SEWAGE IRRIGATION BY FARMERS;

OR,

FIFTY INSTANCES OF PROFITABLE SEWAGE UTILIZATION.

BY

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PREFACE.

In publishing this Paper I beg to acknowledge most warmly the kind help that has been given me by numerous gentlemen connected with the localities referred to, and to inform them that I shall be extremely grateful for any further information available for another edition.

R. W. P. B.

5, Westminster Chambers,
London, S.W., *May* 1878.

THE

USE OF SEWAGE BY FARMERS;

OR,

FIFTY INSTANCES OF PROFITABLE SEWAGE IRRIGATION.

THE question of sewage disposal has generally been dealt with from a lofty point of view, where gigantic figures are used alike for describing the fortunes that are to be made by one system and those that have been wasted by another. This must be the case so long as powerful financial companies are interested in some of the various methods that have been propounded with a view to helping local authorities out of their difficulties.

In the present Paper, addressed to the Institution of Surveyors (which is understood to represent the management of something like three-fifths of the landed property of England), the subject will be treated from an agricultural point of view. Many of the cases that will be referred to are unknown to the public, for they are not such as would be useful to opposing writers; and it is hoped the best possible reason will be apparent why those most familiar with them should be content for them to remain undiscussed. Articles have been printed in London newspapers and

tables have been published in books upon sewage disposal, one after another, all showing that the attempts of sewage companies and local boards to use sewage, make it portable, or put it out of the way, have alike resulted in an expenditure of upwards of a shilling per head per annum; and this, although sewage contains materials which, but for their encumbrance, would produce an income of ten shillings per head per year to the ratepayer. What has been truly said and written upon the subject has had the effect, as might be expected, of making local authorities cautious and slow to take any action. This is probably as it should be. Let owners or occupiers of agricultural land, however, not be alarmed at the failures of local boards or public companies, but rather see that therein is their opportunity to come forward and help the public with considerable and increasing advantage to themselves. Without going into the too-often-discussed question of whether, speaking generally, irrigation is preferable to the chemical processes as a method of sewage disposal, it may be said that, from an agricultural point of view, it is better worth trying to develop; for, while under extremely favourable circumstances every grain of manure may be extracted from sewage by irrigation, there is not another process by which, under any imaginable circumstances, more than a small proportion of the valuable material contained can be made use of.

In the following pages it will be attempted to show that the use of sewage has proved advantageous to a large number of agriculturists in various parts of Great Britain; and that the arrangements existing between ratepayers and farmers, in the many instances where the latter appear to be satisfied, are more favourable to the ratepayers than what has been done by local authorities, in the way of sewage utilization, upon their own account. If these points

can only be made good, and the Institution of Surveyors pretty well agreed, there can be little doubt that the difficulties of many places will prove to be very much less than those which appear to surround the great question as a whole. If this communication leads directly to a single landowner or farmer using the sewage of a town that has, hitherto, polluted a river, or to two men negotiating with a town authority for its sewage, which, hitherto, only one has been willing to take, then the time spent upon it will not have been wasted.

That the use of sewage has proved advantageous to a large number of agriculturists will appear from the following notes, arranged according to the alphabetical position of the initial letter of the place to which each one refers. That the arrangements under which farmers can, and have, used sewage are more favourable to ratepayers than the efforts of their representative boards to do so have yet proved, will be seen from a comparison between these notes and Table No. 1,* which gives the cost of sewage utilization by local authorities. This table has been prepared from Local Government Board reports; but the annual cost of the capital laid out has been taken at 3½ per cent., which is the rate at which money can be borrowed for sanitary improvements. Similar tables, as printed in those reports, would make the comparison appear still less favourable to the local boards, for in them 6 per cent. is allowed for capital expended: this extinguishes the debt in thirty years, although the work may remain effective much longer, while, on the other hand, in any arrangement with a farmer, the purification of sewage, and the payment of money, by whichever side, are coterminous.

At Aberdeen there is an example of sewage utiliza-

* See p. 373.

tion, with reference to which a few notes may be worth making, although the authorities there do not profess to have disposed of the whole of their sewage.

The corporation, some seven or eight years ago, made an agreement for nineteen years, with a landowner to supply him with what sewage he required on fifty acres of light land, upon his paying £5 an acre, or £250 a year, for the use of it.

The land was expensively laid out by the owner (£30 or £40 an acre, it is said, having been spent upon it), and for some years expensively managed.

Rye-grass, carrots, and turnips are the principal crops grown, the latter being very valuable, as they are greatly depended upon for cattle feed.

A year or two ago the proprietor attempted to show the corporation, with a view to getting the sewage at a reduced price, that he was losing money by the transaction. To do this he debited the concern with the money he had spent on the land and management. He failed, however, to make good his point, and it is to be hoped that by this time the profit is more decided. But the object of this communication is not to persuade farmers to sink £30 or £40 in an acre of land and then pay £5 a year for sewage to put on it; for a much smaller sacrifice on their part will enable them to offer very satisfactory terms to their urban neighbours.

At Aldershot, some fourteen years ago, Mr. BLACKBURN levelled and prepared about 100 acres of heath land for the reception of the sewage from the North Camp, which contains an average population of 8,000.

The soil was a blowing sand, not worth, it is said, a shilling an acre; and it is understood that a lease of sixteen years was granted, without any rent, in consideration of the work and money expended by Mr. BLACKBURN

in making the land fit for sewage purposes and starting the farm.

Rye-grass, mangold-wurzel, and potatoes are the principal crops. Part of the rye-grass land has been let to neighbouring cowkeepers at £20 an acre. The potatoes are used largely in the camp. Referring to them, Mr. BLACKBURN said to a Committee of the House of Lords in 1870: "The whole time I have had the farm I have not had two bushels of diseased potatoes in it."

No record of the cost of preparing the land is to be obtained; but almost the whole of it must be due to levelling the surface, and breaking up and draining the ferruginous "pan" which underlies the soil of this part of the Aldershot waste, for the carriers are of a most inexpensive kind, being merely cut in the ground or "built up of tough sods."

In the growing season, or when a crop is being irrigated, the solid matter is extracted by subsidence, but not when the sewage is being applied to rough ploughed land in winter.

A feature to be borne in mind in the Aldershot farm is a steam pumping engine, which is used, in summer-time, to raise water out of a brook on to the land, and which "has proved most valuable."

At Altrincham, with a population between 12,000 and 13,000, the local board hired, some seven years ago, a farm containing fifty-five acres of light, peaty land, on a lease of twenty years, and at a rent of £4 an acre. This land is suitably situated for the reception of the sewage and the town, as might be expected, had to pay more for it than its value to an ordinary farmer. Until quite lately, the local board kept it in their own hands, and found their returns fell short of their expenses by about £130 a year. During that time it was found "that the

cost of purifying the sewage averaged annually 5½*d.* per head of the population contributing, or a rate of 2½*d.* in the pound, including the repayment of principal and interest on account of money expended in laying out and draining the land." The farm is now let "for a term of five years, at a lump rental, which results in a loss to the board of £50 per annum. The tenant takes all the sewage, and clears the board of all liability for pollution of streams, &c., and undertakes to maintain the present levels of the ground." It can be stated here, on good authority, that after the expiration of the existing lease a better rent will be obtained than the present, although that is quite equal to what is paid by other occupiers in the neighbourhood, for superior land.

The number of water-closets in the town may be taken at a fifth or sixth of that of the houses. No provision has been made for excluding surface-water from the sewers, but there is an overflow, which acts in time of storms. The carriers were made of earthenware channel-pipes; but these have now been taken up in favour of simple spade-cut grips. It was not found necessary to alter the surface of the land much, for that was found "pretty well adapted as to fall, &c." The solid matter is taken, by means of a settling tank, from the sewage before the latter is distributed. There has been no litigation, in respect of this undertaking. Excellent crops have been obtained, "the most suitable being rye-grass, turnips, and mangolds"; but wheat, oats, beans, cabbages, and celery have done well. The town is considered to be satisfactorily free of its sewage difficulty.

At *Bodmin*, in Cornwall, with 4,000 inhabitants, three-quarters of whom are supplied with water-closets, the sewage has for three years been used, without any separation, upon seventeen acres of stiff meadow-land, under an

agreement which, though temporary, involves no expense to the rates. The sewage is distributed by means of contour grips cut in the ground.

At Braintree, the sewage of about 5,000 inhabitants has for many years been allowed to flow on the meadows occupied by several farmers along the side of the River Pont, and until within the last three or four years the suspended matters were precipitated in tanks. Now, however, the precipitation has been abandoned, and the sewage is either distributed on 30 acres of gravelly land, which belongs to the town and is farmed by the Surveyor, or on to the farmer's meadows, which together amount to another 25 acres. Half the board's land is irrigated by gravity, the other half can only be reached by pumping. The whole of it, except a small meadow let at nearly £6 an acre, is arable, and although it has a very irregular but considerable natural slope, it has been very satisfactorily irrigated without any permanent work beyond the iron rising main, the surface being unaltered, and the carriers being ploughed each year in contours. Tremendous crops of mangold are grown and sold by auction in small lots on the ground, realising first-rate prices. There are cottages within fifty or sixty yards of the sewage land, but no complaints; the occupiers occasionally using the sewage on their own gardens.

At Carlisle, with 21,000 inhabitants, the sewage was let for a nominal sum to Mr. ALEXANDER MCDOUGALL on a fifteen years' lease, which terminated in 1874. Mr. MCDOUGALL irrigated about sixty acres of gravelly grass land for which he paid £4 an acre, and let at £8 for grazing purposes. The land was not levelled. The sewage was distributed by means of portable wooden spouting.

The sanitary authority, before the termination of this arrangement, were of opinion that sewage irrigation would

be a proper and, possibly, profitable thing for them to have in their own hands, and determined to purchase the sixty acres already in use and some adjoining land for the purpose. The necessary steps have been taken, and irrigation will soon be started again on an extended scale by the corporation.

The late tenant was not bound by his lease to take the whole sewage, but he could prevent any one else from using it.

A number of suburban villas stands on the high ground overlooking the meadows, at a distance of a very few hundred yards, and more are now being built.

The effluent water was reported by the Rivers Pollution Commissioners to have been effectually purified.

At Chelmsford, the local board some ten years ago leased the sewage of about 8,000 inhabitants to Mr. F. MARRIAGE, who had already had considerable experience of sewage farming at Croydon. Mr. MARRIAGE pays £30 a year for the sewage, and the board has to pump it to the summit of his farm, which is on light, loamy, gravelly soil, and of which about 70 acres are irrigated. The farm lies along the side of the River Chelmer. The upper part, having a considerable slope, is arable; the lower part consists of nearly flat meadows. In April last there were about sixty milking cows in the yard, which are said to be fed during the summer almost entirely on sewage grown rye-grass, and there are a number of beasts grazing in the meadows. These meadows appeared to be full of feed, and of a much greener hue than other land around them.

The solid matter is roughly extracted by means of a wattled screen placed across a pit, through which the sewage passes.

The land is very inexpensively laid out; the surface

having been scarcely altered, and the permanent carriers, of which there are very few, consist merely of channels cut in the ground, except where, for the sake of the passage of traffic over them, they had to be made of socket-pipes.

The application of the sewage to the land results in abundant crops of grass, cabbages, and roots; and the experienced lessee has lately been endeavouring to arrange for utilizing the sewage of the entire district of Chelmsford, Springfield, and Great Baddow; but it is understood that the combined sanitary authorities of the district are taking steps to purchase lands upon which the sewage can be applied by gravity; so that pumping will be entirely dispensed with. No figures are at hand showing the pecuniary results to the lessee, of his present farm, but it has all the appearances of a highly profitable one.

Cheltenham, with a population of nearly 50,000 contributing to its sewage, affords remarkable proof that the refuse of a large town can be used by farmers in its immediate neighbourhood, with considerable advantage to themselves.

Here the corporation, about ten years ago, purchased by private treaty 131 acres of stiff meadow land. The estate, which is situated in the parish of Boddington, about two miles outside the town, cost £80 an acre, including some cottages and timber. The sewage had been for some years previously precipitated with chemicals, in two sets of tanks about a mile apart on the west side of the town; so these tanks were kept in use for settling and straining the grosser suspended matter, and two outfall sewers, amounting together to a length of 9,000 yards, were constructed from them to the new farm. These, together with such laying out as the land required, cost £7,500. The preparation of land consisted principally in subsoil drainage, for the surface has been scarcely altered,

and the sewage is distributed over the farm by open contour grips dug in the ground.

Although the two outfall sewers are a foot or two below the surface of the ground in which they are laid, there is a considerable area of lower land close by, on to which it is possible to discharge them at various points. This natural advantage has not been neglected at Cheltenham, for, through the skilful management of the Surveyor, no doubt, and owing to the wisdom of those occupying land near the sewers, more than £100 a year is now received by the corporation for sewage used on private property alone. In this manner sewage is retailed to ten or twelve different occupiers, for the fertilization of over 300 acres of land, independently of that belonging to the town. Seven shillings per acre per dressing is the rate at which the sewage has generally been poured into private lands; but in one case—that of a large dairy farmer occupying the nearest available land to the town—a standing agreement exists that he shall take a certain proportion of the sewage on to his farm, and pay the town £40 a year. This agreement is not with an amateur or enthusiast, but with a practical farmer who, having had ten years' experience of sewage utilization, is now irrigating about a hundred acres of meadow and arable land of the Arle Court Dairy Farm, and feeding, with the produce of it, 120 head of cow cattle, 90 of which he milks for the supply of Cheltenham. Mangold-wurzel seem to be his favourite root crop, for a large extent of land is devoted to mangold this year which has borne the same crop the last four years. Roots grown on this land, under sewage, won first prizes at the annual show at Cheltenham, till they were excluded from competition with the produce of ordinary farms; they were then shown with equal success, and the same result, at Gloucester. They appear to keep

as well as roots grown on unsewaged land, for, in February last, there were many more in stock than would be used by the Arle Court Dairy, and they were being sold at best market price, customers coming for them daily. The sewage was carried from one part of the farm to another in open channels cut in the ground, or, where the ground was too low, in a raised bank of turf. It is worth mentioning that many hundred yards of these channels are cut in meadow land, and the sewage flows and the cattle graze without either, apparently, interfering with the other. The land at Arle Court, so far as this has been done at all, has been prepared at the expense of the occupier, and he does a little in the way of levelling every year. He keeps a man, whose only duty it is to attend to the flow of the sewage, the surface of the ground, and the condition of the channels.

With this exception, the whole of the sewage is distributed, by two irrigators constantly employed by the town, on private lands when the occupiers require it, and, at other times, on such parts of the corporation land as they consider best, with a view to sewage purification. Submitting to these conditions, cowkeepers in the neighbourhood have annually tendered for the land at prices varying from £6 to £9 an acre. It is now let for three years at £800 a year, or a little over £6 an acre, to a tenant who sub-lets it to several smaller occupiers. Each field receives from three to five dressings a year, but it is said that in a dry summer the occupiers would be glad of two or three extra ones. Mr. WOODWARD, who hires the whole farm, considers that "sewage pays best on poor, hilly, heavy grass land, as it makes one acre worth five." The following is a balance sheet referring to the sewage farm and liquid sewage, from which it will be seen that the receipts are nearly enough to repay the cost of outfall

works as well as that of purifying the sewage. The straining is carried on at the tanks, and the solid matter is mixed with town ashes and sold to farmers at 2*s.* 6*d.* a cube yard. If the ashes be regarded as valueless refuse, an average profit of over £50 appears to result from this part of the business.

1871.

RECEIPTS.	£	*s.*	*d.*	PAYMENTS.	£	*s.*	*d.*
Rents	899	12	0	Wages, Tradesmen's Bills, and other Expenses	286	2	11
Fluid Sewage on adjacent Lands	75	10	0	Rates and Taxes . .	26	19	8
Deficiency	134	15	0	Interest on Loan for Land and Works .	796	14	5
	£1,109	17	0		£1,109	17	0

1872.

	£	*s.*	*d.*		£	*s.*	*d.*
Rents	868	15	10	Wages, Tradesmen's Bills, and other Expenses	280	15	5
Fluid Sewage on adjacent Lands	142	0	0	Rates and Taxes . .	27	14	10
Deficiency	80	11	5	Interest on Loan for Land and Works .	782	17	0
	£1,091	7	3		£1,091	7	3

1873.

	£	*s.*	*d.*		£	*s.*	*d.*
Rents, &c.	936	19	6	Wages, Tradesmen's Bills, and other Expenses	286	7	0
Fluid Sewage on adjacent Lands	131	10	0	Rates and Taxes . .	52	2	11
Deficiency	38	7	5	Interest on Loan for Land and Works .	768	7	0
	£1,106	16	11		£1,106	16	11

1874.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
Rents, &c.	848	14	9	Wages, Tradesmen's Bills, and other Expenses	253	3	4
Fluid Sewage on adjacent Lands	86	12	6	Rates and Taxes . .	47	4	0
Deficiency	118	4	1	Interest on Loan for Lands and Works .	753	4	0
	£1,053	11	4		£1,053	11	4

1875.

	£	s.	d.		£	s.	d.
Rents, &c.	890	8	5	Wages, Tradesmen's Bills, and other Expenses	396	5	4
Fluid Sewage on adjacent Lands	145	18	0	Rates and Taxes . .	31	4	9
Deficiency	128	11	0	Interest on Loan for Land and Works .	737	7	4
	£1,164	17	5		£1,164	17	5

1876.

	£	s.	d.		£	s.	d.
Rents	853	6	6	Wages, Tradesmen's Bills, and other Expenses	268	1	10
Fluid Sewage on adjacent Lands	130	5	6	Rates and Taxes . .	50	8	3
Deficiency	55	14	7	Interest on Loan for Land and Works .	720	16	6
	£1,039	6	7		£1,039	6	7

At *Chorley*, in Lancashire, the sewage is conveyed to two farms (principally arable), the one laid out at a cost of £20 an acre and worked by the Improvement Commissioners, the other being provided with simple spade-made grips contouring the ground. The latter is let to a tenant under a yearly agreement, at a rent beyond what the

board has to pay; while the farm in the board's own hands cannot be made to pay its working expenses, exclusive of rent.

At Cleator Moor, in Cumberland, the sewage from 1,373 houses, or about 8,000 people, is removed from the town by means of four outfalls, discharging on to some forty acres of heavy pasture lands in the occupation of private people.

The present system has been in operation about three years; but the local board has no agreement either with the owners or occupiers of the land under sewage. In two cases, the land is farmed by the owners; but in each case the sewage is taken by the occupier for the sake of its agricultural value alone. The grass crops have been very much improved by the sewage; and one farmer has just bought a steam engine, and is laying down iron pipes, with a view to sewaging some of his land which is too high to be irrigated by gravity alone. Irrigation and grazing have been carried on together with no mischievous result.

The greater part of the solid matter is extracted by means of settling ponds; it is then mixed with town ashes, and taken away by farmers. The board have had no trouble by reason of river pollution; but, unfortunately, provision was not made in the town for the exclusion of surface water from the sewers, and, on the occurrence of storms or heavy rains, it is found that the volume of water becomes rather difficult to deal with, as it makes a disturbance in the settling ponds, and carries over the suspended matter, besides polluting the watercourse to a certain extent.

The local board has only spent £500 on outfall works, including damage to property during their construction, and the working expenses which the board pay, in connection with the settling ponds, amount to about £2 a year.

At Cockermouth, a thoroughly water-closeted town, with a population of 5,115, 16 acres of low-lying but gravelly grazing land were hired by the local board some two years ago, on lease for 21 years, with power to sub-let, subject to the tenant previously in occupation having the refusal.

It does not appear what the board has to pay for the land, but the original tenant continues to occupy it, and pays a pound an acre more than he gave the owner, binding himself to receive the whole of the sewage, and keep it out of the River Derwent, by which the field is skirted on one side. This land is irrigated and grazed at the same time, and cattle have been frequently seen drinking the sewage in preference to the river water. The sewage passes through tanks, from which the sludge is pumped by hand. This, when dry, is sold at 2*s.* 6*d.* a cubic yard, a price which produces a profit upon the labour.

The field was nearly level, so that the surface was scarcely altered. The carriers were made entirely with spade and plough, at a very trifling cost; and there are no working expenses paid out of the rates. No provision has been made in the town to keep surface or subsoil water out of the sewers; but it is considered that it would be better if there were, for a large quantity of sub-soil water percolates into the main sewer, which is of brick, and, together with the surface water, adds to the risk and difficulty in times of sudden thunderstorms, when a very little neglect on the part of the tenant might cause the sewage to run over the land, straight into the river.

At *Crediton*, in Devonshire, the sewage of about 4,000 people, generally provided with water-closets, has for many years been used on grass land just outside the town. It is

now let for seven, ten, or fourteen years, to three landowners, who pay together £40 a year for the privilege of using it upon some 60 acres of meadow land. About 25 acres are let annually by auction, and have realized £8 and £10 an acre. The auction this spring, which was not so satisfactory—owing, it is said, to a general abundance of feed in the neighbourhood—resulted in an average price of about £7. A considerable amount of spring water joins the sewage before it reaches the land.

The carriers are simple grips contouring the ground; the soil is heavy and red. No solid matter is extracted from the sewage before it is applied to the land. Beyond the cost of sewering the streets, the sewage disposal involves no expense to the rates. During "most of the summer" it is considered that the meadows do not require the sewage, and it is not then used.

Denbigh, with a population of 5,823, is now being sewered, the "separate system" being in some measure adopted, as an old rubble drain which discharges straight into a brook is left to carry away surface and subsoil water. The use of the sewage has been let at £110 a year (£100, however, being allowed to the tenant out of the first two years' rent) for 30 years to Mr. HUGHES, of Kinmel, who has 250 acres of mixed soil at a suitable altitude for irrigation without pumping. Simple tanks are to be provided for the separation of suspended matters, when necessary. The nearest houses to the land which is to be sewaged are at a distance of about a furlong.

At Devizes the sewage of some 7,000 people has, for the last ten years, been discharged into an ancient watercourse, which from time immemorial has been diverted on to pasture lands a quarter of a mile below the town. The soil of these meadows is light, and they are said to command high rents.

There is no charge upon the rates for working expenses in connection with the disposal of the sewage, and the town, which has water-closets almost throughout, is considered, by those in a position to judge, to be satisfactorily free of the sewage difficulty. It appears, however, that at haymaking time and just before it, the sewage is sometimes not dealt with at all.

At *Doncaster* the sewage of about 20,000 people has for the last five years been pumped on to a farm the property of the corporation. This farm, which consists of 263 acres of light, gravelly land worth, without sewage, from 15*s.* to 40*s.* an acre, is let on a fourteen years' lease at a rent of £800, or rather more than £3 an acre. The surface of the ground was but slightly altered. The sewage is delivered on to the various high points in the farm by means of iron and earthenware pipes, either laid at a sufficient depth below the surface to be out of the way of the plough, or else under the fence along the headland, and then distributed by contour grips simply ploughed or dug in the ground. Nine-tenths of the farm is arable; about 40 acres of this are devoted to Italian rye-grass, and six or seven to market-garden stuff, such as rhubarb, strawberries, gooseberries, currants, and cabbage, cauliflower, &c. Rye-grass is always cut four times a year here, and in some seasons might be cut a fifth time. Mangold do well, and keep as well as mangold grown in the ordinary way. They were being used on the 16th of last April. A large storage reservoir was provided, when the farm was laid out, for use when for any reason it might be thought undesirable to put the sewage on the land; but this has been abandoned upwards of three years, and the sewage is now sent on to the land at all seasons with as little delay as possible.

Edinburgh, probably, from an agricultural point of view, affords the most remarkable instance of sewage

utilization that is to be found anywhere, although the supply of sewage is, owing to the city being so close to the sea, far in excess of the requirements of the limited area of agricultural land in its immediate neighbourhood.*

The sewage of certain districts of Edinburgh has long been used in rough and rude irrigation, in some cases since 1760, the lands irrigated being known as the Craigentinny Meadows, which have an area of about 220 acres, "Lochend" Meadows, about 28 acres, "Lochryn-on-Dalry" Meadows, about 40 acres, and "Brigend" and "Cairn Tows" Meadows, about 35 acres, making a total of 323 acres. There are about 250 acres of the Craigentinny and Lochend Meadows under sewage irrigation; of these 200 acres are permanent pasture grasses, and 50 acres Italian rye-grass. About 2,500,000 gallons of crude sewage, every twenty-four hours, flows through the "Foul Burn" on to the meadows. The grass is sold by public roup at the beginning of April in each year, in allotments of from half a statute acre to one acre in area, at prices varying from £20 to £40 per acre, per annum; one allotment (acre) sold last year for £44 15s. The permanent grass is used for cow feeding, and is bought by dairymen, at Musselburgh, Portobello, Leith, and Edinburgh, who have to cut and remove it. This is done about four times in the season, and yields an aggregate crop of about 40 tons to the acre. The Italian rye-grass is cut five times a year, and produces occasionally 60 tons to the acre. The irrigation is carried on in the cheapest and rudest way by the owners of the land adjoining the streams of sewage, no cost having been incurred in providing permanent carriers of either wood, iron, stoneware, or brickwork. A considerable portion of the sewage is absorbed by the "sea sand" of which the irrigated meadows of

* Local Government Blue Book, 1876—Sewage Disposal.

Craigentinny Farm is composed, and thus the soakage of sewage from this land into the "Firth of Forth" is only partially purified.

The annual cost of applying the sewage and receipts for the produce are:—

Receipts.	£	Expenditure.	£
250 Statute Acres of grass, at an average of £30 per acre	7,500	Wages of Watermen, three in summer and one in winter, and cost of cleaning out carriers . . .	180
		Estimated Rent of Land, 250 acres at £2 per annum*	500
		Balance	6,820
	£7,500		£7,500

About eight acres of the Craigentinny Farm, which is land of excellent natural quality, but too high to be irrigated by gravity, has had sewage pumped on to it by steam power. This land has received about 3000 tons of sewage per acre, in six or eight dressings, during the year; and the rye-grass growing on it has realized from £25 to £36 an acre, prices equal to those obtained at "Lochend," where four times the quantity of sewage has been applied.

At Guisborough (Yorkshire), in 1871, the local authority, having been threatened with litigation, entered into an agreement with Admiral Chaloner, who owns considerable property in the immediate neighbourhood, to deliver on to land of his, about 800 yards from the town, the whole sewage, for a term of twenty-one years commencing on the 1st of January, 1872.

Admiral Chaloner was to do all the work within the limits of his own land, and pay to the local board a rent of

* First Report of Rivers Pollution Commissioners (Mersey and Ribble Basin).

£5 a year for the sewage, with all liabilities. About 21½ acres of old grass land, part of which had been very good and part a complete bog, were prepared for sewage at a cost of £1,556. This work included thorough deep drainage, a considerable amount of levelling, laying carriers, and making new roads, besides building a cottage for the man in charge.

Here the sewage of about 6,000 people, to whom water-closets are only now being introduced, is distributed over the land in the condition in which it leaves the sewers, without separation or deodorization of any sort.

Italian rye-grass, it is said, certainly pays best. The average price per acre received for rye-grass was, in 1872, £10 7*s.* 2*d.*; in 1873, £15 5*s.* 2*d.*; in 1874, £24 18*s.* 11*d.*; in 1875, £26; and in 1876, which was a very unfavourable year for selling cut grass, only £17 18*s.* Last summer and autumn were both wet and cold, and only three cuttings were obtained, which realized together an average of £12 11*s.* 3*d.* an acre. Mangold, turnips, and carrots have been found to answer best as root crops, and rhubarb has paid very well, but that can only be sold in small quantities at Guisborough.

A profit and loss account has been kept since the farm was started, and after allowing £2 an acre for rent, and five per cent. upon the £1,556, besides paying all expenses, the following balances appear:—

	£	*s.*	*d.*
For 1872, a loss of	47	3	5
„ 1873, a profit of	45	3	2
„ 1874, „	163	0	10
„ 1875, „	140	10	11
„ 1876, „	50	6	3
	£399	1	2
Less	47	3	5
	£351	17	9
This gives an average profit of	£70	7	6

Or enough to pay an additional 4½ per cent. on the capital sunk, making altogether 9½ per cent. Last year, owing to the unfavourable season, barely 5 per cent. was realized upon the outlay. Notwithstanding the unsatisfactory sale of rye-grass during the last two years, the plant, Admiral CHALONER considers, improves year by year, which convinces him that the land has permanently benefited by the application of sewage. The soil, generally, is heavy, but loamy. Admiral CHALONER believes that a large quantity of water, which bothers him considerably in times of extreme wet, might be easily diverted from the sewers. This, evidently, was not considered to be an object when the sewers were constructed; but it appears that the importance of keeping as much surface water as possible out of the sewage is now recognized by the local authority, who are likely to carry out some inexpensive alteration in the town sewers for the relief of the sewage farm.

At Handsworth, near Sheffield, the sewage of one outfall, which serves a population of about a thousand, has for the last 14 years been used by the occupier of some land through which the outfall sewer passes. He applies it to grass land, and also very considerably to rhubarb, during the winter months. The sewage has occasionally been intercepted by another occupier of land higher up the sewer. This has been very much to the annoyance of the gentleman who first took it, and who is said to consider that long usage, or some other circumstance, has given him a kind of ownership in the liquid.

No money has been spent in levelling the land, which is of a moderately stiff character. The sewage is spread over the land by means of grips cut in the ground and wooden spouting. In this way it covers an area of some 12 acres. Grazing and irrigation go on together in the same field, when convenient.

Hoddesdon, a village of 2,000 inhabitants, in Hertfordshire, has been lately sewered by the rural sanitary authority, and about 17 acres of gravelly land, almost devoid of soil, were taken, on a 21 years' lease, from the Marquis of SALISBURY, for the disposal of the sewage.

The surface of the ground, which has a considerable natural slope in one direction, has been but little altered. It has, however, been provided with an earthenware carrier along its upper edge, a covered settling tank, capable of being completely emptied on to the lower part of the land, only, and a wooden building, consisting of stable, carthouse, and labourers' rooms.

At Michaelmas, 1876, a tenant was found for this sewage land, who occupies a considerable acreage of market garden ground in the neighbourhood, and supplies the London markets. He has been granted a 14 years' lease at a rent of £4 an acre, and now after a year and a half's trial appears to be well satisfied with his prospects. In March last he was cutting sewage-grown brocoli which he considered "pictures," "more like cauliflowers than brocoli." He is also growing cabbages, beans, and other vegetables.

Surface water is kept out of the sewers to a considerable extent, but the tenant would prefer to have had this done more completely.

The tank is no longer used for the retention of solid matter, the sewage being allowed to run on the land as it comes from the sewer. The land is close to Rye House Railway Station and several cottages. Its rent, without sewage, had been 22*s.* 6*d.* an acre, which amount is believed to be all that is paid for some of the adjoining land.

Leamington, with 22,000 inhabitants, has been as fortunate as Denbigh in being able to sell its sewage for

agricultural purposes; but, unhappily, Lord WARWICK, who undertook, in 1871, to pay £450 a year for the sewage for thirty years, requires it to be delivered on to a farm of his, called Heathcote Farm, which is at a distance of two miles from, and at an altitude 130 feet greater than, the old sewer outfall into the river. Previously to the agreement with Lord WARWICK, the corporation had spent £8,000 in precipitation works (which have since been abandoned), £5,000 in defending a Chancery suit, and £1,500 in cleaning out the River Leam, in consequence of an injunction in Chancery. The new pumping station, rising main, &c., including all necessary works up to the point of delivery at the summit of the farm, cost £16,239, and the working expenses of the pumping establishment amount to £1,035 a year; so, if the capital be borrowed at 3½ per cent., the cost of sending the sewage to Lord WARWICK'S farm would be, £568 interest on loan, *plus* £1,035, or £1,603 a year. This annual payment may be regarded as almost entirely due to the unfortunate fact that Lord WARWICK'S land happened to be above the town instead of just below it. What has to be dealt with in this Paper, however, is principally the question of whether sewage can be advantageously used by farmers when they have it delivered at a suitable altitude. Only such facts, therefore, as have a bearing upon that question will here be referred to.

Heathcote Farm contains about 310 acres, which are irrigated. The soil is mainly loam over gravel or marl, but about a fourth part is clay; the whole being "rather of a second quality as regards natural fertility."*

Although the rain-water falling on some of the streets is excluded from the sewers, they receive all that is collected by roofs of houses and yards. In very wet weather

* Chalmers Morton.

more water reaches the pumping station than can be dealt with by the pumps or the reservoir (which is of sufficient capacity for the sewage of a night or a dry Sunday), and an overflow occurs into the Leam.

The cost of pumping unnecessary or useless water, and the desirability of water supplying a river having to pass through sewers and sewage-tanks, will not be discussed here; but Captain FOSBERY, Lord WARWICK'S agent, who has had the general management of the farm ever since, and even before it was sewaged, says it is most certainly desirable, from his point of view, that provision should be made for the further exclusion of surface-water from the sewers, although in dry seasons any supply from which the summer flow of sewage might be increased would be of the greatest service to the occupier of the land.

The quantity of sewage pumped daily on to the farm varies from 800,000 to 1,000,000 gallons. It is, therefore, rather dilute, and by the process of pumping made more even in quality and appearance than might otherwise be the case. It is, however, delivered on to the land as it reaches the pumping station, thick and thin together, with the exception of such chance materials as may be kept back for the safety of the pumps.

The land was laid out under Captain FOSBERY'S supervision, at a cost of about £7 an acre, including drainage to a depth of 4 or 5 feet. The surface was altered but very little; the position of the carrier, and even the number of carriers, by which the sewage is introduced to the field, having been, it seems, governed by the natural lie of the land—a plan preferable to the too common practice of paring down the surface and robbing it of soil till it can be irrigated from channels drawn with a parallel ruler.

From the accompanying table it will be seen that this

farm has been worked with a view to producing milk meat, and grain.

With reference to the former, Lord WARWICK has a satisfactory contract with a milkman in Leamington, under which his lordship supplies him with the produce of fifty good dairy shorthorns:

"Four men are daily engaged in distributing the sewage, generally at as many different points upon the farm, according to the needs of the crop, or of the land, or the power of the soil on different fields, to deal with it at such times, as it is not wanted for the promotion of current growth. These four men are, however, available for other work during a great part of their time. During spring and summer they are employed in cutting grass for purchasers, who bring their carts for its removal, paying from 8*d.* to a shilling a rod for the grass as it is cut. They receive 17*s.* a week, besides 1*s.* an acre for the grass they cut, and can generally make about 21*s.* a week during the year. The water is in autumn and winter roughly directed by plough and spade-made furrows over the stubbles and the fallow intended for next year's beans, oats, barley, and mangold-wurzel. In spring and summer, the Italian rye-grass takes most of it, but mangolds, cabbages, and various garden crops are watered as they want it"; root crops, however, with the exception of cabbages, Mr. TOUGH, Lord WARWICK'S bailiff, says, never have sewage applied to them before May or June.

Immense crops of mangold are grown; the yield of 1874, in two large fields, is said to have been in several places where the weight was taken over half a ton to the rod.

As many as ten silver cups have been won by roots grown on this farm with sewage, besides a number of money prizes.

The sewage, when not required upon the Heathcote Farm, is supplied in considerable quantities (as will be seen from the table) to six of Lord WARWICK'S tenants who occupy adjoining farms, and who, together, have irrigated over 200 acres of their own holdings. In each of these cases Lord WARWICK has constructed the works necessary to deliver the sewage on to the nearest point of the farm, and the tenant has made the carriers necessary for distribution. These generally consist of grips cut in the ground or built up above it with turf, and are of a very inexpensive character.

Sewage is used by the tenants upon grass and arable land. The receipts from this source amounted to £46 in 1875, and to £60 in 1877.

There are a number of cottages on the sewage farm, and the families have been singularly free from any illness.

Captain FOSBERY is able to state that, notwithstanding the £450 a year with which the concern is unfortunately debited, the returns have been sufficient to pay a very good interest on the capital expended, after deducting rent and all working expenses.

At Leek, in Staffordshire, the sewage of some 12,000 inhabitants, about a third of whom are provided with water-closets connected with the sewers, is carried out of the town by two outfalls, which discharge on to grass lands belonging to private gentlemen. The sewers were constructed in their present position on condition that certain owners should make what use they pleased of the sewage, without any liability for river pollution through neglecting to use it. This appears a one-sided arrangement, but it has been found to act very well for upwards of fifteen years; for the sewage from the southern outfall, which is rather more than half, is used over some 60 acres

of sloping grass land of a generally light character in the occupation of several different farmers, who would be glad to increase the area under irrigation, if more sewage were available. The northern outfall discharges on to some low flat alluvial meadows, about 70 acres of which absorb all the sewage that comes to them during nearly the whole year. There are, however, six weeks or two months at hay-time, when it is found more convenient to let the sewage of the northern outfall flow away without passing over the land.

This town may be said to be bounded on two sides by sewage fields; yet some very elaborate returns which have been most carefully and ably kept by the sanitary inspector for many years, show that its sanitary condition has been very much improved by the works that remove the refuse of the town from beneath the ground on which it stands to the surface of that immediately adjoining it, while it is a well-known fact that one field which is sewaged at Leek, is let at £7 10*s.* an acre, and the adjoining one, not sewaged, at £3 15*s.*

The sewage of Leek is disposed of so as to keep the town in a healthy condition and free from litigation, and to keep some of the agricultural parishioners supplied with an article they are glad to make use of, without any expense to the ratepayers. No money has been spent upon levelling the land, and, with one very slight exception, the surface carriers are merely plough and spade-made channels.

Longton affords an example of how a landowner may, with due consideration for his own interests, offer more satisfactory terms to a local authority for its sewage disposal than the authority can obtain by other means. This borough has a population of about 20,000, and is one of that closely-packed group of pottery towns, the greater

number of which are still in the utmost doubt and difficulty in reference to sewage matters. It has, however, been fortunate enough to secure an arrangement with the Duke of SUTHERLAND under which his Grace has constructed 1256 yards of outfall sewer and undertaken on being paid £500 annually to deal with the sewage of the borough and all its liabilities for a term of twenty-one years. The Duke had had some experience of sewage farming, for at the very spot where the new outfall sewer leaves the public street is a greengrocer's shop with about twelve acres of market garden behind it, on which the sewage of the adjoining districts of Dresden and Florence (containing together five or six thousand people) has been used for four years. The market gardener pays his Grace a very high market-garden rent for these twelve acres, and supplies the town from them with rye-grass and vegetables.

The new main sewer intercepts the sewage of Florence and Dresden, as well as that of Longton, and is made to supply the market garden, which it passes through on its way to the larger farm which is now being laid out. About 120 acres are already under sewage, and let to the market gardener above referred to; but many hundred acres of the Duke's land is favourably situated for the reception of the sewage, and much of this, it is said, will be gradually brought under sewage cultivation. Beyond the grubbing of hedges, the surface of the land has scarcely been altered. The soil is stiff, and the tenant considers that the "separate system" of sewers, which has been adopted in Longton, is very desirable. Rye-grass can be cut only four times a year, but there is a good market for it in the town, and it is found very profitable.

At Mansfield, where there are about 12,000 inhabitants and 300 water-closets, the sewage of the whole town goes

straight into the River Maun, which more than forty years ago was diverted at a point just below the town by the late Duke of PORTLAND into a cut called the "Flood Dyke," made for the purpose of irrigating his now celebrated Clipstone Meadows.

These meadows comprise an area of upwards of 300 acres of land, extending over a distance of about seven miles in length. They are watered by the River Maun as it flows eastward from the town of Mansfield. The value of the land has been raised from the annual sum of £80 to that of £3,660, at a cost (from their commencement in 1816 to their completion in 1837) of £40,000. The profit of each acre after defraying all expenses has been computed at nearly £12 a year, without taking into consideration the great benefit they are to the arable land adjoining them.

In February last, the Flood Dyke, a canal some 20 feet wide, was carrying a sluggish flow of dirty black water which it discharged at intervals on to dark green sloping meadows, at the foot of which, in the bed of the old river, ran a stream of tail water sufficiently clear for fish and stones to be easily counted at the bottom.

The Duke's steward, Mr. HENRY WOOD, has kindly reported, for the purposes of this Paper, that there is no season of the year at which the water cannot with advantage be turned on to the meadows, and that the steeper the ground the better is the quality of the grass produced.

To some it will no doubt occur that since the Clipstone Meadows have been in successful operation for forty years, and the town of Mansfield has not been sewered half that time, their great value is not mainly due to the manure they receive from the refuse of that town. This is not, however, a sound deduction, for the greater part of the

soluble matter wasted in a town must reach the river that drains it. If there are no sewers, it will follow the course of the surplus rainfall, either over the surface or through the ground. In this case the river would be spared some of the putrescible organic matter due to sewers, but the bulk of the nitrogen would find its way to the river as nitrates and nitrites—forms very suitable to vegetation.

At Ormskirk, in Lancashire, a town with 6,000 inhabitants, and a considerable number of water-closets, the local board, after four years' experience of sewage farming, succeeded, about four years ago, in letting their farm to a working farmer at a rent, it is said, of £100 a year more than they give for it under a ninety-nine years' lease. The farm consists of 68 acres of black peaty soil, overlying the clay, which the occupier considers comes a great deal too near the surface. Only 40 acres, all of which are arable, are at a suitable altitude for irrigation; and in summer-time, when the land is pretty well covered, difficulty is found in providing a place for the reception of sewage. Rye-grass, potatoes, and market-garden stuff are grown, rhubarb being noticeable as a crop that evidently does well. The solid matter is settled in tanks at the upper edge of the farm, and mixed with town ashes, for use on land. The surface of the ground has been scarcely altered. The sewage, on leaving the tanks, is carried along either of the two sides of the farm by means of a pipe channel raised on a bank of earth, and from these it is distributed over the land by means of simple grips cut temporarily in the ground. The rye-grass is cut for hay twice in the season, and for sale or home use as required.

At Penrith, the sewage of some 7,000 people was discharged into the River Eamont. Till some ten years ago

the outfall was objected to, as a nuisance, by the owner of the property in which it was situated, who occupied a mansion within a few hundred yards of it. Law proceedings were talked about, but were averted by the complainant having conceded to him the right to use the sewage for his own purposes and profit. The co-operation was secured of Mr. McDougall, who had already used the Carlisle sewage for some years. This gentleman took some 70 or 80 acres of gravelly grass land close to the river, on a lease, with the rights in the sewage which had been granted away by the local board. On to this land, at his own expense, he diverted the whole sewage, by means of a sewer nearly half a mile long; and, as lately as last month, the sewage was seen running thick and thin on to the grass, amid a herd of 120 beasts. There is a very pretty arrangement here for adding some disinfecting mixture (patented by Mr. McDougall) to the sewage; but this is only used during very hot weather, and then not continuously. The ground is very uneven, and the sewage is conveyed by means of earthenware channel-pipes, laid permanently along the higher parts of the field; from these it is distributed by portable spouting of wood and iron. No advantage is apparent in these carriers corresponding to the trouble and expense they involve. The unevenness of the ground, however, has not interfered with the purification of the sewage, which was reported by the Rivers Pollution Commissioners to have been satisfactory.

At Plympton St. Mary, near Plymouth, the sewage of over 3,000 people is given to Lord Morley, who for the last five years has distributed it over some 100 acres of porous sandy meadow land. Lord Morley employs a man whose duty it is to attend to the irrigation; but the land is in the occupation of eight different tenants, who,

to use the words of the irrigator, are "crazy after the sewage," excepting during some two or three months in the summer, and then the sewage is run straight into the tideway without any cleansing beyond what is effected by settlement in some tanks through which it passes all the year round, and which are emptied of deposit once a year. His lordship does not allow a field to be irrigated that has cattle in it, as his agent is of opinion that this would lead to the land being trampled into holes. It appears probable that the sewage would otherwise be used more in the summer months than it has been.

The schools and the church are within 100 yards, and a number of villas within 200 yards, of the outfall.

The surface works are mere contour grips cut in the ground, and these, together with under drainage and outfall sewer, appear, from the well-known Rochdale Returns, to have cost Lord MORLEY £1,000.

Mr. NEWBURY, his lordship's agent, says the undertaking has been most successful, the land being improved twofold by the sewage.

Rugby has contributed, probably, more to the national stock of sewage utilization facts than any other place except Edinburgh, for as early as 1865 the Highland and Agricultural Society of Scotland awarded a premium of thirty sovereigns to J. A. CAMPBELL, Esq., for a report of his on "The Application of Sewage," which was based upon his own experience, during eleven years, of the use of a portion of the sewage of the town of Rugby. During those eleven years, Mr. CAMPBELL irrigated about 190 acres of land, laid out with 3-inch iron pipes, through which the sewage was pumped by a 12 H.-P. steam engine.

The early experience at Rugby led Mr. CAMPBELL to report as follows:—

"Although I fully appreciate the value of sewage for

certain descriptions of crop, and under certain conditions, I do not think I should be justified in recommending it for general adaptation to the usual routine of the farm. It seems pretty evident to me that the expense and trouble of applying it by means of pipes to arable ground would not be compensated by the increase of the crop; nor could it be applied with regularity on account of the variable nature of the climate. To the dairy farmer, for the purpose of obtaining heavy crops of green forage, it will be always useful, and by its application to grass lands it may be made of essential benefit to the community."

This is merely quoted to show that the author of it, who will be again referred to, is not an enthusiast upon the subject, but a gentleman likely to consider the question from a practical point of view.

Rugby has a population of about 9,000, and water-closets are adopted throughout the town. Eight years ago the local board leased a farm of 65 acres for thirty years at a rent of £265, the board paying tithes. On to this the sewage runs without pumping.

Until 1874, the farm was worked by the local board, who lost money by it. Since then, however, it has been let under a yearly agreement, for £350 a year, to Mr. CAMPBELL, who had previously rented the same land for ordinary cultivation at £3 an acre. The board employs a man, at a pound a week, whose duty it is to properly distribute the sewage. The distribution is no longer effected by means of expensive iron pipes, as it has been, but with open channels cut in the ground. The soil is a gravelly loam overlying the blue lias clay. Mr. CAMPBELL kindly reports for the purposes of this Paper, as follows:—"Italian rye-grass answers best; but I have good crops of wheat, oats, mangold-wurzel, and turnips. The grain crops give a large amount of straw, which is now very valuable,

and consequently they sell well by auction as the straw goes off."

The rye-grass here is cut five times a year, and sold at from 10*s*. to 20*s*. a ton. The coarser particles of solid matter are arrested in screening-tanks before the sewage is allowed to flow on to the land. Where new sewers are constructed in the town, provision is made for the exclusion of surface-water; and this Mr. CAMPBELL'S experience has made him consider desirable.

For the utilization of the sewage of another portion of the Rugby district, about thirteen acres of arable land have been hired from the rector at a yearly rental of £54, and sublet at £79 a year, at which rent it continues to be held.

Ruthin, in North Wales, was drained some seven or eight years ago by Mr. MARTIN, C.E., of Exeter, and the sewage of about 3,000 people was conveyed by two outfall sewers on to meadows immediately adjoining the town. These meadows (112 acres in all) were taken on a twenty-five years' lease by Mr. MARTIN, who, together with his landlord, has leased the sewage from the town council for the same period at a rent of £20 a year.

Two-thirds of the town are provided with water-closets, and a considerable amount of spring water finds its way with the sewage on to the land. No solid matters are extracted. A man, a lad, and a donkey are employed to direct the sewage and attend to the garden and the carriers. These are merely contour grips cut in the ground. Only about £250 was spent in the preparation of the surface, which is by no means even; but the land, a large part of which had originally been a morass, was already drained and fit for profitable agricultural occupation.

The whole of the land is let annually by tender in

eight or ten lots, the persons taking them being at liberty to cut and use the grass as they please from the middle of April to the end of November.

In 1875, the 112 acres produced £521 5*s.*; in 1876, £514 11*s.* 5*d.*; and in 1877, £557 18*s.* In 1875, 4½ acres of young grass were cut for the first time and were sold for £40; otherwise the increase of price would have been constant.

Since the end of last November, £50 has been taken for sheep feed. A quantity of the hay grown on these meadows last year was sold at £6 a ton.

Every year there are meadows which, not being mown, are available for sewage irrigation during the hay season; but an acre of garden ground is provided which receives the sewage when, for any temporary reason, it is not wanted on the grass. The garden stuff has produced upwards of £15 in the season. The soil varies from loam to clay and peat, all of which, except a small portion of the clay, rest on alluvial gravel. The London and North Western Railway Company's platform has only the width of their road between it and the principal outfall, and the centre of the town is not more than 300 or 400 yards from the meadows.

At Ruthin, Mr. MARTIN appears to have already brought into satisfactory operation a nearer approach than can elsewhere be found to the arrangement that the whole of these notes point to as the proper solution of the difficulty in a large class of cases.

The sewage of South Molton, in Devonshire, a thoroughly water-closeted borough with 3,000 inhabitants, is carried out of the town by means of three outfalls, and has for a number of years been let at rents varying from £6 to £10 per annum for use on old pasture land, about

thirty acres of which have been irrigated by means of contour grips cut in the ground. Two of the outfalls were provided with tanks for the interception of solid matter. These, in one case being very near the town, have been objected to as a nuisance, and the council have purchased sixty-eight acres of land about a mile off which will be prepared for irrigation and let with immediate possession. It appears from this that the corporation, having had considerable experience, are of opinion that farmers are able to deal with sewage satisfactorily from a sanitary as well as from an agricultural point of view.

At Swinton, a suburb of Manchester, having scarcely any water-closets, provision was made some seven years ago for the upward and downward filtration of the sewage of some 10,000 inhabitants. Some of the heavier particles may still be arrested in tanks, but the sewage now passes from them in a very dirty, black condition on to a 16-acre meadow of very stiff land, which evidently does very nearly all the purification that the sewage is subjected to. The meadow is divided, as meadows in stiff soils commonly are, into "lands," and for the purposes of the sewage a small grip has been dug out of the crest of each land. In the part of the field which was laid out first, these grips were lined with earthenware channel-pipes; but this process has not been continued in the part prepared more recently, the simple grip being found sufficient.

This meadow was first let by tender at £38 a year. It is now let for £72, or £4 10*s*. an acre, the tenant attending to the sewage, which produces for him three cuttings a year. Grazing is forbidden by the local board, lest the carriers should be injured. Storm water is kept out of the drains as far as practicable. The outfall sewer has

also been tapped for the convenience of a farmer, who pays the local board £5 a year and uses the sewage when he pleases.

At Tavistock, with a population of about 7,000, two-thirds of which are supplied with water-closets, the sewage has, for the last six years, been let at £50 per annum, under a yearly agreement, to the Duke of BEDFORD. It is used upon some 90 acres of meadow land in the occupation of two tenants, who undertake to utilize the sewage without annoyance to the neighbourhood or the river authority.

Tavistock has a very abundant water supply from the neighbouring hills, and the sewers collect a large quantity of subsoil water in addition, the result being that there is liquid enough to cover the ground three or four times each year. The meadows are let at about £5 an acre. The outfall is within a hundred yards of upwards of a hundred cottages, the inhabitants of which are reported to be in a satisfactory condition of health. The sewage used to pass through a tank, where the solid matter was, to some extent, arrested; but the process of emptying was so offensive that the tank was abandoned, and, in deference to the views of neighbours, the field in which it stood has not since been irrigated. This circumstance affords an important note upon the commercial side of the question, as well as from the sanitary point of view, for the tenant, Mr. Battams, who rents some 600 acres of grass land from the Duke, says that, owing to his ceasing to irrigate those ten acres, he has to give up fatting five beasts, which means a loss to him of about £25 a year. The soil is of a mixed character, being stiff over a considerable area, but the whole overlies an open gravel. The surface has been but very little altered, the carriers

being spade-made in contour lines. The greater part has been deeply drained with rough stone drains.

At Tyldesley, near Manchester, the sewage of 5,000 inhabitants, with scarcely any water-closets, is delivered, under an agreement terminable by either side at six months' notice, on to a farm almost a quarter of a mile from the town. The occupier, who has been in the same farm (a large one) for the last 40 years, has used the sewage during the last seven on 40 or 50 acres of meadow land, which have been irrigated with brook water from time immemorial.

He is well acquainted with the subject of irrigation, and fully recognizes the value of sewage as manure, but considers that without the help of the brook it would be of little practical use, as the flow would be too small to cover any considerable area. He does not like to graze and irrigate land with sewage at the same time, lest his fields should be infected with disease from cattle slaughtered in the town, but he sees the importance from an economical point of view, of eating down the food as rapidly almost as it is produced. By doing this the fine quality of the herbage is maintained. Complaints have been made by the landlord of the farm (who is also interested in the lower part of the river), that river pollution has not been prevented by the measures at present adopted; and it has appeared probable that he would make the local authority comply with the Rivers Pollution Act independently of his co-operation. It has not, however, been established that the fouling of the river was due to any circumstance within the control of the farmer; and it is understood to be probable that, at the tenant's desire, the arrangement may continue as hitherto. No preparation has been made for the sewage, beyond what existed when

the meadows were irrigated by the brook, excepting some wooden troughs which carry the sewage across the river, and which, from the marks of overflows on their sides, appear not to be large enough for their purpose. No provision has been made in this town for the exclusion of surface water from the sewers.

Waltham Abbey, with a population of 5,000, affords a remarkable instance of parochial unanimity upon the question of whether sewage is desirable or not to occupiers of land. Here the whole personal refuse is collected by means of very sound modern sewers at a point in the Town Mead only just outside the town itself, where there are tanks and a steam pumping-engine. The tanks were constructed some seven years ago, with a view to the sewage being relieved of its suspended matters by precipitation with lime or some other chemical; but for the last four years they have only been used as storage reservoirs to hold the sewage on Sundays, or during parts of week-days when it is not found desirable to keep the pump at work. The surface and subsoil water of the town is kept out of the sewers as far as practicable, and the reservoir is found sufficient to make pumping unnecessary more than half the day.

For the last four years the solids have been roughly strained and settled from the sewage, and it has been pumped on to the surface of the ground for irrigating the Town Mead and some market-garden land adjoining. The mead is what is known as "Lammas land," on which every householder in the parish may graze as many horses, beasts, or sheep as he pleases between the 12th of August in one year and the 6th of April in the next. On the 6th of April it is shut up for hay, to be cut by the tenants, of whom there are about a dozen, each having a certain plot marked out by little low stumps permanently

kept in the ground. Only one cutting is allowed, and the consequence is that when the cattle are turned on in August the grass is pretty nearly knee high.

Notwithstanding the complicated character of the ownership in the Town Mead, the whole sewage is pumped on to it (without injury, it may be presumed, to any one interested) from the middle of September till the beginning of May, when it is diverted on to the market garden.

The various owners of the mead take care that their own plots receive a fair share of the sewage, and the cattle, which have the free run of the whole, appear to be very fond of the sewage-grown grass, for it is said that they may be seen nibbling it before the sewage has disappeared from the ground on which it grows. The market gardener says he finds it very useful with mangold-wurzel, brocoli, savoys, cabbage, and celery.

He has only used the sewage during the last two years, before which difficulty was found in disposing of it in June and July, while the mead had long grass or hay upon it.

The soil is light but peaty. No expense has been incurred in preparing the mead, beyond what was required to cut a grip along the higher edge. So much of the central part as cannot be irrigated from this is reached by means of portable wooden spouting. There are several houses within three or four hundred yards of the sewage ground, one being the residence of a magistrate, whose garden runs down to the mead. This gentleman had his attention called to the sewage, about two years ago, by an intolerable smell arising out of some neglect in the management of the tank; but since that he says he has experienced nothing to complain of.

At Ware, in Hertfordshire, the local board, in 1873,

took a farm of 114 acres, with a good house and buildings, on a twenty-eight years' lease, at a rent of £460. This is considered to be about 30*s.* an acre more than could have been expected from a tenant-farmer. The board, however, since the sewage has been applied, has succeeded in subletting the Rye Farm, on a seven, fourteen, or twenty-one years' lease, at an enhanced rent of £483. The farm is situated in the parish of Stanstead, close to the celebrated Rye House, whose summer-house, known as the "Retainers' Hall," is only separated from irrigated rye-grass land by the boarding of which it is constructed. The farm-house itself stands almost in the centre of the sewage land, and the tenant, who also farms another large farm in the neighbourhood, only spends part of the year at the sewage farm-house. When asked in March last whether he suffered any annoyance during his stay there, he answered, "Nothing beyond the increased appetite of my family." The Rye Farm appears not to be at such a level as would allow of the Ware sewage flowing on to it by gravity. The whole personal refuse of some 6,000 people, together with as little surface water as practicable, was therefore pumped through a rising main into a concrete reservoir at the summit of the farm, which, having naturally a hogsback tolerably regularly down its centre, is laid out with a wooden carrier along the ridge. The tank was used for settling the solids; but this process was found offensive when the tank was emptied, and has lately been abandoned, the sewage being poured on to the land as it leaves the sewers.

The soil is light, with gravel under it, and the sewage has, at present, been distributed over about 80 acres only. The tenant has no fears about sewage-grown mangold not keeping, as has sometimes been alleged, for owing to an

oversight he has had some kept for over two years in a perfectly sound condition.

Wellington, in Shropshire, a town of about 6,000 inhabitants, where water-closets have not yet become general, is sewered into a small watercourse, of which so much as is within the town has been culverted. From this it is diverted on to meadows said to considerably exceed 100 acres in extent, and which cover some four miles of country between the town and the River Tern. The soil is principally light, and several owners enjoy the advantage of the sewage, but none of them have any agreement with the local authority, although an understanding exists among themselves, which insures each having his share. The sewage is disposed of at no cost to the rates. Heavy crops of grass are obtained, and those in a position to know consider that Wellington is satisfactorily free of the sewage difficulty.

Wellington, in Somersetshire, another town of 6,000 inhabitants, is also able to dispose of its sewage satisfactorily at no expense to the rates, beyond the original cost of constructing the sewers.

The sewage of this place has for many years been conveyed by three distinct outfall sewers on to different meadows, for the benefit of the occupiers. There are no water-closets in the town, but all the privies are connected with the sewers. No money has been spent in altering the surface of the ground. The carriers are simply grips cut with spade and plough. The soil is light; and the best proof that the sewage is of agricultural value is (in the words of the local board surveyor) "that the occupiers of the land through which it passes are very chary over it." No extraction of solid is attempted, excepting in summer-time, when tanks are used, and the sludge is

taken out and dried for use with the drill. No provision is made for excluding surface water from the sewers, but the Surveyor's experience at Wellington has led him to consider that such provision is desirable.

At Wilsden, in Yorkshire, containing a population of over 3,000, the sewage of rather more than half the town has for the last thirty years been discharged on to meadows for the farmers' own benefit. Some 14 acres of nicely sloping land are irrigated, and this is said to be worth £30 or £40 a year more than it would be without the sewage. No money has been spent in levelling the ground. Where inequalities exist, the sewage is carried across the low ground in wooden spouting, and it is spread by means of grips cut with the plough.

Middens are in general use, but these are connected with the sewers. The sewage is probably, therefore, considerably decomposed before it reaches the land; and, although no attempt is made to extract any solid matter, these are said to disappear very rapidly. There are houses divided from the sewage field by a high road only.

So much of the town as is drained on to this land is said to be satisfactorily rid of its refuse, and at no expense. The Local Government Board is urging the Board of Health to sewer the other and higher part of the town, and the owner of the land already under sewage is willing to receive the sewage of the whole town. He wishes, however, to have an agreement that surface and spring waters shall be kept out of the sewers, and, as the board object to this, nothing has yet been done in the matter.

At Wrexham, the corporation, in 1870, took a lease of a farm, containing about 84 acres, and became sewage farmers. In 1872, they determined to let the farm with the sewage of their 9,000 constituents, and were fortunate enough to secure as a tenant Lieut.-Colonel JONES, V.C.,

whose name has become well known in connection with the sewage question.

Colonel JONES has written a very interesting pamphlet, entitled "Will a Sewage Farm Pay?" * which contains every detail as to the management, working, and accounts of this farm; so these need not be fully gone into here.

During the first three years of his sewage farming, Colonel JONES got together a dairy of 25 cows, the milk from which he sent twice a day into Wrexham. About three years ago, however, he handed his cows and dairy establishment over to an experienced milkman at a valuation, and has since continued to supply fodder for the cattle.

About 17 acres are generally laid down in rye-grass, which stands three years, and produces about 40 tons annually in seven or eight cuttings.

The remainder is devoted to wheat, mangold-wurzel, and potatoes, with the exception of about 5 acres, which are stocked with market-garden stuff.

The soil is light and the surface has been altered as little as possible, the carriers being made to contour the slopes. These, where practicable, are mere channels cut in the ground; but where extreme proximity to the stream, which must not be polluted, or steep gradients, render such inadmissible, the earthenware carriers are adopted. Colonel JONES has done all that can be done by writing to bring about a separation between the sewage and the surface water of Wrexham, and he is well known to have called attention to the advantages of the "separate system" generally. His representations with this view have resulted in provision being made for the exclusion of surface water from any extensions in the sewerage system which may be made from time to time. The solid matter, which

* R. Potter, Publisher, Wrexham.

is arrested in tanks before the sewage is allowed to pass on to the land, used to be carted on to a few acres of land which were at too high a level to be irrigated; but since the commencement of last year, it has been dried by a process called Kidd's process, and mixed with sulphate of ammonia and bone meal, and sold as "The Farmer's Friend," at £6 10*s*., with advantage, it is said, to purchaser as well as to the manufacturer.

From the following balance sheets it will be seen that the last five years' working has produced favourable balances of £186 3*s*. 3*d*., £276 4*s*. 6½*d*., £271 18*s*. 6½*d*., £392 19*s*. 0½*d*., and £105 2*s*. 5*d*., respectively. The first year alone resulting in a loss which amounted to £81 18*s*. 6*d*. These appear, after £5 an acre is allowed for the 84 acres of corporation land, and £3 an acre for 20 acres since added to the farm on account of rent, taxes, &c., besides 5 per cent. on all capital, together with another 5 per cent. on such as has been laid out on permanent works, such as levelling, carriers, roads, &c.

BALANCE SHEET FOR YEAR ENDING FEBRUARY 2ND, 1874.

Dr.					Cr.				
1873.		£	s.	d.	1874.		£	s.	d.
Feb. 2nd.	To Capital	1,043	7	4½	Feb. 2nd.	By Cash in hand	18	8	6
Feb. & Mar.	„ Capital advanced by Col. Jones	150	0	0	„	„ Valuation—Live Stock £741 0 0			
July.	„ „ „ „	150	0	0	„	„ „ Dead Stock 688 9 4	1,429	9	4
1874.					„	„ Improvement (at cost price) .	334	18	5½
Feb. 1st.	„ Interest on above Capital, viz.: One Year at 5 per cent. on £1,193 7 4 = £59 13 4				„	„ Profits on dealings with Agricultural and Horticultural Association	2	12	10
„	„ Half-year at 5 per cent. from July on £150 0 0 = 3 15 0				„	„ Open Accounts . . .	63	7	2
„	„ Payment to Sinking Fund for permanent improvements, 5 per cent. on £334 18 5½ = 16 14 1								
		80	2	5					
	„ Capital—One-half Year's Rent to date . . .	170	12	6					
	„ „ Poor Rate . .	17	0	0					
	„ „ Open Accounts .	51	10	9					
	„ „ Balance . .	186	3	3					
	Total . .	£1,848	16	3½		Total . .	£1,848	16	3½

BALANCE SHEET FOR THE YEAR ENDING FEBRUARY 2ND, 1875.

Dr.	£	s.	d.
To Balance of Sundries and Implement Account	32	4	0
„ „ Rent and Taxes Account	0	9	8
„ „ Barley Crop (Couch Field)	15	18	6
„ „ 1873 Crops	3	17	3½
„ Interest on Capital, viz. :—			
One Year at 5 per cent. on £1,830 = £91 10 0			
Sinking Fund at £5 per cent. on			
£479 = 23 19 0			
	115	9	0
Balance of Profit	276	4	6½
Total	£444	3	0

Cr.	Acres.	£	s.	d.
By Balance, Italian Rye-grass Account	13	184	16	10½
„ „ Mangolds Crop	5	46	8	10
„ „ Filter Beds (Market Garden)	4	20	15	10½
„ „ Permanent Pasture	41	58	8	4
„ „ Oat Crop	2½	11	5	6
„ „ Wheat Crop	6	56	10	11
„ „ Potatoes	2	2	6	4
„ „ Carrots	1½	0	17	9
„ „ Tank Account (Solid Manure)	1	17	17	0
„ „ Barley Crop (Couch Field), from Dr. side	6	—		
Total Acres	82			
By Balance, Dairy and Stock Account		44	15	7
Total		£444	3	0

BALANCE SHEET FOR THE YEAR ENDING FEBRUARY 2ND, 1876.*

Dr.	£	s.	d.
To Balance of Sundries and Implement Account .	37	4	0
„ „ Oat Crop (Couch Field) . .	48	6	1
„ „ 1874 Crops	19	9	4
„ Interest on Invested Capital, viz.:—			
„ 3 Months at 5 per cent on £1,900 = £23 15 0			
„ 9 „ „ 1,300 = 48 15 0			
„ Sinking Fund „ 550 = 27 10 0			
	100	0	0
Balance Profit	271	18	6½
Total .	£476	17	11½

Cr.	Acres.	£	s.	d.
By Balance, Italian Rye-grass Account .	17	275	1	1
„ „ Mangolds Crop . . .	5	28	0	3
„ „ Filter Beds (Market Garden)	3	17	19	3
„ „ Permanent Pasture . .	56	30	14	4
„ „ Oat Crop	4	6	12	6
„ „ Barley Crop . . .	4½	23	15	9
„ „ Odd Crops (Potatoes, Turnips, &c.)	5	9	2	10½
„ „ Oat Crop (Couch Field, from Dr. side)	6	—		
Total Acres .	100½			
By Balance, Dairy and Stock Account .		67	13	6½
„ „ Tank Sludge . . .		13	3	4
„ „ Rent		4	15	0
Total .		£476	17	11½

* The Dairy Stock was handed over by valuation, 15th May, 1875, to Mr. George Jackson, who purchases fodder for his stock from the farm.

BALANCE SHEET FOR THE YEAR ENDING FEBRUARY 2ND, 1877.

Dr.	£	s.	d.
To Balance of Couch Field Turnips (6 Acres) .	0	0	9
(Above level of Tanks manured with Sludge.)			
„ Balance of Loss on 1875 Crops Account. .	3	0	1½
„ „ „ Tank Sludge . . .	1	0	2
„ „ Horse Labour	23	3	6
„ „ Sundries and Implements . .	24	4	0
„ Interest at 5 per cent. on £1,600 . £80 0 0			
„ Payment to Sinking Fund, 5 per cent. on £700 . . . . 35 0 0			
	115	0	0
(To pay off cost of permanent improvement during term of lease.)			
„ Balance Profit on the Year's Farming . .	392	19	0½
Total . . .	£559	7	7

Cr.	Acres.	£	s.	d.
By Balance Italian Rye-grass Account .	17 .	229	2	11
„ „ Mangolds	6½	56	6	11½
„ „ Market Garden . . .	5 .	52	2	3
„ „ Permanent Pasture. . .	52 .	52	2	7½
„ „ Wheat Crop	5 .	55	6	6
„ „ Oat „	4 .	22	6	4
„ „ Potato „	4 .	20	4	0
„ „ Dairy	0 .	38	15	8
„ „ Rent	1½ .	33	0	4
Total Acres .	95			
Total . . .		£559	7	7

BALANCE SHEET FOR THE YEAR ENDING FEBRUARY 2ND, 1878.

Dr.	£	s.	d.
To Valuation of Live and Dead Stock . .	877	3	2
„ „ Permanent Improvements. .	786	6	5
„ Wages	464	5	6½
„ Rent, Rates, and Taxes	455	6	7
„ Other Payments	160	10	8
„ Interest on Capital at 5 per cent. on £1,600 . . . . £80 0 0			
„ Payment to Sinking Fund, at 5 per cent on £800 . . . . 40 0 0			
	120	0	0
(To pay off cost of permanent improvement during term of lease.)			
„ Balance Profit on Year's Farming. . .	105	2	5
	£2,968	14	9½

Cr.	£	s.	d.
By Receipts	1,188	4	8
„ Sundry Debtors	154	19	9½
„ Valuations, Live and Dead Stock . .	818	4	0
„ „ Permanent Improvements . .	807	6	4
	£2,968	14	9½

In the villages of the West Riding of Yorkshire, which contain from 2,000 to 7,000 people each, and no water-closets, the value of sewage appears to be recognized, for, in a day's walk in that part of the country, scores of instances will be seen of the slop-water from a house or a row of houses being carried by a gutter on to a sloping meadow instead of into a ditch. At Idle, Cullingworth, and Harden, near Bradford, this has been done on a somewhat systematic and more extended scale, apparently with very satisfactory results.

From the foregoing notes it appears—

1st. That there are upwards of 100 owners and occupiers of land in Great Britain who use sewage for the sake alone of what they can get out of it by agricultural means.

2nd. That of this number more than 60 are tenant farmers who continue to use it although they have, annually at least, the option of ceasing to do so.

3rd. That of the latter number about five-sixths, and of the total number about three-fourths, actually pay money for the use of the sewage, either in the form of out-fall rent, unquestionable increase of land rent, or the price of occasional dressings.

Nearly four thousand acres of sewage land have been referred to, and these are in the hands of more than a hundred distinct occupiers. These occupiers may be divided into three classes:—

Those who have to cleanse a certain quantity of sewage on a certain area of land;

Those who may take, or leave alone, as much of a town's sewage as they please; and

Those who may take, or leave alone, what sewage can be spared by others having a prior right.

The first class occupies 1,670 acres of sewaged land,

and deals with the sewage of twenty distinct sanitary districts, with an aggregate population of about 200,000, on as many as twenty-one different farms.

Of these twenty-one farms, twelve are let by local authorities to tenants who undertake to cleanse the sewage as well as use it for their own purposes; and nine are held by persons who take the sewage on their land for no other reason than the belief that their holding will be benefited by it. Now, it is a fact deserving the notice of local authorities, as well as of private users of sewage, that while ten out of the twelve authorities having sewage to use, manage to become owners or lessees of *arable* farms, six out of the nine agriculturists who take sewage with all its liabilities for the sake only of fertilizing their land, happen to occupy permanent grass farms. Now, taking the second class, composed of persons using as much or little sewage as they please. These are sixteen in number, and, with the sewage of about a quarter of a million people at their command, irrigate amongst them nearly 1,500 acres.

This area, with the exception of part of the Edinburgh land, about an acre of osiers at Tyldesley, and part of the Handsworth land, which bears rhubarb, is entirely occupied by permanent grass. The difference between this class of sewage user and the first, consists in this one having the power to pass the dirty water on if it is not wanted, and so neglect to prevent river pollution, and cast the duty on some one else. It is of the highest importance, therefore, to establish what are the periods during which the interests of the unfettered sewage farmer dictate that he shall let any one else have the sewage for better or worse.

At Crediton, where sewage is only put on grass land, it appears to be passed on during "most of the summer."

At Devizes, it is not used while the hay is tall or being made.

At Edinburgh, three watermen are employed in summer to irrigate the Craigentinny Meadows, and one in winter.

At Handsworth it runs on to grass land all the year round.

At Leek, the outfall, commanding meadows only, discharges on to those meadows during the whole year, except about six weeks or two months, when the growth of the grass prevents access to the channels without damage to the crop.

From Mansfield, the Duke of PORTLAND'S bailiff, Mr. WOODS, kindly reports that there is no season of the year at which the water cannot with advantage be turned on to the Clipstone Meadows.

At Plympton, the occupiers of Lord MORLEY'S Meadows are "crazy after the sewage," excepting during two or three months in the summer.

At Waltham Abbey, the town mead is irrigated from the middle of September till the beginning of May, when the occupier of the adjoining market garden takes the sewage.

These few notes show that the grass farmer can, without any scheming, do with sewage till May. Then comes the very important note from Leamington (where Lord WARWICK has produced sewage-grown roots to win ten silver cups and a number of money prizes) that "Root crops, with the exception of cabbages, never have sewage applied to them before May or June;" and another from Arle Court Farm, Cheltenham (where many prize mangolds have been grown) that Mr. WOOD has mangold on the same ground five years running.

Now, the third class, into which sewage users have

been divided for the purposes of this Paper, includes some sixteen or eighteen farmers at Leamington and Cheltenham, who, together, irrigate about 500 acres of land when the sewage can be spared to them. For this advantage they have been found ready to pay nearly £200 a year, besides doing such work as the land may require before it can be irrigated. What has been done at these two places goes principally to show that a farmer can, under a great variety of circumstances, if he chooses, try a dressing of sewage on his field (whether arable or pasture) without any such outlay as would only be justified after he had determined to irrigate permanently.

To any one desirous of trying the use of sewage on their land, but unacquainted with the practice, it will be satisfactory to learn that at no place mentioned (with seven exceptions) do the surface carriers, great or small, consist of anything but spade or plough cut channels. At Aberdeen and Guisborough, however, they are made of earthenware channel-pipes; at Penrith, channel-pipes are used for the permanent carriers, and portable wooden spouting is used for branch purposes. These both appear troublesome features—the one to keep in repair in a field occupied by cattle; the other to use, and their merit is by no means apparent. At Altrincham, channel-pipes were laid, but have, in a very large measure, been removed in favour of the simple grip. At Swinton the land first laid out had channel-pipes; but, in extensions, spade-cut furrows have taken their place. At Wrexham, solid channels are only used where the necessary proximity of their position to that of a pure watercourse makes them desirable; or where the gradients are so steep that channels simply cut in the ground would not stand. At Ware, the main carrier consists of a wooden spout packed up on legs or laid in the ground at regular gradients, and from this the

sewage is carried on to the land, as at Penrith, by means of smaller portable spouting.

The amount of alteration required by the surface before land can be satisfactorily irrigated with sewage must of course vary with localities; but what has been done at Leamington and Warwick by some fifteen users of sewage, both on meadow and arable land, as well as at Chorley, and several of the places where grass land has been irrigated, proves that, under very varying conditions, it is practicable to irrigate land with the same surface that has been given to it by the process of ordinary farming.

Besides the cost of great levelling operations, the tendency they have to rob parts of the surface of their share of soil, is a decided disadvantage. Few accurately-levelled fields of rye-grass are free from patches of a yellowish colour, which, on investigation, turn out to be due to want of soil.

From what has been said about tanks, it is plain that they are only useful under certain circumstances, and that they require careful handling to prevent them from being a nuisance.

Upon the question of whether or no it is dangerous to graze and irrigate land at the same time, much valuable evidence has been adduced on the negative side, while none to the contrary has come under the Author's notice.

That heavy as well as light land may be profitably irrigated has been proved at Cheltenham, Crediton, Chorley, Leamington, and Swinton. It must not, however, be wanting in drainage; but if land be sufficiently drained, either naturally or artificially, for advantageous farming without sewage, it is sufficiently drained for the most advantageous use of sewage. Heavy land, however, under sewage should be laid down in pasture, for sewage adds considerably to the labour and difficulty in working it.

Climate has, no doubt, considerable influence upon all agricultural phenomena, but no variety to be met with in this kingdom south of Edinburgh seems to be inconsistent with the profitable use of liquid sewage. The meteorological character of the country varies very considerably between Edinburgh and Plympton; for, while the average annual rainfall at the latter place must be nearly fifty inches, that of Edinburgh is under thirty, and places situated at intermediate latitudes, where sewage has been profitably used, have annual rainfalls varying from the twenty-five inches registered at Chelmsford and Guisborough, to double that amount at Penrith, Cockermouth, and Cleator Moor.

The question of whether the separate system of sewerage is desirable or not requires a few words. It concerns, principally, those who are obliged to cleanse all the sewage that comes to them. There are twenty-one such cases referred to, and the Author is in a position to know that, in fourteen of them, those most interested would gladly see storm waters kept out of the sewers. Thirteen of these gentlemen, including Mr. BLACKBURN, Colonel JONES, Admiral CHALONER, and Captain FOSBERY, speak from experience of arable farms, and there can be little doubt that they are right; but with grass land the question is not of such importance. Subsoil water, which makes a less varying addition to the flow of sewage, is probably always an advantage to the sewage farmer, provided only he has enough land for the proper utilization of all the manure contained in the sewage he has to deal with.

The sewage of a town has never, probably, been spread over enough land for its complete utilization; and one thing that must always make this difficult, in the majority of cases, is the absence of available water in sufficient

quantities to spread the sewage where it is required in summer, and to irrigate the already highly-manured land, which requires moisture rather than manure. It is plain, from the table referring to the Leamington farm, that, the field which received nearly fifteen thousand tons of sewage per acre, between the 8th of February and the end of August last year, a very large proportion of the manure must have been wasted, for, supposing the average manurial value of the refuse of the Leamington population to be 10*s.* per head per annum, then the value of the dressing per acre would be about £107, which is, probably, at least four times the value of the crop that it could produce.

"Sewage sickness" is a term that has become common, because it sounds appropriate; but, as a matter of fact, time has no effect in making land "sewage sick," for its pores may be filled, as at Edinburgh, year after year, with infinitely more dissolved manure than can possibly be made use of by vegetation; and the land will continue to be as productive and as capable of receiving sewage as ever. A crop may, however, be ruined if it is covered with sewage, even although it may not have had enough for its manurial requirements; or land may be done more harm to than good, temporarily, by one single ill-timed dressing. Experience has proved that over-feeding with sewage for years has no ill effect, although land may be choked with it in one meal.

At none of the places mentioned, excepting one, has the use of sewage involved the user in litigation. The Ware Local Board were, however, a few years ago, summoned before the magistrates by the Lee Conservancy, who alleged that sewage was allowed to run over the surface of the ground into the river, but the case was dismissed.

The object of this Paper has been to lead to an increase in the present number of sewage farmers. If this is to come about largely, sewers must be laid out with a view to commanding by their outfalls (or by outfalls that might be made if required) the greatest area of land, and the greatest number of agricultural properties or holdings. Would-be sewage farmers must bear in mind that there is a large variety of circumstances under which it would be possible, and very advantageous to a town, to send part of its sewage to a farm, although that farm may be at level considerably above the general outfall level of its whole system of sewers.

Advocates of sewage precipitation processes should not regard sewage farmers as their rivals; for a chemical process might be very largely used with advantage where farmers are being persuaded or taught to use sewage. But this should be the distinct aim of all authorities; for there is no chemical process that could not be worked to greater advantage during two months of the year than twelve, or applied to a small quantity of sewage at less cost than to a large.

In conclusion, thanks are due to the many gentlemen in nearly every district who have given valuable assistance towards the preparation of the statistics of this Paper.

TABLE No. 1.

	Population.	Process.	Interest on Loan at 3½ per cent.	Loss in Working.	Gain in Working.	Total Annual Cost.	Cost per Head per Annum.
			£	£	£	£	s. d.
Blackburn	90,000	Irrigation	3,394	1,226	—	4,620	1 0¼
Merthyr	53,330	,,	1,866	1,067	—	2,933	1 1¼
Tunbridge Wells . .	23,000	,,	3,186	528	—	3,714	3 2¾
Wolverhampton. . .	71,000	,,	1,330	—	646	684	0 2¼
West Derby. . . .	31,400	,,	2,217	—	1,015	1,202	0 9
Kendal	13,700	Filtration	660	—	385	275	0 4¾
Leeds	285,000	Precipitation	2,135	15,000	—	17,135	1 2½
Bradford.	173,723	,,	2,100	6,276	—	8,376	0 11½
Coventry	40,000	,,	420	2,850	—	3,270	1 7½

HEATHCOTE FARM.—*Crops and Quantities of Sewage applied in* 1877.

CROP.	Acreage. A. R. P.	Times dressed.	Total Tons of Sewage.	Tons per Acre.	Value of Sewage per Acre. £ s. d.	Tons per Acre per Dressing.
Permanent Pasture and Italian Rye-grass	33 0 0	29	393,643	11,928	87 4 6	411
Italian Rye-grass	8 0 0	26	85,468	10,708	76 10 6	412
Ditto ditto	8 2 0	27	93,979	11,056	80 17 0	409
Ditto ditto	4 0 0	36	58,510*	14,627	107 0 0	401
Ditto ditto	8 0 0	14	45,938	7,492	54 16 0	535
Ditto Strawberries and Rhubarb	10 1 34	18	72,128	2,585	18 18 0	144
Fallow for Oats	7 0 0	20	56,378	8,054	58 18 0	402
Ditto for Mangold	5 1 12	15	30,913	5,805	42 8 6	387
Cabbage	4 2 0	5	16,333	3,630	26 10 6	726
Ditto	5 0 0	4	9,481	1,896	13 16 6	474
Mangold	14 0 14	13	89,568	6,358	46 10 0	489
Ditto	7 0 0	23	58,664	8,380	61 6 0	364
White Turnips	3 0 0	2	3,133	1,044	7 12 6	522
Italian Rye-grass	11 0 36	32	143,638	12,796	93 11 6	400
Savoys	2 0 0	2	2,173	1,086	7 19 0	543
Fallow for Turnips	20 0 0	5	42,000	2,100	15 7 0	420
Italian Rye-grass	20 1 17	7	32,268	1,585	11 11 0	226
Parsnips and Cabbage	9 0 4	10	45,000	4,986	36 9 0	499
Permanent Pasture	10 3 24	4	17,500	1,605	11 14 6	401
Fallow for Mangold	9 1 29	4	17,500	1,916	14 0 0	479
Sewage supplied to Farmers			190,000			
Total			1,504,215			

* The whole of this quantity was applied between the 8th February and 31st August.

NOTE.—100 tons of sewage per acre represents a dressing an inch thick.