On the health of towns : as influenced by defective cleansing and drainage. And on the application of the refuse of towns to agricultural purposes / Being a lecture delivered at the Russell Institution, May 5, 1846.

ON THE

HEALTH OF TOWNS,

AS INFLUENCED BY

DEFECTIVE CLEANSING AND DRAINAGE.

AND ON THE APPLICATION OF THE

REFUSE OF TOWNS

TO

AGRICULTURAL PURPOSES.

BEING A LECTURE DELIVERED AT THE RUSSELL INSTITUTION, MAY 5, 1846.

BY

WILLIAM A. GUY, M.B., CANTAB.

PROFESSOR OF FORENSIC MEDICINE, KING'S COLLEGE; PHYSICIAN TO KING'S COLLEGE HOSPITAL, &c. &c.

Second Edition.

LONDON:
HENRY RENSHAW, 356, STRAND.
1846.

LONDON:

PRINTED BY G. J. PALMER, SAVOY STREET, STRAND.

ADVERTISEMENT TO THE SECOND EDITION.

SINCE the first edition of this Lecture was published, its subject has derived new interest and importance from two events which are well fitted to follow the one upon the other. The one is, the probable repeal of the corn-laws, by which English agriculture is opened to competition, and the other, the reference to a select committee of the House of Commons of the bill of the Metropolitan Sewage Manure Company, and of the general question of the application of the refuse of the metropolis to the purposes of agriculture. The increased importance thus conferred on the subject-matter of the second part of this Lecture has induced the author to exercise much care in its revision, and to make slight alterations in the text, and some additions to the Appendix.

The Lecture was originally printed at the instance of several gentlemen who were present at its delivery. Its object was to promote the cause of sanatory improvement by connecting the health of towns with

the important question which has lately engaged so much of public attention; and, especially, to prove that the waste of health and life at present taking place is closely connected with a waste of the raw material of food. It is scarcely necessary to state that the lecture takes a popular rather than a profound view of the subject. Such alterations have been made in it as were rendered necessary by the want of the tables and diagrams by which it was illustrated, and a series of Appendices have been added, which will be found to contain additional illustrations of the leading positions advanced.

LECTURE.

Gentlemen,

In seeking this opportunity of addressing you on the *Health of Towns*, I have been influenced partly by a sense of the great and growing interest which attaches to this subject, and partly, but in a still greater degree, by my own deep conviction of its surpassing importance. It is this conviction which has induced me, on more than one occasion, to offer my services, as a lecturer, to the Health of Towns' Association; and in doing so, as in addressing you this evening, I feel that I am acting in the spirit which has influenced the most distinguished members of my profession, who have ever esteemed it both a duty and a privilege to make known the means by which disease may be prevented, and health preserved; knowing full well, from their own daily experience, how much more is to be effected by the simplest methods of prevention than by the most skilful attempts at cure.

The great and growing interest, which, as I have

said, attaches to the subject of the Public Health, and to that of the Health of Towns, as an important constituent part of it, is of comparatively recent origin; for although health has always been justly regarded as the first of earthly blessings, and its preservation as a sacred duty, it has been looked upon rather as an individual concern, than as a matter in which communities and nations have a deep and lasting interest. Hence, though individuals have always shown themselves solicitous for the preservation of their own health, the health of the mass of the people has attracted little attention, and has been rarely made the subject of legislation.

The national indifference to this subject, however, like the equally strange apathy evinced in the matter of education, has lately been replaced by an interest and a zeal more worthy of a great and enlightened people; and the period is evidently fast approaching when the Public Health will take its place among the matters most deserving of the care and attention of the Legislature.

The sanatory movement, of which you must all have witnessed some indications, may be said to date from the publication, in 1842, of the valuable Report of the Poor Law Commissioners on the sanatory condition of the Labouring Population of Great Britain. This was soon followed by the appointment of a commission for inquiring into the health of large towns and populous districts, which issued its first report in the year 1844, followed by the publication of a vast mass of additional evidence, and by some valuable suggestions

based upon that evidence. The importance which the government attached to the labours of this commission was evinced by a paragraph in the speech from the throne, at the opening of the last session of Parliament, and still more satisfactorily by the Towns' Drainage Bill, which, with some essential improvements, we may hope soon to see passed into a law.

To complete this short sketch of the rise and progress of the sanatory movement, it is necessary to mention the gratifying fact that in the metropolis and in the principal provincial towns, associations have been formed for the purpose of diffusing a knowledge of the circumstances that injuriously affect the health and lives of their inhabitants, and of the means by which the one may be preserved and the other protected. Nor must I omit to state that the working classes, who are the great sufferers by the neglect of sanatory measures, have formed among their own body an association for the same laudable purpose.

But a still more convincing, and, if possible, more gratifying, proof of the hold which this great movement has taken upon the public mind, is to be found in the fact that a young nobleman, Lord Ebrington, not satisfied with the honour which waits on rank, but determined, in the true spirit of nobility, to earn his own independent claim to the respect and gratitude of the public, has lent a new grace and dignity to the office of the lecturer, by becoming a public teacher of the great truths revealed by the labours of the Health of Towns' Commission. I, for one, must confess that I am not indifferent to the companionship into which this act

of his lordship has brought me, and that I appear here this evening with more satisfaction, when I reflect that in the useful labours of public teaching, I have his countenance and example.

I have thus briefly alluded to the leading particulars of the sanatory movement with a view of justifying my appearance among you this evening, on the score of the interest which my subject is calculated to excite.

But the labours of the Health of Towns' Commission prosecuted in the spirit of Mr. Chadwick's valuable report, have given an unusual interest to the subject of the health of towns, by demonstrating that public health is a branch of national economy, that unnecessary sickness and premature death impeach the prudence, no less than the humanity of the nation which suffers them, and that sanatory measures are, in every sense, and in every way, a gain.

Among the most striking illustrations of this great and important truth, the most remarkable, perhaps, is the value which has been assigned to those refuse matters of towns, which, when allowed to accumulate within their precincts, impair the health of their inhabitants, and give rise to severe and fatal diseases.

Nor is it possible to overlook the additional interest which attaches to this part of the sanatory question in consequence of the great and comprehensive measure of commercial reform which has been so lately submitted to the legislature by Sir Robert Peel. This is not the place nor the occasion for discussing the merits of this measure; but I may be permitted to allude to the apprehension existing among the owners and cul-

tivators of land so far as to observe that the value attached to the refuse of towns, coupled with the proved possibility of applying it to the land with an economy at present unknown, and, by the great majority of persons not even imagined, is calculated to remove such apprehensions, and to place beyond the reach of doubt the power of England to compete in agriculture as in manufactures with the most favoured nations of the world.

To establish this position is one of the objects of this evening's lecture, in the course of which I hope to be able to show that the principal cause of the unhealthiness of towns is to be found in the presence of those very substances which, if applied to the land, would endue it with inexhaustible fertility, that health and plenty are thus indissolubly united, and that we have it in our power, at the same time that we are effecting a great economy, to confer an immense benefit on every class of the community.

These leading statements resolve themselves into a series of subordinate propositions, which may be briefly stated thus. 1. That towns are unhealthy; 2. That one of the leading causes of their unhealthiness is defective cleansing and drainage; and 3. That the refuse of towns, which, when allowed to accumulate within their precincts, impairs the health of their inhabitants, and gives rise to severe and fatal diseases, may be most advantageously applied to agricultural purposes.

I shall address myself to each of these propositions in turn. And first, as to the fact that towns are unhealthy.

This fact stands in need of no laboured demonstration. All the inhabitants of towns are conscious of it, and practically admit its truth. But the degree of that unhealthiness is not quite so generally known; I must, therefore, display it by the aid of figures. For this purpose I avail myself of one of the reports of the Registrar General, from which it appears that if we compare one million of the inhabitants of large towns with the same number of the inhabitants of rural districts, the inhabitants of towns lose nearly 8000 more every year than the inhabitants of the country. The exact number is 7,773.

Another proof of the unhealthy condition of our large towns is to be found in the low average duration of life of their inhabitants. For instance, the mean duration of life in Surrey is 45 years; it is 37 for London, and only 26 for Liverpool. The inhabitants of the metropolis, therefore, taking one with another, when compared with those of Surrey, lose 8 years of their lives, and the inhabitants of Liverpool 19 years!

The unhealthiness of large towns, therefore, is proved both by the excessive mortality, and by the low average age at death of their inhabitants.

It may be interesting to compare the mortality of some of our principal towns.*

Taking the average number of deaths for the three years 1840—42, and comparing that number with the population, as ascertained by the census of 1841, we obtain the following results;—Liverpool loses every year 35 in the thousand; Manchester 32; Bristol 31; Hull and Leicester 30; Preston 29; and so on until

* See Appendix A.

we come, step by step, to Halifax and Kidderminster, which have a mortality of 21 in the thousand. Several towns of considerable size present the still more favourable rate of 20 in the thousand, 2 per cent, or 1 in 50.

The mortality of our large towns, therefore, varies from 35 in the 1000—that of unhappy Liverpool, to 20 in the 1000—that of several populous towns. The mortality of England is 22 in the 1000, or 1 in 45.

The most obvious inference to be drawn from this statement is that, as a general rule, towns, and especially large towns, are extremely unhealthy; which is the first subordinate proposition that I undertook to establish.

A very important inquiry which connects itself closely with this proposition, and forms a necessary link in my chain of reasoning, is this, *are all parts of our large towns equally unhealthy?*

A single fact will suffice to furnish an answer in the negative to this question. In one of the reports of the Registrar General, the several districts of the metropolis are divided into three groups of ten districts each, under the titles of the *healthiest*, the *medium*, and the *unhealthiest* districts.

The ten *healthiest* districts, with an allowance of 202 square yards of space to each person, have a mortality of 1 in 49.

The ten *medium* districts, with about half the space namely, 102 square yards, lose 1 in 41.

While the ten *unhealthiest*, with the meagre allowance of 32 square yards to each inhabitant, have a mortality of 1 in 36.

From this table we learn two facts, first, that some

parts of large towns are much more fatal to life than others, (an answer to our question,) and secondly, that the mortality increases with over-crowding, attaining its highest point in the most densely peopled districts.

Now, I need not tell you that these crowded districts are the abodes of the labouring classes and of the poor—the districts of narrow lanes, blind courts, and dark cellars—the chosen resorts of filth and fever, of every physical and moral abomination, of all the barbarism that hides itself in the midst of the splendours and triumphs of civilization. A description of the worst of these places could not fail to excite emotions of disgust and horror. They combine in a frightful degree all that is most offensive to the senses, most revolting to the feelings, most injurious to health, most fatal to morals. In one word, they present in their most hideous and revolting aspect the inevitable consequences of the cruel system of *laissez faire*,—a system which is the shame and reproach of England, and which, if persevered in, will one day be her ruin.

I might produce, if time permitted, a vast number of illustrations of the great truth, that, as things now are, the poorest and most densely peopled districts of our large towns are the seats of an excessive mortality. But I must proceed. I will, however, merely state, *en passant*, that Liverpool, which is the most densely peopled town in England, is also the unhealthiest, and that Manchester, which emulates it in this respect, as well as in the large population of cellar-dwellings and blind courts which it contains, comes next in order;

while Birmingham, which allows its inhabitants more room to breathe, has no cellar-dwellings, and few blind courts, presents a far more favourable rate of mortality.

The towns and parts of towns, then, which are most densely peopled, are also most unhealthy; and I have already stated that the most crowded districts of our large towns are those which are inhabited by the labouring classes and the poor; so that I might with equal propriety have affirmed that the districts inhabited by the labouring class and the poor are extremely unhealthy. Those whose professional avocations, or motives of charity lead them to visit the streets and houses of the worst parts of the metropolis will have no hesitation in admitting the truth of this statement. But even they are probably not quite prepared to hear of such a fearful sacrifice and curtailment of life as have been shown to exist among the class inhabiting these districts. Thus, to take a single metropolitan parish—that of St. Giles', and St. George's Bloomsbury, —while the gentry who inhabit the open squares and broad streets, live on an average forty years, the working class, who inhabit narrow lanes, blind courts, and dark cellars, live only seventeen years; that is to say, they lose, one with another, just twenty-three years of their lives. In Shoreditch, the loss amounts to twenty-eight years. I might multiply examples of this fact to almost any extent, but I think that I have given a sufficient answer to my question, and have proved what is by no means unimportant for my present purpose, that sickness and death press most heavily on

the crowded districts inhabited by the labouring classes and the poor.

I now, therefore, proceed to prove my second position,—*that one of the leading causes of the unhealthiness of towns is defective cleansing and drainage*; and I shall do this by means of a single striking and familiar example.

The Rev. J. Clay, of Preston, in his evidence before the Health Commission, institutes a comparison between three classes of streets in that city, which he characterizes as "*well-conditioned*," "*moderately-conditioned*," and "*ill-conditioned*;" or, in other words, *well-cleansed and drained*, *moderately cleansed and drained*, and *badly cleansed and drained*. To these he adds a fourth class, consisting of certain courts and alleys selected from the ill-conditioned quarters, as being the very worst among the bad. The results of this comparison are very striking. In the *well-conditioned streets* the mortality among children under one year old, is 15 in the 100; in *moderately-conditioned streets*, 21 in the 100; in *ill-conditioned streets* 38 in the 100; and in the *worst-conditioned streets* 44 in the 100, being, as nearly as possible, three times the mortality of well-conditioned streets.

I might adduce similar evidence of the fatal effects of deficient cleansing and drainage from the evidence laid before the Health Commission by competent and skilful observers in Liverpool, Manchester, Nottingham, Leicester, and the chief centres of manufacturing and commercial activity. But I prefer to strengthen my position by adducing the beneficial results which

have followed an improved system. Mr. Holland of Manchester states that in 20 streets in Chorlton-on-Medlock, the mortality fell from 110 to 89 per annum, after, and no doubt principally in consequence of, the streets being properly paved and drained. Mr. Gardiner and Mr. Noble have confirmed the result by showing that in certain streets in St. George's district, Manchester, the deaths in 1838-9, amounted to 495; but that in 1841-2, after the streets were paved and sewered, the deaths were only 432, being a diminution of 53, or about one-eighth. In a district in Ancoats, a diminution of 40 deaths out of 270, or about one-seventh, followed a similar improvement.

But a still more striking illustration of the same fact may be found nearer home. It is contained in Mr. Liddle's evidence before the Health Commission.

"Windmill-court, in Rosemary Lane, was one of the most unhealthy in my district. It was unpaved and filthy, and with stagnant water before the houses. I used to visit it sometimes two or three times a day for fever cases. About twelve months ago it was flagged; it was well supplied with water from a large cast-iron tank, which enables the inhabitants to have a constant supply instead of an intermittent one, on three days a-week. The court is regularly washed down twice a-week, and the drains are so laid that all the water passes through the privy and carries off the soil, which was formerly a most foul nuisance, and a constant expense to the landlord. In the seven months ending March, 1843, I attended 41 new cases of sickness in that court; in the last four or five months, I have had but two cases."

I need scarcely add that these improvements *paid* the landlord.

Having now proved, by two opposite modes of illustration, that defective cleansing and drainage are among the leading causes of the unhealthiness of large towns, let us next inquire a little more narrowly into the effects which they produce. What are the diseases occasioned by this neglected state of the poorer districts of our large towns?

In addition to a general impairment of health and unusual liability to disease, there is one particular class of disorders which is always to be found in these neglected places. I mean the class of contagious disorders. History teaches us that pestilence has always haunted scenes of filth. The plague, the black death, the camp, jail, and ship fevers, the cholera,—all have made these scenes their favourite resort, and typhus fever, our modern pestilence, forms no exception to the rule. I shall content myself with a single authority in support of this statement. It is that of the experienced physician of the Fever Hospital, Dr. Southwood Smith, who has taken so active a part in the great sanatory movement.

"The records of the London Fever Hospital," he says, "prove indubitably that there are certain localities in the metropolis and its vicinity which are the constant seats of fever, from which this disease is never absent, though it may prevail less extensively, and be less severe in some years, and even in some seasons of the same year, than in others." "In former years, in

some localities there was not a single house in which fever had not prevailed, and in some cases not a single room in a single house in which there had not been fever." "The districts in which fever prevails are as familiar to the physicians of the Fever Hospital as their own names."

Now, what is the character of these districts? In answer to this question hear Dr. Southwood Smith again.

"In every district in which fever returns frequently and prevails extensively, there is uniformly bad sewerage, a bad supply of water, a bad supply of scavengers, and a consequent accumulation of filth; and I have observed this to be so uniformly and generally the case, that I have been accustomed to express the fact in this way:—if you trace down the fever districts on a map, and then compare that map with the map of the Commissioners of Sewers, you will find that wherever the Commissioners of Sewers have not been, there fever is prevalent, and, on the contrary, wherever they have been, there fever is comparatively absent."

These are strong expressions, but I believe not stronger than the author of them is warranted in using.

Some idea may be formed of the evils which our negligence in the matter of sewerage and drainage inflicts, when I tell you that the annual deaths from typhus fever amount to 16,000, and the attacks of this loathsome disease to between 150,000 and 200,000!

Of the *expense* which this disease entails upon the

community I shall have an opportunity in the course of the evening of giving you a very striking example.

I have now, as I trust, proved to your satisfaction, —1, *That towns are unhealthy;* and 2, *That one of the leading causes of their unhealthiness is defective cleansing and sewerage.* It now only remains that I prove to you that this fruitful cause of disease may be made a source of fertility,—that it is within our power to minister to the health of our towns and the fruitfulness of the surrounding country by one and the same means.

I shall do this by establishing the two following subordinate propositions.

1. That the refuse matters of our towns are rich in the elements of production.

2. That these refuse matters may be conveyed and applied to the land with facility and economy.

And, *first*, as to the value of the refuse matters of our towns. I shall prove this by *à priori* arguments; by chemical analysis; and by actual experiment.

At present, as you are well aware, the only refuse matters of our towns which are employed as manure, (and that to a very limited extent,) are the sweepings of streets, and the contributions of the ash-pit and the cess-pool. The valuable contents of our sewers are allowed to run to waste. It is to these, however, that I wish to direct your attention; and I am anxious to prove, anterior to any chemical analysis, that they must needs abound in all the elements of the food of plants.

In the first place, wherever a proper system of house-drainage prevails, the valuable excreta of the human frame containing the ashes of all the food that has been consumed by the inhabitants, find their way into the sewers. Experience has proved that these excreta, but especially the urine, are among the most effective of our manures; and that they far exceed in value the products of the farm-yard and all solid manures, not even excepting guano. It is well known too, that in China, and in those parts of the continent of Europe where agriculture is most skilfully practised, great store is set by this fertilizing liquid.

To this, the most important constituent of sewer-water, we must add, as also derived from house-drainage, the alkalies, potash and soda, which are so largely used for household purposes, in the form of pearl-ash, soap, and common salt. These alkalies form, as is well known, very important elements of the food and structure of plants.

Such, then, are the valuable matters poured into our sewers, wherever a proper system of house-drainage is in force.

Large contributions are also made to the same fertilizing liquid by the refuse of slaughter-houses, markets, and manufactories. The animals fed and worked in our large towns also enrich the sewer-water, by that portion of their excreta which finds its way, in a more or less circuitous manner, into the sewers. Then we must not forget that our granite roads, rubbed down by constant traffic, furnish a large and valuable

supply of silica, alumina, and iron, in a state of minute division, and therefore, ready to become the food of plants.

I have yet to mention the large quantity of soot rich in ammonia and sulphurous acid, which, issuing from our chimneys, is brought down by every shower, and conveyed direct into the sewers, forming a not unimportant addition to their contents.

I should not have entered so much into detail with regard to the contents of our sewers, but that I thought it of great importance to prove by every possible means the value of the fertilizing liquid which we are now so ignorantly wasting.

Having now proved the value of sewer-water by tracing the elements of which it consists, and the several sources from which it is derived, I proceed to prove its value by *actual analysis*. Not that any analysis can add much to the conviction of the value of sewer-water, which the most careless consideration of the sources from which it is obtained must produce. All the constituents of the food consumed by human beings, with the exception of the water and gaseous matters which exhale from the lungs and skin, and which go to swell the immense ocean of aërial manure, must find their way into the sewers; and it is obvious that these substances, with the straw and other unconsumed produce of our fields, form the complement of the water, carbonic acid and ammonia which are floating in the atmosphere. All the other substances which I have named are additions to these, the most valuable constituents of sewer-water.

This statement is fully borne out by actual analysis of sewer-water. I will take the Metropolis as the town in which we have the greatest interest, and avoiding all minor details will present you with the results of a calculation which I have made. The ordinary daily amount of sewage discharged is 9,502,720 cubic feet, or 57,016,320 gallons; and each gallon contains, on a moderate computation, 50 grains of saline matters, constituting the essential elements of plants. I leave out of consideration the valuable matters in suspension. The saline matters removed from 100 acres of ground (50 wheat and barley, and 50 green crops), is 6437 lbs. A calculation based on these data gives 2,104,590, as the number of acres which could be supplied annually with the materials of their present amount of production; being at the rate of upwards of an acre to each inhabitant.

An analysis of the water of the River Medlock, which may be said to constitute the open sewer of a considerable part of the town of Manchester, gives a similar result.

If we take the nitrogen as our test of the quantity of land which could be supplied with the elements of wheat (all the other elements are in much larger proportion) no less than 93,440 acres, or little short of 100,000 acres, of wheat land could be manured by the sewer-water of one of the worst drained towns in England. Now, the inhabitants of the part of Manchester drained by the Medlock fall short of 100,000, so that it follows that in a town in which house-drainage is notoriously imperfect, there is every

* See Appendix B.

year poured into the river for each inhabitant a quantity of fertilizing matter sufficient to supply an acre of wheat.

Even with its present imperfect system of house-drainage, the Medlock contains a sufficient quantity of *phosphoric acid* to supply 95,000 acres of wheat, 184,000 acres of clover, 258,000 acres of potatoes, or 280,000 acres of oats. The *silica* (flint) in solution is sufficient to supply 50,000 acres of wheat. And there can be no reasonable doubt that taking one crop with another, for every inhabitant of a large town there is at present thrown into our rivers, and carried out to sea, fertilizing matter sufficient to crown an acre of land with plenty.

In both these estimates I am assuming the present average produce of the soil; but it is confidently anticipated that under the use of liquid manure that produce would be doubled or trebled, and that consequently the area supplied would be diminished in a corresponding proportion.

But the most satisfactory and convincing proof of the value of the refuse of towns is afforded by the results of its actual application to the purposes of agriculture.

I shall give you a single example of this in the case of Edinburgh, in the immediate neighbourhood of which city the sewer-water has, for a long time, been in extensive use. It appears that by irrigation with sewer-water, lands which were originally worth 30*s.* or 40*s.* to £6 an acre now fetch from £30 to £40 an acre, that poor sandy land on the sea-shore which might be worth 2*s.* 6*d.* an acre now lets at an annual rent of from £15

to £20, and that part of the Earl of Moray's meadow has yielded as high a rent as £57 per acre. So enormous is the increase of value conferred by this fertilizing liquid, that the parties interested in 300 acres of land estimate the compensation that would induce them to discontinue the use of the sewer-water at £150,000. Similar results have been obtained at Milan, and in all other places where liquid manure has been brought into use.*

I have now shown by *à priori* argument, by actual analysis, and by experiment, the great value of the refuse matter of our towns. I next proceed to show *that this refuse matter can be easily and cheaply conveyed and applied to the land.*

The water as it flows from the sewers is a dirty liquid holding a large quantity of valuable salts in solution, and a variable proportion of less valuable matters in suspension. If, after removing the lighter substances which float on the surface, the heavier matters held in suspension are allowed to subside, which they do in the space of two or three hours, the supernatant liquid, though still containing the most valuable elements of plants, will admit of being dealt with as if it were common water. Now we all know from the experience of Water Companies how easily and economically large quantities of water can be transmitted to great distances by machinery. If this plan were adopted, it is laid down by high authority, that while the cost of the cartage of solid manure would amount, under the most favourable circumstances, to 4*s*.

* See Appendix C.

per ton, the cost of conveying sewer-water by machinery would be only 2½*d.* a ton. According to another high authority, while the distribution in the solid form costs about £3, that in the liquid form costs only 6*s.** It has also been experimentally proved that the sewer-water admits not merely of being conveyed to the land thus economically, but that it can be easily and cheaply distributed over the land by means of a hose.†

It would appear from the estimate which I have just adduced, that the cost of conveying the sewer-water by pipes and distributing it by hose would amount to from one-tenth to one-twentieth of the expense entailed by cartage and distribution in the ordinary manner.

In proof of the economy of this mode of distribution by machinery and pipes, I may mention that not long since a plan was seriously proposed of dissolving the guano as it arrived at our sea-ports, and distributing it by means of pipes over the country.

But this distribution by machinery and pipes has been actually put to the test of experiment on a farm of 300 acres in the neighbourhood of Glasgow, where an intelligent and spirited agriculturist has found it worth his while to lay down pipes throughout his estate, at a cost of 30*s.* an acre, and to distribute the liquid manure by a steam engine at one end and a hose at the other. The steam engine was already in use for other purposes.

I may mention that the pipes which are thus made subservient to the distribution of the most valuable ma-

* See Appendix D. † See Appendix E.

nure in existence may also be employed for the purposes of irrigation in seasons of drought, and I have it on the highest authority that in a single dry summer, the cost of the pipes would be defrayed by the water which they would convey.

You will observe that I have assumed without hesitation that there is but one reasonable way of dealing with this valuable manure, namely, to convey and distribute it in the liquid form, as clean water is now conveyed to our towns.

Common sense, confirmed by ample experience, points out the liquid form as that which is in every respect the most convenient as well as the most effective. The water-closet, which, even in the houses of the poor, is fast superseding the barbarous and costly cesspool, is obviously the cheapest and most efficient means of removing the offensive refuse of our houses; the sewer is in every respect an immense improvement upon the nightman's cart; the proposed conveyance of its contents by machinery is a still more obvious step in advance of the tardy and expensive carriage in the solid form; while the distribution by hose completes the chain of wholesome and economical expedients. Add to these considerations the employment of the same machinery for irrigation in seasons of drought, and the system is complete.

One might almost imagine that under the guise of a fable the wisdom of antiquity had designed to shadow forth the excellent uses and surpassing efficacy of water as a scavenger. The strength of a Hercules could not contend successfully with the filth of the neglected

stable, till he had called in to his assistance the irresistible might of water. So, in our heroic days, that which an army of scavengers cannot effect, rivers of water conducted by the strong arm of machinery shall accomplish with ease. The worse than Augean filth of our large towns shall be swept away, and with it the pestilence that lurks in scenes of filth; and as if to make amends for the fearful evils which it has inflicted, the cruel parent of disease shall become the source of overflowing plenty, thus affording to future generations a tardy compensation for the evils inflicted on the past. So much for water as a scavenger. I must not forget that my present business is to consider it as a vehicle for manure, and that I am pledged to show that the liquid form is that in which it may be best conveyed and applied to the land.

I presume that it is quite unnecessary to adduce any proof that the food of plants must be presented to them in a liquid form. It is well known how much the success of all solid manures depends upon the accident of their application being followed by rain, and how completely the best of them will fail in seasons of drought. The extraordinary efficacy of irrigation with mere river water is another proof of the superiority of liquid manure. The small quantity of matter held in solution in the water, applied to the roots of the plant in this manageable form, yields better results than large quantities of solid manure.

But it would be a mere waste of time to enlarge upon this point. The advantage of applying manure dissolved or suspended in water may be taken for

granted; and this being the case, the whole question is virtually set at rest. There remains, indeed, that part of the question which relates to the machinery itself, a question into which it would be presumption in me to enter. I cannot, however, allow myself to suppose that the English engineer will encounter any difficulty in combining in one harmonious system all the obvious requisites for the distribution of the sewer-water, viz., economy, efficiency, and the avoidance of all nuisance in the neighbourhood of his works. To have any misgiving upon this point would be to call in question the engineering skill which is every day triumphing over the greatest difficulties.

In this application of machinery to agriculture it must be obvious that nations abounding in large towns, and having a small proportion of waste land, must possess an immense advantage over thinly peopled and newly settled countries; for while their supply of manure is larger, the distance to be traversed by pipes is less. Adopt this system, and the fear of foreign competition will prove as unfounded as it is unworthy of Englishmen.

I have neither time nor inclination to notice the alternative of continuing to waste all the liquid refuse of our towns, or of employing only the solid deposits, deprived of the most valuable of their constituents.*

I should be grieved, indeed, to think that this dream of sanatory and agricultural improvement was doomed not to meet with its fulfilment. I trust that the commercial enterprize of the people, under the wise control and direction of the Government, will soon put the value of the liquid refuse of our towns, and the pro-

* See Appendix F.

posed methods of conveying and distributing it to the test of experiment; that we may no longer be outraged by this two-fold sacrifice of human life and of the elements of abundance.

I regret that the narrow limits of a lecture do not permit me to enter more minutely into this part of my subject. Indeed, there is not a single proposition which I have put forward that I would not willingly have illustrated by additional facts, arguments, and authorities. But, in touching thus lightly upon matters of so much importance, I have been partly influenced by a desire to reserve a small space for a broad and comprehensive view of my subject as a great question of national economy. I am anxious to take a pounds-shillings-and-pence-view of the matter. Not that health is not far too precious, and life far too sacred to be weighed against gold and silver. They are both beyond all price. Nevertheless, pounds, shillings, and pence may be fairly employed in illustration of the value of health and life; and they form a just measure of the waste of the valuable material which, as I have shown, exercises so baneful an influence upon both.

I stated, at the beginning of this lecture, that the deaths occurring every year in a million inhabitants of large towns, exceed the deaths occurring in the same number of inhabitants of rural districts by nearly 8000. Now, if we estimate the population of our large towns at 4,000,000, we shall certainly be very much below the mark; but even this estimate will give an annual excess of deaths of upwards of 30,000.

But a more satisfactory mode of calculating the mortality of our large towns is to take these towns one

by one, to ascertain the sum total of the deaths that occur in them year by year, and to compare that total with a healthy standard. I have made such a comparison in the case of thirty-six of our large towns.

The population of these towns in the year 1841 was 2,791,835, and the excess of deaths on the average of three years, 1840, 1841, and 1842, above the healthy standard of 2 per cent. was, 20,101. The population of the metropolis at the period of the census was 1,873,817, and the average excess of deaths above 2 per cent. for the same three years was 8,404. If these thirty-six towns are added to the metropolis, the population amounts to 4,665,652, and the excess of deaths above 2 per cent. to 28,505.*

But there are several large towns not included in this calculation which also suffer from a very high mortality, and if they were added, the total excess of deaths would be raised to considerably more than 30,000.

This number of 30,000 deaths, large as it may appear, is, however, less than the annual waste of life occurring in England and Wales; for assuming, as before, that the annual mortality of England and Wales admits of being reduced to 1 in 50 instead of its present rate of 1 in 45, we should have an annual saving of no less than 35,000 lives, and in the United Kingdom, on the supposition that the mortality in Scotland and Ireland is only equal to that of England and Wales, (it is in fact much greater,) there would be an annual saving of upwards of 60,000 lives.

The assumption that the mortality of our large

* Appendix A.

towns, and *à fortiori* of the kingdom at large, may be reduced to 1 in 50, rests upon the best possible basis, namely, the fact that, in the year 1841, there were no less than 37 towns, some of them of considerable size, in which the mortality did not exceed that amount. There is, therefore, the very best ground for believing that the lives annually sacrificed by a neglect of sanatory measures do not fall short of the appalling number of 35,000 in England and Wales, and 60,000 in the United Kingdom. But such a waste of life pre-supposes a proportionate waste of health—a proportionate amount of unnecessary sickness. It is not easy to ascertain the exact relation which the one bears to the other, but if we take the estimate of Dr. Lyon Playfair, that for every unnecessary death there are 28 cases of unnecessary sickness, there will be every year in England and Wales one million of cases, and in the United Kingdom $1\frac{3}{4}$ million of cases of unnecessary sickness.

If you find it difficult to realise so enormous a waste of health and life, you have only to imagine a town of 35,000 or 60,000 inhabitants swept away every year from the face of the earth, over and above those who would die in the course of nature, if sanatory measures were in universal operation. To form a vivid idea of the amount of unnecessary sickness in the United Kingdom, you must imagine that in a city of the size of this metropolis, every man woman and child it contains, is the subject of one attack of sickness every year, over and above the sickness which would occur in the course of nature under a wise system of preventive measures. Such being the sacrifice of health and

life which annually takes place under our present system of neglect, let us endeavour to estimate it by the aid of pounds, shillings, and pence; and, as I have stated that the disease which has been most clearly traced to the filthy state of our towns, and the want of efficient cleansing and sewerage, is typhus fever, let us begin with this.

There is scarcely, as I think, a more striking or suggestive passage in the English language than the following:

"The Bethnal Green and Whitechapel Unions" (I quote from the evidence of Dr. Southwood Smith) "incurred an extra expense for fever cases for the quarter ending Lady-day, 1838, the one of £216 19*s.*, the other of £400, making a total of £619 19*s.*, and being at the rate of £2,467. 16*s.* a year," "and of the total number who received parochial relief in most of the districts, a very large proportion received it in consesequence of their being ill with fever; but in one district, namely, St. George's, Southwark, out of 1,467 persons who received parochial relief, 1,276—that is, the whole number, with the exception of 191, are reported to have been ill with fever."

If such is the cost of one disease alone, in a single parish or district, what must be the expense entailed by 35,000 unnecessary deaths, with the corresponding number of unnecessary attacks of sickness. In the evidence laid before the Health Commission will be found one or two attempts to solve this grave question. Dr. Lyon Playfair, for instance, has estimated the loss and cost of all the preventable sickness and death occur-

ring annually at Manchester, at very nearly 1,000,000 sterling, and Mr. Hawksley states the loss for Nottingham at 300,000. Taking Dr. Lyon Playfair's estimate, but without pledging myself for its accuracy, (though I may state that it is made with great care,) the annual loss and cost for the metropolis would greatly exceed two millions and a half; for England and Wales, it would fall little short of eleven millions; and for the United Kingdom it would be nearly twenty millions.*

There is something perfectly appalling in these figures, and our first feeling in regard to them is naturally one of incredulity. But a little reflection will convince us that they are not the gross exaggerations they may at first appear to be. If we call for the items of the account, and cast our eye over them we shall probably be satisfied with its moderation. Sickness entails loss of wages, medical attendance, nursing, and expensive diet; death, funeral expenses, and the support of widows and orphans. All these are costly, and the expense when multiplied by thousands and tens of thousands soon swells to millions.

When too we reflect on the large sums to which the taxes of this country amount every year; on the interest of the national debt; and on that huge voluntary tax which the people of England impose upon themselves in the shape of spirituous liquors and tobacco; we begin to think it is quite possible that unnecessary disease and death may also be very costly, and that the "fever-tax" may be the heaviest of all our burdens.

* See Appendix G.

I must now endeavour to estimate the other branch of national extravagance which I have brought under your notice—to fix a value on the manure which we are annually throwing into the sea.

I shall say nothing of the liquid manure which, as I have been given to understand, is suffered to drain away into the ditches, thence into the rivers, and from them into the sea, from fully one half of all the farmsteads of England ;* I will speak merely of the unappropriated refuse of large towns.

In Flanders, where manure is carefully collected, instead of being, as here, suffered to run to waste, the excreta of an adult are valued at £1.17*s*. Considering the enormous additions made to this manure in our towns, it will not be thought unreasonable to estimate the value of that part of the refuse which now runs to waste at £2 per head of the population; and supposing that in England and Wales, the towns which are guilty of this extravagance, contain in all only 5,000,000, inhabitants, we shall have an annual waste of at least ten millions of money.

I am now speaking of the gross value of town-manure, and not of the profit which it would yield ; for there is no commodity of which the value is more dependent upon the expense of conveyance and distribution than manure. Thus, manure, which on the field is worth 10 shillings a load, may have fetched in the place from which it was brought, only one shilling, or eighteen pence, the difference being the expense of cartage and distribution. But, in the case of liquid

* Appendix H.

manure, the cost of conveyance and application would be so small, as to increase the relative value of the manure itself, and to yield a large profit on the capital employed. This profit has been variously estimated at from 12 to 15 per cent.

Hence, after all the cost of its application to the land has been defrayed, the refuse of towns which now runs to waste, would have a high money value—a value probably far exceeding, one year with another, that of all the corn and manure which we import.*

If this estimate were extended to the whole of the United Kingdom, it seems highly probable that the value of town-manure annually wasted would be equal to the loss and cost entailed upon the nation by premature death and unnecessary sickness. According to this supposition, which does not appear unreasonable, the total annual waste from these two causes would be about 40,000,000*l.*!

Such, then, are rude, but I believe by no means exaggerated estimates of the twofold waste of health and life, on the one hand, and of the most valuable means of production, on the other, of which England is at present guilty, and it becomes a very serious question whether such extravagance can be persisted in without entailing the most alarming consequences. Our neglect of sanatory measures is obviously chargeable with no inconsiderable part of the heavy and increasing burden of the poor-laws, which, though their ostensible object be the relief of destitution and suffering, must tend to occasion both by withdrawing

* See Appendix I.

several millions a-year from the labour-fund, which fund would probably effect much more towards the prevention of poverty than the best devised system of poor-laws can possibly do to relieve it. Sanatory measures would have all the certainty which attaches to measures of prevention, while the poor-laws are open to all the objections and abuses which attach inseparably to the amiable but inefficient substitute for justice—charity.

Nor let us flatter ourselves that with our increasing population we can afford these annual sacrifices of life. Even admitting that these victims of neglect tend to relieve our redundant population (a theory which is now exploded, for it has been shown that fevers and consumptions instead of diminishing our numbers, tend only to multiply widows and orphans, and to substitute dependent for independent and productive citizens)—admitting, I say, that these victims of neglect were a relief to our redundant population, is there any one, I would ask, so infatuated as to think a large population an evil? If the dogma of Malthus, that population always tends to increase faster than the means of subsistence, were true, then a large population would be an unmitigated evil. But whatever the history of past times may seem to teach us, whatever our own observation may appear to suggest, of this we may rest assured, that neither history nor experience can suffice to establish the tendency in question. So perfect is the mutual dependence of the animal and vegetable kingdoms, that the increase of the one must lead inevitably to the in-

crease of the other, provided always,—and here is the hidden stumbling block of the school of Malthus—provided always, that the land receives back again that which has been removed from it in the shape of food. If, instead of restoring to the land all that we have taken from it, we perversely cast it into the sea, we bring about that exceptional state of things which Malthus, in his ignorance, regarded as the rule of the world, a part of the original design of Providence.

A very slight alteration of the favourite dogma, *population tends to increase faster than food*, will convert a dangerous fallacy into an important and useful truth. If, instead of asserting that *population has a tendency to increase faster than food*, we say *population tends to increase faster than human skill and economy applied to the cultivation of the soil*, we substitute a motive to exertion for one of the most depressing and paralyzing theories which the wit of man ever yet devised.

A large population is an essential element of a nation's greatness. England could not have attained to her present height of prosperity and power without it, nor can she hope to keep her proud place among the nations unless she fosters and encourages to the utmost the increase of her numbers. But a mere increase of numbers without a corresponding increase of wealth, would be an addition to our burdens; not an accession of strength. Wealth can only be made to keep pace with numbers by the exercise of economy—economy of health and life, economy of time, economy of all the means of production. We must contrive, above all things, to economise manure, which is the

raw material of food. If we persist in wasting that which we have at hand, we must soon exhaust all foreign supplies, and then we must be reduced, whatever may be our laws regarding the importation of corn, to that dependence on foreigners, which those whose want of economy and want of skill have brought about the necessity, inveigh against as the greatest evil that could befal us. An abundance of food lies at the root of all prosperity; for it is not till the imperious wants of nature are satisfied, that the artificial wants which civilize and exalt mankind spring into existence. The money which each man earns over and above that which is necessary for his sustenance, is the fund which purchases clothing, decent shelter, books, pictures, and all the instruments of improvement and refinement; and the creation of all these things supplies, in its turn, the materials of a prosperous trade and an extended commerce. Hence the immense importance of a skilful and economical system of agriculture—hence the imperative necessity for the exercise of a rigid economy of all the means of production—hence the promised value of the commercial reform which shall substitute for the paralyzing effects of protection the wholesome stimulus of competition.

It is impossible to view the position which England has attained without a lively apprehension. A vast colonial empire can only be retained by a decided naval supremacy, and naval supremacy pre-supposes commercial superiority; commercial superiority, in its turn, is based upon a large and cheap production of exchangeable commodities; and a large and cheap production

must ever find its best support in a large and wealthy home population; in other words, in a population having a large surplus of means over and above those which are necessary for the supply of the first imperious want of nature—food. To obtain a large industrial population—a population having a due proportion of adult labourers—we must preserve health and protect life by sound and comprehensive sanatory measures; to insure an ample supply of food, we must turn our own domestic resources to account. In both these respects England is highly favoured—her children naturally strong and robust, display every quality which ensures success to individuals or to nations—skill, energy, perseverance, courage, self-dependence—her climate, with all its disadvantages, being remote from the two extremes of heat and cold, is in the highest degree favourable to successful agriculture; her population large in proportion to the space they occupy, yield in abundance the raw material of food; and her towns, with their constant traffic and extensive manufacturing operations, are so many mechanical and chemical laboratories for rubbing down and preparing from the substances dug from the bowels of the earth, or reclaimed from the sea, the elements of the food of plants. These huge manufactories and storehouses of manure are as yet notorious chiefly for their fatal effects on health and life; but the time is near at hand when they shall be regarded in their true light, as the destined agents of a perfect revolution in agriculture, the centres from which a healthy and prosperous population shall distribute, through the length and breadth of the land, the elements of abundance.

The machinery which has hitherto been employed only in the service of the manufacturer, or in effecting the speedy and economical transport of men and merchandize, shall for the first time be devoted to the purposes of agriculture; and the very same means by which we shall henceforth be secured against the recurrence of drought, will be employed to reconcile abundance and cheapness of food with the interest of the owner and cultivator of land.

It is by this means, and not by legislation alone, that England must hope to keep her present place among the nations. In this, as in all other things, she must vindicate her claim to "teach the nations how to live," and above all she must combine a tender regard for human life with the encouragement of those exertions by which alone life can be supported. By economy of time and labour, England has achieved her greatness; by continuing to practise the same economy in respect to all her immense resources, she must preserve it. Want treads upon the heels of waste, and waste of food, or of that which is the raw material of food, in spite of the wisest laws, will entail upon us a continuance of the great evil under which this country has so often suffered —a high price of the first necessaries of life. Health and Plenty, the twofold theme of this evening's lecture, should be the first object of a nation's care; for health is the parent of wealth, and abundance the only sure source of all civilization—the only safe guarantee of national prosperity.

APPENDIX.

Appendix A.

Mortality of Towns.

The following tables will serve to illustrate the mortality of large towns. They are formed from materials obtained from the Reports of the Registrar General.

Mortality of Town and Country contrasted.

	Country Districts.	Town Districts.
Population to a square mile	199	5,108
Annual deaths in 1,000,000 living	19,300	27,073
Rate of Mortality	1 in 52	1 in 37
Annual excess of deaths in town districts		7,773

Mortality of large Towns, (1840, 1841, 1842.)

	Deaths per 1000.
Liverpool	35
Manchester	32
Bristol	31
Hull and Leicester	30
Preston	29
Bolton, Nottingham, Salford, and Wolverhampton	28
Ashton and Oldham, Birmingham, Bury, Leeds, Newcastle, Sheffield, Wigan	27
Bath, Coventry, Derby, Dudley, Rochdale, Shrewsbury Sunderland, Walsall	26
Carlisle, Gateshead, Norwich	25
Bradford, Clifton, York	24
Tynemouth	23
Aston and Basford	22
Halifax and Kidderminster	21

	Population 1841.	Annual excess of deaths above 2 per cent.
Liverpool, &c. &c.	2,791,835	20,101
Metropolis	1,873,817	8,404
Total	4,665,652	28,505

Appendix B.

Analyses of Sewer-Water.

The following table shows the quantities of the several constituents of plants contained in the water discharged by the River Medlock on the 2nd of October, 1845, that day being regarded as a fair average. It is taken from a recent report on the improvement of Manchester. The analysis is by Dr. R. Smith.

	Per diem.	Per annum.
Potass	178 cwt.	3,200 tons.
Soda	257 "	4,640 "
Lime	940 "	16,900 "
Magnesia	9 "	160 "
Phosphoric acid	71 "	1,280 "
Silica (in solution)	266 "	4,800 "
Alumina (ditto)	18 "	320 "
Oxide of Iron	124 "	2,240 "
Sulphuric Acid	444 "	8,000 "
Chlorine	151 "	2,720 "
Organic Matter, 1,355 cwt., containing 6 per cent. of Nitrogen, or	80 "	1,440 "
Insoluble matter, chiefly silica, alumina, and iron.	1860 "	33,600 "

A specimen of sewer-water collected at four different times of the day from the King's Scholars' Pond Sewer, gave the following results :—

Matters in solution, per gallon - - - 80 grains.
Matters in suspension, per gallon - - 1000 grains.

This specimen of sewer-water having been collected on a day on which no rain fell, is very rich both in soluble and insoluble matters.

An analysis of the sewer-water of Edinburgh as it flows from the sewer, gave 82·7 grains of solid matter in solution, and 244 grains of solid matter in suspension.

The 50 grains of saline matter assumed in the text, is therefore in all probability, very moderate.

The following table is important, inasmuch as it shows the value of the principal constituent of sewer-water. It will be found at length in the Report on the improvement of Manchester.

	Carried away from 50 acres of wheat and barley and 50 acres of green crops.	Excreta of 100 adults.
Potass and soda	780 lbs.	827 lbs.
Lime and magnesia	948	3158
Phosphoric acid	1549	1713
Silica	450	166
Metallic oxides	8	6
Sulphur and chlorine	21	87
Nitrogen	2681	2312

With the exception of silica, nitrogen, and metallic oxides, all the elements of the food of plants exist in the excreta of an adult in quantity more than sufficient to manure an acre of ground. The remaining silica and metallic oxides are contained in the unconsumed products of the soil, and the remaining nitrogen is partly in them, and partly exhaled from the human body.

Appendix C.

Illustrations of the Value of Sewer-Water.

"Edinburgh has many advantages over many of her sister cities; and the large supply of excellent spring-water is one of the greatest blessings to her inhabitants, both in respect to household purposes and in keeping the streets clean, and lastly in irrigating the extensive meadows situated below the town, by the rich stuff which it carries along in a state of semi-solution, where the art of man, with the common-sewer-water, has made sand-hillocks produce riches far superior to anything of the kind in the kingdom or in any country. The effect of the water is astonishing; they produce crops of grass

not to be equalled, being cut from four to six times a-year, and given green to milch-cows. The grass is let every year by public auction, in small patches, from a quarter of an acre and upwards which generally brings from 24*l.* to 30*l.* per acre. This year (1826) part of the Earl of Moray's meadow gave as high as 57*l.* per acre." — *From Mr. George Stephen's Essay on Irrigated Meadows, published in* 1829, pp. 72, 73.

"The practical result of the application of sewer-water is, that land which let formerly at from 40*s.* to 6*l.* per Scotch acre, is now let annually at from 30*l.* to 40*l.*; and that poor sandy land on the sea-shore, which might be worth 2*s.* 6*d.* per acre, lets at an annual rent of from 15*l.* to 20*l.* That which is nearest the city brings the higher rent chiefly because it is near and more accessible to the points where the grass is consumed, but also partly from the better natural quality of the land. The average value of the land irrespective of the sewer-water application may be taken at 3*l.* per imperial acre and the average rent of the irrigated land at 30*l*, making a difference of 27*l.*; but 2*l.* may be deducted as the cost of management, leaving 25*l.* per acre of clear annual income due to the sewer-water." —*Evidence of James Smith, Esq. Deanston. Report of the Health of Towns' Commission.*—Part ii. Appendix, p. 326.

"Some of the meadows irrigated by the sewage-water of Milan, yield a net rent of 21*l.* per tornatura, (a measure of 10,000 square metres, equal to about two acres and a-half,) besides a land-tax of 61 francs 10 cents, the expenses of administration, repairs of buildings, &c. These meadows are mowed in November, January, March, and April, for stable-feeding; in June, July, and August they yield three crops of hay for the winter; and in September they furnish an abundant pasture for the cattle, till the beginning of the winter irrigation."—*First Report of the Health of Towns' Commission.*—Vol. ii. p. 403.

Several instances have been recorded of the excellent effects produced by irrigation with water, containing but a small quantity of sewage manure. One of the most striking is that of the Duke of Portland's water-meadows at Clipstone Park.

"The land immediately occupied by these meadows was, in its wild state, a line of hill-sides covered with gorse and heather—a

rabbit warren, over which a few sheep wandered— and a swampy valley below, thick set with hassocks and rushes, the favourite haunt of wild ducks and snipes; through which the little stream, the Maun, wound its way in its descent from the town of Mansfield.

"The whole tract, both upland and lowland, was of very little value. The valley was in many parts from nine to ten feet deep in bog, and almost worthless; the hill-sides varied in quality, but 80*l.* a-year would have been a full rent for the 300 acres. Indeed, the whole of the Clipstone Park Farm, when taken in hand in the year 1816, containing 1,487 acres, had been let for the sum of 346*l.*

"The effect of this irrigation has been to raise the annual value of this land to 11*l.* 4*s.* per acre."—*Journal of the Royal Agricultural Society of England.* Vol. i. 1840, pp. 356, 367.*

Appendix D.

Cost of Conveying and distributing Liquid Manure.

"The cost of transmitting water to a distance of five miles, and to a height of 200 feet, including wear and tear of pumping machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to about 2½*d.* per ton. The cost of cartage to the same distance and height will, under favourable circumstances, amount to 4*s.* per ton."—*Evidence of T. Hawksley, Esq. First Report of the Health of Towns' Commission,* p. 322.

"It is quite clear that a very great weight of liquid material may be moved by pumping more cheaply than by any other known mode of conveyance."—Ibid. p. 322.

"On a full examination of the evidence adduced, and of the evidence indicated, it will, I trust, be found satisfactorily established, that the houses of towns may be constantly and rapidly cleansed of noxious refuse by adaptation of drains and public sewers, and that by such an adaptation, for one street or one district cleansed at the present expense, three may be cleansed by the proposed mode; that the natural streams flowing near towns may be preserved from the pollution caused by the influx of the contents of the public rivers, by

* The reader is referred for an analytical digest of the leading facts relating to this subject, to the prospectus issued by the Metropolitan Sewage Manure Company.

the conveyance of all refuse through covered pipes; and that the existing cost of conveyance, by which its use for production is restricted, may be reduced to less than one-fortieth or fiftieth of the present expense of removal by hand labour and cartage."—*Report of the Poor Law Commissioners*, &c., p. 63.

"By the application of capital and machinery, the cost of conveyance of substances in suspension in a fluid, even at the water companies' prices, may be rendered thirty and even more than forty times as cheap as collection by hand labour and removal by cartage. In the metropolis, where the persons who water the roads may obtain water gratuitously from pumps, the water supplied by standpipes by some of the water companies at 1*l.* per 100 tons is found to be twice as cheap as the mere labour of pumping the water into the cart."—Ibid. p. 53.

"The expense of distributing the same quantities of manure, irrespective of the different degrees of productiveness from the different modes of application, would be on the average, for distribution in the solid form, about 3*l.*, and in the liquid form, by irrigation, about 6*s.*"—*Mr. Dean. First Report on the Health of Towns' Commission.*

Appendix E.

Practicability of the proposed Plan of Conveying the Liquid Manure by Pipes, and Distributing it over the Land by Jets.

"The water could not well be distributed over the open tillage land by irrigation; it would therefore be necessary to resort to some mode of distributing it by jet. This requires the conveyance of the water in pipes, under a pressure of from 100 to 150 feet of altitude, to a number of convenient points in the different farms where it is to be used. In this there is no difficulty; it is a simple engineering question, the success of which is certain, while the cost can be estimated on known data. I made an experiment, on a large scale, at the Southwark Water Works, which satisfied me of the practicability of distribution by the jet. With an altitudinal pressure of 120 feet of water, and using a 2½ inch hose with a discharging orifice or nozzle of one inch in diameter, I found that I

could, from one point, distribute water over an area of two statute acres—but, to be safe, say one statute acre. Dividing the quantity so required annually into three portions, for separate applications, one jet of one-inch orifice will deliver each portion in about an hour, as ascertained from data founded on an experiment made the same day to ascertain the quantity of water discharged in a given time from a similar orifice with a similar pressure."—*Evidence of James Smith, Esq., of Deanston, Report of Health of Towns' Commission.* Part ii., Appendix, p. 327.

Since the first edition of this Lecture was published, I have witnessed an important experiment which fully proves the practicability of this mode of distribution.

Appendix F.

Observations on the proposed modes of dealing with the Contents of the Sewers.

Two methods have been proposed for applying the valuable refuse of towns to agricultural purposes. They are the exact counterparts of each other. The one collects the *solid* the other the *liquid* manure; the one constructs gigantic and costly works along both banks of the river in order to intercept the contents of all the sewers; the other adopts the more economical plan of dealing with single sewers or groups of sewers in detail: the one uses extensive open tanks, or settling ponds, the other covered wells: the one conveys all the refuse of the town to a distant point, so that, even if convinced of the error of wasting the liquid manure, the benefits of its distribution would be confined to a part only of the environs of the metropolis; the other diffuses its benefits equally over the surrounding country: the one resorts to the *dearest* the other to the *cheapest* mode of conveyance: the one produces a solid manure, of which a large proportion consists of mere silt, and the remainder must be injured by the proposed admixture of lime; the other has made to its hand a liquid manure, abounding in all the elements of plants, and which it takes care not to deprive of any of its valuable constituents.

Such are some of the leading features of the two plans. It will

be seen that the first plan is open to the following fatal objections. 1. It must entail an amount of expense, for which, in the present state of the money market, there is no hope of making provision. 2. The settling ponds, wherever they are situated, must create, on a gigantic scale, the worst nuisance of Edinburgh and Paris. 3. The solid manure, containing so large a proportion of silt, must have a very low value, which would be still further diminished by the proposed method of treating it with lime. 4. The expense of conveying the solid manure would still further depreciate its value as an article of commerce. 5. As its efficacy, like that of all solid manures, would be contingent on a fall of rain, or on artificial irrigation, its value would be liable to be still further depreciated by frequent experience of its failure. 6. If a supply of liquid manure should be grafted on the original plan, it could not be carried into effect to any extent without enormous expense, as the mains would have to be carried back to the remote districts from which a great part of the contents of the sewers had been derived. On the other hand, the second plan has these strong arguments in its favour :— 1. It can be carried out on a limited scale, and with a moderate capital, whereas the rival plan presupposes an enormous expense, before the process of collecting and manufacturing the solid manure can come into operation. 2. It creates no nuisance. 3. The liquid manure is acknowledged to be the most valuable in existence, and in the best form for application to the land. 4. The mode of conveying and distributing it by pipes and hose is obviously in the highest degree economical. 5. Its value is not contingent on rain or a supply of water from other sources, but it is most efficacious when solid manures are least so. 6. It will be much easier to graft a mode of collecting and using the solid contents of the sewer-water on the original plan of distributing the liquid manure, than it could possibly be to add the distribution of the liquid to the plan of using only the solid contents of the sewers. Lastly, (and this is an immense contingent advantage,) the same machinery by which the liquid manure is distributed, may be made subservient to irrigation in seasons of drought.

It may be well to correct one or two errors into which the opponents of the liquid-manure system have fallen, by stating that the

sewer-water, instead of being, as is often supposed, a thick, muddy substance, which it would be impossible to transmit through pipes, is to the full as manageable as the water of the Thames, and that, instead of being a nuisance to the inhabitants of the country, its odour is both less offensive and more transient than that of the solid manures now in use. The gases which arise in a concentrated state into houses and through gulley-holes, will be dissolved in water, spread over a large surface, rapidly absorbed by the soil, and freely exposed to the air.

It is necessary to notice one other objection to the liquid-manure system, namely, that while the liquid is pumped away, the solid matters are left behind to clog the sewers or to pollute the Thames. To this objection there are two answers. The liquid may be pumped away with all the matters which it holds suspended; or, if this should be deemed objectionable on the ground that the machinery might be injured and the pipes clogged, the following plan might be adopted. The sewer-water may be made to flow through a grating with openings of a quarter or half-an-inch in diameter, by which fragments of stone, brick, wood, cork, &c., may be arrested. These should be sorted, and such as are combustible, burned in the furnace. The sewer-water should then be received on a fine inclined sieve, or series of sieves of different degrees of fineness, so as to arrest the smaller floating matters. These should be collected, mixed with the ashes of the furnace, and, if necessary, with half-burned peat, sawdust, or burnt schale, and compressed so as to form dry inodorous cakes of solid manure. The liquid which passes through carries with it a certain proportion of silt, consisting of small fragments of granite, mixed with iron, some organic matter and salts. This from its great weight will fall to the bottom of the well in from one to two hours, and may be removed in any convenient manner. Though much less valuable than the floating matters, it is not valueless, for crushed granite is already in use as manure, and the silt consists of this substance mixed with a certain proportion of the more valuable matters just specified. The sieve might be in the form of a cylinder revolving on its axis, or an inclined plane resembling the machinery of a paper-mill. Such is the plan which I have been induced to suggest as strictly subservient to the distribution of

the liquid manure, but, at the same time, as possessing several obvious advantages, and combining, in a perfectly inoffensive manner, the best parts of the two plans which I have just contrasted; its peculiarity being, that it deals with the solid matters not primarily as a manure, but as a nuisance, and that it economises *all* the constituents of the sewer-water.

Appendix G.

Economy of Sanatory Measures.

Mr. Banfield, after estimating the savings which might be effected by the abolition of the Corn Laws, the reduction of the duties on sugar, the removal of duties on articles of necessity and raw produce, and the disuse of intoxicating liquors, at £55,000,000, goes on to say, "this divided amongst five and a half millions of families gives £10 10s. per annum, or five shillings a week additional to each. I am inclined to estimate the money saving that may be achieved by improving the health of towns at a sum equal to this."—*Four Lectures on the Organization of Industry, being part of a Course delivered in the University of Cambridge in Easter Term,* 1844, p. 78.

Appendix H.

"The recent urine of one cow is valued in Flanders, where liquid manures are highly esteemed, at 40*s.* a year. It contains on an average, as we have seen, 900 lbs. of solid matter, and this estimated at the price of guano only, is worth at present £4 sterling. Multiply this by 8 millions, the number of cattle said to exist in the United Kingdom, and we have 32 millions of pounds sterling, as the value of the urine, supposing it to be worth no more than the foreign guano. It is impossible to estimate how much of this runs to waste, but one-tenth of it will amount to nearly as much as the whole income-tax recently laid upon the country." — *Johnston's Agricultural Chemistry and Geology,* p. 681.

Appendix I.

Estimates of the value of Town Manure.

In Flanders, where much manure is used, the collected excrements

of a man are valued at 1*l.* 17*s.*"—*Dr. Lyon Playfair. Health of Towns Commission.* Part ii., Appendix, p. 47.

"I have ascertained that the quantity of sewer water due to a town of 50,000 inhabitants amounts to about 1,190,080,946 gallons per annum, which quantity will yield an annual application of 17,920 gallons per acre to an extent of 66,410 acres. Taking the average cost of guano and farm-yard manure at 2*l.* per acre, and deducting 12*s.* 9*d.*, the cost of the application of the Sewer Water, there will appear a saving due to the Sewer Water of 1*l.* 7*s.* 3*d.* per acre; allowing one half thereof to go to the farmer, there will remain a free income due to the Sewer Water of 45,241*l.*, which is nearly 1*l.* per head of the population."—*Evidence of James Smith, Esq., Deanston. Report of the Health of Towns Commission.* Part ii., Appendix, p. 328.

"Taking a general view of the subject, we may assume a clear revenue from the Sewer Water of all towns of 1*l.* for each inhabitant, either in a direct money return, or partly to the inhabitants in a reduced price, from the increased abundance of produce."—*Ibid.*

"The value of town manure may be estimated by the fact, that a portion of the drainage of Edinburgh, spread upon certain level lands towards the sea, has increased the value of these lands by more than 5000*l.* a-year; and that, if the whole drainage of London could be so used, at a sufficient distance from the town, the value would exceed 500,000*l.* a-year. Now engineers, who pump from the Thames many miles above London to supply pure water to the inhabitants, could as easily, by pumping away to any desired distance the fluid from the drains, supply the most valuable manure yet known (fluid town manure) to the horticulture and agriculture of the district; and the purity and beauty of the Thames, where it passes through London, would be preserved. Fluid manure, by sinking at once into the earth, is much less offensive to the neighbourhood, and affects less the purity of the atmosphere, than an equal quantity of solid manure spread, as it usually is, on the surface of the earth."—*From Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow*, p. 12.

LONDON:

G. J. PALMER, SAVOY STREET, STRAND.