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JOURNAL OF THE SOCIETY OF ARTS.

No. 1,308. Vol. XXVI.

FRIDAY, DECEMBER 14, 1877.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROFESSOR BELL ON THE TELEPHONE.

In consequence of the large attendance expected on the evening of Wednesday, the 19th December, when Prof. Bell will repeat his lecture on the Telephone, the Council have made arrangements for the lecture to be delivered in the Great Hall of the Freemasons' Tavern, Great Queen-street, W.C., instead of at the Society's House.

Every Member can admit two friends to the Meeting by means of the usual ticket, or by personal introduction. Members will be admitted on signing their names.

The chair will be taken at the usual hour, 8 p.m.

SILVERSMITHS' WORK.

The Council offer the sum of £100 (placed at their disposal by Messrs. Watherston and Son), together with the Society's medal, for "The best essay on the Art of the Silversmith, past and present, of all nations, with practical suggestions for its future development."

The essay must be historical as well as practical, and should point out the *chefs d'œuvre* produced in various countries.

It is necessary that the obstacles which have tended to retard the progress of the art in England should be set forth, with a view to their removal, and that suggestions should be made for improvements in the various branches of the art.

The names of the judges will be published hereafter.

The premium will not be awarded unless an essay of sufficient merit is submitted.

FOURTH ORDINARY MEETING.

Wednesday, December 12th, 1877; WILLIAM HAWES, F.R.S., Deputy Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bragge, William, Shirle-hill, Hamstead-road, Birmingham.
 Crease, Major John Frederick, Eastney-barracks, Portsmouth.
 Crisp, Frank, F.L.S., 5, Lansdowne-road, Notting-hill, W.
 Downing, Nicholas Berriman, Eastfield-lodge, Waltham-stow.
 Glover, Henry, Wellington-road, Bow, E.
 Lumsden, David, Telegraph Department, General Post-office, E.C.
 Ramson, Tarrar, Lowestoft.
 Shakespear, Colonel John D., F.G.S., Scientific Club, 7, Savile-row, W.
 Whitmore, Lawrence Hersee, 124, Sloane-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Bramston, John, Colonial Office, Whitehall, S.W.
 Carteighe, Michael, F.C.S., 180, New Bond-street, W., and 81, Mornington-road, N.W.
 Cullen, William Hart, jun., 13, Victoria-road, Holloway, N.
 Hewan, Archibald, M.D., 9, Chester-square, W.
 Kenrick, William, Mayor of Birmingham.
 Postans, Arthur William, F.C.S., 35, Baker-street, Portman-square, W.
 Reid, Patrick Sandeman, 20, John-street, Adelphi, W.C.
 Sabel, Ernest E., F.R.G.S., 85, Cannon-street, E.C., and 185, Maida-vale, W.
 Sabel, Paul, 85, Cannon-street, E.C.
 Smith, James S., 12, Worship-street, E.C.

The paper read was—

FREEDOM IN THE GROWTH AND SALE OF THE CROPS OF THE FARM, CONSIDERED IN RELATION TO THE INTERESTS OF THE LANDOWNER AND THE TENANT FARMER.

By J. E. Lawes, LL.D., F.R.S., &c.

The agriculture of Great Britain, considered as a commercial undertaking, may be said to be carried on by two partners; the one providing the capital in land and buildings, and the other the capital in live stock, implements, manures, and that required for the payment of wages, &c. The interest of the one partner is permanent; he may be called the owner of the business; whilst that of the other is limited to a period mutually agreed upon. The landowner receives interest upon his capital in the form of a fixed annual payment, or rent. The profits of the tenant, on the other hand, are fluctuating, for they depend, not only on the fixed amount of rent paid, but upon whether the seasons are favourable or unfavourable, upon his skill in management, and upon a variety of other circumstances. The tenant gets a higher rate of interest on his capital than the landowner, as is to be expected that he should do, since he takes a more active share in the management of the business. The landowner, however, controls some of the most important operations on the farm. He decides what crops may, and what crops may not, be grown; what produce may be sold, and what may not be carried off the farm. The tenant attends to the cultivation of the land, buys and sells stock, and, subject to the important restrictions above-mentioned, manages the farm in the manner which he considers the most conducive to his own interests.

It is frequently assumed that the interests of

the landowner and of the tenant are somewhat conflicting; and much of the reluctance of the tenant to furnish statistics arises from a fear that the knowledge thus provided would induce the landowner to demand a larger share in the profits of the business. It appears to me, however, that the interests of the landowner and the tenant are, in every respect but one, identical. The tenant acts like any other man of business. After providing for the maintenance and education of his family, he saves as much as he can to place them out in life. A farmer's son generally becomes a farmer. If the capital of the farmer be reduced, a reduction of rent is sure to follow, sooner or later. With large profits, on the other hand, there is an increase in the amount of capital to be invested in farming, there is more competition for farms, and rents rise. Excepting in the form of loans by bankers to farmers, probably not much capital goes into the business of farming from external sources. A certain amount is brought into it by those who, having been successful in other pursuits, take up with farming; but whether they are generally successful in making a profit out of it is very doubtful. Their farming must rather be classed with that of the landowner, who derives little other benefit from it than the pleasure which the occupation affords.

I have said that the interests of the landowner and the tenant farmer are identical in every respect but one. Those of the landowner are permanent, whilst those of the tenant are limited. Accordingly, with a view of maintaining the fertility of his soil, the landowner introduces into his agreements certain restrictive covenants, in regard to cropping, and to the sale of the produce of the farm. He argues that any profit which might accrue to the tenant from the removal of such restrictions, would be obtained at his expense, and would reduce the letting capability of his land. It must be conceded by the tenant that, as such restrictions, have been in force for so long a time, the burden of proof that they might be removed without injury to the landowner rests upon him, or upon those who advocate his claims.

This brings me to the special subject of my address to you this evening, namely—freedom in the growth and sale of the crops of the farm, considered in relation to the interests of the landowner and the tenant farmer.

The restrictions introduced into the covenants by the landowner for his protection may be briefly summed up as follows:—

Not to grow two white straw crops in succession.

Not to sell straw, hay, roots, or, in fact, any fodder crops off the farm.

In some districts a second white straw crop in succession may be taken in the course of a rotation; that is to say, three in five years, instead of two in four years. In such cases, it is generally stipulated that the second corn crop shall differ from the first; that wheat shall not follow wheat, nor barley barley.

In regard to these restrictions, I propose to consider the following questions:—

Are they necessary for the protection of the landowner?

If once necessary, are they equally so now?

Does a comparison between past and present

prices of agricultural produce, or our increased knowledge in regard to the action of manures, and to the exhaustion of soils, or the fact that large external sources of supply of fertilising materials are now at our command, justify us in concluding that these restrictions might safely be modified, or even in some cases removed?

The arguments for and against the modification or removal of restrictive covenants, may be briefly stated thus:—

ON BEHALF OF THE LANDOWNER.

That long experience has shown such restrictions to be necessary to prevent undue exhaustion of the soil.

That to give power to the tenant to grow what crops he pleases, and to sell straw, hay, roots, and fodder crops generally, would exhaust the land, be prejudicial to the interests of a succeeding tenant, and would render the letting of the farm more difficult, if not actually reduce its letting value.

That even if the tenant were permitted to grow and sell what crops he pleased, it would not be to his interest to do otherwise than he is now allowed to do.

That, all things considered, restrictive covenants are beneficial to both the landowner and the tenant.

ON BEHALF OF THE TENANT.

The restrictions on the sale of straw, hay, &c., artificially enhance the prices of those commodities, are therefore injurious to the consuming public, and amount to protection in favour of the few farmers who are permitted to sell them.

That, in the event of the outgoing tenant having the power to sell all the products off the farm, the incoming tenant could still purchase all he required; since, having no carriage for removal to pay for, he would have the advantage over all other purchasers.

That restrictive covenants prevent the tenant from applying his skill and capital to the best advantage.

That at least, in a large majority of cases, the modification or removal of existing restrictions would not prove injurious to the more permanent interests of the landowner.

In these few paragraphs, I have endeavoured to summarise the arguments which would probably be used against or for any change in the usual restrictive covenants. I have, however, omitted from those which the tenant might adduce in favour of change some which, whilst they would materially strengthen his case, I should perhaps hardly be justified in making him responsible for. If we compare the agriculture of the present day with that of half or three-quarters of a century ago, we shall notice some changes which are evident to all. The actual and relative prices of meat, grain, straw, and hay, are very different now from what they were then. The farmer has now at his command enormously increased and increasing supplies of purchasable cattle foods and manures. There are other changes which are not so obvious at first sight, but which are equally important, such as our greatly increased knowledge of the action of manuring substances, and of the capabilities and of the exhaustion of soils.

The agriculture of the last century consisted of

little else than taking several corn crops in succession, until the produce did not pay the cost of cultivation, and then allowing the land to recover its fertility by rest. During this period it afforded scanty food for stock. After a time it was again broken up; and so on. As population and the demand for food increased, the periods of rest were shortened, and the land was rarely left more than two or three years in succession without being ploughed up and a corn crop sown. Still later, a rotation of crops, which required the land to be broken up every year, was adopted.

Under this more modern system, the demands upon the soil would obviously be greater; and, accordingly, it was considered expedient to place some restriction upon the course of cropping and the sales by the tenant, to prevent him from sending off the farm too much of the produce of the soil. By degrees such covenants became almost universal, and at the present time very few tenants are allowed perfect freedom of action.

Looking at the various things which a farmer may and may not do, it is difficult, if not impossible, to give any rational explanation of their adoption. Some things which he is permitted to do, and which are considered consistent with good husbandry, may be as exhausting to the soil as the growth of a second corn crop, or the sale of straw. Thus, deep cultivation, liming, draining, and bare fallow, have all for their object to enable the farmer to take more out of the soil without putting anything into it. On the other hand, very few farmers find it to their interest to exhaust the land as much as they are permitted to do under the provisions of their leases or agreements. Whether they purchase cattle food, or manures, or not, they generally consume on the farm a portion of the corn which they might, if they please, carry to market. It is, indeed, only soils of high natural fertility that can furnish sufficient produce to pay rent and the expenses of cultivation, and also yield a profit to the tenant, without some aid from external sources.

It is now more than forty years since I commenced experiments at Rothamsted, with different manuring substances, first with plants in pots, and afterwards in the field; and I have the record of more than eighty different chemical substances, or combinations, having been tried in one year in the very early days of those experiments. In the course of their extended and continued prosecution up to the present time, it has been found that some of the most important crops of the farm can be grown for twenty, or even more than thirty, years in succession on the same land, in full agricultural quantity, by means of chemical salts alone, of which the three most important constituents are nitrogen, phosphoric acid, and potass. As during the whole of the long periods mentioned manures supplying these substances have been used, in some cases separately, and in others in various combinations, year after year, on the same plot of land, and with the same crop, it is obvious that the results obtained have furnished the basis for forming a pretty accurate judgment of what constitutes exhaustion of the soil. They also enable us to determine which of the constituents of the crops are derived from the atmosphere, and which must be supplied by, and are taken from, the soil.

Time will not permit me to direct your attention

to the results of these experiments except in the briefest possible manner. At the outset I must observe that the experiments to which I am about to refer are conducted without reference to the question of economy or profit; and I must beg you, therefore, to dismiss from your minds any consideration as to their cost. What I wish to illustrate, and to impress upon your minds, is that the three constituents of manures—nitrogen, phosphoric acid, and potass—are not only the most effective on the growth of crops, and, therefore, the most important, but they are also those which, in proportion to the requirement for them, are generally contained in only small available amount compared with the other constituents of crops which are derived from the soil. The economical application of these essential elements of plant food is a subject which would require entirely separate consideration. It would involve an inquiry into the relative economy of manure made by stock and that purchased from external sources; into the natural fertility of soils, or their capability to yield up annually more or less of plant food; and into the prices at which straw, hay, roots, &c., could be more profitably consumed on, or sold off, the farm.

Permanent Grass.—The application of artificial manures alone, containing nitrogen, phosphoric acid and potass (with some other constituents of known little effect), for twenty-two years in succession, has given an average annual crop of hay of nearly three tons per acre. Twice during the period a second crop has been cut without further manuring; and it has, on each occasion, yielded nearly $2\frac{1}{2}$ tons more.

Permanent Wheat.—In like manner, artificial manures used alone, supplying nitrogen, phosphoric acid, and potass, have given an average, over twenty-five years, of $36\frac{3}{4}$ bushels of dressed corn, and more than 2 tons of straw, per acre per annum. The produce of the present year was 40 bushels of dressed corn, and 1 ton 14 cwts. of straw. No dung has been applied to this land for 38 years.

Permanent Barley.—In a similar way, artificial manures alone, containing nitrogen and phosphoric acid, *without potass*, have given an average, over 25 years, of 6 quarters of barley, and nearly $1\frac{1}{2}$ ton of straw, per acre per annum. Another plot, with the same amounts of nitrogen and phosphoric acid, but with potass added, has given, on the average, only a fraction of a bushel more corn, and less than 2 cwts. more straw, per acre per annum. No dung has been applied to this land for 30 years. It is evident, therefore, that, up to the present time, the soil itself has yielded up as much potass as was required for the large annual crop above-mentioned.

Permanent Root Crops.—Root crops are generally considered to be more dependent on applied manure than any other; and this opinion is fully confirmed by the Rothamsted experiments. In a continuously unmanured four-course rotation, which has now extended over a period of 30 years, the root crop of the first course, though small, was very much heavier than it has been since, having been quite insignificant, and averaging less than a ton per acre per annum, over the last six courses. Notwithstanding this, the barley averaged $36\frac{1}{4}$ bushels, and the wheat 30 bushels over the seven unmanured courses.

With the exception of three years, during which barley was grown without manure, roots have been grown over an area of 8 acres, without manure, with farmyard manure, and with different artificial manures, from 1843 up to the present time, as under:—

Norfolk whites	6 years.
Swedes	4 "
(Barley)	(3) "
Swedes	15 "
Sugar-beet	5 "
Mangels	2 "

Roots, total 32 years.

In the case of the Norfolk whites and Swedes, the leaves as well as the roots were removed from the land; but in the case of the sugar-beet and mangels, the leaves were spread upon the land, and the roots only were removed. In 1876, the produce of roots (mangels) with artificial manure alone, containing nitrogen, phosphoric acid, and potass, was 22 tons 11 cwt., and in the present year, 1877, it has been 22 tons 2 cwt. No dung has been applied to these plots for nearly 40 years.

Some specimens of the produce of the present season, grown with artificial manure alone, on land which has not received any dung for so many years, are to be seen on the table. Compared with the monsters which you are accustomed to see exhibited, these are of very moderate dimensions. They are grown very close together, 26 inches between the rows, but only 11 inches from plant to plant in the rows. Such roots will, however, contain a much higher proportion of dry or solid matter than larger ones; and samples from the same plots as those before you have this year given to analysis from 9 to 10 per cent. of sugar, or more than the amount of total dry or solid substance in many monster roots.

From these few illustrations, it must be evident to you, that manures supplying nitrogen, phosphoric acid, and potass will keep up the fertility of my soil, and enable it to produce crops of hay, corn, and roots, in full agricultural quantity, for very many years in succession. Nor is this result dependant on anything exceptional in the quality of my particular soil; on the contrary, I do not hesitate to give it as my opinion, that cultivated soils generally, whether in Great Britain or elsewhere, which have become impoverished by cropping, would, in a greater or less degree, be restored to fertility by the application of manure supplying, in an available condition, one or more of the three constituents, nitrogen, phosphoric acid, and potass.

It may be said roughly that from 90 to 95 per cent. of the dry substance of the crops I have referred to, as grown by artificial manures alone, consisted of organic matter of which the manures applied contained none. There can be no doubt that the constituents of this organic matter were derived, directly or indirectly, from the atmosphere, and not from either the soil itself or the manures. And if a system of compensation to outgoing tenants for unexhausted manures should at any time be generally adopted and enforced, there can be little doubt that the three constituents of crops, soils, and manures, to which I have especially directed your attention, will alone be admitted as subjects of claim; and the difficulty of estimating

the amount of them remaining in the soil in a condition capable of being yielded up to growing crops within a definite period of time, will tax to the utmost the knowledge and skill of the valuer or arbitrator.

Assuming then, that nitrogen, phosphoric acid, and potass, are the most important constituents of manures, and are those in which our soils are the most likely to become deficient by indiscriminate cropping, let us see how the stores of them within the soil are affected under the adoption of an ordinary four-course rotation, subject to the restrictive covenants usually enforced.

It was due to the sagacity of the father of the present Earl of Leicester, that this system of rotation was brought into general use on the light lands of Norfolk. At the commencement of the present century, large areas of those soils, which are now extremely productive, were considered to be not worth cultivation. In themselves they were very poor in the elements of fertility, and very little could be purchased from external sources. Consequently, it was of the utmost importance that the sales should be so regulated that a minimum amount of the most essential fertilising constituents should be given in exchange for a given amount of money. In other words, that for the same amount of money received by the tenant for his produce, he should export from the soil as little as possible of the constituents essential for the growth of future crops.

In the following table is shown the amounts of

Constituents contained in £10 worth of each Description of Produce, reckoned at the Prices of Sixty or Seventy Years ago.

PRODUCE THE SALE OF WHICH IS ALLOWED.

PRODUCE.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Live weight of animal	18·0	10·0	1·3	29·3
Wheat grain	27·0	13·0	8·0	48·0
Barley grain . . .	24·0	12·0	8·0	44·0
Oat grain	30·0	9·5	7·0	46·5
Average	24·8	11·1	6·1	42·0

PRODUCE THE SALE OF WHICH IS PROHIBITED.

PRODUCE.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Clover hay	120·0	32·0	103·0	255·0
Meadow hay	80·0	23·0	90·0	193·0
Wheat straw	58·0	32·0	85·0	175·0
Barley straw	65·0	27·0	110·0	202·0
Oat straw	70·0	25·0	120·0	215·0
Average	78·6	27·8	102·0	208·0

nitrogen, phosphoric acid, and potass, that would be lost to the farm in the disposal of different kinds of produce, in equal money value, reckoned according to the prices prevailing sixty or seventy years ago; and for convenience of illustra-

tion, £10 worth of produce is assumed to be sold in each case. In the upper division of the table are enumerated those products which, according to the usual restrictive covenants, may, and in the lower division those which may not, be sold off the farm.

It will be seen how admirably a system of rotation, with covenants permitting the sale of meat and grain, but prohibiting the disposal of hay or straw, was calculated to conserve the three important constituents of soils and manures—nitrogen, phosphoric acid, and potass. Thus, of nitrogen, by the sale of £10 worth of meat, the tenant would only send off the farm 18 lbs., whereas in £10 worth of clover hay he would export 120 lbs., and in £10 worth of meadow hay, 80 lbs. Of phosphoric acid, in £10 worth of meat, he would send off only 10 lbs.; but in £10 worth of clover hay, 32 lbs, and in £10 worth of meadow hay, 23 lbs. Of potass, in £10 worth of meat, he would send off only 1½ lbs, and in £10 worth of clover hay, 103 lbs, and in £10 worth of meadow hay, 90 lbs. Again, of nitrogen he would only send off from 24 to 30 lbs. in £10 worth of wheat, barley, or oat grain; whereas in £10 worth of wheat, barley, or oat straw, he would export from two to three times as much. In £10 worth of wheat, barley, or oat grain, he would sell from 9½ to 13 lbs. of phosphoric acid; but in wheat, barley, or oat straw to the same value, he would sell about twice and a half as much. Lastly, of potass, there would be in £10 worth of wheat, barley, or oat grain, only 7 or 8 lbs.; but in £10 worth of wheat, barley, or oat straw, considerably more than ten times as much.

Leaving out of view the details, and confining attention only to the lines of mean results in the table, it will be seen that, by the disposal of £10 worth of the produce, the sale of which is prohibited, there would, on the average, be more than three times as much nitrogen, about two and a half times as much phosphoric acid, and more than sixteen times as much potass lost to the farm, as in £10 worth of the produce, the sale of which is allowed.

Thus, modern science not only confirms the value of a system introduced about three quarters of a century ago, but it shows clearly upon what its value really depended.

In the next table is shown the amounts of nitrogen, phosphoric acid, and potass, in £10 worth of each of the same descriptions of produce, reckoned according to their fair average selling price in recent years.

It will be observed that, at the present day, the farmer gives much less of the three constituents in live weight of animal, hay, or straw, for £10, than he did three-quarters of a century ago; or, in other words, the prices of these articles are much higher now than they were then. On the other hand, wheat, barley, and oat grain, are cheaper now than they were then, and he has to give more of them, and of their important constituents, for the same money, than he did formerly.

The fact is, that, by the sale of £10 worth of straw, the exhaustion of nitrogen would, at the present time, be only about the same as by the sale of £10 worth of grain, whereas formerly it was from two to three times as great. Of phosphoric acid, again, the loss to the land, by the sale of £10 worth

Constituents contained in £10 worth of each description of Produce reckoned at the average prices of recent years.

PRODUCE THE SALE OF WHICH IS ALLOWED.

PRODUCE.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Live-weight	9·0	5·0	0·65	14·7
Wheat grain	36·0	17·3	10·7	64·0
Barley grain	32·0	16·0	10·7	58·7
Oat grain	40·0	12·7	9·3	62·0
Average	29·3	12·8	7·8	50·0

PRODUCE THE SALE OF WHICH IS PROHIBITED.

PRODUCE.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Clover hay	72·0	19·2	61·8	153
Meadow hay	64·0	18·4	72·0	154
Wheat straw	32·4	17·9	47·4	97
Barley straw	36·3	15·1	61·4	113
Oat straw	39·1	14·0	67·0	120
Average	48·8	16·9	61·8	127

of straw, is now only about the same as by the sale of £10 worth of grain, whereas formerly it was more than twice as great. Lastly, of potass, whilst formerly considerably more than ten times as much would be sold off in £10 worth of straw than of grain, at the present time only between five and six times as much would be exported in £10 worth of straw as in £10 worth of grain.

Again, calling attention to the mean results only, you will see that, in consequence of the change in prices which has taken place between the two periods, the amount of nitrogen now sold off in £10 worth of meat or grain would be 29 lbs., whilst that in the same value of the produce the sale of which is prohibited would be 49 lbs., or little more than one and a-half time as much; whilst formerly it was more than three times as much. Of phosphoric acid the average amount in £10 worth of the saleable products would, at the present time, be under 13 lbs., and in that of the prohibited products about 17 lbs., or less than one and a-half times as much in the latter; whilst, at the former period, it was two and a-half times as much. Of potass, £10 worth of the saleable products would now contain, on the average, under 8 lbs., whilst the prohibited products would contain 62 lbs., or about eight times as much; whilst formerly £10 worth of the prohibited product contained 16 times as much potass as the same value of the saleable product.

The obvious result of all this is, that, at the present prices of the different descriptions of produce, the tenant would exhaust the land of nitrogen, phosphoric acid, and potass, very much less by the sale of £10 worth of meat than he would, three quarters of a century ago, by the sale of a given money's worth of grain, and much less by the sale of a given money's worth of hay or straw, now than formerly; so that, to compensate for such sale of hay or straw, it would be necessary to import less of

these constituents from external sources at the present time than at the former period.

To illustrate the matter in a practical way, let us assume that the farmer of 1807, and the farmer of 1877, were each permitted to sell the products the sale of which is at present prohibited, on condition that he purchased and brought on to the land the amount of nitrogen, phosphoric acid, and potass, which he carried off in the produce sold. Of course this would have been impossible in the case of the farmer of 1807, as the necessary artificial manures were not then in the market. But, assuming that the same sources were available to him, and at the same prices as at present, how would the case stand? After selling £10 worth of the produce the sale of which is now prohibited, the farmer of 1807 would have to expend about 111 shillings to restore the constituents exported, leaving him only 89 shillings out of the £10 received. The farmer of 1877, exporting much less in £10 worth of these products, would have to expend only about 69 shillings to return the nitrogen, phosphoric acid, and potass, retaining in his pocket 131 shillings of the £10 he had received, or about $1\frac{1}{2}$ times as much.

At the time when the four-course rotation and the restrictive covenants connected with its adoption were introduced, nothing was, however, known of the importance of nitrogen, phosphoric acid, and potass. Between the years 1805 and 1812, Sir Humphrey Davy delivered a course of lectures on agricultural chemistry, in which was embodied all the best knowledge of the day relating to the subject. He does, indeed, mention nitrogen, phosphoric acid, and potass, in various parts of his lectures; and even quotes experiments on vegetation, which he made with saline substances containing them; but still he seems to attribute comparatively little importance to them as constituents of soils or manures. Referring to the mud of the Nile as an example of one of the best natural soils, he gives an analysis of it by a French chemist, in which neither of these important constituents is mentioned. Speaking of fallow, he says:—"The vague ancient opinion of the use of nitre and of nitrous salts in vegetation, seems to have been one of the principal speculative reasons for the defence of summer fallows." Sir Humphrey Davy's lectures appear to have excited very little attention among agriculturists, and to have exerted little or no influence on agriculture. In fact, from the date of his lectures up to the appearance of Liebig's first work on the subject in 1840, a period of about 30 years, the application of chemistry to agriculture was little thought of in this country. It is somewhat remarkable that, during the time when Sir Humphrey Davy was delivering his lectures, he and other eminent scientific men of the day were accustomed to visit in the adjoining parish to that in which I reside, at the house of Sir John Sebright, the grandfather of the present baronet. Sir John attained considerable eminence as an agriculturist, especially as a breeder of stock; and he informed me that the subject of the application of chemistry to agriculture was frequently discussed at those gatherings, and the general opinion was that little or no benefit would result from it.

EXHAUSTION OF THE SOIL.

Some years ago, I read a paper before the London

Farmers' Club, in which I endeavoured to define what is known in agricultural language as "condition" of soil, and to draw a distinction between it and what may be called the natural fertility of the land. "Condition" I described as representing those fertilising matters within the soil which had been accumulated within it by the operations of the tenant. It was to the value of these that it was the intention of the framers of the Agricultural Holdings Act, to give the outgoing tenant a legal claim. The almost complete evasion of that Act appears to be due to a fear that the great ignorance which exists as to the effects of unexhausted manures, might lead to large and unjust claims being put forward or awarded, rather than to any desire to deprive the tenant of that which is justly his. That such a fear is not altogether devoid of foundation, my experience when called as a witness in connection with a claim for compensation in Ireland sufficiently proves. If, however, a tenant had freedom of action as to cropping and the disposal of his produce, he would have little cause to trouble himself about compensation for unexhausted manures.

From the point of view of practical agriculture, exhaustion of the soil may be defined as such a condition brought about by the removal of crops, that a good or profitable crop of the same description of produce as the one last taken, cannot be grown without fresh manuring. For example, in most descriptions and conditions of soils, a growing corn crop will so far exhaust the nitrogen available for such crops within its reach, that a second corn crop would find a deficiency of it unless it were supplied by manure. In fact, in almost all cases, a supply of available nitrogen by manure would largely increase the growth of a second corn crop. Assuming that a second corn crop were so taken, and the straw as well as the corn sold off the farm, there would obviously be a large export of phosphoric acid and potass; but to what extent the soil would, in an agricultural sense, be "exhausted" thereby, would entirely depend upon the "natural fertility," and the "condition" of the particular soil. The question of in what degree, or in what way, restoration should be made, is one for the exercise of the judgment and intelligence of the tenant, founded on his knowledge and experience of the quality and condition of his soil.

After very careful consideration of the subject, I am disposed to conclude that no stipulation on the part of the landowner, to the effect that a given quantity of manure, natural or artificial, shall be brought upon the farm from external sources for a given quantity of produce exported, would be generally applicable, or obviate the difficulty supposed. There would be no difficulty in estimating the amounts of nitrogen, phosphoric acid, and potass, sent off the farm in known descriptions and amounts of produce; nor would there be any in determining in what descriptions and amounts of manure the constituents exported in the produce could be replaced. But, to use a common expression, such an arrangement "would not work." Indeed, the clause often introduced into agreements, binding the tenant to bring back rotten dung, or an "equivalent" in artificial manure, might be so taken advantage of as to reduce rather than to restore the fertility of the soil.

In reference to to the subject of the restoration of

the constituents removed, I may quote an extreme case by way of illustration. On one of the experimental plots at Rothamsted, the potass of both the straw and the corn of 25 large crops of barley has been removed from the land without any restoration of potass during the whole of the period. On another plot in the same field potass has been applied in addition to the same manures every year, for 25 years in succession, without increasing the crop more than by a fraction of a bushel of corn, and about $1\frac{1}{2}$ cwt. of straw, per acre per annum. It surely would be unreasonable to call upon the tenant to be at the expense of replacing the potass of the exported produce in purchased manures, if the soil itself were competent to supply the amount required. It is true that we are, at present, very ignorant in regard to the resources of various descriptions of soil; and it is quite certain that very many soils could not yield the amount of potass which has been taken from my soil, in the case I have just cited. But assuming a soil to be deficient in available potass for the crops the tenant wished to grow, would not he, rather than the landowner, be the sufferer if he attempted to grow them without supplying it? If he were at the expense of supplying sufficient available nitrogen and phosphoric acid to produce the crops he desired, assuming the soil to contain an abundance of potass, and if, instead, the soil were deficient in potass, the manures he did apply would not have their full effect, and he would incur a corresponding loss of money in the operation.

If the motto, "Practice with Science," have any real significance as applied to agriculture, the union of the two should at least teach the lessons that the resources of the soil itself are to be turned to profitable account; that those constituents which the soil itself will yield in abundance need not be added; but that those in which it is deficient should be applied to it in the cheapest possible way. Experience alone can teach the farmer what are the resources of the soil with which he has to deal. Light land farmers know full well that the inherent resources of their soils have a limit which is very soon reached; that a too liberal use of nitrogen, in the form of nitrate of soda, is liable to be followed by mildew, or a laid crop; and they are thus warned that they cannot, without loss to themselves, disturb the healthy balance of plant food.

The soil of many of the experimental plots at Rothamsted has been subject to a degree of exhaustion, such as cannot possibly take place under any conceivable system of commercial agriculture. But the growth of corn, hay, or root crops, year after year on the same land, for a quarter of a century or more, without manure, with individual manures, and with various combinations, has provided important data for judging of the available resources of that and of similar soils. Looking to the very various condition of the different plots so differently treated, the interesting question suggests itself—whether, if each of them could be magnified into a farm of 100 acres, with the history of its treatment attached to it, the purchasing or letting value would be different in the different cases?

It is quite certain that the most experienced land-valuer could not detect any visible difference

between the land which has grown wheat or barley for 25 years or more with superphosphate of lime, and salts of potass, soda, and magnesia, and that which has grown the same crop with salts of ammonia alone. He might, perhaps, observe a difference in the stubble, but that would be in favour of the plot exhausted of potass and phosphoric acid by the continual use of ammonia salts alone, rather than of that to which an excess of the mineral constituents had every year been added without nitrogen. Compared with the land of neighbouring farms, the chief difference he would observe would be a marked freedom from weeds on the experimental plots. For myself, after much consideration of the subject, I feel that I should have extreme difficulty in assigning a higher letting value to land corresponding in condition to that of one plot rather than to that of another, or in fixing a different rental from that of similar land in the neighbourhood. At any rate, the difference would be but slight, and would be applicable for only a short period of time. The land in my immediate locality is not, as a rule, kept in high condition, nor very clean, and I am disposed to think that the comparative freedom from weeds of the more exhausted experimental land at Rothamsted would compensate for any loss of condition which it may have sustained by the treatment to which they have been exposed, and that I should give it the preference on that account.

For my own information, and for that of the numerous agriculturalists who visit Rothamsted every summer during the growth of the crops, I have grown many more corn crops in succession, by means of purchased manures, on most of the land on my farm not under continual experiment, than I should think of doing if my only object were profitable farming, or than could possibly be done by farmers generally; and I think the unanimous opinion of the many practical farmers who inspect the crops so growing at Rothamsted, would be that the land is surprisingly clean, and that there is no evidence of exhaustion such as they would expect to see under the circumstances.

The sources of supply, external to the farm itself, of nitrogen, phosphoric acid, and potass, may be briefly summarised as follows:—

Nitrogen.—The sources of supply of nitrogen, at present known, are more limited, in proportion to probable future requirements, than those of either phosphoric acid or potass. There are, however, vast deposits of nitrate of soda in Peru and Bolivia. Those in Bolivia have not as yet been worked. At present, the other supplies are more than equal the demand. A future generation of British farmers will, doubtless, hear with some surprise that, at the close of the manure season of 1876, there were 40,000 tons of nitrate of soda in our docks which could not find purchasers, although the price did not exceed £12 or £13 per ton. Peruvian guano, sulphate of ammonia, and soot, are manures which also supply large quantities of nitrogen. The consumption of purchased cattle foods is another large and increasing source of supply of nitrogen to our soils.

Phosphoric Acid.—The external sources of phosphoric acid, once limited to that in bones, are now very extensive; and the supplies of it from

various mineral deposits throughout the world are quite equal to any demand for it that is likely to arise.

Potass.—Until within the last few years, the chief source of potass was wood ashes, and this supply would have been quite insufficient to meet any large demand for it for manure. The discovery, in Prussia and Anhalt, of vast deposits of salts of potass, mixed with salts of soda and magnesia, has greatly increased the supply, and lowered the price of potass in the market. A company has recently been formed, which has acquired the right to work extensive newly discovered deposits in Germany. From their prospectus it appears that the area of their concessions has already been proved to contain enough of crude potass salts to supply the whole of the arable land of Great Britain with very many tons per acre.

These large external sources of supply of nitrogen, phosphoric acid, and potass, which were unknown to a former generation of farmers, would afford the means of adequate restoration to the land under a very much less restrictive system, both as to cropping and sales of produce, than that which now prevails, and is considered essential for the maintenance of the fertility of our soils. It is generally supposed that larger quantities of both corn and meat are produced upon a given area of land in Great Britain than in any other country. With concentrated production, agriculture ceases to be a mere process of sowing and reaping. It becomes a process of manufacture, involving numerous complicated problems, for the solution of which the aid of science is necessary, and should be gladly welcomed. The importance of science to agriculture is, however, more fully recognised in several other countries than in our own. Even the farmers of the United States, who, with their vast area of virgin soil, are able to supply us with both corn and meat at prices which we find it difficult to contend against, have their *Journal of Scientific Agriculture*, and they are generally much better acquainted with the investigations in progress at the different agricultural stations on this side of the Atlantic than are our own farmers.

May we not attribute some of the indifference to the teachings of science, which is displayed by the British agriculturist, to the influence of the restrictive covenants under which he works? May not the farmer, argue with some show of reason, that it is useless to trouble himself about scientific principles, so long as his landlord places a veto upon his application of them to practice?

If it be true, as I said at the commencement, that the interests of the landowner and the tenant are intimately connected, and mutually dependent, rather than conflicting, and that the tenant cannot suffer loss without injury, sooner or later, overtaking the landowner, the present time would seem to be very appropriate for considering whether the restrictions on cropping and sales might not, with advantage to both, be materially modified, or even in some cases entirely removed? The last few years have entailed serious losses upon the business of farming. Owing to cattle diseases, and other causes, the live-stock of the country has diminished. I have myself, for the last three years in succession, recorded in the *Times* a wheat crop much below the average; whilst, until quite recently, the price has been kept down by large imports. Further,

there has been a considerable increase in the cost of labour, without a corresponding increase in its efficiency. All these unfavourable circumstances have pressed heavily upon farmers; and it is generally believed that an unusually large number of farms are just now thrown upon the hands of the landowner. It is to be feared that many tenants have been living upon their capital, and that it is only the fortunate few who have of late years been able to lay by any money.

I would not say that freedom of action as to cropping and sales would be a complete remedy for all these adverse circumstances; nor should I wish to see it granted indiscriminately. But I do not hesitate to say that, if I entered upon the business of farming to make money, I could not conduct it to the best advantage without such freedom. If there are many farmers who have too little knowledge and intelligence to comprehend the requirements of an improved system of agriculture, and have too little capital to carry it out with success, there are, on the other hand, many who possess both the requisite intelligence and the requisite capital. It is on their behalf that I would address the owners of the soil. But, in proposing the relaxation or abandonment of long-established restrictions, I would not by any means assume that the tenant alone will reap the benefit. Not only the producer, but the consumer—the public at large—must derive advantage from an improved and more productive system of agriculture. Nor could these results follow without favourably reacting upon the interests of the landowner.

Since restrictive covenants were first generally established, great changes have taken place in almost every important element of the question involved. There have been changes in the actual and relative prices of the various products of the farm. There has been advance in our knowledge of the capability, and of the exhaustion, of soils, and in our knowledge of the action of manures. The sources of external supply of the most important constituents of manure have been vastly developed, and are capable of further development. All these changes point in one direction—in the direction of greater freedom in the cultivation of the soil, and of greater freedom in the sale of its products. Thirty years ago, it was believed that "protection" was necessary to keep up the value of the land of this country. Time has shown how fallacious was that belief. Is it not possible, or even probable, that the fears now entertained that the fertility of our soils, and their rental value, cannot be kept up without the artificial protection of restrictive covenants, may prove to be equally groundless?

DISCUSSION.

Dr. Voelcker, F.R.S., said he had been a frequent visitor from year to year to Rothamsted, and he need not say how deep an interest he had taken in the highly important experiments which had been carried out there for many years, with so much energy and success, and sacrifice of capital and time. These experiments redounded to the glory of England, for there was no other country in the world where anything like the same attempt had been carried out practically, and on so large a scale. He said this from experience, for there was no agricultural station on the Continent of any importance which he had not visited; and to make a comparison

between the results in Germany, France, and other continental countries with those of Rothamsted, he would say that you might put all the others together in one scale, and Mr. Lawes' in the other, and his side of the balance would go down heavily. He felt sure that this paper would make a mark not only on the general community but on all classes of society, for all were interested in the progress of agriculture. The improvement of the soil had a great deal more to do with the welfare of the country than many people supposed. One consequence which he thought would result from this paper, after it had been digested and pondered over by the public, would be greater freedom of cultivation, and this was most important, for it implied the employment of larger capital in farming operations. The chief reason why this was not done was the restrictive covenants which might once have been necessary, and no doubt were useful in former times, but were now somewhat out of date. With a larger expenditure of capital would come a superior class of men; for men could not farm now-a-days as their fathers did, whose operations consisted chiefly in putting in the seed and reaping the crop. Greater intelligence would be required and a strong impulse given to superior agricultural education, and to the raising up of some men of an altogether different calibre from a great many of the small tenantry. When they had a superior class of men cultivating the land this would necessarily affect other social relations. Mr. Lawes had pointed out the great difference between an artificial fertility, or what was called "condition," and permanent, or natural fertility, and this was a subject on which a great deal of misconception existed, more especially on the part of landlords. Many of these were afraid that their tenants would carry off the fertility of the land in the crops they cultivated, and thus by giving them unrestricted freedom of action they would be damaging their own interests. Now, he had long come to the conclusion that it was impossible to deteriorate permanently a naturally productive soil, like many of our soils. On the other hand, it was utterly impossible to increase permanently the fertility of naturally poor soils. What you could do, and thereby affect both the interest of the landlord and the tenant, was to alter the condition of the land. You might let it get out of condition, but he was thoroughly convinced that what was profitable to the occupier was also advantageous to the landlord. What, then, the landlord ought to do was to keep a tenant who was in good condition himself, and knew how to keep his farm in good condition. If he were a landlord, he would not have a bad-conditioned tenant upon his land, but should rejoice in seeing him do well; but he would give him perfect freedom to sell off his straw, or anything he liked, so long as he kept himself in good condition, because in doing so he would keep the land in good condition also; and there would be no difficulty, should he from any cause be obliged to leave, in obtaining another equally good-conditioned man to succeed him, who would, probably, pay even a higher rent. Mr. Lawes had alluded to the fact that certain constituents, although removed in considerable quantities, and from year to year, really did not effect the permanent fertility of the land. For instance, you might exhaust some soils of potass to a considerable extent without making any impression, and a little consideration would show that this must be so. Many soils contained from $1\frac{1}{2}$ to 2 per cent. of available potass, and a still larger quantity locked up in the shape of minerals which only gradually came into play, but the quantity of potass carried off in crops did not exceed two cwt. per acre, if so much. Now $\cdot 1$ per cent. of any constituent, calculated on a depth of six inches, was equivalent to one ton per acre. Therefore, if a soil contained only $\cdot 1$ per cent. of the potass, a ton might be carried off from a depth of six inches, but you had not only $\cdot 1$ per cent, but something like $1\frac{1}{2}$ and upwards in many soils. It

was quite true there were other soils from which you could not continually take crops without restoring the potass. It struck him that what they should do was to endeavour to convert cheap materials into more expensive ones—to supply the deficiency of any material, whether potass, phosphoric acid, or nitrogen, in a cheaper form, and convert into produce for which a higher price could be obtained. That seemed to him to be profitable farming. There was a limit to bad farming. A man could not grow on many soils two wheat crops in succession, nor could he do so by merely supplying nitrate of soda, for he would find that the corn went down the second year if he used nitrate of soda only on permanently poor soil. Some might say it was all very well, but Mr. Lawes was an experimental farmer; he was a man of science; but what about the practical man's farm? He was happy to say that he was in a position to point to an instance of a farmer who, even in these late seasons, when so many people had had bad times, had been farming profitably. It might be thought that he had a very good landlord; and his reply was, he had the best landlord possible, for he was his own landlord; and thus you had an illustration that what was profitable to the landlord was also profitable to the tenant. He referred to Mr. Prout, of Sawbridgeworth, who for the last eleven years had followed a course of cropping infinitely more exhaustive than any which could be advocated generally. He had bought some land which would hardly find tenants at 15s. per acre, but at the present time he believed it would let for 42s. to 45s. per acre. During these years he had grown on many of his lands, continuously, corn crops, not without manure, but without farmyard manure, and he kept neither sheep nor cattle. He believed his stock consisted of one milch cow and six horses, and with these six horses and a steam plough he cultivated 700 acres, and sold everything off the land, but when he had a valuation made a short time ago, it showed that he had done extremely well as a landlord. Here was an illustration of intelligent farming, of the great advantage of freedom of action, and of the benefit which resulted to society at large from such an intelligent system of culture.

Mr. J. J. Mechi quite agreed with Professor Voelcker, that the nation at large, and farmers especially, were greatly indebted to Mr. Lawes for his continued information and experiments on improved agriculture. The mode of farming now was very different from what it was 50 or 60 years ago, when all the modern discoveries and appliances connected with agriculture were unknown. The farm then had to keep itself. There were no artificial manures, no guano, no importation of foreign feeding stuffs, no cotton cake, rape cake, or linseed cake; in fact, in those days it became absolutely essential to protect the landlord from the selling of the various crops, which were considered to exhaust the soil, because there were no means of restoring lost fertility. All that was now changed, and he considered leases based on the old system entirely inconsistent with the present improved practice of agriculture. He agreed with those who said that a man could not injure his landlord's land without, at the same time, injuring himself; but still there were people who, either from want of capital or from greed and false economy, would endeavour to sell everything off and bring nothing on; but such a course was one to ruin them as well as the land. The question was—how were they to get additional capital applied to the soil? It could only be done by attracting it. What would our cities have been, if those who conducted business in them were bound by certain fixed rules how they should do so? The principle was the same in agriculture. He would like to ask Mr. Lawes whether, in his opinion, the manure obtained by feeding beasts on cake was not cheaper on the whole, and more effective than artificial manure, allowing for the different outlay of capital? His own opinion was, that provided you understood the management of cattle, which was an important

point, and that you placed them in suitable condition for health, and fed them in a manner consistent with their well-doing, that then the manure so produced, if taken care of and not wasted, would produce greater results than if you depended on artificial manure alone. It seemed absurd, when straw would fetch £4 a ton, and it was only worth 12s. 6d. a ton as manure, so that 1 cwt. of guano would restore the damage done by the removal of the straw, that a farmer should be called upon to sacrifice three-fourths of the price of the produce. Science had done a great deal by showing the value of artificial manures, but it was considered bad farming still to sell roots, though you could sell them for from £1 to 25s. per ton, and their value as manure was little more than 5s. He believed that agriculture in this country was comparatively in its infancy; that the capital applied to it was not more than from £5 10s. to £6 per acre, whereas it ought to be double or triple that amount. With regard to pasture land, it was remarkable that the tenant could not be bound down not to exhaust the farm; for though he was prevented selling the hay, he could sell out the heart of the farm, in the shape of milk and young stock.

Mr. Clare Sewell Read, M.P., could not agree with Dr. Voelcker that Mr. Prout had the best possible landlord in being his own. His (Mr. Read's) landlady was a good deal better landlord to him than he could be to himself, for he paid her about 3 per cent. for the money she had invested, and although farming was a very bad trade at the present moment, on the whole he could employ his capital to greater advantage than by investing it in land at that rate. And he had perfect permission to farm his land as he liked, and he treated it just the same as if it were his own. There was one other point on which he disagreed with Mr. Lawes, viz., when he said that very little outside capital was brought into agriculture, and that, as a rule, it was only farmers' sons who became farmers. In his own particular district, during the last few years, three out of four of the farms which had been let had not been taken by farmers' sons from the district, and though a quarter of the new tenants might be farmers from elsewhere, the other half were gentlemen who had made money in other ways, who were agricultural pupils, and who, perhaps, had more money than they knew what to do with. Coming to the practical part of the paper, he thought the more it was read the more it would be appreciated. He thanked Mr. Lawes for the kind way in which he had spoken of that great Norfolk agriculturist, Mr. Coke, of Holkham, but he would call attention to the fact that his son, the present Lord Leicester, did not insist on all his tenants following the four-course system introduced by his father. His practice was to grant leases for 20 years, and during the first 16 he allowed the tenant to farm as he liked. At the end of that time, unless a renewal was agreed upon, the land was to be brought into the four-course system of husbandry; the only reservation being that, in case he saw during the first 16 years that the tenant was going to the bad, and farming his land in an exhausting way, he should be able to pull him up, and insist on the four-course system being adopted at once. If all landlords would follow his example, a great deal of the agriculture of this country would be improved, and they would not hear of so much agricultural distress as at present; but even in Norfolk the noble example of Lord Leicester was not generally followed. On a great number of estates the same rigid four course-system was insisted on; and only the other day a relative of his own signed a lease containing exactly the same clauses as his grandfather had agreed to in 1798. This, of course, was owing to the family lawyer, whom he always pointed to as the greatest enemy of agricultural progress in the present day. He knew a tenant who received six months' notice to quit last Michaelmas, having had a quarrel with the game-keeper, and he had on the farm a stack of 20 tons of hay. The proposed incoming tenant did not want it, but the

landlord would not allow him to sell it, and insisted on its being consumed on the farm, which was almost impossible. Ultimately, he believed, another tenant came forward who took to it, but if this had not happened, what a position he would have been placed in. The hay was worth £6 a ton, and his advice would have been to sell the hay and let the landlord sue him for the damages; and then he should have called Mr. Lawes as a witness, who, he believed, would have told the jury that the loss to the landlord would not have been more than 10s. or 12s. at the most. Only last Christmas he saw a tenant ploughing up a fine layer of sainfoin, which would have produced a much better crop the next year, whereas he could not expect a good yield of wheat from the land; he did so simply because he dare not break through the four-course system. In his own way he had made some experiments on continuous corn-growing; on one field he had grown corn continuously for eight years by the aid of artificial manures, and had succeeded much to his satisfaction. The only two good crops he had this year were a crop of winter oats and one of barley, after wheat, manured pretty freely with nitrate of soda and superphosphate. Mr. Lawes said his land was not much better than the majority, but he would allow him to say to his farming friends that they must be careful how they applied these doctrines to really light and poor soils. Although Rothamsted might not be extraordinarily fertile land, it had the elements of fertility in it, and it had the great advantage of what was termed a coolish bottom. If they applied a continuation of artificial manures to hot, sandy soils, with the idea of producing a mine of wealth, they would find it would impoverish the land and ruin the farmer. Their northern friends would be glad to learn what was the result of Mr. Lawes's barley crop this year; and he believed a great deal of his success was due to the fact that his land was particularly clean. He would also ask him if it was not the fact that though by constant weeding he had attained this result, he every now and then found a quantity of wild oats coming up. People thought that wild oats were things that passed away in one's youth, and that the land would soon become exhausted of such pernicious weeds, but it was a singular fact that, notwithstanding all you could do, there were certain soils which would produce a continuous crop of certain weeds, however well you might till them. He could not sit down without expressing his deep gratitude to Mr. Lawes, not only for his present valuable paper, but for his long continued and most valuable experiments. He was glad to hear what Dr. Voelcker had said, and to find that with all the State patronage abroad, a country gentleman in England, with capital and energy, had had the pluck to go through with these experiments for over 30 years, experiments which completely threw everything else of the kind into the shade. He believed Mr. Lawes would be glad to see even more visitors at Rothamsted, and he could assure his friends there was no pleasanter or more profitable way of spending a holiday.

Mr. Wm. Botly was glad to find that Mr. Lawes had corroborated some points which he (Mr. Botly) had brought forward in a paper he had read before the British Association at Edinburgh. The main point he there insisted on was the necessity for security of tenure, and compensation for unexhausted improvements, and if this could be secured, he felt sure it would benefit both the farmers and the country at large, financially and politically. This was illustrated by the fact mentioned in the paper, that there was a large quantity of nitrate of soda lying at the docks which could not find a purchaser. To improve agriculture you must have more capital, skill, and enterprise invested in it, and this could only be obtained by conceding tenant-right.

Mr. James Stratton, as a tenant-farmer, desired to express his gratitude to Mr. Lawes, from whose experiments he had learned almost everything which had been profitable to him. As to consuming straw by bullocks,

and so on, nobody in his senses would do it, if he were allowed to sell the straw. He did last year, for a fancy, fatten out 50 fine bullocks, and this was the result:—They were put into the stall worth £14 each, and they came out in April worth £20, but the £6 profit just paid for their keep in corn. The straw which they had consumed he could have sold for £300, and the manure which they made covered just 33 acres, so that the manure cost £10 per acre. This, therefore, was a suicidal policy which he should never follow again. They were in an open farm-yard. Mr. Mechi had remarked, that the pasture farmers exhausted their land by selling off cheese and bone, but he could not agree with the idea. He had been a farmer on pasture to the extent of more than a £1,000 a year, and he could point to pasture which had been farmed in that way from time immemorial, and now let at £4 per acre. If it had been subjected to this exhaustive process for 400 or 500 years, what must the land have been worth originally. The crops at Rothamsted were better than he had ever seen them, and as to the idea that farmers would not pay attention to the results because they were experiments, he thought it almost an insult to their common sense. They must see that Mr. Lawes' experiments on a few acres were a fair index of what might be done on hundreds of acres. He would not speak of his own experience further than to say that he farmed not quite 3,000 acres, and he had copied Mr. Lawes for a great many years with complete satisfaction.

The Chairman said he was that evening occupying a place which should have been filled by someone having more knowledge of agriculture than himself. He was a man of business, and had been all his life, and he could fully understand the doctrine which was now prevalent among farmers, that their interest was to produce the greatest possible quantity from the land which they cultivated. And undoubtedly that was the interest of the great mass of the people in this country, who, whilst maintaining free trade in every possible way, desired to produce as much as possible from the land given to them for use, and which they could not increase. Therefore, when they found so many gentlemen connected with the land advocating freedom in the mode of cultivation, and an entire abolition of unnecessary restrictions, it appeared to him that they were rapidly following the commercial classes into the region of free trade, and if they did so to the end there could be no doubt the result would be advantageous both to the nation and to themselves. He thought Mr. Read had been rather too hard on the family lawyers, however, because there were many lawyers who had the control of property in the city of London who could not be called family lawyers, but who showed quite as much intolerance in the granting of leases as the most old-fashioned family lawyer in the kingdom. He concluded by moving a cordial vote of thanks to Mr. Lawes.

The motion having been carried unanimously,

Mr. Lawes said he had but little to do beyond thanking the meeting for the kind manner in which it had listened to his remarks. Mr. Mechi had asked whether keeping stock was not more profitable than buying artificial manures. His view was that there was stock land and corn land. Where you had good stock land, there could be no cheaper mode of making manure than by feeding stock liberally; but there was a great deal of corn land not at all adapted to stock, and the less you had on it, except in summer, the better. These lands had great resources in themselves, and there was no reason why they should not be utilised. When you made manure out of cattle food, you applied to the land a great many things which it did not want; but when you applied artificial manure, you only used those things in which the land was deficient, and took out that which it would provide you for nothing. Some day, when there was a sufficiently large audience who were at liberty to deal with it, he

should like to discuss this question of what was the most economical mode of farming. He did not say that everyone was to grow as much corn as they could; they would soon come to the end of that by producing wild oats, or some other of those pests which could only be got rid of by some other course of cropping. Although he had grown a great deal of corn, it was rather to find out how to grow it than to induce everyone to follow him and grow corn for ever. It would require a long evening to properly discuss this question, and the character of the soil, climate, and a variety of circumstances would have to be considered. With regard to barley, he had stated that he had had 25 crops one after the other with nitrogen, either as ammonia or nitrate of soda, but without potass, and that by the use of potass they had produced practically no better result. This year, for the first time, the potass had failed a little and they had now produced about 10 or 12 bushels more per acre with potass than without, showing that they were coming to the end of the potass in the soil. This year they had obtained 54 bushels of straw and corn with potass, and 42 without it. Of course this was to be expected, and they had expected it much sooner. The same with wheat; he expected the end would come in a few years, but they had now gone on between 30 and 40 years. When the end came they would not be sorry, because then they would have the knowledge they were seeking for.

Mr. C. S. Read asked what were the manures used besides potass which produced the 54 bushel crop?

Mr. Lawes said phosphoric acid and nitrate of soda. With nitrate of soda alone they produced 35 bushels, and the land had had no potass applied to it for 55 years.

MISCELLANEOUS.

HEALTH.*

By Edwin Chadwick, C.B.

It will be my duty to submit to you, as well as I may, from my own point of view, the present position of sanitary science, for its future practical advancement.

A Stationary Death-rate, with a Largely Increased Population, is really a Reduced Death-rate.

It has been recently put forward by a gentleman who held this chair at Liverpool, that notwithstanding all the expense incurred by local authorities for sanitary works, there has been little alteration in the death-rate during the last forty years. In great part this is true, and I may show why it is so; but the figures are misleading, for with an increase of the population during that period, from about fifteen to twenty-two millions, with extensive conditions of overcrowding of the dwellings of the wage classes, and of cottages which formerly served for one family, but which have now frequently one family to each room, there have been augmentations of death-rates at many points, insufficiently counter-balanced by reductions at others. It will be found that a stationary death-rate is, relatively to a largely increased population, a reduced death-rate. But the statement is, as I shall show, so couched as unjustly to depreciate our increased power of sanitation. Then we have had the doctrines of Malthus raised against us, and it is held forth that by increasing the population we shall by division diminish its subsistence fund and intensify misery. Those doctrines were pressed for application when the population was one-third what it now is. They were again

* Opening Address to the Health Section of the Social Science Congress.

pressed as of increasing necessity, when it was one-half what it now is. In what comparative condition of comfort would the population now be, and in what prosperity and strength would the nation be, if it were now as it then was? In my service in Poor-law administration, I had to deal practically with those doctrines. In one county we at once struck off 10,000 able-bodied men from the pauper-roll of out-door relief in aid of wages. The Malthusians declared that wages must be reduced by that measure, and that its working must be horrible. But lo! wages, instead of falling, rose higher than they had ever been before. In the very county where the objection was raised the population has been increased during the last half century from half a million to upwards of two millions, wages have been doubled, and—until the late check to manufactures and population—productive population had become scarce, as I foretold it would be. I might add that, if by sanitation the population were increased to the extent foretold, why then, as it is estimated that of the habitable parts of the globe only one-sixth is really believed to be inhabited, we shall have sufficient outlets for the superabundance of a strengthened population. Noting the fact that at the period of the promulgation of the population doctrine, epidemic visitations were regarded as “positive checks,” absolutely unpreventable and uncontrollable,—I beg attention to the progress made in the development of the powers of sanitation in absolute prevention; especially as bearing on those visitations. In our first meeting in Birmingham, in 1857, Lord Stanley, now the Earl of Derby, referred to my official Report of 1842, on the sanitary condition of the labouring population, in terms with which subsequent dedications to me of works on the subject—of which I prize most the dedications by officers who have served with me—have concurred, in accepting that Report as the starting point of public effort in sanitation. I therefore propose to submit examples of the development of those powers since that period. Our general death registration is defective in itself, and it is yet more defective for our present purpose, because in the same registration districts houses situate outside sanitary works which have had no amendment are mixed up with others in areas which have been so amended, and it is hence very difficult to obtain distinct and just conclusions in respect to the results of such works. We may, however, see more clearly the operation of principles, and obtain more satisfactory conclusions, by observing their working on similar classes of persons in similar conditions, as in the army and the navy; or in public institutions under distinct professional observation and care. It is to such instances that I beg to solicit attention. And first, as to the prevention of the greatest sources of preventable diseases, “the children’s diseases” and “children’s epidemics.”

A Norma of Sanitation for the Infantile Stages of Life.

In 1838, there fell to the direct administration of our Poor-law Board, of which I was the secretary, two large institutions for the care of destitute orphan children, which suffered severely from passing epidemics or typhus fever. In one, at Norwood, containing 700 children, there was a severe outburst of typhus fever, by which more than a third were attacked, and more than 30 were killed. The general declaration of medical men at the time was, that the mortality was occasioned by deficient food. But the food was better and more abundant than the food of the independent wage classes. I got the case examined by the late Dr. Neil Arnott, who was a specialist in one element of sanitation—ventilation. He pronounced the main evil to be, not deficiency of food, but deficiency of pure air, and that the remedy was the constant removal of putrifying matter by good drainage, and of foul air by ventilation. This was adopted, with the result of a reduction of the death-rate by about one-third. Next followed the production of clean skins, by regular head to foot ablutions

with tepid water* ; and this was followed by the reduction by about another third of the ordinary death-rates. Other improvements in detail have followed, chiefly in physical training. As sanitary improvement has advanced in these institutions, there have been fewer inmates of the sick wards, to the extent that not a fourth of the beds provided for sickness are now usually occupied. The particular institution first attacked, and now eight other large orphan institutions, district asylums, are, in fact, children’s hospitals, where numbers are received only to die. All the inmates, as a class, are of the most wretched type of children, all weakly and susceptible to disease; but of those who come in without marked disease, there is now an almost absolute immunity from the “children’s epidemics.” Cases of typhus, at one time scarcely ever absent, have not been seen there for several years. The mean death-rates in these institutions have been steadily reduced to about 3 in 1,000, that is to say, to nearly one-fourth of the general death-rate of children of the school ages, including the children of the well-to-do classes of the population. It was recently stated, as evidencing the success of the “boarding out” system, that the deaths had not exceeded 2 per cent.; and this, probably, may be taken as an average children’s death-rate for the cottage;—that is to say 20 per 1,000, as against 3 per 1,000 in the district orphan institutions, with little variation in the separate institutions. Medical officers in charge of them, but who are in private practice, have repeatedly expressed to me their astonishment at these results of sanitation as surprising and wonderful to them. I was lately present at a prize-giving to agricultural labourers by Lord Shaftesbury, where one prizeman was a shepherd who, out of 100 lambs he had reared, had only lost one. Such emulation may well be directed to the preservation of human life. On a visit to one of these orphan institutions, I told the governess of the infants that the Queen of the Belgians had offered a gold medal to whichever manager of such institutions should rear the greatest number of infants, and I asked the governess whether she would compete in conservancy of life against that shepherd with his lambs. She proudly declared that she would do more than that, and with the infants of the ages under her care she really has done more. It is, however, to be noted that the schools are on the half-time principle, which we introduced with the Factory Acts, as preventive of the physical injury done by over-sedentary work in the long-time schools; and I may add that by a better adjustment of the book teaching to the children’s mental powers of receptivity, and by the “freshening up” of the faculties by brisk gymnastic exercises and military drill, these children, though naturally of an inferior type, are got well through the R’s in less than four years, as against seven in the common elementary schools, and at half their cost for teaching power; and with the economical outcome, that the efficiency of three is imparted to two for industrial occupations. Formerly, very much from bodily inaptitude, not one out of three got good places; now a very small percentage fail to do. Here, then, we have a great sanitary norma established with factors that go to the prevention of an annual excess of upwards of 50,000 deaths in the school stages of life, in England and Wales.

A Norma of Sanitation in Adult Stages of Life.

I would now call attention to another norma of sanitation, for adult stages of the population.

It has fallen to my lot, in the course of my early service, to examine and compare the results of sanitation in our prisons. Prisons, I need not remind you, were, in the time of Howard, seats of the reputed special “gaol fever,” to which not only prisoners, but juries and judges

* On skin cleanliness generally, as a factor in sanitation, see an exposition of mine made for the Congress on Domestic Economy, held at Birmingham, and published, with other papers, by the Society of Arts.

who tried them, have heretofore fallen victims. But now, by clean air, clean persons, pure water, and by regulated regimen, prisons are made seats of health, and display the most conspicuous norms, to be kept in view of the power of sanitation in adult life. Sir Robert Christison, the distinguished consulting physician on the prisons of Scotland, declares that the general prison of Scotland, that of Perth, is apparently the most healthy place in the world. He states to me:—"The healthiness of the general prison is almost marvellous. I have, down to the present time, inspected it as Government inspector six times annually for thirteen years past, and have very seldom indeed found more than one man and one woman in bed amongst 750 prisoners—once or twice no one!" In the common condition previously from such a number of prisoners, a large sick ward would be occupied. He is most emphatic in his expressions of astonishment at the result. I have heard similar expressions from prison surgeons in England, and that they are wont to say of patients in their private practice, "Oh, if I could only have that case in prison, I could save the life." It may be said that the epidemics which ravage the populations under the rule of Baily bodies, vestries, and the like, do not now touch the populations in the prisons under the care of the State. Epidemics rage around them, but do not enter them, unless it be by some extraordinary accident, or some very culpable negligence.

I once met a prison surgeon of our Model Prison at Pentonville, who appeared to be in trouble of mind. I asked him if anything had happened? He had got a case of small-pox in the prison! The disease was then ravaging the courts and alleys in the vicinity of the prison, where as many as a third of the wage classes in some of them were attacked. But this by no means consoled him; a case had no business to be in his prison. A case of cholera occurred in one of the Scotch prisons, and there was a serious consultation about it, and an elaborate speculative report as to how such an extraordinary event could have occurred there. We heard at the Board of Health that there was an attack of dysentery in a prison, and on hearing of it we were perfectly certain that there was misfeasance or culpability somewhere. On inquiry it turned out that an ill-constructed prison drain had burst into the prison well, from which the prisoners were supplied with drinking water. In the Milbank Prison cases of typhoid fever were at one time frequent, and were traced to sewer-tainted water from the Thames. For the protection of the prison population, this source of supply to a large proportion of the outside population, was stopped, and spring sources, such as we recommended for the metropolis, were resorted to, with the result that typhoid fever, which continued to prevail amongst the general population of the metropolis, has been long extinguished amongst the population of the prison. In another prison an outbreak of typhoid fever took place, which was found to have arisen from the overflow pipes being connected direct with the main sewer, which conveyed the gas from the sewer to the prison water tank, so that those gases were absorbed by the water which the prisoners drank. This connection was severed, and the prisoners were restored to their superior health. But, in the metropolis and other larger cities, from the work of ignorant plumbers, to whom is left the uncontrolled internal distribution of water, the like connections are made by waste or overflow pipes opening into the common sewers, whence the sewer-gases of ill-constructed sewers of deposit and consequent putridity are led into the cisterns of the houses under vestry rule,—with the continued consequences to the general population from which the population under State sanitary rule are protected. Temperance, or the enforced exclusion from alcoholic drinks (as well as from tobacco) may, it is observed, have claims as factors in the great sanitary results, but to what extent the prison surgeons I have

consulted cannot determine, for they have observed similarly good results manifested in the health of female prisoners who have not been gin or beer drinkers, but chiefly tea drinkers.

To prisons, then, we should accustom the health authorities to look as strongholds of attained and attainable sanitation. About two-thirds of the prisoners, as appears in Scotland, enter the prisons with disease upon them, often in advanced stages. Eliminating these cases, we may get a measure of progress from the military prisoners whose death-rates as outsiders we know. Men have been taken from the ranks, where the death-rates were 17 in 1,000, and put into the prisons where the death-rates were only 3 in 1,000. I am led to consider, from various evidences, that a death-rate of 3 in 1,000 may be taken as an attained normal death-rate for the adult stages of the life of the ages of the prison populations.

Here, then, we have two great sanitary norms—one of a death-rate of a little more than a fourth of the common death-rate in the infantile and juvenile stages of life, and the other of the like proportion in the adult stages. These results of sanitation in the exemptions from ordinary as well as extraordinary epidemics, excite the astonishment of the professors of the curative means. Yet these results are obtained by very rudimentary means applied, especially in the juvenile stages, by agencies for which high refinement cannot be claimed. On examining these same results it is evident that they are yet susceptible of further advances. Undivided professional attention (which is frustrated by the administrative arrangement which necessitates anxious attention to private practice), and close observation of the comparative experience of several of such establishments, would evolve important contributions to sanitary science. Thus, the effects of sanitation, under different conditions of climate, have yet to be observed and discriminated. In one children's institution at Calcutta, similar to those instances cited near the metropolis, a death-rate of about 7 in 1,000—not of a fourth, but of one-half the ordinary death-rate here—has been obtained, which gives good promise of the practicability of rearing children Indian-born of British residents, and so establishing succession in our Indian dominions.

Different Species of Disease, attendant on Different Doses of Aerial Impurity.

I obtained observations of one large prison, that of the French prisoners of war in this country, who were confined on the high and fine site for air, the granite of Dartmoor. As the number of prisoners, and the crowding of the prison was increased, and in the then ignorance of the principles and means of sanitation, typhus became rife and dreadfully predominant. As the numbers of the prisoners were reduced by exchanges, typhus was reduced, and finally disappeared; yet phthisis remained, and was prominent, but when the number of prisoners was still further reduced, phthisis was reduced, and on the prison being further thinned finally disappeared. The apparent immunity from phthisis amongst the reduced numbers of the prisoners attracted the attention of a physician who was a very good observer (the father of the late Dr. Hunt), who applied the fact successfully in his practice. He was wont to send patients who were smitten with consumption up to Dartmoor, and to provide that they should be kept alone in rooms carefully aerated. Cases occurred of whole families in lower sites smitten with phthisis, of whom he could persuade only one to take the remedy of pure aëration, and that one recovered, whilst the rest who remained fell one after another. This great prison presented an example on a large scale of the deterioration of the finest air and water by insanitary treatment; and, moreover, of another important subject needing further observation—the production of different orders of disease in the same air, by different doses of aerial impurity on the sites and under the same atmospheric conditions.

(To be continued).

CORRESPONDENCE.

LIGHTNING CONDUCTORS.

In reference to a letter addressed by me in the *Times* on this subject, and reprinted in the *Journal of the Society of Arts* on December 7, at page 39, will you find me further room to say that the modification of opinion to which you have kindly drawn attention by a footnote, relates more pointedly to the straining produced in copper ropes by their process of manufacture than to their relative conducting power, when this is compared with solid copper rods, or tapes. All that I intend at present to say is, that I think I have hitherto somewhat too hastily assumed that copper wire ropes are proved to be molecularly injured by twisting in manufacture. I have recently learned, what I was not aware of some few months since, that Mr. Newall professes to manufacture his ropes without strain from twist; and I have every reason, from his great skill as a manufacturer, to believe that whatever he professes he efficiently does.

I am not, however, yet prepared to say that ropes formed of small wires do not offer a somewhat larger resistance to transmission of electric force than solid rods, or tapes, of the same weight of metal per foot. That is an altogether different point, and one which I think yet requires further experimental investigation. It is, nevertheless, unquestionably true that well manufactured copper ropes of sufficient dimensions, do furnish altogether efficient protection against damage by lightning. You will at once perceive the bearing which this explanation has upon the footnote which you were so good as to append to your reprint. The asterisk should have been after "Process of Manufacture,*" and not after "Dimensions.*"

I should be glad also if you will allow me to say that the letter to the *Times*, which you have reprinted, expresses my own views of the matters of which it treats, rather than any formal decision of our Lightning-rod Committee, which has not yet matured its deliberations upon the requirements of lightning conductors, or authorised the issue of any specific instructions concerning them. I quite inadvertently dated my letter from the rooms of the Meteorological Society, rather than from my own residence; and this, without further notice, might possibly convey an impression in this particular which I did not intend to give.

ROBERT JAMES MANN, M.D., &c.

Wandsworth-common, December 8th, 1877.

NOTICES.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock. The following are the arrangements for the last Meeting previous to Christmas:—

DECEMBER 19.—"The Telephone," by Prof. A. G. BELL. Repetition of the former discourse. Lord ALFRED S. CHURCHILL will preside. The meeting will be held at the Freemasons' Tavern.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by WILLIAM ARNOT, Esq., F.C.S.

LECTURE IV.—DECEMBER 17TH.

Paper made by hand and by machinery. The Fourdrinier machine. Surface sizing. Drying machinery. Finishing.

LECTURE V.—JANUARY 14TH.

The Chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

LECTURE VI.—JANUARY 21ST.

The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

JUVENILE LECTURES.

A short Course of Two Lectures, suitable for a juvenile audience, will be delivered during the Christmas holidays, by Prof. BARFF, M.A., on "Coal and its Components." Special tickets will be issued for these lectures.

MEETINGS FOR THE ENSUING WEEK.

- MON.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Arnot, "Manufacture of Paper." (Lecture IV.)
British Architects, 8, Conduit-street, W., 8 p.m. Mr. Looock Webb, "The Law of Easements."
Medical, 11, Chandos-street, W., 8.30 p.m.
Asiatic, 21, Albemarle-street, W., 8 p.m.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. T. H. Huxley, "The Extinct Animals termed Belemnites, and their Ancient and Modern Allies."
- TUES.... Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Annual General Meeting.
Statistical, Somerset-house-terrace, Strand, W.C., 7½ p.m. Mr. Ernest Seyd, "Diagrams exhibiting the Position of the Banks of England, France, Germany, Austria, the Netherlands, Belgium, Italy, and Russia."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
- WED.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. A. Graham Bell, "The Telephone." (Meeting will be held at Freemasons' Tavern, Great Queen-street).
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Commander Edwin Bourke, R.N., "Notes on the Meteorology and Physical Geography of the West Coast of Africa, from Cape Verd to the Cape of Good Hope." 2. Prof. H. Mohn, "The Meteorological Observations made by the Norwegian Research Expedition in the North Atlantic in the Summers of 1876 and 1877." 3. Rev. T. A. Preston, "Report on the Phenological Observations during 1877."
Geological, Burlington House, W., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C. 8 p.m. Mr. Walter De Gray Birch, "An Unpublished Saxon Charter lately restored to the Library of Worcester Cathedral."
- THUR.... Royal, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Mr. Thomas Meehan, "The Laws Governing the Production of Seed in *Wistaria Sinensis*." 2. Prof. A. Nicholson and Dr. J. Murie, "The minute structure of *Siroamatopora* and its allies." 3. Mr. Worthington G. Smith, "Remarks on a Fossil *Peronospora* with Zoospores *in situ*." 4. Prof. M. Watson and Dr. A. H. Young, "The Anatomy of the Elk (*Alces machilis*)." 5. Prof. Dickie, "Algae of the Arctic Expedition." 6. Dr. J. S. Baly, "Phytophagous Coleoptera."
- Chemical, Burlington House, W., 8 p.m. 1. Dr. Armstrong, "The Constitution of the Terpenes and of Camphor." 2. Dr. Armstrong, "Communications from the Laboratory of the London Institution." 3. Dr. Silden, "Hydrocarbons obtained from *Pinus Sylvestris*, with some remarks on the Constitution of the Terpenes." 4. Mr. Y. W. Thomas, "Cuprous Chloride and the Absorption of Carbonic Oxide and Hydrochloric Acid." 5. Mr. F. Jones, "The Action of Reducing Agents on Potassium Permanganate." 6. Dr. Wright and Mr. Paterson, "Citric Acid as a Constituent of Unripe Mulberry Juice."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. A. Barrett, "Sir Henry Bishop." Illustrated Musical Lecture.
- Numismatic, 4, St. Martin's-place, W.C. 7 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.
- FRI..... Volunteer Sick Bearers' Association (at the House of the Society of Arts), 7 p.m.
Philological, University College, W.C., 8 p.m. Mr. J. A. H. Murray, "Some Doubtful Points and Practical Difficulties in English Grammar."