies in price from twelve annas to one rupee four annas according to make. At the latter price the metal parts are brass and the whole implement generally all round made with a smarter finish. The implement is simple, has nothing to get out of order and can be worked by any boy or woman without fatigue. About 2 maunds of grain can be shelled in a day.





A. J. J.

THE HAND MAIZE SHELLER.

AGRICULTURAL SAYINGS IN BENGAL.

By JAMINI MOHAN GHOSH, B.A.,

Mymensingh.

Every country has its sayings, and it is in the fitness of things that as one of the foremost agricultural provinces in India, Bengal should possess a wealth of agricultural folk-lore.

Like other folk-lores of Bengal, these agricultural sayings are attributed to Khana, a mythical lady, who is said to have been gifted with supernatural astrological knowledge. The reason of enshrouding them with legendary mystery, so common in this country, may be to lend a religious sanction to them, so that they may be scrupulously observed by the intensely religious peasantry of this country. These sayings are mostly in the form of couplets, dealing with the various aspects of cultivation, and are represented as being addressed by Khana to her father-in-law, Baraha. Nevertheless they very often betray in their language and observations, the rhymer to be no other than a tiller of the soil. For who but a cultivator would characterise the "uncertain heaven" with patches of clouds, as a field "broken up with axe and spade," or would consider it "a favour of Luxmi (goddess of Fortune) to have the compound of his house filled with water-gourd and cucumber" and feel "her presence when his thatched roof is covered with leaves of water-melon."

That the true cultivator must needs labour on his own soil is expressed in the saying that "he who himself works or employs labourers gains heaps and he who takes umbrella on his shoulder (i.e. supervises the labourers in his fields) gains half, while the cry for want of rice rends the house of him who asks questions

(of his labourers) remaining idle in his house." Neither should one have partners in his field, for "only father and son should plough one's field, failing which take only one's own brother." Again, says another proverb, "he who having oxen does not plough suffers misery for ever."

Rain is an important factor in the agriculture of India. And it is, therefore, only proper that in Bengal, where there is practically no irrigation, a large portion of agricultural sayings should relate to rainfall.

Rain from about the middle of November to the middle of January is very injurious to the ripening paddy crop, and hinders the gathering, drying and threshing of the crop, so run the couplets,—"If rain falls in the month of *Agrahayan* (middle November to middle December) the king himself goes a-begging" (signifying famine). Also, "if it rains in *Pous* (middle December —middle January), even the husks bring money (so great is the scarcity)."

On the contrary, rain is very welcome from February to April as the ploughing and sowing season commences, and a moist soil is easy to be ploughed up, so goes the proverb: "If there be rain during late *Magh* (*i.e.*, early February) the holy land is of the blessed king" (meaning there is the indication of a prosperous season) and also "if it rains in *Chaitra* (middle March —middle April) there will be growth of paddy."

Again, small millets are helped by a shower in late February or early March, and we have "if it rains in *Falgun* (middle February—middle March) *Cheno* and *Kaon* (small millets) grow twice."

Drought in late May and early June assists the young seedlings of paddy to grow instead of being swamped by rain, but during next two months, *i.e.*, the rainy season, we must have rain for them, as also for sowing late paddy in the high lands; this is expressed in the familiar sayings: "(If there be) a drought in *Jaistha* (middle May—middle June) and shower in *Ashár* (middle June—middle July) the earth cannot bear the burden of crops."

During the rainy season, an easterly wind would sometimes disperse a gathering cloud and without rain there is very little prospect of a good harvest, so "if there be easterly wind in *Ashar* and *Sraban* (the rainy season)," the cultivator is advised to "hang up his plough and go to commerce."

Rain is very much appreciated by the peasants in *Kartic* (middle October—middle November) and is known in these parts as *Kátái*. It helps the ears to come out, and is very necessary for the development of the corn, and "Khana says that a little rain in *Kartic* (gives) twice paddy."

Now, having completed the cycle of sayings on the effect of rainfall throughout the various months of the year, we shall give some of the sayings on the signs of rain. How far they are predictive I have not been able to test, and I give them for what they are worth. But in some of them at least, there is some truth as in the fact that "when the frog croaks incessantly, know it will rain soon," but with this is coupled the rather incredible saying in which "Khana says that if it blows north-east on the first day of the year, there will be (ample) rain."

The ninth day of the new moon in *Ashar* (*i.e.*, late June) is regarded as a very significant day by the cultivators, and rain or drought on this day is believed to give the forecast for the year. Says Khana, "Father in-law, what's the need of calculating, for if on the ninth day of the new moon in *Ashar*, it rains heavily, herons will walk over mid-ocean (meaning there will be drought), if on the other hand there be a few drops of rain, fishes will abound even in the mountain (*i.e.*, there will be heavy rain throughout the year), also if it drizzles the earth will shake under the burden of crops, but if the sun (after the day's labour) takes his throne smiling (*i.e.*, if there be a cloudless afternoon) the cattle of cultivators will be sold in fairs" (meaning a very bad year for them). The rainbow is also supposed to give indications for the year and we have "if there be rainbow on the west (sky) there will be drought throughout the year, while if there be a rainbow on the east there will be storm and rain.

A writer in an Indian agricultural paper vouches for the accuracy of the saying that "if the days be cloudy and the nights starry, these are the signs of drought, also that "the easterly wind in *Bhadra* and *Aswin* (mid August—mid October) brings a downpour," so the cultivator is advised to "go home after cutting through the *ail*" (to prevent the field from being flooded and the standing crop being injured). The halo round the sun or the moon is also supposed to be an indication of rain, and we have that "if the halo be distant, rain is imminent, while if the halo be nearer, it means flood."

I now conclude these sayings on the signs of rain, with the one which foretells "drought or excessive rain in a month having five Sundays." There are others on the subject which seem to be even more vague and arbitrary than even some of the preceding ones.

Paddy being the staple crop, receives the greatest attention in these sayings, and so we have the favourable circumstances for a good harvest summed up in a single couplet thus, "If (the fields) are full (of water) in Cancer* and dry up in Leo, also if they are filled to their ears in Virgo, and if it rains without wind in Libra, then where will ye keep your paddy?" (so abundant will be the harvest.)

The lowlands, specially in Eastern Bengal, are inundated by the overflowing of rivers during the rainy season. The yearly inundation is also a very vital factor to agriculture as it leaves behind a deposit of silt. A high and sudden rise of water will destroy the standing crops, while a low and slow rise is beneficial for the development of the plants. And so "the first rise of water in *Baisakh* makes the *aus* paddy grow twice." The indications of inundation seem rather queer, thus "if it is warm in *Pous*, cold in *Baisakh*, the pits will be filled in by the first part of *Ashar*, and Khana says, O my husband, there will be no water in *Sraban* and *Bhadra*." Also, "if during mid *Asar* a southerly wind blows, there will be flood during the year." But

* In the Hindu Astrology months often go by the name of the Signs of the Zodiac

the queerest of all is that which would foretell a good harvest of paddy from a good harvest of mango, and also a flood from a good season of tamarind.

Conditions of soil and of climate differ very much with different places, yet the above may be taken to represent fairly the circumstances for a good harvest in a normal year. But it would be absurd to lay down for the whole of Lower Bengal and for high and low lands as well that a cultivator would be "happy and prosper in husbandry and also gain honour if he plants paddy within five days of the month of *Ashár*." Neither can it be advised with certainty to "plant as much pulses as one can from the fourth of *Bhadra* to the fourth of *Aswin*." Also there is much truth when "Khana would advise a son of the peasant to sow mustard seeds during the latter part of *sarat* (*i. e.*, mid September to mid October). Also "he who without transplanting chilli seedlings in *Bhadra* or *Aswin* spends his time in sleep and in the *Kártik* and *Agrahâyan* (*i. e.*, the next two months) transplants the old seedlings, will not have to fill his store of chillies, as those plants will die of fungus diseases."

Again, among the sayings on the proper time of planting is one which advises a husbandman to "plant turmeric in *Baisakh* or *Jaistha*, throwing away pieces and dice, to hoe the soil in *Ashár* and *Srábon* and to make it thorough in *Bhadra*, (otherwise) says Earth, 'what yield can I give, if planted on any other rule.'" Also, "if you don't plant *Ol* (*Amorphophallus campanulatus*) in *Falgun*, then there will be topsy-turvy in the end," so also *Patal* (*Trichosanthes dioica* Roxb.) planted in *Falgun* gives twice the crops."

The sayings on the planting of bamboo are rather interesting. Thus we have "O brother cultivator! plant bamboos eight cubits apart at a depth of one cubit, and after planting three hundred and sixty clumps of them, lie ye peasant, on your bed-stead." Presumably one or two bamboos from each clump, would enable him to provide for his daily necessaries throughout the year. But the reckless cutting of bamboos would destroy a clump, so a man wishing to preserve his bamboos must be "as

stiff (sparing) as the twig of a bamboo," for "the cocoanuts of the spendthrift, and the bamboos of the miser do not run short throughout the year." Wholesale destruction is also reprehensible in the case of plantain, which is also a very important plant, as its flower, leaves and even the trunk are of everyday necessity in a household. The leaves serve the purpose of plates and are largely utilised during feasts even in the houses of the rich, while the flower and the trunk are cooked up for meals. Nevertheless the "leaves must not be cut off as soon as planted," for that would injure the plant, and it is the peasant's interest to save a valuable plant "that would provide him with cloth and food".

Ploughing is begun on auspicious days, and the Hindu cultivator consults the village astrologer before beginning to plough his fields a-new. Many stringent rules have been laid down for it. Thus, "Hear cultivators, says Khana, when you go to your fields with plough, seek out an auspicious moment for that, also let not have any untoward news on your way, next ascertain the directions and begin ploughing from the east, then will your whole labours be fulfilled without fail." The cultivator, also, should not "take to his plough on the new and the full moon, for then his misery would last for ever, his bullocks will have gout and he will not have food in his house."

That different crops would require different degrees of preparation of the soil is laconically summarised in a single couplet. Thus the radish requires a thoroughly prepared soil, so "sixteen ploughings" are laid down for it, and "half of that for cotton," a tap-rooted plant. But paddy having crown-roots, "half of that" (*i. e.*, four ploughings) would suffice for it, while "the betel-vine (would grow) without any ploughing." Also "the soil for sugarcane should be thoroughly pulverised," which requires a great deal of labour, so "let him who has grandsons, great-grandsons cultivate sugarcane." Again, the soil for *Mat* (*Arum indicum*) is prepared by a spade, while ploughing is required for preparing a soil for *til* (*Sesamum indicum*).

That some plants would thrive in light, while others would require shade, has not also been lost sight of in these sayings. Khana would say "Paddy in sunshine, and betel-vine in shade, (thrive);" while "though the *Ol* in shade would itch the mouth, it would do no other harm." But it is to be doubted whether "the potato would circle round the plant (*i.e.*, abound) if planted near a bamboo clump."

Next we come to the sayings on the soil. Different crops require different soils, so we have "sandy loam for *aus* paddy, and clayey loam for jute." Again says Khana, "Hear me, O son of a peasant, plant *Patal* on the sandy soil, for that will bring you to your desire's end." Also "if you plant *Kachu* on the river bank, it will go three cubits deep under ground."

The rich soil of Lower Bengal, fertilised for the most part by an annual deposit of silt, requires very little of artificial manuring for the staple crops: besides in India, manuring has not been systematised and its utility is not so very well understood as in Europe and America, so there are practically no sayings on the manures for field-crops. Nevertheless, there is some very practical and sound advice in these sayings: thus "if one scatters ashes in a *Kachu* field, Khana says, there will be no end of them" (*i.e.*, it will give plenty of yield). In the case of bamboo it is advised "to loosen the soil in *Falgun*, to put (fresh) earth (at the root) in *Chaitra*, for 'with such treatment,' says bamboo, 'I grow soon.'" Also "Hear, ye' son of a cultivator' put the husks of paddy under a clump of bamboo, for if husks be put at the foot of a bamboo two *Kors* of land will be covered by the clump. Water in which fishes have been washed is said to be good for water-melon, while "chillies thrive in paddy-lands."

While concluding our observations on these 'rudely-carol'd chiming phrase, in uncouth rhymes' we cannot but admire them for the broad commonsense, and the keen observative nature they sometimes display. These also give an insight into the character of our peasants. Though prejudiced and imbued with a firm belief in fatality which is ingrained in an oriental nature, they have sense enough not to be solely guided by these

sayings, however oracular they may be represented. No cultivator would hopelessly give up his plough though in the coming Bengalee year "Saturn is the king and Mars his minister, and in vain would one hoe and plough," rather should he join in the pious prayer of our fathers in the holy Rig Veda, "Sweet be our crops, sweet be our cattle."

WORK DONE TOWARDS THE IMPROVEMENT OF COTTON IN THE BOMBAY PRESIDENCY.

By G. A. GAMMIE, F.L.S.,

Imperial Cotton Specialist.

In 1788, the constantly increasing demand for cotton, which arose in Europe after the invention of the steam engine and the labour saving machinery of the mills, induced a representation by British manufacturers to the Honourable East India Company on the subject of encouraging and improving its cultivation. They particularly specified the variety from which the superior Dacca muslins were made, the supply of which was diminishing.

In the Bombay Presidency cotton of the best quality was produced in Broach and Ahmedabad. That of Surat was held to be inferior and that of Kathiawar was said to be worst of all.

In 1802, it was stated that the district of Broach and other territories in Guzerat, ceded to the Company in 1776, paid a portion of their revenue in cotton. In addition to the cotton received thus, the Company purchased a quantity for shipment to China.

In 1810 two commercial firms represented that the purchases of the Company had raised cotton to a ruinous price, and they asked Government to withdraw its competition for a time. This it declined to do, asserting at the same time that they did not monopolise the market.

A quantity of West Indian and American cotton seed was forwarded by the Court of Directors with printed instructions

for their cultivation, which, when translated into Guzerati, were not considered of use to the ryots. In 1809, in consequence of the suspension of intercourse with the United States of America, a great increase occurred in the export of Indian cotton to England, but on the resumption of intercourse, the Court stated that a large quantity remained unsold on account of the renewed understanding with America and the coarse nature of Indian cotton. In 1812-13 they ordered that no cotton should be shipped to England on their account. They urged the necessity of securing greater cleanliness in the cotton. The mixture of seeds and dirt was the chief objection to its use, and they repeatedly gave positive orders that the defects complained of should be remedied.

In 1810 the Court directed the attention of the Bombay Government to the Island of Salsette as a suitable locality for the cultivation of American cotton. On a report being called for, it was pointed out that although stray Bourbon plants had naturalised themselves on the island, every attempt to cultivate the species had failed.

In 1815, an experiment with the same species on a large scale was conducted in the Kaira district of Guzerat and resulted in failure, which was attributed to the lack of moisture, although the country cotton yielded well under the same conditions. This trial having been conducted in the western part of the district where the soil was considered chiefly at fault, during the following year the experiment was repeated in the eastern part where the plants grew luxuriantly without irrigation. The produce was reported on in London as being the best sample imported from Bombay raised from Bourbon seed. The expense of cultivation, however, was so great that there was a loss of 28 per cent. on the transaction. Small experiments in 1817-18 with the same species in the Ratnagiri district were reported to have been entirely satisfactory. To encourage the extension of Bourbon cotton in the Kaira district, the Collector was authorised to offer substantial premiums for successful cultivation, but even this inducement seems to have failed in its object. Bourbon cotton subsequently sent to London

from this district, was not received favourably in the market where it was considered to show signs of deterioration.

In 1828, the consumption of cotton had become so enormous that the importance of improving the quality of Indian cotton was pressed upon the attention of the East India Company. It was thought that some means should be devised to divert the steady flow of money for the new material from the United States to British possessions. It was assumed that the inferiority of Indian cotton was due only to defective methods of cultivation which could be remedied by the application of skill and capital. The Court of Directors asserted that the Guzerat cotton was not suitable for the British market on account of its very short staple, and this defect existed in spite of the fact that Guzerat was equal in richness and fertility to any part of the world. The attempts at improvements had been confined to the introduction of Bourbon cotton only and had not been attended with success.

Lord Ellenborough suggested "the expediency of attempting on a small scale the cultivation of all the finer sorts of foreign cotton in different and distinct parts of India, under every different circumstance of soil and climate, and of transmitting to England, cleaned in the American manner, samples of the cotton so raised, for comparison with the cottons of other countries."

The Court of Directors wrote urgently on the subject to the Bombay Government in February 1829, directing it to select about 200 acres to serve the purpose of an experimental plantation at the cost of the State. They suggested, as a commencement, the careful cultivation of the finest indigenous kinds in India, such as the *Baiyati* of Bengal (the Dacca Muslin Cotton) and the best descriptions grown at Broach and Surat. At the same time a supply of Georgian and New Orleans seed was ordered. They also proposed that experiments should be made with the finer sorts of exotic cottons in various parts of the Presidency and especially in the districts near the coast. They further recommended the distribution of good seeds to the rayats, and the award of premiums to those who exhibited superior samples, and they also sanctioned the lease of lands at a low

rental to all British subjects disposed to embark on cotton cultivation. Subsequently a supply of Upland Georgian, New Orleans, Sea Island and Demerara cotton seeds was sent to Bombay, with printed instructions as to their cultivation. Two of Whitney's saw gins were sent with the sanguine hope that they might expand the cotton trade prospects of India as they had already done those of America.

The Bombay Government established experimental farms at Broach, in Guzerat and in Dharwar and Khandesh. A few plantations were also ordered to be made in Salsette. The Superintendent at Broach commenced operations by purchasing small quantities of seed cotton which he had cleaned under his own supervision. The cost of cleaning by the foot roller was prohibitive, but the cotton was considered excellent by the London dealers, as was also the cotton cleaned by the *Churka* or hand gin, but that prepared by the American saw gins was injured so greatly that the staple was cut to pieces.

In the Southern Mahratta Country, the Superintendent decided to adopt the following line of action:—to clean the cotton in an economical way so as to increase its value without adding too much to the cost of production and to distribute seeds of the best Guzerat, New Orleans and other annual cottons, so as to produce new varieties of the staple. The cleaned cotton which he produced during the first year on a small scale by more careful methods of picking and ginning, was favourably reported on, but he failed to persuade the rayats in general to adopt his systems. He represented that the bad state of Dharwar cotton was really due to grave faults in the mode of packing and carriage, this being to carry it in loose bags on the backs of bullocks which were daily loaded and unloaded on their way to the coast. The farm established at Sigehali was not prosperous, and the yields from exotic cottons were small and unfavourably reported upon.

As the results of 18 months' experience on his farm at Dunda in Broach, the Superintendent averred that no improvement could be expected from any alterations in the mode of cultivating cotton in Guzerat. Finally, the experiments with exotic cottons

were abandoned on the ground that there was no probability of their returning a reasonable profit to the cultivator.

The Superintendent at Dharwar in 1835 arrived at the conclusion that the cultivation of perennial cottons would not extend throughout the district. The Collector, being referred to for his opinion, said that after five years of experiments no rayat even in the vicinity of the farms had taken up any foreign cottons, and, moreover, that no one had altered his methods of cultivation or other processes in any way whatever. It was also reported that all cottons of long staple had become short, and that the American saw gins had failed by cutting and twisting the staple, while the indigenous foot roller was not adapted to foreign cottons. In 1836 it was decided to abolish the experimental farm in Guzerat and the Southern Mahratta Country, as to continue them longer was held to be a useless expenditure of the public money. In the same year, it was proved that the soil and climate of the Deccan were not congenial to cotton.

In 1840, Dr. Gibson stated his conviction that, of the exotic cottons, only the New Orleans succeeded under trial in the Deccan, and he also urged the futility of further experiments with Pernambuco and Egyptian cottons in inland situations.

Private speculators who availed themselves of the facilities granted to cotton cultivators met with no success in their enterprise, and Sir J. R. Carnac, then Governor of Bombay, asserted that "cotton culture holds out no inducement for any private person who knows what he is about, to engage his capital in any speculation on a large scale."

For some years subsequently only a few measures were taken towards the improvement of Indian cotton. Cotton seed was distributed and advances were made to certain persons and several unsuccessful attempts were made to improve the *Charka*. An Egyptian machine was proved to be no better than this. A grant of £100 was made by the Court of Directors as a premium to any mechanic who could produce a serviceable model, but even then no promising result was obtained. The Government in 1836 repealed the tax of Rs. 2-12 on each

Chucka, whether worked for one day only or throughout the season. This tax produced Rs. 14,000 annually. In the following year, 1,500 additional machines were being worked in the town of Broach alone. In 1839, the local authorities were directed to take steps to abolish the *kuli* system in Guzerat. It had hitherto been the regulation that the cotton crop was stacked in the *kuli* or village farm yard until the assessment was paid.

In 1838, the growing necessities of the British manufacturers again compelled them to submit their periodical petition for a supply of improved Indian cotton. The Court of Directors, which had always responded willingly but unsuccessfully to this cry, resolved to secure the services of experienced American planters for the purpose of training cultivators in the best methods of growing and cleaning cotton.

Three American planters proceeded to Broach in 1840, and as usual, arrived too late to start the actual cultivation of cotton that season.

In the following season, they sowed New Orleans seed in three farms, but the plants thrived so badly that the total produce did not amount to a bale of cotton. A plot of Sea Island was also entirely destroyed by insects. An experiment was also made with a quantity of indigenous cotton cultivated in the American manner, but the cotton ultimately produced was not in any way superior, either in quantity or quality, to that grown by rayats.

The American planters were convinced that the New Orleans could not be profitably introduced into Guzerat, but they believed that the quality of the indigenous cotton could be improved.

The three Americans so despaired of success that they resigned their appointments and left the country.

In 1842-43, only five small plots were prepared and sown with New Orleans, Sea Island and Bourbon seed, but the produce collected from these only amounted to about 11 pounds per acre.

The exotic cottons of the year 1843-44 failed, and it was now accepted as proved that the soil of Broach was unsuitable for the cultivation of American cottons.

In 1843-44, nothing was done beyond again demonstrating that the saw gin injured the staple of Indian cottons.

In 1849, after a few years of misdirected efforts, the Government of Bombay decided to abandon further experiments at Broach.

The results of the whole series of experiments at Broach have been summed up as these: "Some kinds of exotic cottons, such as the New Orleans and Bourbon, yielded occasionally a small crop, when cultivated as garden plants, with great care and great expense, but they never escaped partial damage from the effects of the season. When the same kinds were cultivated on a larger scale, even with the greater skill, labour and care of the experimental establishments, the crop invariably failed. The possibility of raising garden samples of any kind of cotton, anywhere, by unlimited care and expenditure, is scarcely doubted, but the feasibility of doing so upon terms within the reach of the rayats and within the actual market value of the article, has not been demonstrated at Broach. It was proved that, by double the care and attention and more than double the expense of the native cultivation, a large yield and better and cleaner quality might be obtained from the indigenous cotton than the rayats can produce, but not sufficiently so to repay the additional outlay, and, finally, that the native cotton, when cleaned by the American saw gin, was generally injured in its staple."

In the Surat, Kaira and Ahmedabad districts experiments with Upland Georgian, Bourbon and other exotic cottons were conducted between the years 1849—1860, but in every case these failed and the same unhappy results were experienced in some of the Deccan districts and Thana in the Konkan.

In 1844, it was proposed to test the cultivation of improved varieties of cotton in the Khandesh district. New Orleans was tried, and, as usual, having failed, Government ordered that no further attempts should be made in its introduction to this district. In spite of this discouragement in 1848-49, New Orleans was again sown, but owing to an adverse season the crop was extremely short, and it was considered by the merchants as being

superior to the indigenous cotton although inferior to New Orleans. The yield of exotic cotton was calculated to be about one-third that of the indigenous variety. In 1855, the cultivation of New Orleans cotton had practically died out and the rayats emphatically expressed their conviction that the climate and soil were absolutely unsuitable for its culture.

In Ratnagiri in the Konkan, experiments with Bourbon and Sea Island cottons at first were promising, but further trials on a large scale resulted in loss.

In the Belgaum and Dharwar districts, experiments for the introduction of New Orleans cotton were commenced in 1842, and after some reverses the cultivation of the plant became fairly established, and it has maintained its hold in certain favourably situated Talukas up to the present day.

The net result from the expenditure of money, skill and experience during nearly 80 years was that the New Orleans cotton was successfully introduced into the Karnatak and that it refused to grow with certainty in any other parts of the Presidency. This remains the only exotic cotton now grown as an annual field crop in India. All perennial tree varieties have been definitely proved to be unreliable as sources of profit.

Throughout the whole of the history of the attempts to improve the cottons of India it is sufficiently evident that no consideration was ever given to the chance of improving any indigenous variety by scientific methods; the sole aim seemed to be to compete with the American market by introducing the cultivation of its chief cotton varieties into India. The following remarks written by Dr. Forbes Watson afford ample food for reflection to the agriculturist.

"It has been pointed out that, as regards length of staple, the cotton of Western and Southern India compares favourably with that produced by the short stapled cottons of the United States of America. The principal objection to Indian cotton is its great impurity caused by the admixture of broken leaf and crushed seed which it contains. These objections will probably never be quite surmounted, because the presence of leaf is due

to the greater dryness of the Indian cotton plants at the time of picking and the presence of fragments of seed is caused by the firmer adhesion of the cotton to the seed. Indian grown cotton from acclimatized Bourbon and Upland Georgian plants is freer from broken leaf, showing that it retains one special characteristic of the American cotton plants in which the leaves remain in a more succulent condition throughout the time of harvest.

"Another grave objection to Indian cotton is the injury which it suffers from neglect or adulteration.

"To remedy this last and fatal defect a Cotton Fraud Act was brought into operation in Western India in 1863, but it is doubtful whether the attempt to improve matters by legislation was successful or not. However, tons of earth and sand were removed from cotton during its operation and the mixture of inferior with superior qualities was prevented to a certain extent."

SANN-HEMP, AMBARI AND AGAVE AS FIBRE CROPS IN THE CENTRAL PROVINCES AND BERAR.

By D. CLOUSTON, B.Sc.,

Deputy Director of Agriculture, Central Provinces and Berar.

THE only fibre crops other than cotton grown to any extent on a field scale in these Provinces are Sann-hemp (*Crotolaria juncea*) and Ambari (*Hibiscus cannabinus*). The total area in 1907 under fibre crops other than cotton was 55,402 acres in the Central Provinces and 32,361 acres in Berar. Sann is always grown as a pure crop, but Ambari is only cultivated as a mixture with other *kharif* crops. In Berar it is estimated that 24,099 acres were actually occupied by Ambari in mixed crops, and 8,262 acres under Sann. The area occupied by Ambari in mixed crops in the Central Provinces is not separately computed, so that the return of 55,402 acres shows the area under Sann alone; no estimate can be attempted of the area under Ambari.

Sann or Jubbulpore hemp (*Crotolaria juncea*) is a leguminous crop cultivated in these Provinces for its fibre only. *Crotolaria juncea* is supposed to be the only variety grown locally, though Roxburgh calls Jubbulpore hemp *Crotolaria tenuifolia*. The correct botanical classification is a matter which has not yet been authoritatively decided and requires investigation, but it is generally believed that only one variety is grown throughout the Central Provinces and Berar. It thrives well on almost all kinds of soils that are free from water-logging. The land on which it is grown gets very little cultivation. It

is usually ploughed or bakhared once in the dry weather, followed by one bakharing after sowing the seed in the beginning of the rains. The seed is sown broadcast at the rate of about 30 lbs. per acre. The crop is a vigorous grower, requires no weeding, and is sometimes even grown on *kans*-infested land, where it is supposed to be effective in killing this obnoxious weed. The plants attain to a height of seven feet on good land, and from 4 to 5 feet on poor land. The crop is generally cut in December by which time the seed is matured. The crop is cut with sickles and bound into bundles which are usually stacked in the field till March or April. By postponing the time of retting till the hot weather, a much shorter period of immersion in water is found to be sufficient. The bundles are steeped in streams or in ponds made near wells. Dirty water is always preferred as it hastens fermentation. The bundles are placed, heads and tails, two tiers deep, and are weighted down with stones or mud. When the water of a stream is not sufficiently deep, a trench is dug into which bundles are placed and covered with the mud taken from the trench. In retting, the bark is partially removed by drawing a handful of the stalks between the thumb and first finger. The stems are then stripped one by one. The retter, having broken the lower end of the stalk so as to get a free end of the fibre, grasps this end of the stalk with his left hand and removes the fibre in strips by running up the thumb and first finger of the right hand between it and the stalk. The cost of retting is considerable. Day labourers on the Experimental Farms produce about 4 lbs. of fibre per day only. Cultivators commonly pay one pice per bundle for retting. If a suitable machine could be secured, which would extract the fibre at cheap rates, a great impetus would be given to the cultivation of Sann. In some places baling presses have been set up, so as to reduce the cost of carriage.

When the grower keeps the fibre for his own use or sells it in small lots at the bazar, he washes off the mud attached thereto. If it is to be sold in bundles for export to Bombay, some cultivators not only neglect to wash the fibre but even

take steps to increase the weight by fresh additions of sand or mud, always taking precautions to cover the outside of the bundles with the cleaner material. This method of adulteration has given rise to serious complaints in the trade. It was not noticed till the famine of 1899—1901 when, owing to the great scarcity of water, Sann had to be steeped in muddy water, which resulted in the export that year of very dirty fibre. As the buyers had not suspected this, the fibre was sold at good prices, and the cultivator, assuming that this form of adulteration could be repeated with impunity, adhered to the practice. In 1907 Messrs. Kiddle, Reeve & Co. complained that some of the fibre that came from certain districts of the Central Provinces contained as much as 80 per cent. mud, while that received from Konkan, Guzerat and the Deccan contained less than 2 per cent. They were fully convinced that the mud was wilfully added. The steps taken by the Local Government to stop this malpractice were so effective that in 1902 the same firm reported that "the extraordinary admixture of dirt which appeared in the hemp offered for sale during the past two years, and more especially during the last cold weather, has almost entirely disappeared from the supplies which are now arriving in considerable quantities." But in 1903 adulteration of the fibre was again practised, and the same firm again drew the attention of the Local Government to it in the following terms: "During the past season, 1903-04, the mixing of earth with the fibre has been carried on in a very gross manner and to an extent even greater and more general than during the worst period prior to our invoking your assistance." The Local Government once more used its influence through its District officers in checking this wholesale method of commercial swindling, and its measures were again successful. In districts from which the dirtiest fibre had been received, the names of local buyers (middlemen) were taken and forwarded to the firm for the guidance of their agents.

The area under Sann in these Provinces has been doubled during the last 10 years. The principal districts in

which it is grown as a fibre crop are in the Central Provinces—Betul 11,323 acres, Seoni 8,645 acres, Mandla 5,844 acres, Narsinghpur 4,851 acres, Jubbulpore 3,867 acres, Raipur 2,390 acres and Nagpur 2,010; in Berar—Yeotmal 3,106 acres, Buldana 2,069 and Akola 2,025. The probable reason why the crop is largely grown in these districts is that aboriginal cultivators are numerous and not that climatic conditions are peculiarly favourable. The Spanish-American war gave a considerable impetus to the trade, as the price of Manilla hemp rose from £14-10-0 per ton in 1897 to £62-10-0 in 1899, and the much improved Sann-hemp was found to be a good substitute. Prices have been well maintained ever since; at present it ranges from Rs. 8 to 9 a maund, at which price Sann, if grown on land suited to the crop, will pay better than some other crops commonly grown at present. Moreover, its cultivation is well understood and the crop is a hardy one, so that its cultivation is likely to extend. It is fully recognized that land is substantially benefited by a crop of Sann, which is considered equivalent to a good dressing of manure. To a limited extent Sann is also grown to plough in as a green manure, particularly for irrigated wheat in Nimar and sugarcane in Betul.

A careful estimate of the comparative costs of cultivation and outturns of wheat and Sann, shows that the latter is the more profitable crop. Land is not ordinarily manured in the wheat tract. The cultivator either uses his cattle dung as fuel for his own purposes, or sells it in the nearest town where there is always a good demand for cow-dung cakes. The wheat on such land, impoverished as it is in nitrogen, is invariably of stunted growth, attaining a height of about 1½ feet only. Sann being able to get supplies of nitrogen from the air grows much more luxuriantly so long as the land is well drained. On the well-drained deep alluvial soil along the banks of some rivers, commonly known as *Kachar*, which is excellent land for wheat, Sann cultivation is so much the more profitable that it has been largely substituted for wheat. In some cases the tenant who may not be a proficient Sann grower himself or is perhaps

influenced by prejudice, lets such land to *Gonds* and other low caste cultivators who are expert in cultivating Sann as well as in preparing the fibre for market. These sub-tenants are said to pay as high as Rs. 50 an acre for good *Kachar*, and the crop of Sann grown thereon is said to fetch as high as Rs. 100 per acre. It is believed, therefore, that Sann can be grown more profitably than wheat in the wheat growing tracts, even after making due allowance for the costly process of hand-retting practised at present. Its cultivation has extended and will continue to extend in that tract if prices remain as high as they have been of late. In the cotton tract no extension of this crop can be looked for, as cotton pays better even than Sann. In the rice tract Sann could be profitably grown on much of the land that is at present reserved for cold-weather crops.

Anything like a rapid extension of Sann cultivation will, however, be impossible for the following reasons. Many high caste cultivators are prohibited by religious prejudices from growing the crop. They will grow Ambari for their own use, but Sann never. The cultivator who grew it in defiance of caste rules was outcasted. Its cultivation has, however, proved so profitable of late that some high caste cultivators have waived their religious prejudices, and now grow the crop. The good *Kunbi* compromises the difficulty by employing a Gond or other low caste man to sow his Sann seed for hemp. Again, the labour necessary for retting the stalks is expensive, and considerable difficulty is often experienced in getting sufficient water in the dry season for steeping the bundles of stalks. The cultivator in the rice tract is not willing to grow a *kharif* crop such as Sann on his *rabi* land, as he already complains of the shortage of labour to transplant his paddy owing to the great amount of work demanded of him within a short period of time at the beginning of the rains. What he wants is to distribute his work more equally over the whole year, whilst the extension of Sann cultivation would have the very opposite effect. The most formidable difficulty of all in the way of extending the cultivation of this or any other

fibre crop is not to prove that it is a more profitable crop than other crops, but rather to overcome his prejudice against growing any crop which is neither a food for himself nor his bullocks, more especially if its preparation for market entails a good deal of labour. At present then the cultivation of Sann-hemp in these Provinces is still to a large extent monopolised by low caste cultivators, who find it more profitable on the land suited to it than any other unirrigated crop grown. Some of these cultivators are sub-tenants who pay extravagant prices for good Sann-growing land in virtue of the profit they derive from its cultivation. Despite the prejudice against the crop, its cultivation is almost sure to continue to extend if prices continue as high as they have been for the last year or two. Being a leguminous crop, its power of enriching the soil in nitrogen should recommend it as a good crop to grow in rotation with cereals.

The area under Sann-hemp in the Central Provinces has increased from 29,094 acres in 1896 to 55,402 acres in 1907. The total quantity of Sann-hemp exported and the value of the same from 1904 to 1906 are shown below :

				Weight.	Value.
				Mds	Rs.
1904	...	...	...	226,751	12,78,783
1905	...	...	...	197,402	10,82,534
1906	...	...	...	176,230	9,60,923

Ambari or Deccan hemp (*Hibiscus cannabinus*) is also grown to a small extent in these Provinces. Its fibre is inferior to that of Sann, the bazar price per maund being about Rs. 6. I am not aware that their outturns have been experimentally compared, but the general opinion is that Sann gives the greater outturn of fibre also. In the Central Provinces, Ambari is grown only as a mixed crop with juar, tur, mung, urad and cotton, the common practice being to mix half a pound of Ambari seed with that of the principal crop. This method of sowing Ambari tends to give rise to branching in the plants, but as the fibre is only required for the cultivator's own use, this is not so important. There does not seem to be a great future for this fibre crop in

these Provinces. At present it is grown on a small scale in preference to Sann because of the prejudice of the growers against the latter crop.

Agave is another fibre crop which has been but little exploited in these Provinces. The species common to the Central Provinces is believed to be *Agave cantala* species. It is usually grown in hedges around groves and gardens, but nowhere in abundance. It is very seldom utilized for the extraction of fibre. In the Kawardha Feudatory State adjoining Bilaspur, it is cultivated on a somewhat larger scale and its fibre is used not only in manufacturing ropes, but also in making valuable cloth; and the root is used in the processes employed in the manufacture of gold and silver ornaments. The cultivation of Agave is never likely to become popular in these Provinces. As in the case of *Sann*, the better class of cultivators are prejudiced against it. The labour involved in pounding the leaves in the process of extracting the fibre is considered both hard and degrading, while the juice of the leaves produces *eczema* or *dermatitis* on the legs and arms of those engaged in extracting the fibre. The prejudice is perhaps due to the fact that the extraction of aloe fibre is a regular jail industry and not a common village practice. A crop which gives no outturn for the first three years does not appeal to the average cultivator whose tendency is to look for speedy returns on his invested capital. Again, cattle destroy the crop in its young stage, if the cultivator cannot afford the necessary protection for the first year or so. And finally, on soils of average fertility it is believed that the crops grown at present are more profitable. Aloe cultivation has been largely extended of late at the jails of these Provinces. The species grown are chiefly *Agave cantala* and *Agave rigida var sisalana*. Major W. B. Lane, I.M.S., Inspector-General of Prisons, Central Provinces, had 87,159 aloes planted out last year in the various jail gardens, of which 17,575 were planted in the very thin laterite soil known as *bhata*, round the Raipur Jail. At these jails all the work of cultivation, of extracting the fibre and of making it into ropes, rugs, etc., is done by the prisoners. This industry is a most suitable one for

jails, as it affords labour at all times of the year and of different degrees of hardship, from light to very heavy tasks, and is, therefore, suitable for all kinds of prisoners. The only retting machine that has given satisfactory results is Winsor's. One of these is already in use, and two others have been ordered for districts where the jail population is small. There seems little possibility of the cultivators taking up the cultivation of Agave as a fibre crop for reasons already explained. On the *bhata* plains of Chhattisgarh, however, where there are hundreds of thousands of acres of waste land lying unused at present, it may be possible to start aloe plantations: but if this is to be done successfully, the work will have to be undertaken by an enterprising firm with sufficient capital and practical knowledge to manage it properly. It has yet to be proved, however, that the aloe can be profitably grown for commercial purposes on these murram soils without irrigation. The plantations started at the Raipur Jail should solve this problem.

KATRA (HAIRY CATERPILLARS) IN GUJARAT.

By CHHOTABHAI U. PATEL,

Entomological Assistant, Baroda State.

KATRA is a Gujarati name given to the hairy caterpillars of the following three species:

1. *Amsacta moorei*, Butl. 2. *Amsacta lactinea*, Cram. 3. *Amsacta lineola*, Cram. The general characteristics of these insects in Behar have been described in the third issue of the Agricultural Journal of India, Vol. I, page 187, where the moths were figured in colour. The three species differ a little from one another in points of minor importance, and so they have not been described separately here.

In almost all parts of Gujarat and Kathiawar, these insects are to be found, and are known by different names in different parts; *viz.*, "Katra" (in Baroda and Kadi districts), "Bava" or "Kutra" (in Kathiawar). Generally, these insects appear after the first fall of monsoon rain and attack the newly growing crops. When the circumstances throughout the year are favourable to their increase, they appear in swarms and cause very great damage to the young crops, especially to millets, so much so that whole fields have to be resown. Thus by late sowing the plants do not become vigorous and as a consequence the yield is poor. At times it so happens that in sowing and resowing, the season for a particular crop passes away and people have to put their fields under some other crop for which no previous preparation was made; or they have to leave them fallow.

Thus it is that, while the immediate loss causes a waste of seed and labour, the ultimate effects of its ravages are very great.

This is why the word "Katra" has become proverbial among the Gujarat cultivators. An accurate survey of its distribution in Gujarat has not yet been made, but there are certain villages in the Atarsumba Peta Mahal (near the Kapadvanj Taluka of the Kaira District), where they appear in swarms every year regularly. At other places in Gujarat, they appear in a small number every year and in swarms every third or fourth year.

Life History of the Insect.

Before devising measures of treatment, one should know the full life history of the insect. In the following paragraphs, it has been described from field observations, and failing these, the insectary observations have been noted at some places.

Eggs. These are small round bodies of the size of poppy seed with grooves parallel to the shorter axis, evenly distributed on the surface. There are a few thin, white, short hairs scattered over the surface. They are yellowish when freshly laid and become dark before hatching. They are laid by the mother generally on weeds grown on headlands and in some cases in the fields. Each female moth lays from 700 to 1,000 eggs in four or five rows touching one another. The egg stage lasts from 2 to 3 days.

Larva. —After two or three days very small Larvæ (caterpillars) begin to appear. The tiny caterpillar eats its way out of the egg shell in about a couple of hours. The newly hatched larva is about $\frac{1}{10}$th of an inch in length. The colour of the body is dark and there are long, thin hairs scattered over the upper surface of the body. The mouth parts are orange red. It is, as usual, provided with three pairs of legs and five pairs of sucker feet. Its sole business is now that of feeding and growing. For some days the caterpillars feed on weeds near by, and by the time the cultivated crops begin to grow, they (caterpillars) grow big enough to walk into the fields. Their favourite food plants are "Chidho" among weeds; Bajri (*Pennisetum typhoideum*),

jowar (*Andropogon sorghum*), Kodra (*Paspalum scrobiculatum*) and the first two leaves of Tuer (*Cajanus indicus*) among cultivated crops; and the leaves of Thoria (*Euphorbia neriifolia*) among living hedges. They grow fast and attain a length of one inch or 1¼ inch in ten to twelve days.

The colour of the body is now changed to orange and there are small white nodules at the base of each bunch of 10 or 12 long orange coloured hairs. If there is not sufficient food to them, most of them die before attaining this stage. If the leaves on which they rest, are shaken or slightly disturbed, they at once fall to the ground and run actively to hide themselves. In another 10 to 15 days, they become full fed. They are then about 2½ inches in length. The greater number of them go for the hedges for pupating.

Pupa.—Though no living pupa has been found in the fields or hedges, the facts that the caterpillars go down in the ground when full fed, that the empty pupa cases are found underground and that in the insectary, if they are provided with earth, they pupate underground, show that they pupate about 2" or 3" underground in hedges and under trees. For passing a long period in the dormant stage, the caterpillars, after going underground spin cocoons with the hairs on their bodies and pupate inside. They generally remain in this condition till the first fall of rain of the next monsoon, and so they have only one brood in the year. But exceptionally, if in the same season the rain stops altogether after the first fall, and if the weather remains hot till the pupæ of the present brood have passed about 12 days or a fortnight in that stage, moths emerge from them in the same season. In this case they have two broods in the year.

Imago.—Moths begin to emerge from the pupa, from the next day after the first fall of monsoon rain, and within 10 or 12 days all come out. The colour of the wings is white with a few black spots. The dorsal surface of the abdomen in some species is red and in others orange or dull red. There are three dark spots, on each abdominal segment, arranged horizontally, the

middle one being bigger than the other two. The lower surface is dirty white, and there are two black spots arranged laterally on each abdominal segment. The length from head to tail is about $\frac{3}{4}$" in the female and $\frac{1}{2}$" in the male. They measure two inches and one and half inches across, respectively when on wings.

On the same day or on the next day after they emerge from pupa, the male and female mate; the former dies after mating, and the latter survives for a day or two, and dies after laying eggs. At dusk and at night they are found flying about, either in search of their mate or seeking a suitable place for laying eggs; and during the day they hide themselves in hedges and such other places where they can protect themselves against enemies. They cling to the leaves or twigs so firmly with their legs, that high wind is unable to blow them away, and it is not without some force that one can detach them from the leaf or twig. They are weak fliers and cannot fly to a distance of more than 20 to 30 feet in one flight. At night they are attracted to light.

Parasites. The maggots of two kinds of Dipterous flies and one Ichneumon fly, have been observed feeding in the bodies of the caterpillars. They have not yet been identified. In a swarm of "Katra," a great number of these flies can be seen flying about very close to the caterpillars, and it is presumed that they do so for depositing their eggs on the bodies of the hosts.

Predators. The black crow and a kind of black sparrow, known in Gujarati as "vahi," are seen eating these caterpillars voraciously.

Remedies.—Keeping the habits of the insect noted above in view, the following suggestions are made for dealing with the pest, and one or all of them may be utilised according to the requirements.

1. Before the monsoon sets in, all the dirt and soil on the headlands of the fields should be collected and burnt. Along with this soil many pupæ are collected and burnt. This operation

is known in Gujarat as "burning stool" and is practised by all careful cultivators.

II. From the very first night after the first fall of monsoon rain, a lantern may be placed burning every night in the field and should be continued for about ten or twelve nights. As the moths that emerge are attracted to lights, it is easy to trap them in this way. For killing the moths, a tray half full of water mixed with about 5 tolas of kerosene oil may be placed below the lantern. All the moths that are attracted fall into the water and are destroyed by the kerosene. For diffusing the light over a wider area, the tray may be placed on a stand, a foot or two feet high; a small heap of earth will serve the purpose of a stand.

Where these insects appear in swarms every year, this method can be advantageously practised by mutual co-operation of cultivators, and if an organised effort is made once, the pest can be checked for some years.

III. For about a week just after the first rain the weeds and grasses grown on headlands should be examined, and if small "Katra" are seen in a great number, they can be isolated from the field by digging a channel about a foot deep all round. The Katras will fall into this trap and may be killed.

IV. If they have already entered the field, leaves of "Thoria" may be scattered into the space between the rows of the crop. They will feed on these leaves and thus the crop can be saved.

Light Experiment.

The light experiment was made in June last in a village named Kanial in the Atarsumba Peta Mahal, where the swarms of "Katra" appear every year.

Some fields of the eastern *sim* (area) were selected for this purpose, and a diagram of the fields is attached.

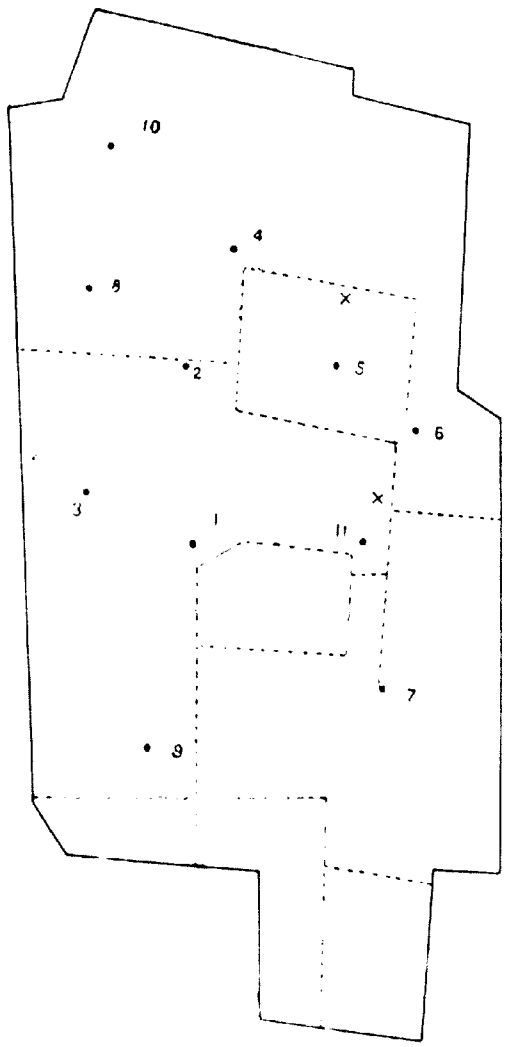


Diagram of the Fields Treated.

The continuous thick line in the diagram shows the boundary of the experiment, which encloses an area of 36 acres of land. The dotted lines inside this boundary represent live hedges. The points show the position of various lamps placed every night, and the figures used are the corresponding numbers of the lamps that

are used in the following paragraphs. The cross marks show the places where "Katra" appeared.

Two lanterns, Nos. 1 and 2, were placed burning at night on the 11th, 12th and 13th June 1907, and no Katra moth was found in the trays below the lanterns next morning. The first rainfall began at night on the 13th and it rained till the next morning. From 14th to 19th nine lanterns (Nos. 1 to 9) were placed at different places as shown in the diagram, and Nos. 10 and 11 were added from the 20th. All these were continued till the 2nd July 1907. The statement on page 159 shows the number of moths trapped at each lamp every night.

From this statement, it seems that all the moths that were likely to be trapped, were trapped within ten days after the first fall of rain. For fixing this period, one lamp was placed in a field far away from these fields on the 21st and 22nd. On the 21st, three moths were trapped, and on the 22nd, none was trapped. Again, on the 30th, a lamp was placed in a field of the adjoining village, and none was trapped at it. These outlying places were full of Katra. This phenomenon shows that where the lamps were placed, all the moths were trapped within 10 days, and where they were left alone, they laid eggs and died naturally in the same time after the first rainfall.

All the lamps were lighted at 7 P.M. every night and were extinguished at 5-30 A.M. next morning. For ascertaining the best time at which they come in large numbers, the moths attracted to each lamp were counted at different times during the night from 20th to 23rd June 1907, and from the analysis of these four nights, it seems that the best result is attained after 10 P.M.

As there was no rain for about 22 days after the first one, people were unable to grow any crops in the fields, and consequently the Katra, that appeared on weeds in the fields other than those treated, had not sufficient food for thriving. The excessive heat killed a very great number in their young stage. People had therefore no chance to compare the result of the experiment at a glance. However, those who were shown the

Detailed Statement showing the Moths trapped at each lamp every night.

Date and time.		Number of moths trapped at the several lamps.											Rain in the morning.	Particulars of rainfall.	Remarks.
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.			
Morning of 15th June 1907.					1		5	...			Not lighted.	Not lighted.	6	Slight, previous night.	
16th June		30	39	65	76	45	112	180	105	87			790	*Nil.*	
17th June		30	8	4	69	8	13	1	20	12			174	*Nil.*	
18th June		15	3	10	32	5	4	3	4	1			77	*Nil.*	
19th June		2		2	4		2	2	2	3			17	Slight, early morning.	
20th June					1		2						3	*Nil.*	
20th night and 21st morning	7-30 P.M.		2					...							
	10 P.M.				2	2	1	1							
	After 10	11	8	4	29	15	14	18		1	5	14			
	Total	11	10	4	31	17	15	22		1	5	15	131	*Nil*	
21st and 22nd	8 P.M.	1													
	10 P.M.	1			1										
	After 10	4		1	3	1	3	3		1					
	Total	6		1	4	1	3	3		1			21	Slight at intervals.	
22nd and 23rd	8 P.M.														
	10 P.M.	1				1									
	After 10	1			1										
	Total	2			1	1							4	*Nil.*	
23rd and 24th	8 P.M.														
	10 P.M.				1										
	After 10						1								
	Total				1		1						2	*Nil.*	
24th and 25th														*Nil.*	
25th and 26th														*Nil.*	
26th and 27th														*Nil.*	
27th and 28th														*Nil.*	
28th and 29th														*Nil.*	
29th and 30th														*Nil.*	
30th and 1st July		This night one lamp was placed in a field of the adjoining village.												*Nil.*	
1st and 2nd														*Nil.*	

experiment all along, were taken out in the fields, and they saw that there were "Katra" in the other fields and not in the area treated. Thus they were convinced of the effects of the experiment.

As regards the Katra that appeared near lamps Nos. 3, 5 and 11, it is presumed that at each of these three places a female moth, while flying to the lamp, might have dropped down to take rest and there laid eggs.

Cost.—In an area of 36 acres 9 Hinks' hurricane lanterns and two ordinary cocoanut oil lanterns were used. On an average of 5 days, the kerosene oil consumed was 15 tolas per lamp per night and the cocoanut oil consumed was 6 tolas per lamp per night. The total cost in oil for ten days would be Rs. 3 or Re. 0-1-4 an acre. This cost will slightly vary according to the number and extent of hedges, but it may be taken as a fair average.

INSECT PESTS OF MANGEL WURZEL.

By H. MAXWELL LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Pusa.

The Mangel Wurzel is not one of the ordinary crop plants in general cultivation in India: its cultivation has, however, been recommended owing to the valuable qualities of the plant, and it has been under experimental cultivation at Pusa during three *rabi* seasons. Like many exotic plants introduced to a new country, it has been severely attacked by insect pests, and this has occurred to such an extent that any one attempting to cultivate this crop will have to be prepared for their attacks and take them into account in dealing with it. Three insects especially attack this plant. Surface weevils are destructive to the young plants soon after they come up; Surface caterpillars are a constant pest throughout the cold weather, and finally, as the warm weather commences, the "Indigo caterpillar," so familiar to planters in Behar, may transfer its attentions to this crop, even in preference to lucerne and may do much to complete the damage done by the preceding insects.

Surface weevils are small, dull, grey weevils (*Tanymecus calcicus* Desb.), so like the soil in colour that they are difficult to see: they are usually abundant at the commencement of the *kharif* and of the *rabi* seasons. At Pusa, their attacks on the young Mangel Wurzel were severe in two years out of three: they were not anticipated the first year and, by eating the leaves of the young plants, did a considerable amount of damage: strong growing plants survived and since the seed is thickly sown and the young plants must be freely thinned, the weevils

were not really injurious, once the young plant had a good number of leaves and was growing well up. In the second year, they appeared again and were kept in check by strewing the field with chips of any cucurbitaceous fruits (such as the various gourds, pumpkins, etc., grown in gardens), and examining these chips daily for the weevils which collected there to feed. A large number of weevils were destroyed in this way, but it is possible that there would have been no more had the area of the crops been very much larger and the damage would have been proportionately much less. The obvious precaution is to get the plants growing freely as early as possible in the season, so that the injury caused by weevils will not check the growth of the plants. The Imperial Agriculturist finds that sowing should be done in the latter half of October, and not later than the end of October, on land previously well irrigated, so as to secure full germination.

After the weevil, the ordinary Surface caterpillar appears. This insect has been fully described (see Vol. II, p. 42, of this Journal). If extensive injury is to be avoided in the bad years that come every now and then, these caterpillars must either be poisoned with baits or collected when weeding is being done and so destroyed. They will otherwise cut off so large a number of plants that the gaps will be extensive and will materially reduce the yield. This form of damage commences in December and if checked then, does not recur seriously in that season but, if left alone, there will be a more extensive attack in February, when gaps cannot be filled.

Finally, in March appeared the Indigo caterpillar (see this Journal, Vol. I, p. 338). In the last season this was so abundant as to wholly strip the plants of leaves, and though the attack came late, the roots could develop no more after the leaves were stripped off and in consequence never reached their full size. The caterpillars also, with the Surface caterpillars, in seeking food after they had devoured the leaves, eat into the roots at the surface of the soil. For this pest there is no practical cure, and the only precaution is to get the crop on as early as can be done, so that when the weather warms up in

March, the roots may have reached such a stage of development that the destruction of the leaves is immaterial and, should the eggmasses or young caterpillars be seen, the best precaution is to harvest the roots as soon as can be done. To the indigo planter growing Sumatra indigo, the predilection of the caterpillar for Mangel Wurzel may be useful, since, if he grows an acre or more of it, it will protect his indigo in the same way that lucerne does, only apparently more efficiently.

In the above account, we have referred to the pests doing damage only on a small area of five acres or less: this damage will probably be less, in proportion, the greater the area sown. It is clear that, in Behar, the crop is likely to suffer from insects, and that it is essential that it should be sown as early as possible and brought on quickly. These same pests occur over India generally, and in any experimental cultivation on the crop, they may be looked for. It is probable that continuous cultivation for a series of years would acclimatise the plant and render it less liable to the attacks of these pests, but as at present seed is not raised locally but is imported fresh yearly, the damage due to pests is likely to continue.

CULTIVATION OF COTTON IN INDIA.

By G. A. GAMMIE, F.L.S.,

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[Paper read at the Industrial Conference held at Surat in 1907.]

History of Cotton.

The fibre which furnishes the staple article of clothing in India is scarcely mentioned in the early literature of the East, but this may be explained by the contemptuous indifference evinced by learned men to the products and necessaries of every-day life.

The Sanskrit word translated "cotton" is first mentioned in the Institutes of Manu, where it is enjoined that the sacred thread of a Brahmin must be made from cotton. Herodotus gives a clear description of the cotton plant, when he says that the wild trees of India bear wool like sheep and the Indians use cloth made from these trees. Theophrastus describes a plant with a leaf like that of a black mulberry, the whole plant resembling the wild rose, and being grown in rows in the fields. The first mention of cotton as an article of foreign trade is by Arrian, who flourished in the first century. He says that the Arabs exported cotton to the Red Sea. From India the cultivation of cotton seems to have been spread westward as far as Southern Europe.

Cotton seems to have remained unknown in China until the 13th century. As the cottons of this country approach closely in appearance to those of Bengal and Burma, it is probable that they, with tea, were introduced from India. In the New World,

where varieties of cotton distinct from these of India are produced, the product must have been used from the earliest times. The knowledge of spinning and weaving gradually extended westwards and reached England in the 17th century. In the early years of the last century the production of cotton in the Southern States of America was enormously increased, and this rise in importance of America as a formidable competitor induced the Directors of the Honourable East India Company to initiate the experiments for the purpose of improving the quality and quantity of Indian cotton for export to England

Experiments to Improve Indian Cottons

The causes of the decline in the appreciation of Indian cottons in the European markets have been often explained. As regards the intrinsic value of the staple, the superior kinds of Indian cottons compared favourably, on the whole, with the American short stapled cottons. The average staple of Upland Georgian is between 1·00 and 1·02 inch, that of the best Broach from ·90 to barely one inch. The circumstances which tend to increase the inferiority of Indian cottons are carelessness in picking, which causes a loss of 2·5 to about 7 per cent. against under 2 per cent. of the American Upland Georgian. It must be remembered that the friability of the leaves of the Indian cotton plant is due to the drought of the picking season, so that, even with extreme care, it will never be quite possible to pick Indian cotton in a perfectly clean state.

Owing to the stronger attachment of fibre to the seed, Indian cotton is more liable to be injured in ginning than that of America and Egypt. The tenacious adherence of the fibre to the seed of course spoils the cotton in two ways, by the liability of the fibre to be cut and torn, and by the breaking or crushing of the seed from which oil exudes to stain the fibre. The high pressure to which cotton is often subjected in baling is said also to be detrimental to the quality of the fibre.

According to Watson, the native varieties of cotton may be divided into two principal groups : the North Western, yielding

about one-third of its weight clear cotton and including the Broach, Dholleras, Bhavnagar, Old Khandesh (*Varadi*) and the *Jari* variety of Umravati cotton; and the South-Eastern group yielding about a quarter of its weight of clear cotton and including the Hinganghat, the Bani variety of Umravati cotton, the Kumpta, Madras (Upum variety) and the New Khandesh cotton (from Hinganghat seed). The short-stapled Sind cotton, yielding rather more than a third of its weight of clean cotton, may be considered as forming a group apart. The varieties under the names of Western and Tinnevelly cotton, must have been yielded by the Bourbon variety, which has been acclimatized in the Madras Presidency since the beginning of the last century.

The four varieties which in point of quality proved superior to all the others were the Hinganghat, Broach, Kumta, and the Dharwar American cotton. The varieties next in order are the Khandesh, Western Dhollera, Umravati and Madras cotton, whilst the Sind cotton must be placed last of all.

The principal descriptions of Indian cottons according to Beaufort are Hinganghat (Central Provinces), Broach (Southern Guzerat), Dhollera, Bhavnagar (Northern Guzerat, Kathiawar, Cutch), Umravati (Berar, Khandesh, Deccan), Kumpta and Dharwar (Southern Mahratta Country), Sind (Sind), Bengal (Central India, Punjab, United Provinces, Bengal), Western (Sholapur and Northern part of Madras), Salem (Salem and Coimbatore), Coconadas (Kistna, Nellore, Godavari), Tinnevelly (Tinnevelly, Madras, Trichinopoly).

Two factors of inferiority in Indian cottons are staple and yield, and many experiments have been attempted with the express object of increasing the value of these. The most obvious and speediest solution of the difficulty, namely, the introduction of higher class American or Egyptian, was suggested at first, but long experience has shown that, except in some particularly favoured districts, no advantage whatever is gained from efforts in this direction.

Recent experiments point out that successful results will ultimately be arrived at by the exceedingly slow but certain

methods of selection. Theoretically no practical difficulties are anticipated in the establishment of farms to produce seeds of improved varieties in moderately large quantities, but the maintenance of these varieties, when they perhaps cover large areas in cotton districts, is a subject which has not yet been sufficiently discussed in all its bearings. Loyal co-operation on the part of cultivators and merchants will be necessary for many years to come. It is impossible for the members of a small Department to control arrangements beyond a certain point.

It must not be supposed that the cultivator himself is not fully alive to the importance of seed selection. Many farmers handpick the seed required for the following year's crop: some in suitable parts of the Dharwar district already find it to their advantage to introduce seed of a superior variety from Broach, others particularly reserve the green seeded form of Dharwar American, and in Khandesh the coarsest varieties are deliberately selected on account of their hardiness, productivity and higher percentage of cotton.

Taking into consideration the want of capital and the average small holding of the Indian farmer, any method of cultivation which would entail expenditure on artificial or farmyard manures, is at present out of the question. The general consensus of opinion of the expert cotton growers who conducted experiments in the cotton department, appeared to be that no improvement was to be expected from any alteration in the native methods of cultivating cotton, as the implements already used were extremely well adapted to the purpose. The defects complained of, as has already been shown, were due to faulty processes during and after harvesting the produce.

The experiments, however, in these early years, were directed with the purpose of introducing the finer exotic varieties into the country. This object was only attained by the establishment of the Upland Georgian into the Dharwar district and of Bourbon into parts of Madras. The sum of experience gained amounted to the fact that experiments with foreign cottons were often successful when conducted as costly garden trials, while, on transfer to

the fields, it was found the plants would grow so moderately as not to afford a reasonable profit to the cultivator. Further, the foreign cottons with naked seeds fell an easier prey to harmful insects than the native varieties, which, with one exception, have their seeds guarded by a dense covering of short hairs.

The universal result of the experiments may be summed up in the words of the report issued on those at Broach. "Some kinds of exotic cotton, such as the New Orleans and Bourbon, yielded occasionally a small crop when cultivated as garden plants with great care and expense, but they never escaped partial damage from the effect of the seasons. Where the same kinds were cultivated on a larger scale, even with the greater skill, labour and care of the experimental establishments, the crop invariably failed. The possibility of raising garden samples of any kind of cotton anywhere, by unlimited care and expenditure, is scarcely doubted, but the feasibility of doing so upon terms within the actual reach of the ryot and within the market value of the article, has not been demonstrated at Broach. It was proved that, by double the care and attention and more than double the expense of the native cultivation, a larger yield and better and cleaner quality might be obtained from the indigenous cotton that the ryots can produce, but not sufficiently so to repay the additional outlay."

This may be considered the final word on the subject, until the Agricultural Departments in India again took it under consideration. They have profited by the lesson that little can be gained by the introduction of foreign cottons which have to be subjected to a long course of acclimatization. The failure of these cottons on a large scale, after their success has been completely established in garden trials, has been repeated, and the inevitable result should now be accepted as a fact, so that further loss can be avoided in the future.

The pursuance of a rigid system of selection on a scientific basis and the more intelligent appreciation of the laws which govern the production of crosses and hybrids will probably lead to definite results, at first on the seed farms and afterwards on the

fields. New varieties will be introduced into districts suitable in every way to their individual requirements of climate and general environment. The Agricultural Department can furnish the necessary scientific guidance, but nothing can be done on a field scale without the assistance of the farmer and trader.

Cotton Soils and Culture.

Black soils in India are pre-eminently the best for cotton. Red soils are scarcely ever used for this crop. The superiority of the black soil is probably due to its depth and adhesiveness, which render it very retentive of moisture.

Mr. Mercer made the following remarks regarding the state of native cotton culture: "In Gujrat, Khandesh, Southern Maratha Country and Berar, I find an approach to the American mode of culture, by sowing in drills and at regular intervals, while in Madras, the North-West Provinces and almost every other part of India where cotton is grown, the broadcast system alone is used. The first, by allowing the crops to be kept free from grass and weeds, by means of plough or cultivator, and the ground about the plants being thoroughly and constantly stirred, gives an advantage both in regard to cheapness and the improvement of plants themselves that the other never can possess, and is, indeed, the chief excellence of the American mode of culture and the only one of its features which has been found not to need much modification.

"It appears that the natives of large tracts, as Guzerat, Berar, already employ a mode of cultivating the cotton plant, in principle nearly the same as the American, but better suited in some respects to locality, etc. No people better understand the advantages of rotation of crops than do the natives of India generally. With regard to implements of cultivation, those now in use amongst the natives of the districts where the drill system of cotton culture is practised, are quite sufficient, being fully adapted to the most thorough tilling of the ground. Though the field for improvement is great, still, the manner of growing the cotton is not nearly so defective as it has heretofore been the

practice to represent." Previous experiments, carefully conducted, proved that irrigation, especially in the later stages, is harmful to the crop and weakens the fibre.

In conclusion, at the present juncture, we are only in a position to say tentatively, exotic cottons can only be cultivated in favoured parts of India; tree cotton cultivation is not worth the risk; varieties can only be improved in their own localities, by the adoption of methods of selection and crossing, and varieties can only be maintained in a pure state in the fields if the cultivators and traders are willing to observe the needful precaution.

NOTES.

EXPERIMENTS IN TREATING GROUND-NUT LEAF DISEASE.—The disease known as *tikka*, caused by the fungus *Septoglæum Arachidis*, has been severe on the Government Farm at Kirkee, near Poona, for some years. Experiments in treating it by steeping the seed in copper sulphate and by spraying with Bordeaux mixture were started in 1905-6, and continued last season. The results were disappointing. No improvement in the treated plots could be detected on inspection and, though the yield obtained the first year appeared to indicate a beneficial result, this was not maintained the second year, and the variations between the plots were probably a result of differences in soil. The fungus forms quantities of spores on the lower surfaces of the leaves, and as the crop covers the ground closely, it is unlikely that any spray, however carefully applied, can reach many of the spore-producing spots. Hence, even sprayed plants may infect their neighbours, particularly during the monsoon when there is so much disturbance of the leaves. Steeping was tried although the parasite has not been found in the seed, because there is some evidence that seed from diseased plants may convey the disease. This is, however, likely to be due to casual spores lying in the soil which sticks to the outside of the nut, and such spores would be reached with difficulty by any fungicide. It is, therefore, advisable, when ground nut seed is introduced into a new locality, to have the seed husked first and then treated with copper sulphate before exporting. There is another possible way in which the ravages of *tikka* disease may be lessened. Experience seems to show that early maturing varieties suffer least, for by the time that their leaves are severely affected the nuts have

been set and escape shrivelling. Hence attention should be directed to obtaining an early ripening variety of nut by selection or hybridization. This appears to be the most hopeful method of attacking the ground-nut disease at present available.—(E. J. BUTLER.)

* * *

EGYPTIAN COTTON IN SIND.—In 1905, the area sown in Egyptian cotton was 1,000 acres; it was all on the Jamrao Canal situated in a district measuring 2,000 square miles. The yield was approximately 450 bales. The season was said to be unfavourable to all cotton in Sind. Very sanguine estimates were formed early in the season of the yield of this crop, up to an average of 1¼ bales per acre. While a small percentage of the area sown came up to the estimate, the larger portion was only fair and brought the average yield to a low level.

The price, however, obtained was very encouraging. Eleven bales were forwarded to Liverpool for valuation and were sold in the open market at 9*d.* per lb. The value of good fair Egyptian on the same day was 10*d.*, and middling American 6·04*d.*

The Vice-Chairman of the British Cotton-Growing Association wrote as follows:—"Under these circumstances it would be advisable to endeavour to get as much Egyptian cotton planted in Sind as possible this season, and the planters ought to be able to rely on a minimum price of 7*d.* per lb. out there."

Most of the cotton was bought by a Karachi exporting firm and the price obtained by the cultivators worked out at 5½*d.* for Mit-Afifi and 7½*d.* for Abassi. This firm was said to have obtained 11*d.* per lb. for this cotton in Liverpool.

In the season of 1906, the area under Egyptian cotton was 5,098 acres. It was, as in former years, scattered in small plots over a very large area. Consequently, in order that the zemindars might get as large a price as possible for their produce, it was considered necessary to establish a system of receiving depôts for the collection of the cotton. A central depôt was established at Mirpurkhas and there the cotton was auctioned. This scheme was successfully carried out by the Colonization Officer, Jamrao

Canal; it was the means of greatly increasing competition. Even the worst quality cotton which was greatly discoloured by the attack of boll-worm sold at a rate of Rs. 11-2-0 per maund. This price compares favourably with the best given for Abassi and Mit-Afifi in the previous year.

It is probable that this system of collection and auctioning the cotton under Government supervision will have to be continued for some years till cultivation is fairly established and buyers fully aware of the nature of the produce.

The amount of Egyptian cotton actually sold at Mirpurkhas was 4,879 maunds (of 80 lbs.) of seed cotton and the average rate Rs. 11-15-0 per maund. Besides this, however, much cotton was disposed of by private sale to Ahmedabad spinners and to a Karachi firm for export.

The total yield was probably under 10,000 maunds of seed cotton. This low yield was generally explained by the ravages of the boll-worm, but if the cultivation in 1906 was similar to that practised by many zemindars in the current year, the low yield for the larger portion of the land is explained apart from the effect of boll-worm. Last year's ginned cotton, where not discoloured by boll-worm, seems to have been fully equal to average North Egyptian Abassi. The ginning results were also said to be similar, *viz.*, about 100 lbs. lint to 315 lbs. seed cotton. No complaint was made by spinners as regards length of staple; the strength, however, was reported to have deteriorated.

During the season of 1907 the area sown was 6,335 acres. An area of about 2,000 acres was sown with Abassi seed obtained from last year's crop, ginned in Sind. The remaining area was sown with Mit-Afifi seed imported from Egypt.

In 1907, there was practically no boll-worm on the Egyptian cotton, but a considerable amount was found on Sindhi Cotton in the same districts. The cultivation was in most cases very poor; many cultivators broadcasted the seed on the flat after one ploughing and paid no attention to thinning or weeding. In nearly all cases, too, the irrigation was excessive which is a certain means of lowering the grade of the staple. The results

of this over-irrigation was seen on the growing crop, *viz.*, large masses of foliage developed at the expense of bolls, and the ground became covered with weeds. In a few cases, very good crops were obtained as the result of more careful cultivation. There seems to be no reason why with proper cultivation and rotation returns of 1,000—1,500 lbs. of seed cotton per acre should not be obtained on land that is free from alkali.

As in the former season, the Government auctions at Mirpurkhas had a very beneficial effect in obtaining an adequate price for the cotton. As the stuff was exposed in fairly large lots, buyers came to Mirpurkhas who would not have gone round the district buying in small lots. Most of the cotton was sold by private treaty at slightly less than auction prices. As far as can be ascertained, the total crop was about 1,800 bales each of 400 lbs. Of this the auction disposed of about 55 bales of Abassi and nearly 300 bales of Mit-Afifi. The average price obtained was :—

Mit-Afifi, Rs. 11 per maund of 80 lbs. seed cotton.
Abassi Rs. 13 per maund of 80 lbs. seed cotton.

Mit-Afifi being new to the Indian market, the buyers were probably discouraged by its brown colour. Similar seed cotton was being sold in North Egypt for £4-5-0 per 315 lbs.

Government fees for transport, etc., fall to be deducted from this at Re. 1 per maund. An average figure for total crop would be probably Rs. 11 to Rs. 11-8-0 per maund. The chief buyers were Ahmedabad and Bombay mills, chiefly for trial spinnings, and one or two exporting firms. It was also reported that samples were bought for export to Japan.

In the present season of 1908 the area to be sown is practically the same as last year. 56 tons of Abassi seed and 11 tons of Mit-Afifi seed are being distributed to the zemindars. (G. S. HENDERSON.)

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BOARD OF AGRICULTURE IN INDIA, 1908. The fourth Annual Meeting of the Board was held at Pusa from the 17th to the

22nd February 1908. Mr. J. Mollison, M.R.A.C., presided. Fifty-one members and seven visitors attended the Board. Besides the officers of the Imperial and Provincial Departments of Agriculture, the meeting was attended by the Director-General of Commercial Intelligence, Director of Botanical Survey and officers attached to the Agricultural Departments of Kashmir, Baroda and Mysore States. A few non-official gentlemen, interested in Indian Agriculture, were also present. Bengal, United Provinces, Punjab, Madras and Central Provinces were each represented by five officers of its Department of Agriculture. Bombay was represented by three of its officers, Eastern Bengal and Assam by four and Burma by two. All Directors of Agriculture except the Director of Bombay were able to attend. The subjects brought up for discussion were :

(*a*) The form of Report of the Board's proceedings : (*b*) the future constitution of the Board of Agriculture : (*c*) Programmes of work of the Imperial, Provincial, and Mysore, Baroda and Kashmir State Departments of Agriculture; (*d*) the lines on which Entomological and Mycological work in the Provinces should be conducted ; and the general expansion of the different sections of the Departments of Agriculture : (*e*) the best methods of bringing experimental work to the notice of cultivators : (*f*) the extension of cultivation of fibre plants : (*g*) the scope of improved Poultry-breeding in India. These subjects were largely dealt with by committees, whose able reports, as modified by the full Board, will be published in due course.

The most important discussion referred to the best methods of bringing the work of the Department in a practical way to the notice of cultivators. Many of the members evinced keen interest and many useful suggestions were made.

With a view to removing the necessity of sending students to specialise in England or other foreign countries, it was decided that the Pusa College, with a selected number of Agricultural graduates and distinguished Science graduates of Indian Universities, should start a post graduate specialised course as soon as the College building is ready, in July 1908. The standard

curriculum of studies has been framed and rules of admission are now under consideration. They will be shortly published for the information of the public.—(EDITOR.)

* * *

LAC FUMIGATION.—On harvesting the crop of lac grown at Pusa in the rains, it was found that practically every stick was infested with caterpillars (several species of *Eublemma* and some *Tineids*). These feed on the lac insects and the lac, causing great loss in weight and are a well-known pest in India. The sticks were accordingly scraped at once and the lac spread out in the sun to dry. This being of no avail at all, the next batch of sticks, as they came from the trees, were placed in the fumigating box and treated with carbon bisulphide. The liquid was used at the rate of one ounce to ten cubic feet for twelve hours and on scraping the lac from these sticks, no live caterpillar was found but abundant dead caterpillars and chrysalids. The previously scraped lac was then treated in an ordinary box, the liquid being poured on to a wad of cloth placed at the top of the box and the box then closed. This treatment should either be double the strength of that used for the sticks or continued longer, and it is advisable to keep the box closed until the scraped lac is to be sold. That is, every filled box of scraped lac should be fumigated as it is and kept so as long as possible. Lac treated in both ways was sent to Mirzapur for valuation and the traders were unable to discover anything wrong with the lac, valuing it at the prices then ruling, Rs. 43 and Rs. 30 per maund for the two qualities. The treatment is, therefore, not in any way injurious to the lac and the saving it effects is wholly out of proportion to its cost. Both the rains crop of lac and the cold weather crop are habitually attacked by caterpillars, the former most; such lac becomes wholly valueless and a specially good sample of lac sent by a planter from Assam to London was reported on as "wholly unfit for sale owing to worms." It is improbable that any means of checking these worms in the growing lac on the tree will be found, but it is at least possible to at once treat every stick of lac as it is

out, and prevent the loss as soon as possible. We would draw the attention of every lac grower and lac buyer to this point and to the simple and easy treatment that is effectual.—(H. M. Lefroy.)

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Travancore Coconut Disease. Heavy loss has been incurred in Travancore in recent years owing to a disease of coconuts which affects a considerable area in the north of the State. This disease is spreading slowly and may appear in Malabar before long. It causes the trees gradually to become barren; in some gardens the best trees, that used to give over a hundred nuts a few years ago, now only give ten or twenty or even sometimes none at all.

The first sign of this disease is that some or all of the leaves turn yellow, as if they did not get enough water. Then the tips of the leaflets dry up and hang down. At the same time the outer leaves bend away from the crown and become loosened, so that they can easily be torn off from the tree. In a year or two from the first appearance all the leaves turn yellow and dry up at the tips. When this happens, the bunches of nuts get affected; at first some of the nuts do not ripen properly but fall to the ground in an immature condition; next year there will be fewer and smaller nuts, and after four or five years there may be none at all. Sometimes the flower spathes are unable to break out from the base of the leaves; usually, however, they are formed but are not strong enough to produce good nuts. Such nuts as are given by diseased trees are of bad quality, the copra is hard and gives little oil and the water inside the nut is disagreeable in taste and diminished in quantity.

Gradually, as the palm gets more and more weakened, the new leaves that are formed are smaller than those of healthy trees. The centre shoot, which stands straight up in the middle of the crown, gets shortened and turns yellow or may even wither completely.

After five or ten years the diseased palm may dry up altogether and the head falls off. This is fairly common in some places, as in the Minachil Taluk of Travancore, while in others,

as at Changanacherry, very few trees have died even though some have been barren for many years.

Areca palms are attacked in the same way. As they are smaller and more delicate than coconuts, they become barren more quickly and they may be killed in from three to five years, though often they remain barren for much longer without dying. They are never killed in a few months as in the *Koleroga* disease which attacks areca palms in Mysore.

This disease has caused such losses in some villages in Travancore that there is now only one-quarter of the yield of coconuts that there used to be some years ago. The exports of coconut produce from the State have decreased in value by many lakhs, in spite of a considerable rise in price.

It is caused by a minute fungus which attacks the roots in the soil and causes them to rot. This lives and grows in the soil, but can only spread underground very slowly. It has taken about ten years to get from one village in Travancore to another only a few miles away. If soil from a diseased garden is put into a healthy one, the fungus may be brought over in the soil, especially if it contains any coconut roots, and may begin to attack healthy trees at once. This must be the way that it has spread over a large part of North Travancore in the last twenty years, for in this manner it can, of course, be made to travel quickly. Hence, people should be very careful not to let any soil or roots from a diseased garden into their gardens.

The only way to kill the fungus is to dig up and burn the roots of diseased trees as soon as any are noticed. If all the owners of coconut and areca gardens in districts adjoining Travancore will do this, there is a good chance that the disease will not spread beyond the State. It will require great watchfulness and all must unite in keeping a lookout for cases, for if a few trees are left diseased, they will serve to harbour the fungus and enable it to spread in the soil and attack all the palms near by. The trees should be dug up and the roots burnt as soon as they are noticed to be diseased, as even though the owner may lose a few nuts by digging up the palm, the loss will be small

and he will save his other trees. The palms do not seem ever to recover and it is better to lose a little at once than a great deal later on by allowing all the trees to get attacked.—(E. J. BUTLER.)

* * *

JUTE EXPERIMENTS IN BENGAL.—The Bengal Agricultural Department Leaflet No. 1, 1907, gives the general results of jute experiments which were begun on the Burdwan Agricultural Station in 1904 and have been carried out there and elsewhere in Bengal up to date. The Burdwan experiments have definitely proved that of 57 varieties originally tried, 10 are the best. When the rainfall is normal and well distributed, no irrigation is required. The best time for sowing seed is the third week of April or a little after. The seed must be sown in a smooth seed bed which can only be produced by a large number of ploughings and other cultivation. The crop is exhaustive and requires considerable dressings of manure before the seed is sown. The most paying results at Burdwan were got by applying 70 maunds of cattle dung or $7\frac{1}{2}$ maunds of castor cake per acre. The plants should be thinned out to 1′ apart and reaped in September when the water conditions for retting are better than later. The longer the crop is allowed to grow, the heavier the outturn of fibre. It never pays to cut the crop before it is in full flower. The best quality and greatest outturn of fibre are probably obtained when the fruits are being formed.

Drilling of seed has so far failed to show any advantage over broad casting, both systems being equally good. The following varieties, *viz.*, Baran of Mymensingh, Amonia of Faridpur, Kakya of Bombai and Deswal of Sirajganj, Barapat of Jagannathganj, Nailta of Mymensingh, Paknallya, Tosha of Pabna, Halbilati of Tipperah and Tosha of Faridpur have proved to be equally good and have yielded nearly the same quantity of outturn.

The experiments at the Cuttack Farm showed that under proper treatment jute can be successfully grown in parts of the Orissa Division in rotation with either paddy or potatoes. (EDITOR.)

NOTE ON SOME SHEEP FOUND NEAR CUMBHUM.—On January 31st I visited Cumbhum in order to see some sheep which had been noticed by the Inspector-General of Agriculture from the train, when passing through, some days previously. The noticeable feature about them was their whiteness. I found the flock some little distance from Cumbhum itself, grazing on the gravelly upland soils, where there were a few weeds and a little Sazz (*Pennisetum typhoideum*) and Varagu (*Paspalum*) stubble. There was also a bit of dried grass on the lower slopes of the hills. The sheep were large, standing about 24–27 inches at the shoulder. The colour was mostly a very pale brown but there were many practically pure white. A few were dark brown. This colour is often more marked on the belly and the back of the hind legs. They possess no wool at all but only a very coarse hair which is longer on the underside of the back and belly and on the hams. They possess small flaps of skin such as are found in goats. The rams have short and slightly twisted horns. They are accordingly mainly used for manurial purposes, though their flesh is eaten by the Mahomedans who are fairly numerous in this district. These sheep have little value except for their skins and indeed resemble goats somewhat closely.

The rams at the time of my visit were in a separate flock. They are allowed to run with the ewes in May or June. The lambs are dropped in October and run with the ewes for six months.—(R. CECIL WOOD.)

* * *

BUNT IN WHEAT.—A sample of wheat flour, containing numbers of brown, smooth-walled spores, was recently received at Pusa from Gilgit. A few heads of local wheat obtained from the same locality showed that these spores belonged to the well known "stinking smut" or "bunt" fungus, which causes considerable damage to wheat in some countries. This disease was not previously known to occur in India, or on its borders. Two varieties are found, under the names, *Tilletia Tritici* and *Tilletia laevis*, both of which were present on the Gilgit samples. Probably the latter is more common, as the spores in the flour

were almost all belonging to this variety. Smutted heads are usually erect and can be detected when the crop is nearly mature. The fungus itself is not, however, visible until the grain is broken, when the interior is found to consist of a blackish, hard mass, with a very disagreeable odour. The disease can be almost entirely prevented by steeping the seed in formaline. A pint of this should be added to 50 gallons of water and the seed-grain immersed for four hours, then dried before sowing. A careful watch should be kept for this disease in the Punjab, as the experience in most countries has been that, unless checked, it gradually increases until it may cause severe loss.—(E. J. BUTLER.)

* *

SERICULTURE IN KASHMIR. (Note from the Report for 1907 of the Silk Association of Great Britain and Ireland).—The development of sericulture in Kashmir has been very striking during the last ten years. This industry is now probably the largest of its kind in existence. The report states that the mulberry tree is now being systematically cultivated in Kashmir. Silkworm eggs were given out to 15,784 householders. The women and children were chiefly engaged in rearing the silkworms: 60,000 to 70,000 persons were thus employed. The cocoons are brought to the Central Factory at Srinagar and paid for at fixed rates. In this factory the silk is reeled and over 6,000 men, women and children are employed at the work. The profits to the Kashmir State from this industry are year by year increasing. The progress is indicated by the following figures:—

The outturn of raw silk for 1900		57,921 lbs.	
"	"	1901	95,048 "
"	"	1902	135,221 "
"	"	1903	146,057 "
"	"	1904	132,451 "
"	"	1905	172,165 "
"	"	1906	130,786 "

The raw and waste silk find a ready sale in France and Italy.—(EDITOR.)

* *

A NEW SOURCE OF SULPHATE OF AMMONIA.—A new source of Sulphate of Ammonia has been found in peat which exists in

immense areas in various parts of the world. The process by which Sulphate of Ammonia is obtained from peat is called the Wottereck process. The patentees are the Sulphate of Ammonia Company, Limited, of 171, Queen Victoria Street, London, E.C. By this process 585 tons of moist peat, equal to 200 tons of theoretically dry peat, gave a minimum yield of 10 tons of Sulphate of Ammonia. The maximum cost was found to be £5-0-0 per ton, which is less than half the present market price, £12 0-0 per ton. The destructive distillation of peat produces paraffin, tars, acetic acid and ammonia, which, after being separated, can be sold as commercial products.—(EDITOR.)

* * *

SELECTION OF PIGEON-PEA FOR WILT DISEASE.—Experiments were commenced at the Kirkee Government Farm, near Poona, in 1905, to raise a strain of *tur* (pigeon-pea) resistant to the wilt disease of this crop. A number of varieties were collected and sown on a plot that had been severely affected the previous year. Nine of these varieties, which showed promise, were resown on the same plot in 1906. As the seed was taken only from plants that survived the first year and were therefore presumably somewhat resistant, a higher proportion of survivals was anticipated in the second year. This was actually the case in seven out of the nine varieties, one remaining constant and one showing a decrease in resisting power. Work will be continued with a limited number of plants, and in a year or two it should be possible to select individual plants that are unquestionably resistant to the disease. Selection work of this nature is a more tedious matter than selection for definite qualities such as early ripening, colour or the like, since it is necessary to make reasonably sure that the resistance to disease is inherent, and not merely due to the parasite failing to come in contact with the plant. This is more difficult in the case of a soil borne disease such as wilt, than in others, as the degree of spread of the fungus through the soil cannot readily be gauged. As the parasite is widely distributed in soils which have grown pigeon-pea regularly, and as it enters into the interior of the underground parts, no

other method of checking it appears to be practicable than that here referred to. Whether this will be successful cannot be foretold at present, but the experiments are promising so far as they have gone. (E. J. BUTLER.)

* * *

FLAX AS A FIBRE CROP IN BEHAR. A REVIEW OF A REPORT OF MR. EM. VANDERKERKOVE, FLAX EXPERT. This crop has been grown experimentally for several years in Behar. The chief experiments have been conducted at Dhooria. The cultivation of flax on this estate in 1906 and in 1907 was on an extensive commercial scale. The 1907 crop was grown under the direct supervision of Mr. Vanderkerkove, who is a practical flax expert. He was engaged for a year by the Indigo Planters' Association, helped by funds provided by the Bengal Government. Mr. Vanderkerkove's report on his year's work is reviewed as under :—

Soil and Season. The value of a flax crop is largely determined by the character of the soil and of the soil moisture. The best market rates can only be got if the stems are uniform in length, colour and flexibility. In Behar the light sandy soils and the heaviest clay soils will not usually produce a crop of this quality. Soils intermediate between these two are generally best, but this depends upon seasonal conditions. If the Hastha or Hathia rains in September-October are good, fairly light high land may be found suitable. If the October rainfall is deficient, low-lying clay-like land may probably be best. The important point is that the land should hold sufficient moisture near the surface at the time of sowing to secure even germination.

Cultivation. Flax can only be grown successfully in the *Rabi* season. It can follow a monsoon crop which is taken early off the land if by ploughing and other tillage a clean friable seed bed for the flax is produced before the middle of October. It is unlikely that flax can be grown on the same field oftener than every fourth year. The land should be in good heart from previous manuring. Direct manuring for this crop is not advisable. European experience indicates that a liberal dressing

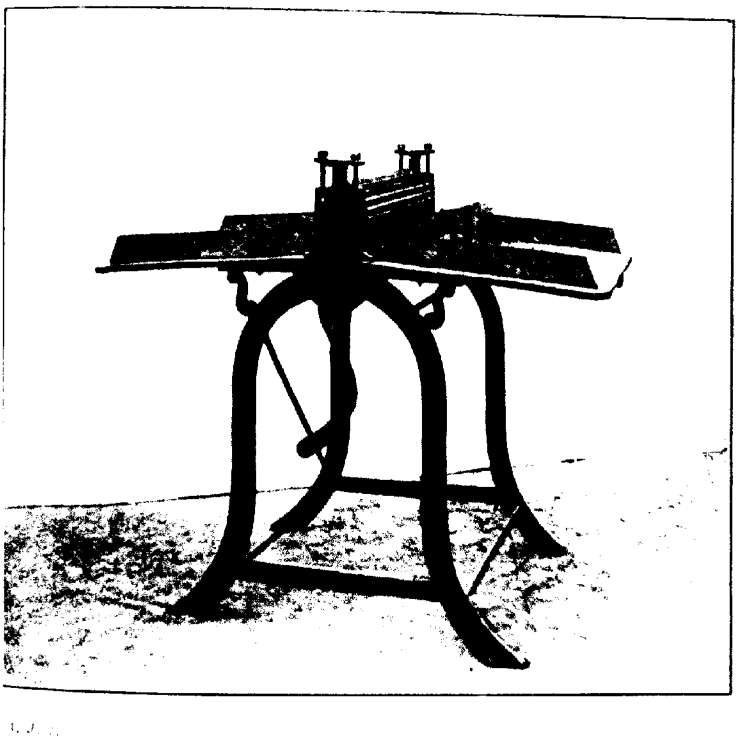
to the previous crop of a general manure, such as cattle dung, indigo refuse (seet), or oil cake would give good results. This dressing should be at least 8 tons of cattle dung or seet, or half a ton of rape or castor cake per acre (these are usually the cheapest manures in Behar).

Seed.—There is no doubt that imported seed should be used in the first instance. Mr. Vanderkerkove considers that Russian seed acclimatised for one year in France, Belgium or Holland may give the best results. There is, however, clear evidence that Russian or Belgian seed imported direct gives good results, and that such seed acclimatised in India continues to give good results at least for some years. The seed acclimatised in India is smaller than that imported. A seed rate of 120 to 150 lbs. of imported seed, or of 100 to 130 lbs. of acclimatised seed per acre, is required when both kinds are of good germinating power. The seed should be sown in October or at latest in the first week of November. The seed may be broadcasted by hand or drilled like indigo in very narrow rows, and could probably be very expeditiously and successfully sown by the cheap hand barrow for sowing broadcast which is so extensively used in sowing clover and grass seeds in England. It is best to sow in the early morning before the sun dries up the surface moisture. The seed should as far as possible be covered by light raking, afterwards the soil should be "rolled" down with a light log to conserve moisture. These operations are very essential to even germination on which the success of the crop greatly depends.

Weeding. The land should be so carefully tilled before sowing that little weeding will be required afterwards. Hand weeding where necessary is essential. A bullock hoe cannot be used. The hand weeding should be done when the seedlings are small. When the seedlings are three inches high, it does more harm than good on account of the damage done by trampling. Clean seed should be sown to avoid as far as possible the need for weeding.

Maturing and harvesting.—Flax in Behar is usually a four months' crop. It reaches maturity for fibre when the first seed

PLATE XXIV.



[illegible]

A FLAX BREAKER.

The woody portion of the retted straw is broken up by the grooved rollers of this machine. The little pieces of wood are the [illegible] adhering to the fibre that they are completely detached in the scutching process.

bolls have fairly set. At this stage the amount of seed obtainable is small, but the quality of the fibre is superior. The usual signs of ripening are that the stems begin to get yellow, that the bottom leaves of the stems become yellow and begin to drop off, and that some of the bolls contain seeds which are beginning to get brown in colour. In an uneven field these signs may appear in patches. When they do appear, the crop should be uprooted patch by patch, immediately. The Indian cooly knows how to do this work because he is accustomed to it with other crops. The roots should be shaken free of earth and the stalks laid neatly in rows or "swathe" and allowed to dry for two or three days. The crop should then be tied into small-sized sheaves. If possible, the coarse and fine, the long and short stalks should be tied in separate sheaves. This helps in sorting the different qualities of fibre when it is being scutched. When sufficiently dry, the crop should be carted to the threshing floor in order to separate the seed by beating the sheaves with sticks or by beating them against a hard floor. The seed can be cleaned by wind in the ordinary way. Only the best seed should be kept for sowing. It can be safely stored in tins or closed earthen ware *chatties*. It is necessary to protect the seed against weevils and absorption of moisture which cause great loss to the germinating power.

Quality. The characteristics of good quality in flax are straight yellow slender stems, small white roots, very few branches and pods, small, soft leaves which are far apart, stems flexible towards the root and 28 to 36 inches long between root and top. Any length less than 18 inches of unbranched stem is useless except for tow. Coarse fibre of low market value is got from flax which remains green too long, which branches out freely and from which the stem leaves do not drop off when matured. A variety with these characteristics yields seed freely. The characters referred to in this para. should be specially studied in seed selection.

Retting.—There are several systems adopted in Europe, *viz.*:—

(1) River retting.

(2) Dew retting.

(3) Stagnant water or "blue" retting.

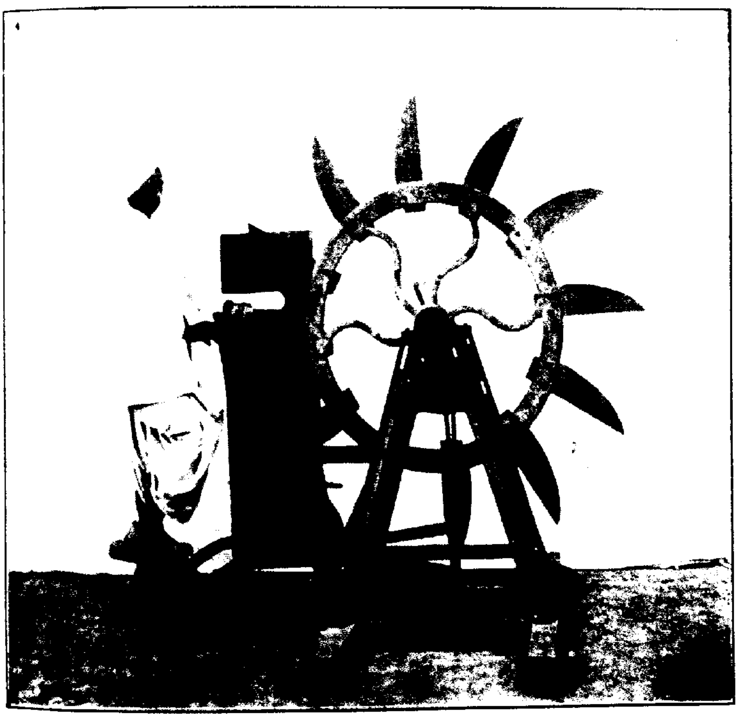
(4) Tank retting with underflowing water. (Loppersum patent.)

(5) Tank retting with washing system. (C. Vanstone's kiste patent.)

(4 and 5) are imitations of river retting.

The flax expert found 4 and 5 unsuitable to India and found it inconvenient to try the others. He decided that it was best to use ordinary indigo vats. The vats should be loaded with sheaves on end as evenly as possible, a second layer being placed above the first in the same way, and both kept in position by a close layer of bamboos on the top; cross beams 4 or 5 feet apart are rigidly kept in position about a foot above the loaded flax. Water is let in until the rising flax reaches the rigid beams. The water should cover the flax. The dissolving of the gums of the flax causes the water to become dark brown in colour; when the water becomes too heavy laden with dissolved matter, the retting bacteria cannot live in it. Consequently the brown water is let out at the bottom of the vat. Fresh water is let in at the top until the effluent water becomes fairly clear. If this fresh water gets also brown in colour, a portion may also have to be renewed before the first retting is complete. Generally, coarse straw which is stained by being laid in the field can be retted quicker than straw of better quality. The warmer the water is the quicker the retting is accomplished. The best temperature is between 64° and 75° F. Water at 80° F. is not unsuitable, but at 90° F. is risky for good results. It takes six to ten days to ret the best quality of fibre. The process is considered complete when the bark and fibre layer cracks slightly by pressing the stem between the fingers. The water is then drained off and the flax is removed to the open to dry, great care being taken in handling it whilst wet to prevent damaging the tender fibre. When dry it is again brought to the vats and again loaded as before. When the water gets brown, it is allowed to run off and clear water let in for a few hours until the retting is finished. The test is to break a stem in two places and draw out the fibre between these two points. If it comes out very easily, the retting is complete

PLATE XXV.



A. J. I.

FLAX SCUTCHING MACHINE.

[illegible] of the large wheel [illegible] rapidly passed [illegible] vertical board. A slight rubbing [illegible] broken straw placed between them, which is sufficient [illegible] the fibre that remains.

The object of twice retting and once drying in between is to improve the quality and colour of the fibre by bleaching in the sun and exposure to the air. Retting is best done in Behar in the cold season as the temperature of the water is then usually just right.

Drying. The sheaves of flax are now removed to an open space, preferably to grass land, to dry. Each sheaf is divided into two or three parts. Each part is bound at the top end and spread out at the bottom end and is set on the ground in the shape of a cone. These cones are turned inside out next day and again set up to dry, the whole object being to expose to the sun and air, all the stems, so that they may dry and bleach thoroughly. When completely dry, the flax should be tied up into neat bundles, keeping all the root ends as even as possible.

Breaking. This consists in passing the flax in very even handfuls between two sets of fluted iron rollers. These break the woody part of the stem and do not damage the fibre. Breaking facilitates scutching. A hand-power machine is illustrated. (Plate XXIV.)

Scutching. A scutching machine can be worked by manual foot power or a number can be worked from a power shaft. The construction is difficult to describe. Six or 10 hard wood blades about 2 inch thick, fixed like the spokes of a cart wheel on a hub revolve at a high rate of speed on a shaft. In revolving, they pass close to a hard-wood board fixed in an upright position close to the revolving blades.

In this board there is a slit. Through this slit the flax with a firm grip is passed in and withdrawn in handfuls first, one end of the handful and then the other. The process is repeated until the fibre is beaten clean. In scutching, a considerable amount of tow is produced, which has to be separated from the cleaned fibre. The cleaned fibre is graded according to quality, twisted and formed deftly into bundles. The scutching should be done before the flax becomes over dry and brittle. In Behar the cold weather, from November to 1st March, is the best time. Mr Vanderkerkove has been able to train ordinary coolies to do the work

expertly. A foot-power scutching machine is illustrated. (Plates XXV and XXVI.)

Baling. The cleaned fibre is carefully graded according to quality. Each graded lot should be baled separately. This work requires expert knowledge. The bales for shipment are covered with gunny cloth, and each should be distinctively marked, to denote the quality of the fibre which it contains. The market rates vary largely. The very best qualities of flax always command very high prices.

Results of Dhoorieh Experiments.—These indicate so far that flax is likely to become a paying crop on a commercial scale in Behar. The net profit from an acre of flax is estimated as follows:—

Income.

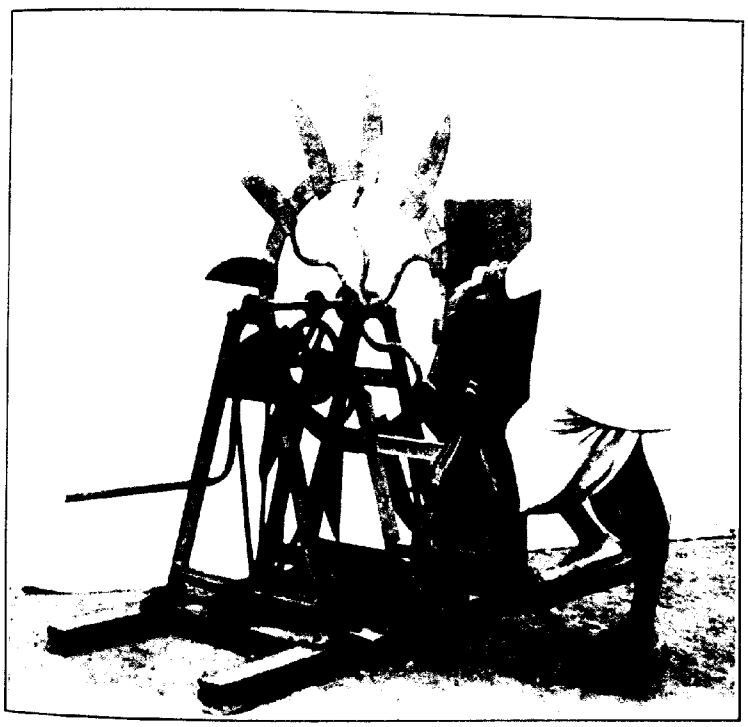
		Rs.	A.	P.
4 maunds of fibre @ £50 a ton	...	111	[illegible]	[illegible]
10 [illegible] tow @ £15	...	12	[illegible]	[illegible]
4 [illegible] of seed @ Rs. 4 per maund	...	16	0	0
		Rs. 1[illegible]	6	9

Deductions.

		Rs.	A.	P.	Rs.	A.	P.
1. Rent	...	2	8	0			
2. Cultivation	...	27	0	0			
3. Sowing crop	...	4	11	8			
4. Preparing for retting	...	2	5	0			
5. Retting	...	3	2	10			
6. Scutching, [illegible] of tow	...	7	2	6			
7. Shipment	...	16	14	0			
8. Miscellaneous	...	1	4	0	66	0	0
Net profit					74	6	9

Future work.—The experimental results have been so encouraging that Mr. Vanderkerkove has been engaged for a term of years. The experimental work which has yet to be done covers a wide field. It will include the testing of (*a*) indigenous and exotic varieties, (*b*) acclimatization of improved seed, (*c*) plant-to-plant selection of seed, (*d*) soils, (*e*) rotation, (*f*) cultivation, (*g*) manures (including its own seet water), and (*h*) retting methods. Demonstration will be made to show whether the crop can be produced profitably in other parts of India and is within the means of ordinary cultivators. The best methods of baling and marketing the crop will be further examined.—EDITOR.)

PLATE XXVI.



C. J. L.

FLAX SCUTCHING MACHINE.
Showing details of Construction.

REVIEWS.

Lac Cultivation in India. (Indian Trade Journal, Vol. VIII, No. 102.)

The chief factor in successful Lac production lies in the improving and systematizing of the cultivation. When experience has shown which tree suits a certain locality best, efforts should be made to establish regular areas of coppice, either from seed or cuttings, to be worked on a definite rotation. Various trees are suitable for Lac cultivation, *e.g.*, *Cajanus indicus* (Arhar Dal) in Assam, on which the best Lac of the Province is produced. This tree too has been found very useful in inoculating other trees such as Pipal, Ber, etc. The cost of cultivating 100 trees, say, of Kusum (*Schleichera trijuga*) is Rs. 15, and at lowest estimate this ought to produce 5 mds. of Lac (best orange shellac is made from Kusum Lac). The present price of Lac is Rs. 60 a maund; thus, there is a good margin for profit. Inoculation of brood Lac should always be from dense wood to less dense wood. A moist situation is essential for successful Lac growing.

Lac was produced in former times on account of its dyeing qualities, now its value lies solely in its resinous properties. The old method of collecting, which was suitable when 'dye' was the chief object, is nowadays harmful, giving a material of dirty and poor quality. On account of the extensive use of shellac in electrical works and in the manufacture of gramophone records, etc., the price of Lac has risen from Rs. 15 to Rs. 60 a maund. For those interested further information may be had from Mr. Stebbing's "Note on Lac Insect"; Dr. Watt's "Lac and Lac Industries" (Agricultural Ledger IX of 1907) and Indian Trade Journal, Vol. I, pages 102 and 437; Vol. III, page 294; Vol. IV,

pages 9, 380, 563; Vol. V, page 19; Vol. VI, page 733. (W. ROBERTS.)

* * *

LIFT IRRIGATION. BY ALFRED CHATTERTON.

IN this pamphlet, specially written for the Industrial Conference held at Surat, Mr. Chatterton demonstrates the efficiency of oil engines and pumps over indigenous water lifts for irrigation. This pamphlet is written in a simple style suitable to the intelligence of ordinary readers. He mentions the difficulties preventing the wide-spread use of oil engines and pumps. He admits the cultivator in India is generally poor and lacks mechanical skill. As it is not within the means of the cultivator to pay Rs. 2,000, the minimum cost of a pumping installation, he suggests that Government should purchase oil engines and pumps and make loans of these on the security of the farmer's crops. Owing to the limited mechanical skill of the ryots, Mr. Chatterton considers the centrifugal pump most suitable. It is extremely simple and fairly efficient and can be had at a very moderate price. Still, there is a further difficulty to contend with, *viz.*, that the supply of water should regularly be not less than 10,000 cubic feet a day for the greater part of the year. Mr. Chatterton, from his experience in the Madras Presidency, says that this quantity of water can be easily obtained in the coast districts in the beds and along the margins of many rivers. If the oil engines and pumps are generally to replace native contrivances for lifting water, a preliminary survey of subterranean water should be carried out in all parts of India and the results should be made accessible to all cultivators. (EDITOR.)

* * *

CROSS-FERTILIZATION OF SUGARCANE. ("Cane Sugar or Beet.")

IN a recently issued pamphlet, entitled "Cane Sugar or Beet," written by Mr. F. I. Scard, F.I.C., the writer gives a résumé of the advantages of the new system of cross-fertilization of definite varieties of canes over the older system of seedling and selection.

Until recently propagation of cane from seed was not thought of, but recent researches have shown that although cultivation diminishes the fertility of the seed, it is possible to raise canes therefrom. This rediscovered power is now used to raise new varieties, which till recently could only be done by careful selection. The tendency of the cane to throw back to its original parents is shown very forcibly when it is grown from seed. The dozen or so of new varieties now cultivated in the West Indies have no doubt been selected from hundreds of thousands of seedlings. Recently, however, efforts have been made to cross-fertilize known botanical varieties, until lately thought impossible. In this way much labour will be saved and the lines of work will in future be much more definite, though the tendency to atavism will no doubt cause some trouble. (W. ROBERTS.)

EXPERIMENTS WITH CALCIUM CYANAMIDE.

IN the February number of the "Journal of the Board of Agriculture" Mr. A. D. Hall describes some experiments carried out at Rothamstead with the new nitrogenous manure, Calcium Cyanamide.

The object of these tests was to find out (*a*) whether, in view of its hygroscopicity, it could be stored under ordinary conditions in bags in a manure store; (*b*) whether there is any danger of acetylene gas being produced from unchanged Calcium Carbide remaining in the manure; (*c*) whether there is any loss of fertilizing value when it is mixed with other manures, particularly Superphosphate. From a sample of ordinary commercial Calcium Cyanamide containing 17·24 per cent. of Nitrogen, small quantities were taken, spread out on watch glasses, and placed under a large bell jar over water. Two watch glasses were withdrawn weekly: one was weighed in the wet condition and the other dried in the steam oven, and the amount of Nitrogen in each sample determined. It was found that in a sample which had gained 67 per cent. of moisture the loss of Nitrogen was only 0·37 per cent. To ascertain the gain in moisture under practical

conditions, a bag containing a known weight of Cyanamide was placed on the floor of an ordinary manure house. After 2½ months, it had only gained 5 per cent. in weight due to moisture, so the loss of Nitrogen in this case would be imperceptible.

Tests were also made to determine the amount of free Calcium Carbide in the Calcium Cyanamide. One sample was found to contain 0·048 per cent. and the other 0·062 per cent., quantities which are negligible, as the amount of inflammable gas which could be produced would be infinitesimal.

Superphosphate, being the only manure containing free acid in quantity, was selected to try the effect of mixing with Cyanamide. Three separate lots of Superphosphate, each of 2 cwt., were taken and mixed with 11 lbs., 22 lbs., and 44 lbs. of Cyanamide respectively. A considerable amount of heat was generated, due to the slaking of free lime in the Cyanamide, but no offensive gases were given off, although the operation of mixing was rendered unpleasant at first by the extreme dustiness of the Cyanamide. In another test, water was sprinkled on the heap while mixing was going on, and this kept down the dust and considerably reduced the temperature. Samples from the mixtures were taken and analysed. It was found that there was no Nitrogen lost, any ammonia that is generated on the slaking of the lime being fixed by the Superphosphate: that in a mixture of 1 part Cyanamide to 5 parts Superphosphate all the water soluble phosphate is converted into dicalcium phosphate, insoluble in water but soluble in dilute citric acid; and that very little change to tricalcium phosphate is brought about, so the loss of fertilizing value is very slight.

Mr. Hall concludes his paper as follows:—

"The net conclusions from the above experiments are that Calcium Cyanamide, as now manufactured, can be stored for a reasonable time under ordinary conditions without danger of sensible loss of its fertilizing properties; Cyanamide can also be mixed without difficulty or loss with Superphosphate, the resulting mixture being as easily handled as any other artificial manure."

(A. G. Birt.)

UTILIZATION OF POND MUD.—("Journal of the Board of Agriculture," November, 1907.)

Pond mud is well recognized by practical men as being of great value where it is easily accessible. The analyses of different samples show it to be very little richer in plant food than good soil. Probably the good effect is due more to physical causes than actual manurial value. It has been found of great use for fruit trees and is much used in the Kew Botanical Gardens for this purpose. (W. ROBERTS.)

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