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MINISTRY OF AGRICULTURE, EGYPT.

REPORT ON THE
MAINTENANCE AND IMPROVEMENT
OF THE
QUALITY OF EGYPTIAN COTTON
AND THE
INCREASE OF ITS YIELD,

BY

H. MARTIN LEAKE, M.A.,

DIRECTOR OF AGRICULTURE, UNITED PROVINCES, INDIA.

CAIRO.
GOVERNMENT PRESS.

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PREFACE.

Egypt has long been adapted to the successful cultivation of a wide range of field crops, but since the first planting in 1820 of Jumel cotton (in which year the export was three bales of about 220 lbs.) the returns realized from the cultivation of Egyptian cotton, uniting as it does a high yield with a quality hitherto unrivalled by any other cotton grown in considerable quantity, have more or less steadily risen, with the result that cotton for many years back has occupied a dominating position in Egyptian agriculture.

It may be said, broadly, that the area of cultivable land in Egypt devoted to cotton is limited only by the facilities for irrigation and the necessity which exists of rotating cotton with other crops. The general prosperity of the country, therefore, is very closely bound up with the success of the cotton crop, and one of the main endeavours of this Ministry is to ensure that everything possible is done that will lead to the furtherance of the cotton growing industry.

In accordance with this policy a Cotton Research Board has been established in the last year to combine, co-ordinate, and extend research on cotton, and steps are being taken to strengthen the scientific staff of the Ministry dealing with the various aspects of the cotton problem. The production and maintenance of pure varieties which combine high yield with the special qualities for which Egyptian cotton is in particular demand is, perhaps, the most important aspect of the problem, and to deal with this provision was made in the current financial year for a very considerable enlargement of the Botanical and Plant Breeding Section of the Ministry.

Before embarking on the more extended programme of botanical work on cotton thus made possible it seemed desirable to have the situation reviewed by an expert on cotton from the botanical side, and, through the courtesy of the Government of India, the Ministry was fortunate in procuring the services of Mr. H. Martin Leake, lately Economic Botanist and now Director of Agriculture in the

United Provinces of India, who has had a long experience in the breeding of cotton and who is recognized as one of the foremost authorities on the subject. Mr. Leake was invited to make "recommendations with a view to the maintenance and improvement of the quality of Egyptian cotton and the increase of its yield." During a visit to Egypt in May last, and again in the three months September to November, he took full advantage of the opportunity of studying the Egyptian cotton crop in the field, both in the earlier stages of growth and throughout the picking season. Local knowledge and experience were freely drawn upon by consultation with the officers of this Ministry, the State Domains, and the Sultaniya Agricultural Society, and the trade aspect was examined by conferences both with representative Egyptian ginnerers and with the fine spinners in Lancashire. The report which Mr. Leake has submitted is, therefore, based on an able and exhaustive study, and is a document of more than usual interest and value to all concerned in the Egyptian cotton industry.

The present-day abnormally high prices for all grades of Egyptian cotton, and the very small margin of difference between the prices of the higher and lower grades, will, I fear, tend to place the grade giving greatest yield in high favour with the cultivator. It is, therefore, all the more necessary that energetic measures be taken to maintain and improve the quality of Egyptian cotton.

J. LANGLEY,

*Under-Secretary of State,
Ministry of Agriculture.*

Cairo, January 25, 1920.

REPORT ON THE MAINTENANCE AND IMPROVEMENT OF THE QUALITY OF EGYPTIAN COTTON AND THE INCREASE OF ITS YIELD,

BY H. MARTIN LEAKE, M.A.,
DIRECTOR OF AGRICULTURE, UNITED PROVINCES, INDIA.

INTRODUCTION.

In letter No. 383 4-1/3, dated May 19, 1919, of the Ministry of Agriculture, I was asked to present a report embodying my "recommendations with a view to the maintenance and improvement of the quality of Egyptian cotton and the increase of its yield." The existing qualities are definite, and possess a material extant physical basis. The question of their maintenance thus offers a definite concrete problem. The same is the case with the question of yield, and the improvement of the yield consists in the very definite and material fact of an addition to the return obtained from the acre or *feddán*. No such definiteness attaches to the third problem laid before me, that of the improvement of quality. Quality is a relative term, and the nature of quality, good or bad, depends on the use to which the material in question is put. These uses may vary from time to time, and it is necessary, therefore, to study these uses, and to form an idea of the probable tendencies in what we may term the economic aspect before it is possible to decide what will constitute an improvement.

There are, in fact, two directions from which a problem such as is presented by cotton production may be approached. We may ignore, for the time being, the economic, and concentrate on the agricultural aspect. In so doing, we should concentrate on the biological and physical problems involved; on the biological side, endeavour to ascertain that plant which will give the maximum return under the uncontrollable conditions of the environment, and, on the physical side, attempt so to modify the controllable conditions of that environment, that the plant which we have chosen may develop to the full. Or, we may commence with the study of the economic aspect, endeavour to ascertain the uses to which the raw product is put and the characteristics which give to that raw product its commercial value; to form an idea of what characteristics are most desirable in as far as their possession is likely to increase the value of the raw material which possesses them, and, having arrived, as far as may be, at a definite conclusion on this matter, we may attempt to arrive at that standard by means of biological investigation.

The former method assumes an adaptability in the market for the raw material which must be practically unlimited. This assumption may be true, or almost true, of certain agricultural products, and in such cases the method may be safely adopted. It is in no sense, however, true of the cotton industry, which is built up of a number of very specialized sections, the raw material of one of which is unsuited, or even totally useless, for the purpose of another. This method is here, therefore, inapplicable, and we are forced back on a study of the economic side of the question if we are to discover the fundamental conditions on which it will be possible to build a sound superstructure of biological investigation. My own personal experience has hitherto been restricted to the so-called short staple cottons, of which the underlying economic conditions are fundamentally different from those of the Egyptian cotton, and I have, therefore, devoted some time and trouble during my stay in England in visiting Lancashire and investigating the economic aspect of Egyptian cotton. Such an investigation is essential to a correct formulation of those recommendations which are the more immediate object of my mission. I propose to commence the report by formulating the results of that investigation. Such procedure will simplify the expression of subsequent recommendations inasmuch as it will indicate the objective to which they are directed.

I.

The most prominent feature of the cotton industry, even in that strictly limited section which makes use of Egyptian cotton, is its diversity. Even among the spinners of Egyptian cotton are to be found users who have specialized on certain classes and who prefer those classes to any others. In many cases they may, and do, use other classes, but such use is definitely a substitution use, dependent on such questions as limitation of supply or relative price, and is not willingly adopted. There is thus a definite and natural conservatism in the trade which opposes free interchange between classes even when such interchange is practicable. The problem of Egyptian cotton is, therefore, not a simple one; it is, on the contrary, a complex of problems. The unit is a single class which, under normal conditions, meets a particular demand. The value of that class is, to a certain extent, determined by the relation between supply and demand within the class itself, and is, in part only, subject to the influence of the relation between total supply and total demand. It may actually occur that the spinner will pay less for an intrinsically superior cotton, in the sense that it will spin finer yarn, than for an inferior one.

We have here, I think, the first consideration that must be clearly borne in mind when approaching the problem from the producers' standpoint. Production is, and must continue to be, diverse. Not

only so, but the various classes require to be produced in quantities approximating to the relative demand. Only so will the full intrinsic value for any particular class be realized. The argument applies equally to the lower, as to the higher, qualities; over-production within the class leads to a low, while under-production leads to a high, price. The step from over- to under-production is, fortunately, sufficiently large owing to the flexibility of the market, and this flexibility we must now consider a little more in detail.

The substitution of superior quality cotton to do the work of inferior can naturally be more readily adopted than the reverse process. The market, therefore, shows greatest flexibility in this direction. But such substitution will only take place, in the absence of any large shortage in total supply, when the price of the superior quality renders the proposition a paying one financially. Such conditions only hold good when the price of superior quality is relatively low or, in other words, when the superior quality is fetching less than its intrinsic value. Such a condition implies a definite loss to the producer. In a country like Egypt, which possesses a monopoly in the production of certain classes of cotton, this probably implies a considerable total loss, since the reduction in price affects the entire out-turn of the superior quality and not merely that portion which is used as a substitute. The rapidity with which Sakel has replaced other forms in cultivation in Lower Egypt affords an instance of this phenomenon. There is no doubt in my mind that the production of Sakel is far in excess of the demand for the manufacture of those types of thread for which it is peculiarly adapted. Its use has, therefore, been extended to other lines, for which it is not so pre-eminently suited, and such extension has been effected at the expense of the producer, in as far as Sakel is worth less per unit than it would be were only sufficient available to meet the needs of that market which requires the qualities peculiar to Sakel. The present demand is, in fact, a forced one, due to the fact that, even at the depreciated price, the money return for the unit area of production is greater than that given by any other form.

That, however, is an illustration of one form of market flexibility merely. There is another and more subtle one, the effects of which are harder to diagnose and still more difficult to foresee. I may illustrate this again by reference to Sakel. It was pointed out to me that the large increase in the consumption of Sakel coincided with the enormous development in the production of *voiles*, for the manufacture of which it is pre-eminently suited. It would appear, therefore, that, but for this coincident development of a demand and of the means of meeting that demand, the price of Sakel would be lower than it is. We must, however, be careful to distinguish between cause and effect here. There appears to be little doubt that the sudden

supply of a class of cotton particularly adapted to the manufacture of *voiles* is in itself, in large measure, responsible for the demand which has arisen for that class of cloth. The demand for that material is largely artificial, depending as it does on fashions, and is capable of stimulation or the reverse; and it would appear that the power of directing the demand in such matters lies largely in the hands of the cotton trade. This form of flexibility is all to the good, for it means that the trade is in a position, to a certain extent, to test the qualities of any new form of cotton, to ascertain the classes of goods for which it is particularly suited, and to stimulate the demand for that class of goods. We must, however, beware of pressing the possibilities in this direction too far. Cotton is not merely the basis of goods which have an artificial value due to fashions. In many cases the use to which the cloth is to be put will dictate, within very close limits, the qualities that the cotton must possess. Notably we may instance the cloth which is used for aeroplanes and for motor tyres. Here no such flexibility is possible, for the demand is, in no sense, artificial. This case is particularly pertinent in the case of Egyptian cotton, for it is Egyptian cotton which has been found to satisfy this demand more nearly than any other.

This brings us to our second conclusion; the production of new cottons is desirable, and the trade is sufficiently flexible to absorb and develop markets for them. But caution must be exercised in their introduction. An initial high price obtained for a small initial bulk may be due to special adaptability for the production of a particular class of goods the demand for which is small. If that high price stimulates largely increased production, the price will fall even to make cultivation unprofitable. Especially is it necessary to distinguish between cottons which possess an intrinsic and those which possess an artificial value. The former require special care in maintenance.

So far we have confined ourselves to the broad issues as indicated by the characteristics of the trade in general. When we come to a more detailed consideration of the process of manufacture we find a new series of phenomena have to be considered. We need not here go into all the characteristics which go to make up a good spinning cotton. We have seen that diversity is essential to the trade; that it is desirable to produce different classes of cottons. The difference between these classes will, however, include most of those characteristics, such as length, strength, fineness, etc., which affect the behaviour of the cotton in the mill, and the particular features of any class will be due to the exact form such characteristics take in that class. But beyond this, the spinner requires something more, something which is not a physical character of the cotton itself in the sense in which length, or strength, or fineness, or twist can be considered such. He requires what is usually known as uniformity; that is,

a low range of variability in each one of those characters which go to make up the spinning value of a cotton.

Herein is to be found the third consideration to which we are led by our enquiry from the manufacturers' point of view. While diversity of class is required, uniformity within the class is of equal importance.

The value of cotton is dependent, however, on other characteristics than those which affect its behaviour in the mill, and the more important of these is colour. The importance of colour lies in the fact that Egyptian cotton, till recently, possessed a characteristic brown colour by which it was distinguishable at a glance from other cottons. The point was recognized by the trade, and the colour imparted to the cloth was accepted as a ready means of determining the fulfilment of contracts, the specification for which includes the use of Egyptian cotton. Such a ready method is valuable, and there exists a natural conservatism in favour of the retention of that colour character. Colour has, however, no further significance. A premium will, for a time no doubt, be paid for colour owing to the lag which finds its basis in such conservatism. But here, again, the market is flexible and is capable of adaptation to the supply.

I have so far dealt with the trade aspect of Egyptian cotton in its present-day form. It is, as must be the case with any highly organized manufacture involving highly specialized mechanical adaptations, very conservative. When, however, we are concerned with problems the solution of which may take years to accomplish, it is desirable to attempt, however imperfectly, to forecast the probable future demand. Such an attempt I have been at some pains to make during my visit to Manchester. The problem is complex, and it is impossible to dogmatize. Nevertheless there appears to be a distinct opinion as to the general trend of this demand. This I will attempt to outline.

The complexity arises from two considerations. In the first place the trade is, as we have seen, so highly specialized that prices are affected by the relation of supply to demand within the class, and it is not possible to deal with the Egyptian crop as an entity. We must go lower than this to find the unit. Secondly, the monopoly which Egypt has hitherto possessed as the sole producer of special classes of cotton is gradually passing. Recently, cottons which possess the characteristics of Egyptian have been produced in the dry zones of America. Mesopotamia, again, and possibly Scind, offer fields which may develop into rivals of Egypt. The monopolist position is thus already threatened, and there is little doubt that it will at no distant date cease to exist. Such widening of the source of supply must inevitably affect the balance which now exists between the various classes of Egyptian cotton.

I may also refer to yet another aspect of the cotton trade which is likely to have a bearing on the future demand. Egyptian cotton ranks second among the world's cottons, and is only surpassed by the so-called Sea Island, the main source of which is certain of the Southern States of America and the West Indies. The Sea Island crop is what is known as a highly speculative one; it has a narrow basis in that its cultivation is restricted to a relatively small tract, and from economic as well as natural causes the supply is a precarious one. Not only is it more troublesome to cultivate, so that the extra price barely compensates for the extra labour and expense involved in the cultivation, but that cultivation is restricted to the more humid and tropical tracts in which the risk of sudden loss through pests and disease is greatly enhanced. The margin of profit is thus insufficient to compensate for the extra risks involved, and the tendency is for the cultivation to diminish.

These facts all have their bearing on the Egyptian problem, and, while they indicate an increasing competition from outside sources in the markets for the present standards of Egyptian cotton, they also indicate a probable reduction in the supply of Sea Island. The conclusion, it is true, is highly speculative, but the tendency is there, and is sufficiently clear to justify the attempt to develop a cotton which will be capable of taking the place of Sea Island in the future.

From the point of view of demand for goods manufactured from the higher grades of cotton, I have found the opinion widely held that this demand is large though, at the present time, mainly potential. It is a demand capable of absorbing any amount of the best staple cotton Egypt is likely to be in a position to offer, and of absorbing it at its full relative value. In other words, the trade is sufficiently flexible to develop a demand equal to any supply that can be offered. That this opinion is correct cannot, I think, be doubted, but it requires to be qualified in certain directions if the interests of the grower and dealer in raw cotton are to be adequately guarded.

The opinion has been expressed in the course of discussions on this subject that the facts do not support this view of the potential demand. It has been instanced that a short crop of Mit 'Afifi in one year has led to the realization of a high relative price for that season's produce, and that that price has reacted in the following year in a largely increased crop, which, in its turn, has resulted in a heavily depreciated price. That experience is no doubt true; but it hardly justifies the conclusion which some would attempt to draw from it. It has already been pointed out that, owing to specialization in machinery and also to the necessity for experience in working a particular cotton if the best results are to be obtained from it, spinners are, as a rule, conservative. They will pay a premium for a class to which they are accustomed rather than change to another class, if the shortage

which is responsible for that premium is of a temporary nature. The spinner at least knows what he can do with that cotton, and his loss is, at most, limited to the amount of the premium he has to pay. The loss with a new cotton is less definite, depending, as it does, on the speed with which he attains familiarity with its peculiarities in working. There is thus a definite time factor in such arguments, the effect and importance of which must not be overlooked.

Before willingly making any change in his raw material, and this is merely another way of saying before he will overcome his natural conservatism, the spinner requires to be assured that the produce to which he turns will be available in sufficient and regular supply. Without such assurance he will only accept the alternative under compulsion. For like reasons new plant, such as is required to meet the expanding needs of the industry, whether as extensions to existing factories or as new ones, will be adapted to handle the most assured supply capable of producing that class of goods for which the factory is designed. There is consequently a lag in the process of adjustment, an interval between the placing of any new class of cotton on the market and the realization of its full intrinsic value, partly, no doubt, due to the fact that it takes time for the particular merits to be appreciated but also very largely due to ignorance of the potential supply. It is true that cases are on record of an immediate and rapid extension of the supply of a new class of cotton ; this is true of Sakel, but such extension here takes place in spite of that lag, which is none the less operative though its operation is masked. There is little doubt in my mind that it is possible that, nay more, that many instances have occurred in which a potentially valuable crop has been lost through too rapid development. The supply has been increased more rapidly than the demand, time has not been afforded to permit a general recognition of the special characteristics to develop, and the full price has never been realized before the crop is condemned and passes out of cultivation. Neglect of the time factor is here responsible for the loss of a valuable improvement.

II.

I may now attempt to extract from the above brief review of the economic conditions which are of influence in determining the value of the raw material of the cotton trade the fundamental considerations for the development of a sound policy on the part of the producer. And here I may note that it does not necessarily follow that the interests of the individual producer will coincide with those of the producing community. We are, in reality in the latter case, concerned with the solution of an algebraic problem, namely, to find the values

for m, n, p , etc., which will give the maximum value to the following expression :—

$$amx + bny + cpz + \dots\dots\dots$$

where $a, b, c, \dots\dots\dots$ are price units, $x, y, z, \dots\dots\dots$ yield units, and $m, n, p, \dots\dots\dots$ the number of the units produced if each of different classes A, B, C, $\dots\dots\dots$. In the case of Egypt, where the limits of area of cotton cultivation are for the moment practically reached, we have the further consideration that

$$m + n + p + \dots\dots\dots = k, \text{ a constant.}$$

The problem, so expressed, is clearly incapable of accurate solution owing to the large number of variables; but the attempt is necessary if the maximum value is to be realized for the crop. The need of a solution, if only an approximate one, is especially necessary in a country like Egypt, in which practically the entire wealth of the country is due to the one crop with which we are concerned.

If, further, the interests of the individual producer are to be protected, yet another algebraic problem must be solved. It will here be necessary that :—

$$ax = by = cz = \dots\dots\dots$$

Unless this condition is fulfilled, supposing, that is, that

$$ax > by > cz \dots\dots\dots$$

the producer of B and, still more, the producer of C, will be placed at a disadvantage as compared with the producer of A. Under such conditions, unless local conditions exercise a selective influence, the cultivation of B and, to a still greater extent, of C, will diminish, while the cultivation of A will extend.

The only alternative is the elimination of the economic factor and for Government to control the proportionate cultivation of the different classes—a procedure hardly conceivable when such control must react to the detriment of a proportion of the individual producers.

We have here indicated the first problem to be solved with relation to cotton growing. Diversity is an essential requirement, and such diversity will only be maintained if

$$ax = by = cz = \dots\dots\dots$$

The absolute solution of this problem, the equalization of the money returned by unit areas under the various types of cotton, is not possible, for the relative values of $a, b, c \dots\dots\dots$ vary from year to year. An approximate solution only can be attained, and may be sought in two directions. The various types which yield the different classes differ not only in regard to those lint characters which give these cottons their distinctive features, but they differ in other characters also. These characters we may term “physiological,” thereby implying a difference in reaction to environment. Egypt, in spite

of its comparative uniformity in this respect, is really uniform neither in climate nor in soil, and these differences are, in all probability, sufficient to meet the diverse physiological needs of the various types. It is more than probable that it will be found, in fact it is found, that the type which is best suited to one set of conditions will not be the one best suited to a second ; and it will thus be possible to demarcate type tracts in each of which the cultivation of that type which responds best to the local environment can be encouraged. I do not overlook the work that has already been done in this direction ; the point is appreciated, notably in the case of Ashmûni in Upper Egypt, but I am inclined to think that a large scope still remains for work in this direction on a systematic and predetermined plan.

Such investigation is definitely agricultural, and it may, even so, be found that though the yield of B may be increased relatively, and even exceed that of A in certain areas, yet that increase still leaves the product *ax* greater than *by*, still leaves, that is, A the more profitable crop. To meet such a case, the possibilities of the second method of equalizing the money value must be investigated.

It has been repeatedly pointed out that commercial cottons of Egypt are impure ; that is, that they consist of a mixture of a larger or smaller number of types, together with a considerable admixture of crosses between these types. It is to this admixture that the deterioration of quality, so noticeable in most Egyptian cottons, and even that striking phenomenon of the definite limit to the life of any particular variety, is attributable. In such a mixture the total yield is clearly an average one, certain of the component types yielding more, and others less, than the average. Also certain of the types will be better, and other less, adapted in their physiological reaction to the local environment. The replacement of the mixture by those component types, or that component type best adapted to the environment, can have only one result, the raising of the unit yield from that of the mixture to that of the best of the component types. This method is what is commonly termed selection, and we may conveniently consider here the third point raised in discussing the economical aspect, the need for uniformity, as well as the question of uniformity just referred to.

I have had occasion to observe that lint diversity, such as exists between the different classes of cotton, is, in practice, associated with a different physiological response to environmental conditions. The converse is equally true ; mixtures such as compose and yield the main classes of cotton contain types which not only exhibit these physiological differences but also lint differences. Selection within the limits of the present accepted classes thus is not limited in scope to the isolation of what we may term physiological types. It may and should

be also directed to the isolation in a condition of purity of those types yielding lint most nearly approximated to the class standard.

Deterioration has been repeatedly referred to as if it were a condition inherent in the plant. The particular variety is, in this view, supposed to possess a more or less definite span of life, after which degeneration sets in and the lint product gradually deteriorates in quality. The word is unscientific and, as commonly and loosely applied, probably covers a number of phenomena. But, in as far as it implies a degeneration in the plant, it is unsound and finds no basis in fact. The cotton plant is notably freely cross-fertilized, and the presence of a single impure plant in a field is capable of producing, in the course of a few seasons only, a degree of impurity which will surprise, and hardly be credited by, those who are unfamiliar with the phenomenon. Given initial purity and adequate protection from chance cross fertilization, this explanation of degeneration will be found to be fallacious. In selection and propagation under conditions which adequately meet the ever-present tendency to pass from purity to impurity, will be found the means of maintaining the uniformity desired by the spinner.

There remains the third desideratum expressed in the second conclusion at which we arrived above, that for the development of new classes of cotton, in other words, the introduction of an additional term into our algebraic formula. The history of the Egyptian cotton-plant is a comparatively recent one, and is too well known to require repetition in the pages of this report. The point I desire to emphasize here is the presence of the Sea Island plant at some stage of the parentage. We are at present too ignorant of the "unit factors" on which the various lint characters depend to state with certainty that those factors which are responsible for the special spinning qualities of the Sea Island cotton are bred out in their entirety. It is still possible that these exist here and there: it is even possible that they commonly exist in the present types of Egyptian cotton, but are suppressed, masked, or inhibited. Under the conditions of the Egyptian cotton field with the mixture of types now prevalent, and with unlimited possibilities for cross-fertilization between these, it would not be a matter for surprise if, now and again, such combinations should occur which will permit the re-expression of those characters. The sporadic occurrence of such "throw-backs" is not unknown, and there is reason to believe that their occurrence is still taking place at the present time: the history of the origin of Sakel, with its superior length, is evidence in this direction. Here, again, selection is the means of preserving and establishing any such variations as may occur, but it is a selection which differs somewhat in form from that previously referred to. The latter can be undertaken within the limits of an experiment station, for what it is desired

to select is known to exist, but in the former the entire area under cotton becomes the laboratory through which the search must be conducted.

The above method for developing new classes of cotton may be termed undirected, for we are dependent on accident for their appearance and merely, so to speak, gather the rosebud offered to us while we may. The development may, however, be directed. For successful development of the directed method we must form a clear mental impression of what it is desired to produce; select, as parents, those plants which, in one or more of the characters concerned, approach most nearly to that ideal, and attempt to combine these in a single individual. It is the method commonly referred to as hybridization. Success will only be obtained if a number of conditions are fulfilled. Purity of stock is essential, and therefore preliminary selection to obtain that purity is necessary; also clear recognition of the factors on which are based those characters which we desire. The path is strewn with difficulties, not the least of which is the exact determination of the ideal, but these difficulties are not insuperable with sustained effort.

We have here considered the methods to be adopted for the introduction of a new term, or new terms, into the algebraic expression given above, and it may be argued that, if the new term conforms to the conditions of equality we have outlined, the advantage to the country from their introduction will be nil; while, if it does not, the already existing types must disappear. The argument is sound, but we must not forget the economic conditions affecting the question. Were these constant, it would be very doubtful whether it would be desirable to attempt the production of types yielding a lint superior to those already in existence. But economic conditions are not constant, notably, as we have already indicated, Egypt is losing her position as a monopolist, and such loss must inevitably lead, in the long run, to a reduction of the profit obtained from the standard classes of cotton produced by her at the present time. She will then be forced to "go one better" than her competitors in producing finer qualities than she has hitherto done or to accept reduced revenues. It is a very real danger that exists, and the presence of this danger makes it necessary to attempt the evolution of new classes. We may express the point in another way; while we do not look upon the multiplication of classes as a means of largely increasing the value of the crop, for qualities superior to the best Egyptian cotton have, at the present time, but a limited market, and any premium obtained in the early years of low production would soon disappear when that production is largely increased, we do consider that their development is a necessary, and vital, insurance for the future.

The expression of the problem in the algebraic form given above

brings into prominence certain other aspects which we must now consider. We desire that the sum

$$amx + bny + cpz \dots\dots\dots$$

shall be a maximum while maintaining equality between the values ax , by , cz , The latter desideratum requires further consideration in the light of what we have just said : this equality would be necessary to maintain diversity if the country were uniform, but it is not. The differences which exist between the various types of cotton plant in their physiological response to environment render it more than probable that, while ax may exceed by in one tract, the reverse will be the case in another. Such considerations will lead to the development of type tracts, and the equality indicated will only develop a practical aspect in those border tracts where the type of cotton to be grown will be determined by the extent of the demand for the alternative classes of cotton these types produce and by the area already under those types. We must, therefore, qualify our earlier statement as to the need for equality in the value of the produce from a unit area. This has no general, but rather a local, significance.

Reverting to the main problem, we have studied certain methods which are directed to the end. They aim at the production of increased yield by purification of the crop and by demarcation of type areas ; at the production of increased price through development of uniformity in the produce. We depend here on certain features of the environment which are selective, that is, features to which the different types react differently. There is, however, another series of environmental phenomena which are not to the same extent selective ; of such a nature are the more important pests of the cotton plant, especially the boll worm. Again much importance has rightly been attached to the height of the water table due directly and indirectly, through the canals, to the rise of the Nile. Lastly, there is that series of phenomena which we may include under the general designation of cultural: the effect on yield of different spacings, different methods of culture, and such like. With these questions, beyond recognizing their importance and emphasizing the necessity for making adequate provision for their study in any serious attempt to face the cotton problem as a whole, we have no concern. It must not be forgotten, however, that such problems can be approached from both sides. On the one side is the plant, in the first case reacting to an insect and in the second to physical condition of the environment ; on the other is the insect and, within limits, a controllable physical state. Not only do the insect and the physical condition require to be studied, but also the plant's reaction to these stimuli. In the first case, concurrently with entomological investigation, which has, among other facts, indicated the seasonal character of the epidemic, efforts require to be made to break the present coincidence between

the period of the main cotton harvest and the season of the maximum development of the pest. This may be effected from the plant side, and a beginning has already been made to stimulate early ripening. It remains, however, to investigate the possibilities of evolving early maturing types.

The second problem is mainly physical, but here, again, comes back ultimately to the plant, its water requirement, and the depth to which the root penetrates. In all its bearings the field of investigation is a wide one and the fringe has, as yet, only been touched. Apart from the purely physical aspect, there is a large opening for physiological investigation.

Such problems as have been outlined in the last few paragraphs are mainly directed towards increasing the value of the yield units $x, y, z, \dots\dots\dots$. There remains the question of the price units $a, b, c, \dots\dots\dots$. Evidence is accumulating to show that the quality of a cotton is directly affected by the conditions under which the plant which produces it is grown. It is no doubt true that, under the normal conditions of cultivation, these conditions are sufficiently uniform, and that even the extreme conditions here found diverge so little from the normal that the quality of the cotton is barely affected. Nevertheless, it is not without importance to determine the point at which such effect is begun to be felt and to ascertain which are the chief environmental conditions concerned in producing the effect noted. The importance of the possession of such knowledge is emphasized if, as seems probable, cultural control aimed at the development of early maturing is to be adopted. The investigations here referred to cover a wide field of pure physiological research.

III.

In the above review I have attempted to bring into prominence the salient features of the Egyptian cotton problem. The subject is a wide one and touches at many points on several of the commonly accepted divisions of science. I may now attempt to collect these into some systematic scheme which will serve as a foundation on which to build the organization which will be required to attack the problem successfully, and as an indication of the staff and equipment which will be required for this attack. It will perhaps be objected that no mention has here been made of the commercial aspect which is concerned with the disposal of the crop. While recognizing the importance of this aspect to the country generally, I do not hold that it falls within the sphere of a Ministry of Agriculture as such. The primary work of that Ministry is completed when it has pointed the way to obtain the maximum yield of pure cottons, and it is only directly concerned with the subsequent disposal of the produce in as

far as it may be necessary to protect the seed supply required for sowing and to ensure by this a condition of purity. This is, however, an important point—the end term of the series which commences with the single plant of the plant breeder. Every link of the chain forming that series must be adequately guarded, and the last, no less than the first, will require consideration if the field of investigation is to be covered.

We can recognize in the above review four primary lines of investigation to which we apply the terms Economic, Botanical, Agricultural, and Commercial, and to these we may add certain collateral lines. These may, in like manner, be termed Entomological, Mycological, Bacteriological, and Physical. But let me not be misunderstood in this matter; the difference between the primary and collateral lines, as here defined, is not one of relative practical importance. The former are concerned directly with the plant and its produce, the latter with the subsidiary conditions of growth which make cultivation an economic proposition. The two groups are truly complementary, for it is as useless to produce a potentially valuable plant, if the conditions of growth do not permit it to develop its inherent qualities, as it is to control those conditions in the absence of a plant capable of reaping the full benefit of that control.

(1) ECONOMIC.

The essential economic considerations have been seen to include diversity of classes, accompanied by uniformity within the class itself. That diversity is required to meet the needs of different sections of the trade; the demand for any particular class is thus to some extent independent of the demand for other classes, and the magnitude of the demand depends on the relative importance of the section mainly concerned in working up that class. A knowledge of the normal relative requirement of the different classes and the normal relative price of these under conditions when supply and demand about balance is of primary importance.

In view of the probable early disappearance of Egypt's monopolistic position with regard to certain classes of cotton, accurate information is also required of the developments taking place in all countries likely to encroach on that monopoly. Especial care requires to be taken in the collection of statistical information on both these heads.

(2) BOTANICAL.

1. *Selection*.—Selection requires to be conducted on two independent lines, and work along both of these should be conducted simultaneously. In the first place, and this forms the most important immediate need, selection should be directed to isolating and maintain-

ing the purity of races yielding the standard classes of the present day. Such selection forms the basis of any scheme which aims at eliminating "degeneration," which, in its ultimate form, is interpreted as due to an inherent plant character giving to the type a limited span of life.

Secondly, it must be directed to the discovery and subsequent isolation of new and hitherto unrecognized types, whether the novelty affects the quality of the cotton or the behaviour of the plant in the field. It will cover the search for such plants as develop improved lint, a higher ginning percentage, a vigorous habit accompanied by high yield or an early maturation.

2. *Hybridization*.—The aim of such work is, ultimately, identical with that of the latter form of selection. Here, however, the method is directed. But more than this is involved. We are still ignorant of the factors controlling many of even the more obvious plant characters, and there is much preliminary work to be done in this direction.

3. *Physiology*.—Physiological investigation will bear on the general problem at several points. At each stage of its history the plant is in direct response to its environment, and growth will be controlled by one or other of the factors composing that environment. In its broadest outline physiological investigation will be directed to determining the limiting factors throughout. In the more particular aspect it will be directed to determining the effect of root interference, the causes of bud and fruit shedding, and the effect of such factors as water supply on quality of lint.

(3) AGRICULTURAL.

In the direct sequence, which we have termed primary, agricultural investigation will carry on the tests of the pure races a stage further, and will require facilities for working up a seed supply of such as successfully pass these tests. Such tests must include not merely comparative trials in one area—for, as we have seen, not the least important aim will be the demarcation of type tracts—but in several areas. Trial grounds will thus be required in each well-defined tract. The working up of a seed supply, involving, as it does, a different set of conditions, and one which will effectively maintain purity, requires separate treatment.

Secondly, provision must be made for subsidiary lines of agricultural investigation, cultural and manurial experiments, and experiments on the water requirements of the field crop. Such investigations are linked, on the one hand, with the physiological work already referred to, and, on the other, with the general agricultural problems of the country.

(4) COMMERCIAL.

I apply this term in the strictly limited sense defined above. The Agricultural Section can, at the most, produce what constitutes a mere fraction of the seed required for sowing, and purity will not be maintained without some organization to control the crop and to prevent admixture followed by degeneration, after the seed passes beyond direct Ministerial control.

*Collateral Lines.**

(5) ENTOMOLOGICAL.

This section of the Ministry is the most highly organized at the present time. The subject, too, lies outside the scope of this report. Reference is made to this line of investigation here merely with the object of indicating that I have not overlooked the subject, and that I recognize that any proposals that I am led to make would be of little advantage did they not fit into the scheme as a whole.

(6) MYCOLOGICAL.

From the aspect of the cotton crop pure and simple there appears to be small field for mycological work, though its importance may develop at any moment. From the point of view of the general activities of the Ministry as a whole there is, especially in relation to horticulture, considerable scope for mycological investigation.

(7) BACTERIOLOGICAL.

Such investigation is concerned with agriculture generally, and is concerned with the subject of cotton merely in as far as that forms one, although the most important, of the crops grown. Little work has been done on bacterial action in the soils of Egypt. The field is large, important, and practically unexplored; there can be little doubt that such action is of considerable magnitude and, if controlled, capable of exerting considerable influence on crop development. On the one hand, the study connects up with purely agricultural

* A certain amount of criticism has been directed against the omission of any reference to chemistry in the list of subjects here enumerated. I think, however, it will be clear that such omission implies no disparagement of the work of the chemist. It must be remembered that I am not concerned with the activities of the Ministry in their entirety, but merely with those activities as they concern the cotton problem. The centre of gravity is thus shifted, and my enumeration extends beyond those subjects which directly bear on that problem only to a degree sufficient to indicate how my proposals dovetail into the general organization. The subjects are necessarily dealt with incompletely and in a somewhat different order from that in which they would occur were a review of the entire activities of the Ministry under consideration.

investigation at such points as manurial and cultural experiment, and, on the other, with the physical investigations on soil moisture, its movement and control.

(8) PHYSICAL.

The most important line of physical investigation is, without doubt, that which concerns the relation between the level of the sub-soil water (water table) and the rise of the Nile, whether that relation be direct or indirect, through the canal system. As such, the subject is closely connected with the irrigation system. Considerable scope for investigation lies also in the direction of determining the permeability of soils of different character and the rate of surface tension flow through these. I am tempted to think that, by a control of such flow through cultural means, irrigation could be much reduced in tracts in which the presence of salts is not marked. This line of investigation is thus intimately connected with the purely agricultural cultural experiments.

IV.

I have briefly outlined eight lines of investigation, using as a basis the commonly accepted divisions of science. These cover the field presented by the cotton problem of Egypt. It will be convenient if, before I proceed further and enquire in greater detail into the requirements both as regards equipment and organization, if these investigations are to be carried out in an efficient manner, I outline the course that will be followed in the development of any particular race which it is desired to develop through the experimental to the practical stage. Such development concerns those sections which I have denoted primary. The close interrelation that exists between these four sections and the necessity for full continuity from one stage to the next, a continuity which organization must recognize and allow for, will thus become apparent.

In its simplest terms, then, the work of the Botanical Section will consist of the isolation by means of single plant cultures—and for the present purpose these cultures may arise as direct selections or as the result of hybridization—of pure races of cotton. Of such races, in the earliest stages, only a small amount of seed will be available. This work is, further, centralized; reduction in the number of races has to be effected, and such reduction must be accomplished by trial under conditions more nearly approaching those of the cultivators' fields. In particular, these trials must be carried out with a view to testing the relative suitability in the different environmental conditions

found in the cotton-growing tracts ; in other words, trial requires to be made with a view to bringing into prominence any particular adaptability of the race to the type tracts to which reference has been made. Such work must, from its very nature, be decentralized.

As a result of such comparative trials under different environmental conditions the number of races which survive elimination will be comparatively small. For these, further trials on a field scale, and an organization for multiplying up a seed supply under conditions which will ensure purity, are required. The degree of supervision here required is such that direct and complete control by the Ministry is essential.

From the seed supply so produced distribution will be made to extra Ministerial agencies, and here, for the first time, direct contact with the public will be reached. As I have stated above, the amount of seed that can be procured under such rigid control will be, under any organization practicable, but an iota of that required to sow even one type tract. Control, and the organization which accompanies it, cannot, therefore, cease here. That seed must be issued to a circle of selected and more reliable cultivators, with whom arrangements for the re-purchase of the crop, for the purpose of increasing the seed supply, are possible. These cultivators will, in the following year, be supplied with a fresh stock from the directly controlled Government stock, while the seed recovered from them is issued to a further set of cultivators.

I may set out the above scheme in tabular form :—

- (1) *Research*: The isolation of races in a condition of purity.
- (2) *Experimental Trial*: Small cultures grown comparatively under differing environmental conditions.
- (3) *Field Trials*: In those tracts only which the trials under (2) have proved suitable.
- (4) *Seed Production*: The bulk development of a pure seed supply.
- (5) *Seed Distribution*: The organization of a seed supply sufficient to meet the full needs of the tract.

We are now in a position to consider the equipment that will be needed to allow the successful development of this scheme for passing from the experimental to the practical issue. At the foundation of the scheme is the Botanical Section, which will require a *research farm*. On this farm will be conducted, by the botanical staff, all that work which aims ultimately at the production of pure races. With a three-year rotation, and an area of twenty-five to thirty acres under cotton at one time, some seventy to ninety acres will be needed for this farm.

For the experimental trial of such races as result from the Botanical Research Farm small experimental plots, totalling two or three acres, will be required, and these must be repeated in each recognized type tract. The number of races sufficiently promising to be subjected to such tests will be relatively small for any one season. Repetition is, however, an essence of the trial in order to reduce as far as possible the probable error, and the area here given will allow for the necessary repetitions to be made at each centre of trial. These areas are too small to form a unit in themselves, and they may conveniently form part of an *experimental farm*.

An experimental farm will be required for each definite tract, and will form the site on which will be conducted all the purely agricultural experiments, including, in addition to the experimental trials just alluded to, the field trials forming the third stage of development. For each of these an area of some 150 acres will be required.

Seed multiplication demands a distinct area, or *seed farm*, with a minimum of 150 acres, giving fifty acres of cotton. Specialization is here required to ensure purity. Again, one such farm is required for each type tract as defined above.

The seed derived from the seed farms is available for distribution, and for this, as follows from what I have already said, no equipment in the form of land is needed.

We may now turn to the question of organization, which will realize most completely the opportunities offered by the institution of such farms throughout the country.

As before, I may commence with the Botanical Section, with its staff engaged in detailed investigation leading up to the establishment of pure races, which, in the first instance, will amount to cultures each totalling in the neighbourhood of some 100–200 plants. From such cultures sufficient seed will be available to provide a supply for the experimental trials and also to multiply up, on the research farm, a seed supply of sufficient magnitude to sow one to two acres. Of those races which satisfy the preliminary experimental tests there will thus be sufficient seed to carry on to the seed farm, which will be fully stocked in the third year.

The Agricultural Section, with its staff, controls the experimental farms, and, by conducting the experimental trials, will have early opportunity to become familiar with the results of the work of the Botanical Section. It will also have the opportunity of forming an independent opinion of the value of the various races submitted for trial. Such check is valuable, affording, as it does, criticism from a different angle. The ultimate selection as to which races are to be continued and which discarded will rest jointly with the botanical and agricultural officers.

The seed farms are not so readily allocated. Their primary function is to work up a stock of pure seed, and for this purpose botanical control and botanical examination are desirable. At the same time their location makes centralized control difficult, while for the same reason they fall naturally into a district organization. We have here to strike the balance between the different disabilities, and I am inclined to think that the deciding factor should be one of individuality. It might be found advisable to adopt a middle in this matter, placing the seed farm nearest to headquarters under the Botanical Section and the remainder under the respective district agricultural officers.

From the seed farm seed is issued to the cultivator, using that word in its widest sense. The selection of these is a matter for the district officer, whose knowledge of his district should be such as to enable him to select the more reliable cultivators for the purpose. These may be actual cultivators or landholders who take a personal interest in the management of their estates. No doubt, too, valuable assistance could be rendered by the State Domains in this direction.

Before proceeding to the discussion of the wider distribution of seed, with the precautions necessary to maintain purity, I may summarize the scheme here outlined by a diagrammatic representation of the stages in the development of a pure race.

The table given at the end of this note indicates the method by which purity is maintained up to the commercial stage with which we have now to deal. It may be described as a series of waves originating with the research farm and passing from thence outwards. There is no backward flow of seed, and the effect of any accidental cause leading to impurity is thus eliminated automatically.

The agricultural organization conceived in this scheme is one of a series of circles (to use an Indian term) based as far as possible on type tracts and, therefore, since these are determined by environmental conditions, on climate. Each circle will be in charge of a circle officer whose work is dual. On the one hand he will have control of an experimental farm and, on the other, he must develop an intimate knowledge of his circle and be in a position to select reliable men to whom he can entrust the cultivation of the seed issued from the seed farms. The former, to be properly developed, will require a great deal of personal work, involving residence at the local headquarters at the busiest season, the latter frequent touring. The two functions are incompatible, and if one or other line of work is not to be neglected it seems essential that two officers should, normally, be allowed on the strength of each circle, an arrangement which has certain administrative advantages.

V.

With such an organization the maintenance of purity in the seed supply up to the stage when issue is first made to the public should not offer any great difficulty. We have now to consider the organization required for the further multiplication of that seed. It is here that the work of the Commercial Section will commence. Such a section is already in existence, but its activities have been confined to the supply of seed to the smaller cultivator, and in 1919 approximately thirty per cent of the cotton area was sown to seed so issued. Effective though that organization appears to be, it does not strike at the root of the problem. The seed is sown under no control, and is of little or no value in increasing the supply of purer seed. Many of the larger cultivators, too, appear to be as careless as the smaller in this matter. It is immaterial whether the cause is ignorance or economic pressure, the effect is the same. Some more general control of the seed supply is needed, and such control must avoid the assumption by Government, as represented by the Ministry, of the function of a general dealer in seed. It would appear possible, by working along the lines indicated below, which are the outcome of conversations held by me in Alexandria, to evolve a workable scheme which will ensure a certain standard of seed and, at the same time, provide the means of working up as far as may be necessary, while maintaining purity, the seed of the races which find their origin in the work of the Botanical Section.

The agricultural organization, as we have traced it, gives a seed supply sufficient to sow 500 acres. Allowing a margin for cases in which doubt attaches, the circle officer should be able to recover seed sufficient to sow 4,000 acres in the succeeding year. He will be able to locate the fields planted to that seed, but it will be beyond his means to recover the seed. Were he now to notify the ginnerers of the names of these growers, with the area grown by each, it should be possible to intercept a fair proportion of the crop so grown as it comes into the ginneries, and, by arrangement with the ginner, this could be ginned and the seed kept separate. Such seed will now receive a Government mark indicating that it is passed as *taqâwi*. I am here making various assumptions; I assume an intimate local knowledge on the part of the circle officer which will enable him to select reliable men; I assume the form that reliability takes will include a willingness to deal with the ginner selected; and I assume the existence of ginnerers who appreciate the importance of a guarded seed supply sufficiently to take the necessary trouble. From what I have been able to gather

on these matters, I am inclined to think that all these assumptions are well founded.

The ginner will now dispose of this *taqâwi* seed in the normal course of his business, but will keep a record for the information of the circle officer of the purchasers. The latter will thus be able, by a system of inspections during the succeeding year, to draw up a list of cultivators whose crop is sufficiently pure to serve as a source of *taqâwi*. His selection will continue until he can find no more fields sufficiently pure to serve as a basis for seed supply—a condition which will occur during the early years of introduction—or until he has arranged for a sufficient supply, allowing for wastage, to meet the needs of the tract it is desired to plant to that kind.

I have described the organization with especial reference to the introduction of new races, but, as I conceive it, that will not be the main function of the scheme. I conceive the scheme, as described, merely as the preliminary stage in the evolution of a more complete one aimed at licensing the ginneries for *taqâwi*.

The licensee will keep a record :—

(1) Of the cultivators whose crops have gone to the production of *taqâwi*, including a statement of the kind and the amount.

(2) Of the persons to whom he has disposed of that seed, again including a statement of the kind and amount in each transaction.

In the selection of the seed cotton he will be guided by information supplied him by the circle officer, aided by his own judgment. Where the source has not previously been inspected, the seed cotton will be passed by the circle officer before it is ginned. All such *taqâwi* seed will receive an official seal. The disposal of this seed will be subject to no further control than is indicated in (2).

These two lists, I suggest, should go to the Commercial Section of the Ministry, which will thus be in a position to collate the information with regard to seed supply by circles and to furnish the circle officer with such collated lists. The Commercial Section will also be responsible for extending the present distribution of seed to small holders,* for which it will obtain its supply from the sealed stock in the hands of the ginners, but the supply to the larger holders will remain uncontrolled.

Under this scheme, when fully developed, the circle officer will be in possession, through the Commercial Section, of information as to the source of the seed from which a large proportion of the cotton in his circle is grown. He will thus be in a position to exercise control over the bulk of the cotton crop of his circle with the minimum of effort.

* The maximum amount issued in one lot is 10 *ardebs*, or sufficient for 25 *jeddâns*, representing a holding of between 50 and 75 *jeddâns*.

I am not here concerned so much with the development of a scheme practical in all its details—for such, practical experience and a local knowledge I do not possess is essential—as with outlining the main features any scheme, to be effective, must possess. Among such features I place the absence of penalty against the licensee. Success or failure will depend very largely on the goodwill of these.

In the “Agricultural Journal of Egypt,” Volume VIII, page 69, an account is given of the system of control of *taqâwi* instituted in connection with the control of cotton seed organized in 1917. The problem was then approached from a different standpoint, and the control is, therefore, of a somewhat different nature to that which I have just suggested. It introduces control at a stage when that control is difficult of application and of nature which, at first sight, appears to be restrictive. It is for that reason that I hesitated to suggest any control at this stage. The fact that the scheme has been developed without serious criticism from the financial interests affected makes it worth considering whether its institution on a permanent basis is not desirable. It is truly complementary to the scheme I have here proposed; there is no fundamental incompatibility between them, since they do not cover the same ground, and there should be no great difficulty in making the two dovetail into each other.

There appears to be a body of responsible ginnerers who fully recognize the importance of seed control and who would willingly undertake to make such returns. The position is more nearly that of a co-partnership for mutual benefit than one of enforcement of a restrictive order. For the services provided Government guarantees a partial monopoly. In such a system any penalty beyond the removal of the license is inadmissible, and penalty, if any be required, will be imposed on the purchaser of non-guaranteed seed. The use to which the returns are put will end normally with the check which they will enable the district officer to make. Of one fact I am thoroughly convinced, if a scheme based on the goodwill and co-operation of the ginner be wanting in success, no scheme based on compulsion and the enforcement of penalties will lead to any better result.

It is recognized that any scheme such as I have outlined will throw a considerable amount of work on the circle officers to accomplish which a large portion of their time will be spent in touring. It is very largely recognition of this fact which is responsible for the suggestion that the normal senior staff of the circle shall be two; the senior engaged mainly in touring and the district work, and the junior on experimental work.

I have left reference to the economic aspect till the last because

the discussion of the system outlined for the introduction of new, and the maintenance of purity in old, races throws a certain light on this. Statistical information is required both of the relative quantities of the different classes grown, of the value realized for these, and of the development of cottons capable of replacing these but grown in other countries. The system I have outlined for licensing ginneries, and the information contained in the lists proposed in connection with that system, should provide the materials for a very accurate estimate of the relative areas sown to the various races, and it is partly on this account that I have suggested the centralization of the work of abstracting these in the Commercial Section. Information with regard to prices, and to the cottons produced in countries other than Egypt, must be derived from external sources. With a definite idea of what information is required, it should not be difficult, by enlisting the services of the Empire Cotton Growing Committee, of the Fine Spinners Association, or of the International Federation, to arrange for statistics to be prepared in suitable form. The work of collating and recording this information requires no separate section, and might conveniently be entrusted to the Commercial Section.

VI.

It will perhaps render these proposals clear if I refer to a few practical problems of the present day, and show in what manner the scheme outlined will affect their development.

Mr. Bolland, some years ago, commenced a series of selections of the standard Egyptian cottons, with a view to developing cultures of these which would give a more uniform product than is now commonly attained. Of these, we may consider the Ashmûni culture. His method is, to describe it briefly, based on single plant selection of typical plants. The offspring of these single plants are grown separately, are examined in detail, and the seed of those plants which conform most nearly to the ideal of the Ashmûni type is harvested, again separately, and sown the following year, as single plant cultures to form his Grade I crop. The seed of the remaining plants is harvested and bulked together to form his Grade II crop. In the following year the single plant Grade I cultures are again examined, and, from them, single plants are selected. The remaining Grade I plants provide the next year's Grade II crop, while the Grade II crop is sown as Grade III crop.

This process is repeated annually, the seed from the Grade III crop being issued to cultivators, who grow it as a Grade IV crop. Certain

of these cultivators sow it under Ministerial supervision, and the Ministry retains the right of purchase of the produce from this. In the remainder of the Grade IV crop, and subsequently, control ceases, and the amount of controlled seed at the disposal of the Ministry is thus limited to that from the controlled portion of the Grade IV crop, or enough to sow some 500–600 *feddâns*.

This area is a mere fraction even of that which is sown to the Ashmûni seed distributed by the Commercial Section of the Ministry—over 100,000 *feddâns* in 1919—and the Ministry is compelled, therefore, to seek its supply from ginneries. Now if this seed, selected on Mr. Bolland's scheme, is materially to affect the Ashmûni crop, and that is presumably the only justification for the labour incurred in that selection, the Ministry must check the sowings and trace the produce of those crops which it finds to be sufficiently pure to the ginneries, and must purchase the seed obtained from it, to form what we may term a Grade V crop. Let us examine the practical aspect of this more closely.

In a letter recently received by the Ministry, I find the following remarks; they refer to produce from the uncontrolled section of the Grade IV crop:—

“The cotton was grown in two villages; the sample from the former shows a good-coloured brown Ashmûni with as good staple as we have seen this season; there are, however, streaks of lighter-coloured cotton, which is curious, seeing that the seed is pure. . . . The latter is, however, entirely different to the first lot; it contains a short wasty cotton, and the class is barely F.G.F. It is surprising that it is supposed to be the same seed, and perhaps you may be able to indicate the cause of deterioration.”

Again, I have examined some samples of the seed cotton of this same Grade IV crop, and have found it more mixed than the majority of commercial samples of Ashmûni that I have seen. In the former case there is a distinct and large divergence between the produce raised from two identical lots of seed; in the latter, admixture sufficient to render the produce less uniform than most of the uncontrolled Ashmûni crop.

The explanation cannot be given with certainty, since there have been no independent observations of the various crops concerned, but it is probably this. In the first case, both crops are sown with the controlled seed, and in one instance germinations were successful and re-sowing unnecessary; in the second instance a large proportion of the crop consisted of second sowings, and these were made with seed of different origin. The second case forms a parallel to the

second instance of the first case, and second sowings with seed of different origin were largely resorted to. In the first of these three instances only can the crop be truly considered to be of Mr. Bolland's Ashmûni; the seed of the remainder is worthless for further distribution. Yet the name is retained for the produce of all these cultures, and the Ministry has no means of judging which are the reliable lots when it comes to purchase from the gins. The cessation of control after the Grade IV crop, therefore, renders it impossible to assure a supply of reliable seed for more than 500-600 *feddâns*.

Were, now, an organization, such as I have outlined, to be in operation, the district officer would be in a position to see that these 500-600 *feddâns* belonged to responsible persons who could be relied on to carry out any re-sowing with the same seed as that supplied. His local knowledge would, moreover, enable him to place the entire Grade IV crop in the hands of reliable persons. Even supposing he fails to exercise any supervision over the distribution of the seed and the sowings, he would know where it was growing, could inspect the crops, see which of these maintained their purity, trace these to the ginneries, and so place at the disposal of the Ministry a yearly increasing supply of seed of known quality.

As a second instance I may take the case of the Domains. Here Mr. Jeffreys has, for a number of years, devoted much labour to purifying the field crops of some of the more important varieties of Lower Egypt, notably Sakel and Assîli. His method differs from the above, and may be termed bulk selection. From the field crop, before general picking commences, he collected a bulk of seed taken only from those plants which correspond to the ideal of the type in question. The seed from the produce so collected is sown separately, rogued during the course of its growth, and again gone through before harvest and a similar amount of seed cotton of the most typical plants taken. The remaining seed is used to extend the area under the selected crop. In this way he has worked up an area of 10,000 *feddâns*, in which the crop is manifestly purer than any I have seen elsewhere, and it forms a distinct advance in uniformity on any of the crops commonly grown. He has also maintained on a fair scale in a state of considerable purity many other types, notably those evolved by Mr. Balls. We are here, however, only concerned with the two varieties, Sakel and Assîli, of which a commercial seed supply is raised. Under present circumstances that seed, totalling 13,000 to 15,000 *ardebs*, is used partly by the Domains for sowing the area under their direct cultivation, using some 3,000 to 3,500 *ardebs*, partly for sowing a large area of leased lands, absorbing some 5,000 to 6,000 *ardebs*. The remaining seed is placed at the disposal of the Ministry, which distributes it through the Commercial Section to cultivators in small lots. In all except the first

case, and the extent of that is only sufficient to produce the same volume of seed yearly, control ceases. The subsequent cultivator is usually a small man who may or may not re-sow with seed of unknown origin.

Apart from the difficulty of re-collecting from a large number of small holders, the value of such seed for *tagâwi* is very questionable. Practically, therefore, the efforts made on the Domains merely result in the maintenance of a certain fairly constant volume of seed, and there is no cumulative effect leading to increase.

Here, again, were there an organization such as I have outlined, the Domains seed would pass to the larger private estates, the district officer would be supplied with particulars of these, would inspect the crops, note which are the purest of these, trace them to the gineries, and place at the disposal of the Ministry for distribution to the smaller cultivators an ever-increasing source of supply of reliable seed.

VII.

I have indicated the essential points of an organization for the development of improved cottons and for the introduction of these on a commercial scale under conditions which will maintain a sufficient degree of purity. As described, the outstanding features of that organization is continuity. But while continuity is essential to the successive stages of that development, such continuity is not possible in the organization. At least three sections of the Ministry—the Botanical, the Agricultural, and the Commercial—are concerned. Success will depend on the maintenance of that continuity of work in spite of the discontinuity of agents, and the danger to the scheme lies at those points where the activities of two agencies meet. The function of organization should be the prevention of any hiatus occurring at these points, and it should leave the maximum of freedom within the sections themselves.

This necessity for continuity requires to be emphasized. Recently a Cotton Research Board has been instituted, with the underlying idea that the control of cotton research shall be undertaken by it, leaving the practical aspects of the problem to the Ministry. Such a division of functions, I think, is hardly consistent with the development of the continuity I hold to be essential for the successful development of the scheme. It institutes a duality of control which is almost certain to lead to a break in continuity and to the establishment of the hiatus it is most desirable to avoid. The idea underlying the separation of research from practice appears to be based on analogy with English conditions. Here the tendency is in the direction of such separation.

I am inclined to think that this analogy is not a true one, especially in matters like agriculture. In England the farmer is educated, and he appreciates the value of improved seed in crop production. He himself carries out the later stages of seed production inasmuch as he purchases a limited amount of pedigree seed, and, from the crop produced from this, sows his entire area if the trial proves the superiority of the race under the local conditions. He is thus able and willing to pay a high price for pedigree seed, for the amount he has actually to purchase is small. It is that ability and willingness which makes the production of pedigree stock a financial proposition for the seedsman. In Egypt the conditions are far different. The cultivator is uneducated and even illiterate. There is no general recognition of the value of pedigree stock, no willingness to pay a high price for such, and consequently no encouragement for the seedsman and plant-breeder on a financial basis. Government must control the seed supply not only during the early stages but throughout. Not only, therefore, is continuity essential in the Research Section pure and simple, but that continuity must extend to the Commercial Section as well: a continuity which is not likely to be fostered by widening the breach between research and practice. Such continuity will, in my opinion, be best maintained by the institution of a cotton committee within the Ministry itself. This committee will be composed of the heads of the various sections concerned with the development of cotton, and will sit under the presidency of the Under-Secretary for State for Agriculture. It will deal with all matters of a general nature affecting more than one section and decide all questions of principle. It must, however, avoid any interference with the actual work of the individual sections once the general lines of policy have been decided. The decision as to what shall or shall not come before the committee must rest with the Under-Secretary for State for Agriculture. Further, the committee will form a convenient body to deal with any matters of general principle now referred to the Under-Secretary for State by Government. The committee should be flexible, and that flexibility may be given to it by a power to co-opt members for particular purposes.

It perhaps carries me too far beyond the range of my terms of reference, but it may help to render my conception of the working of this Ministerial committee more clear if I say that I look upon this committee merely as one of a number of such committees. It is, in my opinion, the most satisfactory means of dealing with all technical subjects which concern more than one section of the Ministry. On the one hand, they form a most convenient means for deciding, by mutual discussion, the lines of work of the different sections so that these may dovetail into each other, while at the same time automatically placing

on record a Ministerial policy ; on the other, they form a definite body to which the Under-Secretary for State can refer such references on technical matters as are received from Government and from which he can obtain an authoritative technical opinion.

The field presented by the cotton problem, however, in its entirety extends beyond the scope of the Ministry of Agriculture. On the one side there are the Domains. These form an enormous potential asset for the development of a controlled seed supply. I have already shown how it is that the Domains have failed to pass from a potential to a practical asset in this respect, and how it is that the very successful efforts are largely dissipated. A liaison requires to be effected between the Domains and the Ministry by which such questions as the varieties it is desirable that the Domains should grow, and the distribution of the seed raised on the Domains' land, can be settled. On the other side is the physical investigation, for the conduct of which the Physical Service is relied on. It may also be remarked that the development of that work may raise important questions of water supply which will involve the Irrigation Department. At least three extra-Ministerial bodies are thus concerned, and between them some liaison is desirable.

I am aware that my proposal for the establishment of a committee within the Ministry will appear to undermine the position of the Cotton Research Board as at present instituted. This it undoubtedly does, but it indicates the desirability of a board occupying the same position with respect to the Ministry as the existing Board, but with somewhat different functions. By the decree instituting that Board its function is defined as "to combine, co-ordinate, and extend scientific researches with a view to assisting cultivators to improve the quality and yield of cotton grown in Egypt." From the general aspect I have already indicated the undesirability of separating research from practice in the economic conditions prevalent in Egypt, and, from the particular aspect, there appears to me the danger of a most undesirable duality of control. As I conceive it, the Board should serve the function of liaison agent between the Ministry of Agriculture and such extra-Ministerial bodies as are concerned with the cotton problem. The Ministerial note explaining the decree says : "The Board will maintain close touch with cotton growers, ginnerers, and spinners, so as to know their 'needs'." I have dealt with this aspect elsewhere. It is the work enumerated by me as economic. I have suggested that this be performed by the Commercial Section, and provision has already been made for it in the proposals I have already made.

VIII.

I have yet to deal with those subjects which I have termed collateral, inasmuch as they are mainly concerned with problems affecting agriculture as a whole and relate to cotton merely as one, though, it is true, the preponderating one, of the crops of the country. The distinction places them in the position of separate and independent sections of the Ministry, between which and the sections already dealt with, if formality is to be given to the relations, touch may be maintained through the Ministerial Committee. As I have stated, the subjects lie outside the scope of this report. I will only note here that the relation between mycology and bacteriology, in its agricultural bearing, is a close one, the methods of research are similar, and the agricultural bacteriologist is, through his training, usually well grounded in mycology. Soil bacteriology appears to be the more urgent line of investigation at the present time, and it may, therefore, be found advisable for the moment to unite these two into a single section.

IX.

There remains one subject which arises from what has been said under the section dealing with botanical research, but which, as it is of wider concern, I have left for separate treatment. In its bearing on the botanical work it concerns the source of the material which will form the basis of that work. In the course of that discussion I pointed out the hybrid nature of the Egyptian cotton crop, and indicated the possibility of the spontaneous origin of new and advantageous types as the result of the fortuitous combination, through cross fertilization, of certain characters. The entire crop is thus a natural laboratory, and the search for, and preservation of, such naturally arising and improved combinations is most important. The search is of the nature of that proverbial one—the needle in a haystack—and it is a practicable impossibility that the botanical staff shall undertake it. Yet it requires to be done. There appear to be two possibilities, in the utilization of Government and private agencies.

The district agricultural staff, developed on the lines indicated, will give a large number of observers scattered throughout the country. In the fields and in the ginneries they will have, from time to time, their attention drawn to plants, groups of plants, or to samples of seed cotton differing from those typical of the locality. It should be the practice for such “finds” to be preserved and the seed submitted to the Botanical Section for trial. In the case of a single plant or an odd “lock” of cotton, the seed will be sent to the Botanical Section to be tested for purity and for the establishment of purity, if the progeny prove impure. If it be a group of plants that has been selected, the case falls under the head of bulk selection. In such a case it may be

desirable for the circle officer to grow it on himself, for it may prove pure, or nearly so, from the start, and, if it does, he will at once be in a position to establish an improved race, thus shortening the introductory process. But he should, in all cases, advise the Botanical Section and give the officers of that section free access to the crop so produced, so that they may originate single plant cultures and thus establish a pure stock showing the desirable characters. Bulk selection may give a sufficient degree of purity, but more probably it will not. If it does not the stock will shortly begin to show "deterioration," and by that time the Botanical Section will have eliminated the impurities and worked up a stock of pure seed which can be used to replace the less pure seed which has begun to exhibit signs of deterioration.

The history of the different types of Egyptian cotton which have from time to time held the field indicates two facts: the frequent spontaneous occurrence of new forms, and the presence in the country of an efficient body of private individuals ever ready to seize on and develop such new forms. The existence of this body is a valuable asset to the country; it is to the labours of the members of this body that practically all the types of cotton at present under extended cultivation owe their origin; there is no reason for supposing that their utility is ended. Their activities require encouragement, but, while this is true, it is equally true that their uncontrolled activities are not without danger to the crop as a whole. The wholesale introduction of new varieties scattered throughout the country is dangerous, for such introduction involves not only impurity and "degeneration" of these but also of the existing crop, both by direct cross-fertilization in the field and by seed mixture in the gins. Thus the new race is endangered and its subsequent re-establishment, should the new one prove undesirable, rendered a matter of doubt.

The problem is to control the introduction of such new races without removing the incentive to those working towards their production. Now this incentive is the money value derived from the sale of seed during the first few years after introduction. With a name for superiority established and a limited seed supply, the price paid for the available seed is high and remains high until extended cultivation, with increased seed production, removes the main factor from which the profit accrues.* I find that it has been proposed

* I am aware that this statement does not appear to be in accord with the statement made on page 28. The discrepancy is, however, hardly more than apparent. The essential fact is that, in Egypt, the later stages of seed production are nowhere undertaken by the farmer himself. Enhanced prices are realized for the seed of a new cotton which has obtained a name, but the purchaser of the seed of that cotton expects to purchase sufficient to sow his entire area. The extra price he is prepared to pay is limited to the profit he expects to realize directly from the crop he harvested. Profits from new introductions are thus limited to the period when there is shortage of supply. There is no continuity in the business such as will lead to the development of a seedsman's trade, dependent on a continuous financial return.

to lay down that the permission of the Ministry must be obtained before such a new race is grown outside the originator's estate. Under present conditions application is made to the Ministry only when a bulk of seed has been obtained, and it is proposed to start the commercial sale of seed. The Ministry has no definite information as to the value of the new race and, therefore, no means of arriving at a decision as to the desirability of granting a licence. Under these circumstances, knowing the danger, it would act wisely in adopting a cautious attitude and refusing a licence. But such refusal can but act as a deterrent to those to whom it wishes to give encouragement.

The weakness in the present system lies in the absence of any independent knowledge of the race which will enable the Ministry to decide, and it is at this point that the remedy must be sought. The consideration of the early history of such a race will point to a practical means of attaining the dual object of controlling introduction without discouragement to the producer.

No such race originates as a bulk production ready for immediate introduction. The beginnings are small; it may be a single plant, and some years are spent in working up purity and a stock of seed before the supply reaches a volume to pass beyond the originator's estate. A decision is, therefore, reached with regard to a particular race some years before it is ready to be launched as a commercial proposition. It is at the time this decision is reached that the Ministry should receive information, facilities given to the officers of that Ministry to inspect the crop, and a small supply of seed placed at its disposal. That sample will be made over to the Botanical Section and examined for purity and general suitability. From two directions, the botanical analysis and the agricultural inspection, the Ministry will thus be placed in the possession of information on which it will be able to arrive at a decision when application for a licence is received.

There appear to be two advantages in this proposal. The demand for early information, facilities for inspection, and the submission of a sample of seed, require no legal enforcement by penalties. The onus of compliance is placed on the producer, and, if he does not comply, he will have no ground for complaint if a licence is withheld. The control will not act as a deterrent to the class it is desired to encourage. Again, the supply of seed will provide the Botanical Section with valuable material for its own investigation—private agency, as well as the district staff, is, in fact, being enrolled in the search we desire to make as thorough as possible.

It may be necessary to give some form of guarantee that Ministerial development will be delayed for a series of years to allow the originator to reap the benefit of his work. Such a guarantee is not likely seriously to affect the section's work. In the event of a really useful "find"

of this nature, the slower method, necessitated by the precaution taken to ensure purity, will, in all probability, develop a supply of pure seed at the stage when the financial interest of the originator ceases. The crop will then be relatively impure, and Ministerial action will take the form, working through the licensed ginneries, of the replacement of the impure by the pure seed.

The difficulty which has been experienced in recent years both with regard to Zagora and Pelion cottons is traceable to absence of early knowledge of their existence. The result has been a hesitation in the matter of licensing which cannot but have disheartened the originator of these. If steps are now taken to procure early information, together with the other facilities to which reference has been made, the difficulties which have arisen in the past should no longer be felt.

X.

In the preceding sections I have reviewed the problem as presented at the present time, and it remains for me to extract from that review, in the form of definite proposals, the salient features of a policy which will lead to "the maintenance and improvement of the quality of Egyptian cotton and the increase of its yield." These proposals fall naturally into two sections, the practical or technical, defining the foundations for such maintenance and improvement, and the administrative, designed to develop those improvements. I omit here any proposals for the establishment of those foundations. That is a purely scientific question, and this report is not the place for a purely scientific dissertation. I have, however, not neglected this matter, and have devoted much time to discussing with the officers concerned the lines of investigation which require to be taken up with this object in view.

The central fact with regard to the cotton crop, from the former aspect, is that it falls into two groups. The one possesses an intrinsic value, that is, meets a particular need for certain definite physical qualities. The trade requires these qualities in the cotton in order to develop certain qualities in the yarn. Substitution is, in this case, impossible. The second requires no such definite qualities. The only cotton at the present time that falls into the former class is Sakel. It is true that Sakel is used for many purposes, not all of which require those intrinsic qualities that it alone possesses, but there is a definite trade of which Sakel alone satisfies the requirements. What proportion of the present production of Sakel goes to meet the requirements of that trade I am unable to say, but, until some other cotton which also possesses these qualities is forthcoming, a certain area, not necessarily, nor even probably, approaching the present area under Sakel, must be maintained.

This, therefore, furnishes my first recommendation :—

1. *The maintenance of the purity of Sakel.*

This I consider to be the point of greatest practical importance at the present moment. It has been argued that the decreasing yield of Sakel makes this practically impossible, for it is not possible to dictate to the *fellah* that he must grow a certain form when it is a foregone conclusion that he will lose by so doing. The argument overlooks one point. Sakel, as I have stated, is used for other purposes than this specialized trade, and it is so used merely because it is produced in such quantity that the price is determined not by its primary but by its secondary or substituted use. Were the production to decrease, and only that quantity to be produced which would satisfy the primary use, the price would rise until it reached a figure which would make its substituted use impossible. The limits to the price that would be reached from this cause cannot be estimated with any exactitude, but it is probable that the increase would be sufficient to counterbalance any deficiency in yield. There is another factor to be considered here. It was pointed out to me in Lancashire that the industrial changes of the past few years have so altered the economic position in the cotton industry that the price of the raw material has now become a matter of secondary importance, and that there is thus a much greater readiness to pay high prices for the raw material than formerly. I am inclined to think, therefore, if this be a true statement, that the market for Sakel will remain even at any price that may be necessary to counterbalance the diminished yield.

The danger to Sakel lies in this. There is no harm, in fact it is probably desirable, that that section of the Sakel crop which at present goes to provide a substituted use should be replaced by a lower grade, but higher yielding, cotton. Such a replacement cannot take place, however, without danger to the entire Sakel crop. Unguided, that replacement might easily end in the disappearance of Sakel as a distinct class. At the present moment Pelion forms a rival which may, at no distant date, replace Sakel as completely as Sakel itself a few years ago replaced 'Afifi. The latter replacement was not fundamentally unsound, for it was a replacement of an intrinsically inferior by an intrinsically superior class of cotton. The replacement of Sakel by Pelion is of the reverse order, and in this fact lies the importance of taking special steps to preserve Sakel.

The preservation of Sakel as one of the standard classes of Egyptian cotton will no doubt form one of the items of work of the Botanical Section in that, from it, a series of pure line cultures will be made. But such work is slow, and it will take some years to work up an appreciable bulk of seed. The method is likely to be slower than the

rate at which Sakel may be replaced in the field if Pelion fulfils the expectations of its admirers. Something more is required, and that something will be found in bulk selection. Only by maintaining a considerable area under Sakel, and by rigorously roguing the crop each year, will it be safe to allow Pelion to develop uncontrolled. Should Pelion or, for the matter of that, any other of the new forms now coming to the fore, repeat the career of Sakel, the pendulum is bound to swing too far in the reverse direction, and the present complaint in the trade of an excess of Sakel will be followed by a complaint that there is too little. It should be the policy of the Ministry to prepare for that time, and it can do so by some system of maintaining an area of pure Sakel sufficiently large to rectify the balance in a couple of years. It is a very satisfactory feature that the Domains already have this problem in hand, and have available a bulk of Sakel seed which is remarkably pure.

Sakel, as has been said, is the only one of the present cottons that possesses an intrinsic value that no other cotton rivals. It has, from the agricultural point of view, however, certain undesirable features. As long as it remains alone as the sole yielder of that especial class, it must be preserved. It is most desirable that this position of isolation should cease at as early a date as possible. This will only happen when a plant with a different habit, but possessing the lint quality of Sakel, is evolved. On enquiry whether such a plant exists, I have heard Casuli mentioned as a possible substitute for Sakel, but have not had sufficient experience of this plant to form any definite opinion, and its special fostering, if it does, requires to be placed in the front line of investigation of the Botanical Section. This leads me to my second recommendation.

2. *The establishment of one or more types with the same intrinsic merits as Sakel, but with an improved vegetative habit.*

The special importance of these two lines of work arises from the fact that Sakel forms at the present time the end term of a series of cottons arranged on the basis of intrinsic merit. Sakel can be used as a substitute, but no cotton can be substituted for it in certain of its uses. The remaining outlets for botanical investigation must not, however, be neglected. I may gather these into a further series of recommendations.

3. *The maintenance of the present classes by a system of purification and establishment of pure races.*

4. *The development of types agriculturally better suited to the environment, including the demarcation of type tracts.*

5. *The development of a class of cotton superior in quality to the best Sakel.*

The commercial aspect of these recommendations is given in some detail in Mr. McConnel's note dated July 26, 1919.

I may now pass to the second, or administrative, aspect. The essential consideration here is the provision of a continuity from the termination of the experimental stages, dealt with in the above recommendations, to the last stage, in which purity of the crop is established throughout extended tracts. This series of recommendations arises from (4) above. The demarcation there indicated can only be made by carefully conducted trials in the various tracts. For this purpose an experimental farm is required in each tract. I may deal with the questions here raised in a series of recommendations.

6. *The division of the country into circles determined, as far as possible, by climatic considerations and each with its experimental farm.*

In agreement with what has been said in the body of this report, the work of these farms will be of wider scope than is here indicated, and this report is concerned with only one of their functions.

7. *The establishment of a seed farm in each of the circles so defined.*

The work of these will be the production of a supply of pure seed in sufficient bulk to maintain the purity of the kind when it passes to the less rigid control of general cultivation.

8. *The introduction of a system of licensing of ginneries for taqâwi.*

The system should not be repressive, and its main object should be to procure information as to the movement of seed used for sowing purposes rather than to direct the movement into unnatural channels.

9. *The introduction of a system of licensing persons desirous of introducing new varieties.*

Again, the system should not be repressive, and should have as its main object the collection of information concerning the development of such varieties. The main danger arising from uncontrolled introductions of this nature has been the absence of any organized system for maintaining the varieties at the time in general cultivation. When such an organization has been established, licenses may be given as a matter of course, for the means of readily eliminating the cultivation of the variety, should it prove undesirable, and of preventing the adulteration of the existing varieties, will be at hand.

In like manner I may summarize the organization I have outlined for the purpose of developing the above.

10. *The division of the Ministry into a series of sections.*

Such a division is already in existence, and I am not so much, therefore, concerned with the principle as with the lines of demarcation. Here, too, I am only concerned with three sections, and I will limit my remarks to these.

The Botanical Section at the present moment administers such experimental farms as do exist. There is also a cadre of inspectors under an Inspector-General concerned at the present time not merely with district work but with the enforcement of agricultural legislative measures. This latter is, in my opinion, entirely objectionable. It brings the Ministry before the agricultural population as primarily a repressive body, whereas its true function is to appear as, and to be, the cultivators' friend. Such police work should be otherwise provided for. With this work removed, the inspectors will form a body of circle officers under the Inspector-General and form a section comparable with the other sections of the Ministry. Their work will be primarily to gain the confidence of the people, for it is only by so doing that they will be able efficiently to perform the duty of supervising the work involved by the licensing system, from the inspection of crops to the marking of the seed. They will be responsible for the experimental and seed development work on the farms of their circle, and, if the inspection work is not to suffer, two officers will be required for each circle, the senior undertaking the inspection and the junior the experimental work.

This recommendation, then, suggests the institution of an Agricultural Section which will include the present inspectorate. The functions of this section will be limited to the extent that the work of administering such legislative measures as are passed will be removed, but be increased to the extent that charge of the experimental and seed farms will be added.

In like manner, the work at present carried out by the Commercial Section is highly specialized and distinct from that of the Agricultural Section as here defined. This section should act independently, and the liaison between it and the Agricultural Section will be maintained through the Ministerial Committee which forms the subject of the next recommendation.

11. *The establishment of a Ministerial Cotton Committee, composed of the head of sections concerned and possessing power to co-opt.*

✱ The functions of this committee have been dealt with in the body of this report. One of its main functions will be the co-ordination of the work of the various sections. As I have pointed out, the source of danger lies at the point where development passes from one section to another, and particular care must be taken to prevent the encroach-

ment of one section on the field of another. At the same time, care must be equally taken to limit the activities of the committee to such co-ordination and to avoid any interference with the actual work of the various sections.

12. *The establishment of an extra-Ministerial Cotton Board.*

So long as the scheme for cotton development entails the joint activities of several bodies which are not all in one Ministry, the existence of an extra-Ministerial Board is necessary to provide the necessary co-ordination between these bodies. I have preferred to refer to this as the establishment of such a board rather than as a reconstitution of the existing Cotton Research Board. The distinction I have already drawn between the function of the existing and the proposed boards will, I think, be obvious. The function of the present Board is "to combine and co-ordinate scientific researches," a definition which not inadequately indicates the function of the Ministerial Committee proposed above, while that of the board, as I have conceived it, is primarily to co-ordinate practice with the results of those researches. To serve this purpose, the constitution requires to be radically altered, and the board should include in its membership representatives of the bodies concerned and not, as at present, members selected on a personal qualification. Probably it will be found to serve its purpose most effectively if it be established as a purely advisory board reporting direct to the heads of the Ministries or departments concerned. Its members would thus be drawn from those persons most intimately concerned with the developments of research for which an outlet is required.

The difference between this and the present Cotton Research Board is fundamental. Nevertheless, I do not wish to imply a wholesale and immediate condemnation of the present Board. That Board has, I think, a useful function at the present time. The research staff will be mostly new and lack experience of the country. I would suggest, therefore, that the proposals I have made be considered as an ultimate policy and that, in the meantime, such proposals as arise be considered in the light of such a development so that no steps may be taken which will vitiate their ultimate adoption.

H. MARTIN LEAKE.

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