

(1) Number of pages 24
(2) Date of repair 11-10-1983
(3) Initials of the Referencer _____

TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

REVENUE DEPARTMENT

G.O. No.	964	Press.
B.P. No.		Mis.
Dated	25-6-1878	197.

Not to be folded or roughly handled

Archives 1-5,806-24-2-78.

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

25th June 1878, No. 961.

Read the following paper:—

No. 298. Proceedings of the Board of Revenue, dated 16th May 1878, No. 1,326.

Read the following letter from W. R. ROBERTSON, Esq., M.R.A.C., Superintendent of Government Farms, to R. W. BARLOW, Esq., Collector of the Chingleput District, dated Sydapet, 8th March 1878, No. 220:—

I HAVE the honor to forward to you, for submission to the Board, a further report on the subsoil drainage experiment made on certain land belonging to the Kottur Village of the Sydapet Taluq in your district.

2. I agree generally in the conclusions and suggestions set forth in Mr. Schiffmayer's letter.

3. The inundation of the drained plots was, of course, highly detrimental to the action of the subsoil drains. The syphon to which Mr. Schiffmayer refers was believed to be permanently silted up, but after the heavy rain it began to discharge on the drained plots a volume of water about eight times as great as it was possible for the drain pipes to carry away even could the water have reached them at once instead of having first to percolate down through 4 feet of earth. The consequence of this was that water accumulated on the drained plots, at one time amounting to not less than one foot in depth over their whole area. Again from the position of the land it received the surface drainage water from a considerable area of neighbouring land. This latter drawback was taken into account when the land was selected for the experiment; it was thought that this surface drainage water could be carried away by a drain under the Adyar road apparently provided for the purpose, but it was afterwards shown that this outlet was altogether insufficient. There was thus a great accumulation of water on the land due to circumstances with which subsoil drainage has not usually to contend. We could by cutting a surface drain into the canal have got rid at once of this flood water, but it was considered objectionable to do this because the silt carried by the water might be deposited in the canal.

4. As I pointed out in paragraph 2 of my letter, No. 1,124, of the 7th of November 1876,* the land employed for this drainage experiment was when the experiment was begun in an exceedingly bad physical state from the swamping and puddling it had undergone while devoted to paddy cultivation.

5. As noticed by Mr. Schiffmayer the drains made 4 feet deep were more successful than those only 3 feet deep. As the cracks in the land by which apparently much of the earthy matter reached the pipes were widest at the surface, and contracted as they descended into the soil, it would, of course, follow that the deeper the pipes were laid the less liable would they be to become choked by silt reaching them through these cracks. However, much trouble is now experienced in getting a 4 feet drain trench cut in a satisfactory way, and it would be exceedingly difficult to get them cut to a much greater depth. It is true that the deeper the drain pipe is laid the wider may be the interval between each drain, thus, say, if a piece of land was satisfactorily drained when the pipes were laid 4 feet in depth and the drains were made 22 feet apart, almost as good results would be secured when the drains were 40 feet apart if

the pipes were laid 5 feet deep in depth; and of course the wider the intervals between the drains the less length of drain would be needed, and consequently the less number of drain pipes. If we could secure satisfactory work in cutting 5 feet drains, it would certainly be preferable to make them this depth than only 4 feet deep.

6. While I agree with Mr. Schiffmayer that the cracks caused by the shrinkage of the land while drying afforded the means by which much of the silt reached the pipes, I also hold the opinion that no inconsiderable quantity of the deposit was due to the downward drainage of the surface water after the first heavy rains flowing through the spaces which must have existed amongst the loose earth with which the drain trenches were filled. When it is remembered how much more open was the soil in the newly filled trenches, even when filled in with great care than was the undisturbed soil between each of these trenches, it will readily be understood that when the land was first flooded, the first rush of water would be down into the drain trenches.

7. As regards the cutting of the drain trench, we have undoubtedly experienced many difficulties, but, after further experience, it seems to me that we might in future overcome some of them by allowing the people engaged in cutting the trenches to work in their own way, while excavating to about four-fifths of the intended depth, the remainder of the excavation to be made by the use of special tools, in order to secure the narrowest cutting possible. In this way we might, I think, secure a solid bed for the drain pipe.

8. As regards a greater slope to be given to the pipes towards the outfall, I fear that this would be impracticable except in very rare instances the fall given to these pipes was 6 inches in 100 feet, and this is considered to be a very good fall and greater than is usually obtained.

9. I do not think that the silting of the pipes is to be attributed to any irregularity in placing them in position. Mr. Schiffmayer gave great personal attention to this matter, and from a large experience in carrying out subsoil drainage works both in England and in Ireland, I am certain that in either of these countries the same care employed in laying drain pipes would have secured satisfactory drainage results.

10. I do not think that it would have been an advantage to have used pipes of a smaller bore than those that were used. The usual rule is to select pipes of the smallest bore that will carry off all the water that reaches them after heavy rain. The smaller pipe, of course, concentrates the flow and makes a stronger current in the pipe which facilitates the removal of silt; but when pipes of a very small bore are used the least displacement of one of the pipes would cause injury to a long line of drainage. Taking into account the large quantity of water that sometimes falls during a shower in this part of the country it will not, I think, be generally safe to use in parallel drains pipes of a smaller bore than 2 inches.

11. It is quite true that in order to reclaim fully land in the state of that on which the experiment was conducted, much more is needed than merely to subsoil drain it; it is a much easier matter to reclaim and bring under cultivation land in a natural state than such land. However, drainage is undoubtedly the first step that should be taken in the reclamation processes. Subsoil ploughing, if possible, would do much good undoubtedly, but subsoil ploughing would be impracticable in a soil full of stagnant water; and in the dry season the difficulty of subsoil ploughing would be equally as great from the hard condition of the soil the result of its shrinkage.

12. After the drains have had time to influence the condition of the soil, it will not be liable to crack to any serious extent. The damage the drains receive from these cracks is, I believe, done generally in the first year, that is, before the soil has had time to benefit from the drainage. To meet this difficulty it would, I think, in the first year or two after drainage the silt might be collected and removed by means of these holes, when they might be permanently closed as it would be unlikely that much silt would reach the pipes after the end of the second year.

13. I believe that in this country, where as much as 6 inches of rain sometimes fall in 24 hours, not more than one inch of which may sink directly into the ground, it will always be necessary to provide surface drains for carrying off flood water even where the subsoil drainage is perfect.

14. It is evident from this and other experiments that we have conducted that we have yet much to determine before we can decidedly say what method of subsoil drainage is best suited for the conditions met with in this country. Arrangements are being made for trying other experiments in drainage on the Sydapet Experimental Farm, as it is evident that the matter requires a much fuller investigation than at first was thought necessary.

15. As the results from the subsoil drainage were not deemed satisfactory, no attempts were made to crop the land.

16. I enclose a map of the experimental ground, and forward one of the silted-up drain pipes.

ENCLOSURE No. 1.

From K. SCHIFFMAYER, Esq., Assistant Superintendent of Government Farms, to W. R. ROBERTSON, Esq., M.R.A.C., Superintendent of Government Farms, dated Sydapet, 15th February 1878.

WITH reference to the drainage experiment made in Adyar under my supervision in August and September 1876, I have the honor to submit that it did not admit of any conclusions being formed regarding its success until after the rains of the last monsoon had set in, on account of the abnormal season experienced last year.

2. After the first heavy shower of rain I examined the field on the 30th of October 1877 when I found the whole covered with a sheet of water to the depth of some inches; the main drain of Plot No. 1 was not discharging any water, but that of Plot No. 2 was discharging a considerable stream which however was very muddy, holding a great amount of earthy matter in suspension.

3. As more rain fell between the 30th of October and the 3rd of November, I examined the drainage again on Monday the 5th November when the field was found to be covered with water to the depth of about 6 inches; the main drain of Plot No. 1 was then discharging a large amount of clear water, but the outfall of Plot No. 2 was completely dry. The syphon which connects this field with the tank close by was discharging water on the field nearly to its full capacity.

4. The amount of water flowing from the syphon increased with the subsequent rains and nearly the whole of the water collected on the surface of the drained land. The stream of water from the syphon was turned from the drained land by making an embankment, but this was repeatedly broken down intentionally it appeared to get the water to flow to the land on the eastern side of the drained plots. The water thus flowed into the field for about ten days and accumulated there to a depth of about one foot. The main drain of Plot No. 1 continued to discharge until about the middle of December, and the standing water disappeared from the surface of the field at the end of November.

5. I must here state that when I inspected the field in question before the drainage was commenced, the occupier of the land, who was present, informed me that the syphon was silted up to such a degree that no water could reach the land. Accepting his statement to be correct, it was considered that there were sufficient indications to justify the expectation that the experiment would be instituted under satisfactory conditions.

6. Agreeably to your order, the main drain of Plot No. 2 was opened at the end of November last to ascertain the cause and extent of the stoppage when it was found that the main drain between the outfall and the second parallel drain was completely silted up. The work was then discontinued, because the soil was too wet to allow of free working.

7. At the end of January last the investigation was resumed when examination pits were excavated at several places as shown in the accompanying sketch. The following is the result:—

Plot No. 1 (DRAINED 4 FEET DEEP)—Pit No. 1, Junction of the Main Drain with the first Parallel Drain.—The junction of the main drain with the parallel drain was in perfect order. All the pipes were properly joined and were nearly free of sediment. The little deposit found in the pipes could be attributed to the roughness of the pipes; some fine rootlets had spread over this deposit.

Pit No 2, Parallel Drain No. 1 about 90 feet distant from the Junction.—The pipes were in perfect order, closely joined, but completely filled. The lower part of the pipes to about two-thirds of their capacity was filled with coarse sand and the remainder one-third with very fine sand; roots of tamarind tree were found in the pipes.

Pit No. 3, Junction of the Main Drain with the 7th Parallel Drain.—The junction of the main drain with the parallel drain was in perfect order; all the pipes were found to lie closely together. The pipes of the main drain were completely filled and those of the parallel drains to about three-fourths of their capacity with a mixture of clay and sand.

Pit No. 4, Parallel Drain No. 7, 90 feet distant from Pit No. 3.—The pipes were found to lie in complete order but completely filled with rough sand at the bottom and fine silt at the top.

Pit No. 5, Junction of the 11th Parallel Drain with the Main Drain.—The pipes were found in the same state as those of Pit No. 4.

Pit No. 6, Parallel Drain No 11, 90 feet distant from Pit No. 5.—The pipes were found to lie in a straight line but not very well joined and completely filled with rough sand at the bottom and fine silt at the upper part.

Plot No. 2 (DRAINED 3 FEET DEEP).—*Pit No. 1, Junction of the 1st Parallel Drain with the Main Drain.*—The pipes were found well joined but completely filled with rough sand at the bottom and fine silt at the top.

Pit No. 2, Parallel Drain, 90 feet distant from Pit No. 1.—The pipes were in the same state as those of Pit No. 1.

Pit No. 3, Junction of the 9th Parallel Drain with the Main Drain.—The pipes were all found well joined; 2-inch pipes were half and the 4-inch pipes $\frac{3}{4}$ filled with fine silt.

Pit No. 4, Parallel Drain No. 9, 90 feet distant from Pit No. 3.—The pipes were found well joined and half filled in three well-defined layers; at the bottom was found clay, then a layer of fine sand, and at the top again clay.

Pit No. 5, Junction of the 15th Parallel Drain with the Main Drain.—The pipes were found well joined, in the small pipes was little deposit but 4-inch pipes were nearly completely filled with fine silt.

Pit No 6, Parallel Drain No. 15, 90 feet distant from Pit No. 5.—The pipes were found well joined but half filled with fine silt.

8. The fact that the pipes at all the places where they were examined were more or less choked up with soil leaves no room to doubt but that the beneficial effects that resulted from the drainage could only have been very little, and in so far the experiment will have to be pronounced a failure.

9. The causes of the failure must, I think, be chiefly attributed—

- (1). To the technical difficulties experienced in carrying out the works.
- (2). To the great propensity of the soil to form cracks when drying.
- (3). To the great accumulation of water on the surface of the field.

10. With reference to the technical difficulties experienced, it will be sufficient to mention that it is considered one of the first conditions to be secured in draining that the bottom of the drain shall not be much wider than the outside diameter of the pipes to be used in order to prevent the shifting of the pipes, and to effect this the use of peculiarly shaped tools is necessary. But in this case the drains were cut only with crowbars and mamooties, which caused the drains to be made very wide to allow of free working with these tools. Although some heavy soil was filled carefully around the joining of the pipes, and I inspected every junction, yet it is quite possible that some pipes were not well joined; or they may have been well laid and afterwards moved by the incautious filling in of the soil, so far as to admit the ingress of soil, especially during the time when the field was inundated.

11. The formation of cracks will, of course, take place in every soil subjected alternately to great wetness and drought, and will for this reason be most large and abundant in soil composed chiefly of clay on account of its capacity to take up a great amount of water. This quality inherent in the clay is, however, considerably increased by mechanical operations when in a very wet state, by which the large capillary interstices and other greater cavities filled with air under ordinary circumstances are reduced in size to such a degree that no air can circulate in them at such a time, and as long afterwards as the soil is kept very wet. A soil in such a state may hold very often twice as much water as under ordinary circumstances. For this reason, a field which has been under the cultivation of paddy as commonly practiced in India for a long time becomes, if deficient in organic matter, disqualified for the production of plants of any agricultural value. A soil which took up a great amount of water must necessarily expand more than a soil which takes up but little of that fluid, and from this follows that it must also shrink more when drying, causing thereby the formation of large cracks.

12. The field under question was exactly in such an unfavorable physical condition brought about by the puddling of the soil for the paddy cultivation.

13. The cracks in the field were very large, and no doubt reached down to a great depth; many of them to the level of the pipes, especially of those which were laid only 3 feet deep. At the first heavy rain water by entering the cracks would be conveyed immediately to the pipes, the joints of which admitting the water at once, and if it held any earthy matter in suspension, this would also enter, but if the pipes were not well connected or otherwise out of order, the sand brought down by the force of the water would enter also, which once inside of the pipes would be deposited. The water in the pipes becoming less turbulent after having entered would not be able to carry away the coarse grains of sand. After a time the soil became saturated and expanded to such a degree as to close the cracks which would prevent the conveyance of the coarse sand into the pipes, fine sand only entering them. That this has taken place is apparent from the well defined stratification of the deposit in the pipes (a pipe showing the stratification of the deposit is herewith sent), and from the fact that the main drain of Plot No. II discharged muddy water immediately after the rain. This water could only reach the pipes by means of cracks or large holes, for if the water had percolated through the soil it would have reached the pipes in a clear state; moreover water percolating through such a soil as this requires a long time before it can filter through the soil lying above the level of the pipes. The pipes in Plot No. I were laid one foot deeper than those in Plot No. II, and were therefore most probably not so much effected by the cracks of the soil, an assumption confirmed by the fact that the pipes of the lower part of the main drain and even of the parallel drain were found nearly quite clear.

14. As the field is lower than the surrounding land and is not provided with means of surface drainage, the 6 inches of rain that fell on the 30th of October 1877 caused the water to accumulate on the field to the depth of about 4 inches. This water would have most probably disappeared within a few days afterwards if there had not been a constant supply by the siphon by means of which the water on the land rose to a height of about one foot, the weight of which must have considerably increased the force of the water running through the cracks and enabled it to keep more earthy matter in suspension and to carry with it a considerable amount of sand.

15. Although the results obtained by this experiment are of a negative character, yet it must not be concluded that it is hopeless to improve land in India by drainage. On the contrary, I believe, there are large tracts of land at present useless, or nearly so, which cannot be ameliorated without the application of drainage. Much of the paddy land which is without a sufficient irrigation supply to raise this crop, and has been rendered unfit by the puddling process in vogue to produce anything else, can scarcely be brought to fertility without the application of drainage. The first and indispensable measure to be adopted to reclaim such land is aerating, since the land has mainly come to the bad physical state by excluding the air, it is evident that the best method of ameliorating it must be found in the opposite direction; and that one of the best effects resulting from drainage consists in facilitating the circulation of the air in the soil will scarcely be denied at present by any one. It must be admitted that the drainage alone will seldom suffice to effect this, and I am convinced that drainage without the application of deep culture and organic manure would lead to many disappointments.

16. There are many cases where drainage merely would produce most beneficial effects on the soil, especially on such as have become excessively wet by the soaking of water from river canals or tanks situated at a higher level where a single open drain to intercept the water may very often suffice to bring a formerly useless piece of land to fertility, but to improve paddy land more or less barren as considered above, the application of deep culture and organic manure can seldom be dispensed with.

17. Assuming that the failure of the drainage at Adyar resulted from the causes mentioned, it remains to be determined how far they can be removed. As regards the technical difficulties, it must be confessed that the imitation of the practice followed in Europe will be nearly impossible. The cutting of drains in such a manner as to get a proper bed for the pipes and allow no room for their shifting can only be made by skilled laborers with proper draining tools. But the Indian laborer has no inclination to use other tools for excavation except his time-honored mamooty and crowbar, and if he were really inclined to use the draining spade, in most cases he would not have the strength to wield it, moreover, the soil during the greater part of the year is seldom in such a state that it can be worked with the spade without the assistance of the crowbar or pickaxe. Considering these peculiarities, it is evident wide drains with roughly worked bottoms very often cannot be avoided. To neutralise the bad effects resulting from wide and badly formed drains, I think the use of collars on the pipes would be of good service. But the application of collars causes another drawback, viz., that the pipes observed when covered by collars as when without them, and as the fitting of pipes cannot be so well adjusted of their use over pipes not quite round or straight, it follows that sand has easier access to the pipes encased in collars than to those without them. There is no other way left than to cover the ends of the collars with plastic clay.

18. The cracking of the soil, which proved so fatal to the drainage at Adyar, is an obstacle of much less importance than the foregoing, because admitting easier remedy. The first step to neutralise the bad effects accruing from the cracks is to drain very deep whenever sufficient fall for the drain can be obtained. As the cracks become more narrow on their descent it is evident that they must be much smaller on reaching pipes laid five or six feet deep than on reaching those laid only three or four feet deep. Moreover, deep draining is preferable from a financial point of view, since it admits of making the drains further apart, and reduces thereby the cost of material, which represents the greater item of expenditure in carrying out drainage.

19. When deep culture and manuring with organic stuffs is combined with drainage the size of the cracks will be considerably reduced, because the soil becoming porous to a greater depth will never become so dry, the circulation of air being facilitated the soil will absorb constantly moisture from the air, and the roots of plants being encouraged to strike down to a great depth will supply on their decomposition the sub-soil with organic matter, which, as is well known, has the power of absorbing moisture from the air in the highest degree. When the soil has become more porous, the water of the casual rains will enter the soil in greater quantity, so that less water will flow off from the surface unutilized. Since the great accumulation of water in the soil is prevented by drainage, the soil cannot expand so much as before, and will therefore shrink less.

20. It is not to be expected that the cracks will all disappear after drainage; this is not necessary and even not desirable. It is sufficient when they are reduced to such a size as not to convey sand and silt in large quantities to the pipes. The large quantity of rain falling at one time, and the force with which the water reaches the ground, causes the fine particles of soil to become suspended in water, and with it they are carried into the interior of the pipes.

21. Assumed that the pipes are properly laid, the only means to prevent the accumulation of silt is, I believe, to give the drains so much fall that the earthy matter suspended in the water is carried away by the current immediately on entering the pipes. It is acknowledged that the greater the fall that can be given to a drain the better, but as fields requiring drainage are mostly situated at a low level, it is sometimes admitted that drainage is possible as long as drains can receive a fall of one foot in 2,000. The parallel drains at Adyar received an artificial fall of about half foot in 100 feet, and, I should think, judging from the result that this fall is insufficient for Indian circumstances generally. But to give more than half foot slope for 100 feet length is impossible with most fields requiring drainage in this country; not only would it cause great expenditure to make an open drain for the escape of the discharged water, but the upkeep of the open drain would be very expensive.

22. In such cases I should think the safest way to success is to utilize wells for the discharge of water. The same well may be used for irrigation purposes. When the water stands too high in the well it can easily be lifted and let off by surface drains. In many cases the water bearing strata when not lying too deep, and when not thick, might be advantageously broken through and the water let off in this direction. This plan is often adopted in Germany when draining in large plains. It will be the safest, and I should say often the cheapest, to drain into a well, since the ryot is accustomed to pay attention to everything relating to his well; most probably he would neglect the outlets of his drainage made in another manner, which often would have to be made not on his own ground, and the result could only be a failure.

(True Copy.)

(Signed) W. R. ROBERTSON,
Superintendent, Government Farms.

ENCLOSURE No. 2.—Sketch Map.

SUBMITTED for the information of Government.

2. The experiment in sub-soil draining was not successful, and no attempt was made to crop the land. The drained plots were inundated. There was a great accumulation of water on the land; the sub-soil pipes choked so completely as to become a solid mass of indurated silt.

3. As Mr. Robertson observes there is much to be determined before it can be said what method of sub-soil drainage is best suited to the conditions of this country.

But the question is of very great importance, and it is only by continued patient and intelligent experiment and observation that it can be solved. The Board will await with interest the results of the experiments Mr. Robertson is now arranging.

(True Copies and Extract.)

(Signed) J. STURROCK,
Acting Sub-Secretary.

No. 299.

ORDER THEREON, 25th June 1878, No. 964.

Miscellaneous.

The experiments should be continued, but the Government desire to be furnished with a report of what has been done in the way of drainage on the Farm itself.

(True Extract.)

(Signed) C. G. MASTER,
Secretary to Government.

To the Board of Revenue.

Edw. F. R. Bantleman.

REVENUE DEPARTMENT.

No. 2531.

From Board of Revenue.

Dated 16th May 1875.

FOR ORDERS.

For notice of the
minutes of the committee
- etc. but call for a
report on the Dykes
- comments on the
same from
25/5/75

Off. of (1878) Revenue

To REVENUE.

THE BOARD OF REVENUE.

Dated June 20th.

Recd.

Recd.

G.O., 20th June 1875, No. 931.

JUN 20

No. 203-203.

Sub-soil Drainage Experiment made at Mr. Adger's, Chingput District. - Observing that the same should be continued, and desiring to be furnished with a report of what has been done in the way of drainage on the farm itself.



2001

FOR ORDERS.

Enclosure No 2
in a letter from the
Supt. of Genl. Land
in the Collection of
Chimney, dated
Sept. 8. 1840
p. 20

Dec 23/40

Dec 23/40

Dec 23/40

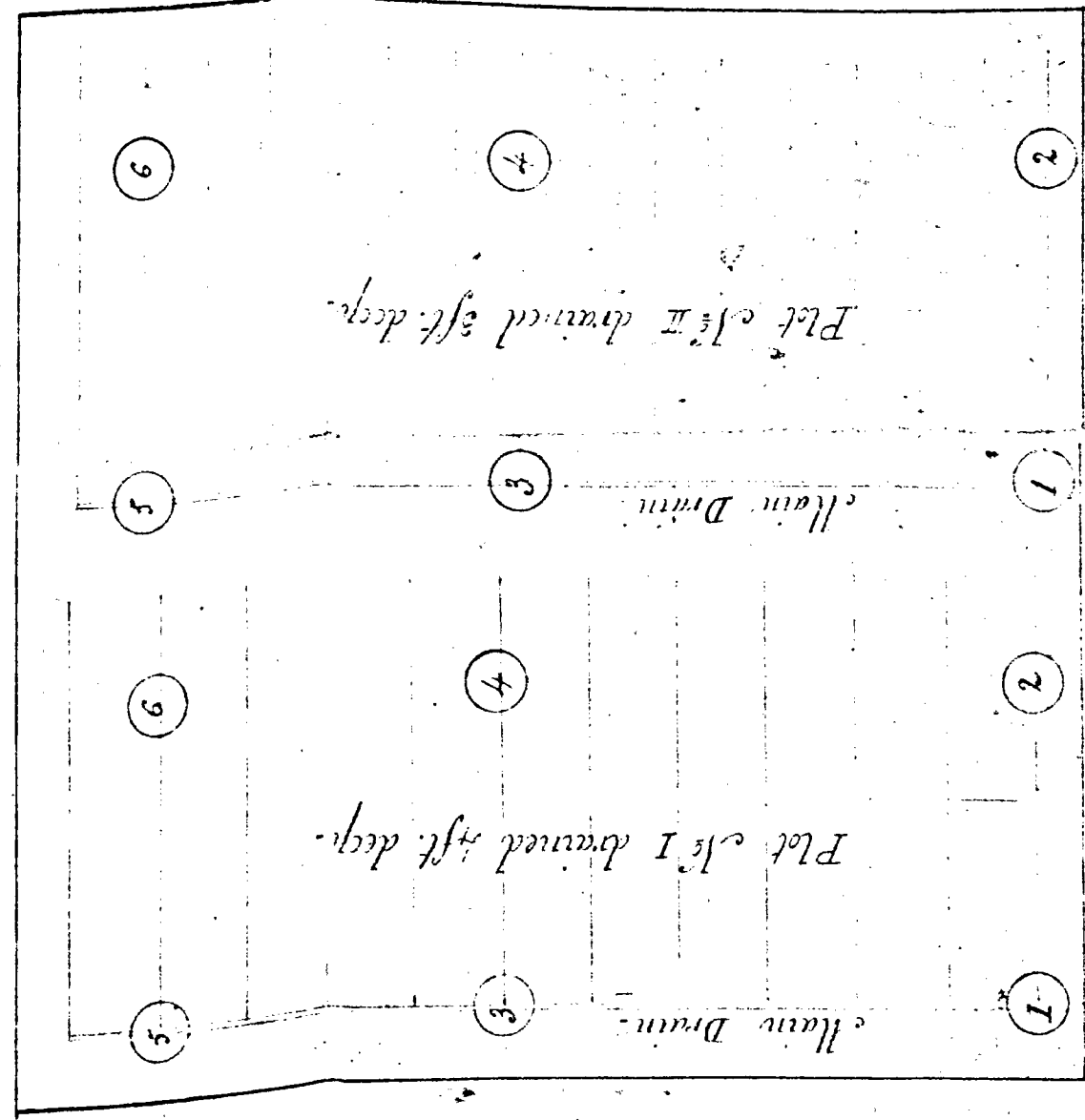
C 15-6-78
C 19-6-78-20-6-78

FOR ORDERS.

Sketch Map
of the subsail pipe-drained plots
in a field
belonging to the Kottur Village.

Scale 1 inch = 50 ft.

E



○ Trial pits.

Canal Embankment
outfall

Canal

W

954
19
No. 1,326.

PROCEEDINGS OF THE BOARD OF REVENUE, dated 16th May 1878.

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9. I do not think that the silting of the pipes is to be attributed to any irregularity in placing them in position. Mr. Schiffmayer gave great personal attention to this matter, and from a large experience in carrying out subsoil drainage works both in England and in Ireland, I am certain that in either of these countries the same care employed in laying drain pipes would have secured satisfactory drainage results.

10. I do not think that it would have been an advantage to have used pipes of a smaller bore than those that were used. The usual rule is to select pipes of the smallest bore that will carry off all the water that reaches them after heavy rain. The smaller pipe, of course, concentrates the flow and makes a stronger current in the pipe which facilitates the removal of silt; but when pipes of a very small bore are used the least displacement of one of the pipes would cause injury to a long line of drainage. Taking into account the large quantity of water that sometimes falls during a shower in this part of the country it will not, I think, be generally safe to use in parallel drains pipes of a smaller bore than 2 inches.

11. It is quite true that in order to reclaim fully land in the state of that on which the experiment was conducted, much more is needed than merely to subsoil drain it; it is a much easier matter to reclaim and bring under cultivation land in a natural state than such land. However, drainage is undoubtedly the first step that should be taken in the reclamation processes. Subsoil ploughing, if possible, would do much good undoubtedly, but subsoil ploughing would be impracticable in a soil full of stagnant water; and in the dry season the difficulty of subsoil ploughing would be equally as great from the hard condition of the soil the result of its shrinkage.

12. After the drains have had time to influence the condition of the soil, it will not be liable to crack to any serious extent. The damage the drains receive from these cracks is, I believe, done generally in the first year, that is, before the soil has had time to benefit from the drainage. To meet this difficulty it would, I think, in future be well to make silt deposit tanks on the principal lines of drainage. During the first year or two after drainage the silt might be collected and removed by means of these holes, when they might be permanently closed as it would be unlikely that much silt would reach the pipes after the end of the second year.

13. I believe that in this country, where as much as 6 inches of rain sometimes fall in 24 hours, not more than one inch of which may sink directly into the ground, it will always be necessary to provide surface drains for carrying off flood water even where the subsoil drainage is perfect.

14. It is evident from this and other experiments that we have conducted that we have yet much to determine before we can decidedly say what method of subsoil drainage is best suited for the conditions met with in this country. Arrangements are being made for trying other experiments in drainage on the Sydapet Experimental Farm, as it is evident that the matter requires a much fuller investigation than at first was thought necessary.

15. As the results from the subsoil drainage were not deemed satisfactory, no attempts were made to crop the land.

16. I enclose a map of the experimental ground, and forward one of the silted-up drain pipes.

ENCLOSURE No. 1.

From K. SCHIFFMAYER, Esq., Assistant Superintendent of Government Farms, to W. R. ROBERTSON, Esq., M.R.A.C., Superintendent of Government Farms, dated Sydapet, 15th February 1878.

WITH reference to the drainage experiment made in Adyar under my supervision in August and September 1876, I have the honor to submit that it did not admit of any conclusions being formed regarding its success until after the rains of the last monsoon had set in, on account of the abnormal season experienced last year.

2. After the first heavy shower of rain I examined the field on the 30th of October 1877 when I found the whole covered with a sheet of water to the depth of some inches; the main drain of Plot No. 1 was not discharging any water, but that of Plot No. 2 was discharging a considerable stream which however was very muddy, holding a great amount of earthy matter in suspension.

3. As more rain fell between the 30th of October and the 3rd of November, I examined the drainage again on Monday the 5th November when the field was found to be covered with water to the depth of about 6 inches; the main drain of Plot No. 1 was then discharging a large amount of clear water, but the outfall of Plot No. 2 was completely dry. The syphon which connects this field with the tank close by was discharging water on the field nearly to its full capacity.

4. The amount of water flowing from the syphon increased with the subsequent rains and nearly the whole of the water collected on the surface of the drained land. The stream of water from the syphon was turned from the drained land by making an embankment, but this was repeatedly broken down intentionally it appeared to get the water to flow to the land on the eastern side of the drained plots. The water thus flowed into the field for about ten days and accumulated there to a depth of about one foot. The main drain of Plot No. 1 continued to discharge until about the middle of December, and the standing water disappeared from the surface of the field at the end of November.

5. I must here state that when I inspected the field in question before the drainage was commenced, the occupier of the land, who was present, informed me that the syphon was silted up to such a degree that no water could reach the land. Accepting his statement to be correct, it was considered that there were sufficient indications to justify the expectation that the experiment would be instituted under satisfactory conditions.

6. Agreeably to your order, the main drain of Plot No. 2 was opened at the end of November last to ascertain the cause and extent of the stoppage when it was found that the main drain between the outfall and the second parallel drain was completely silted up. The work was then discontinued, because the soil was too wet to allow of free working.

7. At the end of January last the investigation was resumed when examination pits were excavated at several places as shown in the accompanying sketch. The following is the result:—
Plot No. 1 (DRAINED 4 FEET DEEP).—At No. 1, Junction of the Main Drain with the first Parallel Drain.—The junction of the main drain with the parallel drain was in perfect order. All the pipes were properly joined and were nearly free of sediment. The little deposit found in the pipes could be attributed to the roughness of the pipes; some fine rootlets had spread over this deposit.

Pit No. 2, Parallel Drain No. 1 about 90 feet distant from the Junction.—The pipes were in perfect order, closely joined, but completely filled. The lower part of the pipes to about two-thirds of their capacity was filled with coarse sand and the remainder one-third with very fine sand; roots of tamarind tree were found in the pipes.

Pit No. 3, Junction of the Main Drain with the 7th Parallel Drain.—The junction of the main drain with the parallel drain was in perfect order; all the pipes were found to lie closely together. The pipes of the main drain were completely filled and those of the parallel drains to about three-fourths of their capacity with a mixture of clay and sand.

Pit No. 4, Parallel Drain No. 7, 90 feet distant from Pit No. 3.—The pipes were found to lie in complete order but completely filled with rough sand at the bottom and fine silt at the top.

Pit No. 5, Junction of the 11th Parallel Drain with the Main Drain.—The pipes were found in the same state as those of Pit No. 4.

Pit No. 6, Parallel Drain No. 11, 90 feet distant from Pit No. 5.—The pipes were found to lie in a straight line but not very well joined and completely filled with rough sand at the bottom and fine silt at the upper part.

Plot No. 2 (DRAINED 3 FEET DEEP).—*Pit No. 1, Junction of the 1st Parallel Drain with the Main Drain.* The pipes were found well joined but completely filled with rough sand at the bottom and fine silt at the top.

Pit No. 2, Parallel Drain, 90 feet distant from Pit No. 1.—The pipes were in the same state as those of Pit No. 1.

Pit No. 3, Junction of the 9th Parallel Drain with the Main Drain.—The pipes were all found well joined; 2-inch pipes were half and the 4-inch pipes $\frac{3}{4}$ filled with fine silt.

Pit No. 4, Parallel Drain No. 9, 90 feet distant from Pit No. 3.—The pipes were found well joined and half filled in three well-defined layers; at the bottom was found clay, then a layer of fine sand, and at the top again clay.

Pit No. 5, Junction of the 15th Parallel Drain with the Main Drain.—The pipes were found well joined, in the small pipes was little deposit but 4-inch pipes were nearly completely filled with fine silt.

Pit No. 6, Parallel Drain No. 15, 90 feet distant from Pit No. 5.—The pipes were found well joined but half filled with fine silt.

8. The fact that the pipes at all the places where they were examined were more or less choked up with soil leaves no room to doubt but that the beneficial effects that resulted from the drainage could only have been very little, and in so far the experiment will have to be pronounced a failure.

9. The causes of the failure must, I think, be chiefly attributed—

- (1). To the technical difficulties experienced in carrying out the works.
- (2). To the great propensity of the soil to form cracks when drying.
- (3). To the great accumulation of water on the surface of the field.

10. With reference to the technical difficulties experienced, it will be sufficient to mention that it is a misdeed one of the first conditions to be secured in draining that the bottom of the drain shall not be much wider than the outside diameter of the pipes to be used in order to prevent the shifting of the pipes, and to effect this the use of peculiarly shaped tools is necessary. But in this case the drains were cut only with crowbars and mamooties, which caused the drains to be made very wide to allow of free working with these tools. Although some heavy soil was filled carefully around the joining of the pipes, and I inspected every junction, yet it is quite possible that some pipes were not well joined; or they may have been well laid and afterwards moved by the incursions filling in of the soil, so far as to admit the ingress of soil, especially during the time when the field was inundated.

11. The formation of cracks will, of course, take place in every soil subjected alternately to great wetness and drought, and will for this reason be most large and abundant in soil composed chiefly of clay on account of its capacity to take up a great amount of water. This quality inherent in the clay is, however, considerably increased by mechanical operations when in a very wet state, by which the large capillary interstices and other greater cavities filled with air under ordinary circumstances are reduced in size to such a degree that no air can circulate in them at such a time, and as long afterwards as the soil is kept very wet. A soil in such a state may hold very often twice as much water as under ordinary circumstances. For this reason, a field which has been under the cultivation of paddy as commonly practiced in India for a long time becomes, if deficient in organic matter, disqualified for the production of plants of any agricultural value. A soil which took up a great amount of water must necessarily expand more than a soil which takes up but little of that fluid, and from this follows that it must also shrink more when drying, causing thereby the formation of large cracks.

12. The field under question was exactly in such an unfavorable physical condition brought about by the puddling of the soil for the paddy cultivation.

13. The cracks in the field were very large, and no doubt reached down to a great depth; many of them to the level of the pipes, especially of those which were laid only 3 feet deep. At the first heavy rain water by entering the cracks would be conveyed immediately to the pipes, the joints of which admitting the water at once, and if it held any earthy matter in suspension, this would also enter, but if the pipes were not well connected or otherwise out of order, the sand brought down by the force of the water would enter also, which once inside of the pipes would be deposited. The water in the pipes becoming less turbulent after having entered would not be able to carry away the coarse grains of sand. After a time the soil became saturated and expanded to such a degree as to close the cracks which would prevent the conveyance of the coarse sand into the pipes, fine sand only entering them. That this has taken place is apparent from the well defined stratification of the deposit in the pipes (a pipe showing the stratification of the deposit is herewith sent), and from the fact that the main drain of Plot No. II discharges muddy water immediately after the rain. This water could only reach the pipes by means of cracks or large holes, for if the water had percolated through the soil it would have reached the pipes in a clear state; moreover water percolating through such a soil as this requires a long time before it can filter through the soil lying above the level of the pipes. The pipes in Plot No. I were laid one foot deeper than those in Plot No. II, and were therefore most probably not so much affected by the cracks of the soil, an assumption confirmed by the fact that the pipes of the lower part of the main drain and even of the parallel drain were found nearly quite clear.

14. As the field is lower than the surrounding land and is not provided with means of surface drainage, the 6 inches of rain that fell on the 30th of October 1877 caused the water to accumulate on the field to the depth of about 4 inches. This water would have most probably disappeared within a few days afterwards if there had not been a constant supply by the syphon by means of which the water on the land rose to a height of about one foot, the weight of which must have considerably increased the force of the water running through the cracks and enabled it to keep more earthy matter in suspension and to carry with it a considerable amount of sand.

15. Although the results obtained by this experiment are of a negative character, yet it must not be concluded that it is hopeless to improve land in India by drainage. On the contrary, I believe, there are large tracts of land at present useless, or nearly so, which cannot be ameliorated without the application of drainage. Much of the paddy land which is without sufficient irrigation supply to raise this crop, and has been rendered unfit by the application of vogue to produce anything else, can scarcely be brought to fertility without the application of drainage. The first and indispensable measure to be adopted to reclaim such land is aerating, since the land has mainly come to the bad physical state by excluding the air, it is evident that the best method of ameliorating it must be found in the opposite direction; and that one of the best effects resulting from drainage consists in facilitating the circulation of the air in the soil will scarcely be denied at present by any one. It must be admitted that the drainage alone will seldom suffice to effect this, and I am convinced that drainage without the application of deep culture and organic manure would lead to many disappointments.

16. There are many cases where drainage merely would produce most beneficial effects on the soil, especially on such as have become excessively wet by the soakage of water from river canals or tanks situated at a higher level where a single open drain to intercept the water may very often suffice to bring a formerly useless piece of land to fertility, but to improve paddy land more or less barren as considered above, the application of deep culture and organic manure can seldom be dispensed with.

17. Assuming that the failure of the drainage at Adyar resulted from the causes mentioned, it remains to be determined how far they can be removed. As regards the technical difficulties, it must be confessed that the imitation of the practice followed in Europe will be nearly impossible. The cutting of drains in such a manner as to get a proper bed for the pipes and allow no room for their shifting can only be made by skilled laborers with proper draining tools. But the Indian laborer has no inclination to use other tools for excavation except his time-honored mamooty and crowbar, and if he were really inclined to use the draining spade, in most cases he would not have the strength to wield it, moreover, the soil during the greater part of the year is seldom in such a state that it can be worked with the spade without the assistance of the crowbar or pickaxe. Considering these peculiarities, it is evident wide drains with roughly worked bottoms very often cannot be avoided. To neutralise the bad effects resulting from wide and badly formed drains, I think the use of collars on the pipes would be of good service. But the application of collars causes another drawback, viz., that the pipes encased in collars are frequently not well connected, since the fitting of pipes cannot be so well observed when covered by collars as when without them, and as the collars must be made wide to admit of their use over pipes not quite round or straight, it follows that sand has easier access to the pipes encased in collars than to those without them. There is no other way left than to cover the ends of the collars with plastic clay.

18. The cracking of the soil, which proved so fatal to the drainage at Adyar, is an obstacle of much less importance than the foregoing, because admitting easier remedy. The first step to neutralise the bad effects accruing from the cracks is to drain very deep whenever sufficient fall for the drain can be obtained. As the cracks become more narrow on their descent it is evident that they must be much smaller on reaching pipes laid five or six feet deep than on reaching those laid only three or four feet deep. Moreover, deep draining is preferable from a financial point of view, since it admits of making the drains further apart, and reduces thereby the cost of material, which represents the greater item of expenditure in carrying out drainage.

19. When deep culture and manuring with organic stuffs is combined with drainage the size of the cracks will be considerably reduced, because the soil becoming porous to a greater depth will never become so dry, the circulation of air being facilitated the soil will absorb constantly moisture from the air, and the roots of plants being encouraged to strike down to a great depth will supply on their decomposition the sub-soil with organic matter, which, as is well known, has the power of absorbing moisture from the air in the highest degree. When the soil has become more porous, the water of the casual rains will enter the soil in greater quantity, so that less water will flow off from the surface unutilized. Since the great accumulation of water in the soil is prevented by drainage, the soil cannot expand so much as before, and will therefore shrink less.

20. It is not to be expected that the cracks will all disappear after drainage; this is not necessary and even not desirable. It is sufficient when they are reduced to such a size as not to convey sand and silt in large quantities to the pipes. The large quantity of rain falling at one time, and the force with which the water reaches the ground, causes the fine particles of soil to become suspended in water, and with it they are carried into the interior of the pipes.

21. Assumed that the pipes are properly laid, the only means to prevent the accumulation of silt is, I believe, to give the drains so much fall that the earthy matter suspended in the water is carried away by the current immediately on entering the pipes. It is acknowledged that the greater the fall that can be given to a drain the better, but as fields requiring drainage are mostly situated at a low level, it is sometimes a limited that drainage is possible as long as drains can receive a fall of one foot in 2,000. The parallel drains at Adyar received an artificial fall of about half foot in 100 feet, and, I should think, judging from the result that this fall is insufficient for Indian circumstances generally. But to give more than half foot slope for 100 feet length is impossible with most fields requiring drainage in this country; not only would it cause great expenditure to make an open drain for the escape of the discharged water, but the upkeep of the open drain would be very expensive.

22. In such cases I should think the safest way to success is to utilize wells for the discharge of water. The same well may be used for irrigation purposes. When the water stands too high in the well it can easily be lifted and let off by surface drains. In many cases the water bearing strata when not lying too deep, and when not thick, might be advantageously broken through and the water let off in this direction. This plan is often adopted in Germany when draining in large plains. It will be the safest, and I should say often the cheapest, to drain into a well, since the ryot is accustomed to pay attention to everything relating to his well; most probably he would neglect the outlets of his drainage made in another manner, which often would have to be made not on his own ground, and the result could only be a failure.

(True Copy.)

(Signed) W. R. ROBERTSON,
Superintendent, Government Farms.

ENCLOSURE No. 2.—Sketch Map.

SUBMITTED for the information of Government.

2. The experiment in sub-soil draining was not successful, and no attempt was made to crop the land. The drained plots were inundated. There was a great accumulation of water on the land; the sub-soil pipes choked so completely as to become a solid mass of indurated silt.

3. As Mr. Robertson observes there is much to be determined before it can be said what method of sub-soil drainage is best suited to the conditions of this country.

But the question is of very great importance, and it is only by continued patient and intelligent experiment and observation that it can be solved. The Board will await with interest the results of the experiments Mr. Robertson is now arranging.

(True Copies and Extract.)

Acting Sub-Secretary.

To the Secretary to Government, Revenue Department,
with sketch map and drain pipe.

Copy to the Collector of Chingleput.
" " Superintendent, Government Farms.

Exd. A. Grubert, W. J. Lewis, and C. Howarth.

4028 Beng 1878-5 *Revenue Department*

No 2531

1878.

Board of Revenue.

MADRAS.

PROCEEDINGS, 16th MAY 1878, No. 1326.

227 June 1878. *Encl.*

On 9th 25 June 1878

Received 12 June 1878

MAY.
No. 1326.

*Subject Disease Experiment — made near
Adyar, Chingleput District. — Submitting to
Government with remarks report from Superin-
tendent, Government Farms, on the results of
the —, and awaiting report on results of arrange-
ments now being made for further experiments
on Sydhpet Experimental Farm.*

*On 15-6-78
On 19-6-78
No 2531*

*Recd 10/6/78
GILL*

*The Government should be satisfied
but the Government have the furnished
with a report of what has been done in the way of
drainage on the farm itself
GILL
On 15-6-78
On 19-6-78
No 2531*