EMCIP

EGYPTIAN MAJOR CEREALS IMPROVEMENT PROJECT

المشروع المصرى لتحسين محاصيل الحبوب الرئيسية

RESEARCH – EXTENSION

GOE/MOA
USAID
CID
NMSU

AID/EGYPT
PROJECT 263-0070

EMCIP

MINISTRY OF AGRICULTURE
GOVERNMENT OF EGYPT
CAIRO, EGYPT

CONSORTIUM FOR INTERNATIONAL DEVELOPMENT
5151 E. BROADWAY, SUITE 1500
TUCSON, ARIZONA 85711 U.S.A.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
U.S. EMBASSY, CAIRO, EGYPT

Technical Report

"DRAINAGE AND IRRIGATION RECOMMENDATIONS FOR EMCIP PROJECT AREAS"

by

L.F. HERMSMEIER

EMCIP Publication No.26

Dr. L.F. Hermsmeier works with the Imperial Valley Conservation Research Center at Browley, California.

Published: August 1981

DRAINAGE AND IRRIGATION RECOMMENDATIONS FOR EMCIP PROJECT AREAS

This report includes an evaluation and recommendations for drainage improvements and irrigation methods at the four EMCIP project areas, and is based on discussions with project personnel, information in previously published reports, visits to Sakha, Gemmeiza and Sids during the period 16 June - 12 July, 1981, and on previous visits to the areas during the preceding seven years. As often reported, a major factor limiting crop production in Egypt is inadequate drainage. Many major drains have been constructed but often field tile drainage is also needed. Results for several years at test sites at Sakha and Sids indicate yield increases up to 100% with good drainage combined with deep tillage and a gypsum treatment (1).

Several elements are necessary for satisfactory tile drain performance. These are design, materials, installation, outlet and maintenance. Design factors are primarily concerned with depth, spacing, envelope requirements, tile grade, tile size, layout in the field, type of tile junctions, and need for structures such as manholes and outlet structures. The materials used including concrete pipe or plastic pipe and envelope material must be of good quality. Proper installation of the drain system is of great importance. It is a waste of resources to have a well-designed tile system with good materials so poorly installed that it is barely functional shortly after installation. Yet this is sometimes the case. Continuous on-site inspection by a well-trained person who has authority to stop operation and make corrections before proceeding when faulty installation occurs is necessary to ensure quality installation. Like a doctor whose patient dies because of poor treatment and is quickly buried, so can the contractor quickly bury his faulty work unless an inspector is always on the job to prevent it. The contractor must have the equipment, experience and desire to properly install the tile drains.

The best designed and installed tile drain system will perform poorly or not at all when there is no suitable outlet. Great progress has been made in Egypt in providing large open drains, often with pump systems. However, at times because of poor maintenance, pump breakdown or above normal drain flow, there will be no free gravity flow to the drain. This is true at the Sakha, Gemmeiza and Sids sites. During these times a pump outlet is required to maintain a satisfactory outlet for a tile drain system.

Almost every drain system requires periodic maintenance to insure continued long time good performance of the system. Sediments and roots can enter the tile drains of the best designed and installed systems. Flushing with gravity flow is useful to determine if a drain is open and functioning. However, a high pressure jetting procedure or mechanical "rodding" is necessary to remove firmly held sediments and roots. Also, sediment in the bottom of manholes needs to be periodically removed and any damage to the manholes repaired.

Sakha

A major soil constraint at the Sakha site is poor drainage (2). There were no tile drains in the project area and surface drains were inadeqaute (3). This project area is located on the same farm and has similar soils as the test sites for two PL-480 drainage experiments (1). Based on results for several years from these experiments, data from other drain experiments and soil tests in the project area, a tile drain design was prepared by Dr. N. M. El Mowelhi. I agree with this design. This tile drainage system, when properly installed and maintained, will provide adequate drainage so that poor drainage will no longer be a soil constraint for high crop yields in the project area.

Specifications for construction were prepared by Dr. El Mowelhi, and a contract for construction by a contractor was signed by the Ministry of Irrigation. Drain construction had been completed on about one-third of the project area of 400 feddans on 5 July 1981 when I made an inspection of the installation process. The drain pipe was being well installed in one operation with trenching by a Hoes trencher. The gravel envelope was also being well installed by a hand-carry operation. The gravel envelope installation rate appeared less than 25% of the machine capability rate for trenching and laying pipe. As drain installation with a gravel envelope becomes more common in Egypt, it is recommended that a box for gravel and a pipe delivery system for the gravel to the tile drain be installed on the trenching machine. The gravel box can be filled with a "skip" loader. With this arrangement the trench is excavated, the pipe is laid and the gravel envelope installed all in one process.

Inspection of drain installation at the Sakha site was under the supervision of Dr. Anwar Abasiri and I was assured that inspection was continuous during periods of installation. Again, it is emphasized that proper installation is essential for good drain tile performance and a good continuous inspection program is necessary to ensure good installation.

A large open drain (Drain No. 8) serves as an outlet for drainage of the project area. Most of the time the water level in this drain is below the outlets of the collectors and free gravity flow is available. However, experience over several years at the PL-480 drainage test sites, which are served by the same main drain, indicate that there will be periods during almost every year when water levels in the main drain will rise well above the level of the collector outlets and there will be a reverse flow from the drain into the collectors and laterals. Obviously, the drainage system will not perform properly under these conditions and damage may be done to the system by causing sediment deposits in the drains. My recommendation is to install a valve (a simple metal plate slide valve should serve well) at the lower manhole of each collector line to prevent flow of water from the drain into the tile drain system during periods of high water levels in the main drain. Then a pump should be installed at this manhole to maintain a water level below the collector line level so that there is free gravity flow into the manhole which acts as a sump. This is a temporary solution of this problem of high water levels in the main drains and resulting submergence of the tile drain outlets. A more permanent solution would be the installation of an electric motor driven pump with automatic controls in a larger sized manhole. The larger sized manhole is desirable to prevent too frequent cycling of the pump from on to off operation. The sump and pump commonly used in the USA can be adapted to Egypt conditions. Consideration should be given to the possibility of collecting drain flow from all collector lines to the lower collector line by the installation of additional drain lines and then using only one pump outlet instead of several pump outlets. My experience indicates a pump outlet is necessary part of every year in order to provide a good outlet for this drain system. A well-designed and installed automatic controlled sump pump tile drain outlet would be very useful on this EMCIP project, both to provide a continuous good outlet for the project area and also to serve as a model to evaluate this practice, which I believe will prove the most economical method of providing an adequate outlet for tile drainage in many areas of Egypt.

Gemmeiza

Poor drainage is also a major soil restraint in the Gemmeiza EMCIP project area. As reported in (2,3), a tile drainage system was recently installed in the project area. Further details of the current conditions of this tile drainage system are reported by Abdullah Nasr and Dale Henry in (4). Based on a field inspection of the area I made on 7 July 1981, information in reports, and discussions with project personnel, the following recommendations are made concerning the present drain system: The present collector system should be repaired and cleaned and, if functioning properly, retained as part of the drainage system. Repairing will include repair of manholes mainly. Cleaning will include removing concrete pieces or other solid material from manholes and removing sediment from the system. Loose sediment may be removed by gravity flow flushing of the collectors and then pumping from manhole sumps. Well settled sediment can only be removed from collectors by mechanical disturbing with a rodding procedure and then gravity flushing or by high pressure jet cleaning. The latter method has been found to be more practical in the USA and is recommended for cleaning these drains. Jet cleaning equipment is available at the Ministry of Irrigation. Experience elsewhere has shown that many tile drain systems, even when well designed and installed, require cleaning periodically to maintain design performance. Therefore, with the large tile drainage systems in the EMCIP project areas and also the large amount of tile drainage already installed or planned for Egypt, drain cleaning equipment for drain maintenance is important. I recommend that high pressure jet cleaning equipment be obtained for the EMCIP project areas. However, in order to expedite operations, cleaning and checking the collectors with presently available equipment will be satisfactory.

The lateral lines are concrete tile spaced at 40 m intervals and covered directly with soil with no gravel envelope. It is difficult to determine their effectiveness but poor drainage symptoms were noted in areas in the field. In a normal farming operation it would be recommended that these lines be retained, additional laterals installed and the present laterals replaced later if they prove to be ineffective. However, in the EMCIP project areas it is important that poor drainage be eliminated as a soil constraint to high crop production and that poor drainage not be a factor that may confound the results of water management, fertility, crop breeding, tillage, and other treatments. Therefore, it is recommended that the present tile laterals be abandoned and new laterals installed. Based on PL-480 tile drainage tests at Sakha and soil tests at this site, a tile drain design has been prepared by N. M. Mowelhi which happens to have the same spacing as at the Sakha site. I agree with this design. I recommend these laterals be installed as designed and that the decision to use the present collectors or to replace them be dependent on an evaluation of their condition after repair and cleaning.

The main drain that serves as an outlet for this tile drainage system has similar conditions to the main drain at Sakha. Observations of water marks in the manholes and discussions with Abdullah Nasr indicate that the drain outlets are sometimes submerged for lengthy periods and water sometimes flows from the drain into the tile drain system. Again the solution is the same as at Sakha although here the main drain problem appears more severe. Pump outlets will be required to maintain good tile drain performance in this project area. Again, temporary diesel motor driven pumps can be used but I recommend that a well designed automatic float controlled electric motor driven sump pump and sump be installed on at least one collector line as a demonstration. Allowing surface drain water to enter tile drain systems is seldom desirable or practical and it is recommended that these tile drainage systems be repaired to prevent the entry of surface water into the tile drainage system. Surface drain water is not designed to enter tile drains in most systems I have observed, but occasionally holes in manholes or other changes are made after installation by farm operators to permit surface water to enter the drain system. This practice should be stopped.

Sids

Poor drainage is also a major soil restraint to high crop production in the Sids project area (2,3). A tile drainage system was installed in the project area in 1972. Details of the present condition of the drainage system have been prepared by Mahmoud Wahba and Dale Henry (4). Some of the manholes are broken above ground and many of the collectors are partially or completely filled with sediment. During a field inspection on 5 July 1981 I noted that all but one outlet was submerged and that one was partially submerged. The submerged outlets are a major factor causing the sediment accumulation in the drain lines. Following are recommendations for drainage of this area. The present tile system appears in reasonably good condition except for considerable siltation and some damage to the manholes. The present system should be repaired, cleaned and tested and if satisfactory, retained as part of the tile drainage system. Repairing will consist of repairing breaks in manholes, providing covers for manholes and removing solid debris from manholes. Cleaning will consist of flushing out of all collectors and laterals. Collectors can be flushed from manhole to manhole beginning near the outlet. Flushing of laterals will require excavation of an entry to the upper end of each lateral and putting flushing water into the lateral by means of a temporary pipe from the lateral to the soil surface. Flushing each lateral will require considerable labor but will be found to be much less expensive than replacing a lateral. In cases where the lateral or collector cannot be successfully flushed, they must be replaced. The flushing will need to be done with high pressure jetting equipment to remove the sediment from the lines. Based on results from a PL-480 drain spacing and depth study at the Sids station in a nearby area with similar soils and on soil and water table measurements in this project area, a drain design spacing of 30 m with 8 cm outside diameter corrugated plastic tubing with gravel envelope has been made by Dr. El Mowelhi and associates and a plan layout prepared. The present lateral spacing is 60 m, so the 30m design spacing will require installing one new lateral between each pair of the present laterals. The collectors have sufficient capacity to carry off the water flow from the additional laterals.

The four tile collector outlets for the project area are frequently submerged and thus unsatisfactory in their present condition. Again, a similar pump system to that recommended at Sakha and Gemmeiza is also recommended at this location. The poor outlets have been a major cause of the heavy silting and poor performance of this tile drain system. Temporary pumps can be used during the cleaning and testing operation but an automatic controlled electric driven pump with suitably sized sump is recommended for long-time operation.

Shandaweel

Natural drainage is normally very good in this project area. There are a few shallow surface drains and no tile drains at this location. At present there is insufficient information to determine if additional drainage is required. It is recommended that the water table levels be measured to determine if they rise to heights that affect crop production. If so, then additional tests can be made of soil properties including infiltration rates, hydraulic conductivity rates and water holding capacity. This information can then be used as the basis for design of a tile drainage and/or surface drainage system.

General Comments on Drainage

Almost every tile drain system requires periodic maintenance for continued satisfactory performance. This maintenance consists primarily of making necessary repairs to the outlets and cleaning the lines. Flushing with gravity flow water determines if a tile line has a free opening for its entire length. However, the tile drain line may be one-half or more full of silt and yet water freely flows through it. To thoroughly clean the drain lines either high pressure jetting or mechanical disturbance of the sediment by rodding and then flushing is necessary. High pressure jetting has proven to be by far the most convenient, economical and effective means of cleaning drain tile. The procedure for jet cleaning of drains is presented in (5). It is recommended that a single jet cleaning unit be obtained for cleaning drains on the three and possibly four EMCIP project areas. The equipment is mounted on trucks and is easily transportable. Currently a maintenance program for tile drainage in Egypt is not generally effective. A good maintenance program will be necessary to ensure continued satisfactory performance over many years of the large amount of drain tile now being installed.

The use of a relatively large number of manholes with tile drainage in Egypt should be evaluated. In most of the U.S., far fewer manholes are used. In the Imperial Valley of California manholes are seldom used with tile drainage. An entire 80 or 160 acre field will be tile drained with no manholes. Manholes do have advantages. They permit easy inspection of drain flow and operation. They readily indicate the location of the collectors and some laterals. They provide a sump for collection of sediment. They provide a convenient means of connecting laterals to collectors, and finally they provide an easy access for cleaning of drains. Manholes also have disadvantages. Of major importance, they are an objectionable obstacle in the field to machine operation and are often damaged or cause damage to farm machinery. They add considerable cost to the installation. They provide an access for silt, stones, debris and surface water into the tile drains, all of which are undesirable. My recommendation is that a study be made to determine if most manholes can be eliminated for tile drain design in Egypt. Access to the tile drains for cleaning and repair is better obtained by temporarily excavating a hole to the drain with a back how and then repairing the drain and filling the hole when the operation is completed.

Lay-out maps of tile drainage systems are very important and more so when there are few or no manholes. Maps of the tile drainage systems currently installed at Gemmeiza and Sids are entirely satisfactory. After installation the design map should be amended to note any changes made during installation so that an "as built" map is made. The "as built" map indicates drain lines as actually installed which frequently is not the same as the design plan

Irrigation Management Procedures on EMCIP Project Areas

Improved irrigation methods can increase water use efficiency and also reduce labor requirements while at the same time maintaining or increasing crop yields. Increased water use efficiency is of great importance in Egypt because of limited water supply and the need for increased crop production. Reduction of the labor requirement for irrigation is also important. Most of the cultivated lands of Egypt are comprised of relatively small fields of often irregular shapes and with small individual land holdings. Capital resources for land improvement in these areas is modest. Any improved irrigation management procedure should be adaptable to these conditions for at least the foreseeable future. These improved management practices should be evaluated on a performance and an economical basis. On the basis of these evaluations, decisions on which alternate solutions are most practical under various situations and at different points in time can be made.

As the title suggests, the major objective of the EMCIP is to increase major cereal production on the farm lands of Egypt. Along with improved varieties, proper fertilization, better cultivation and tillage operations, addition of soil amendments and improved drainage, improved water management can have a major effect on improving crop production by making more water available because of higher water use efficiency.

Improved water management practices should be a major part of EMCIP. The plan proposed by Dale Henry (3) includes a single water management practice for all four EMCIP project areas. This method consists of an underground low pressure pipe delivery system. Outlets of the pipes are to be located in the center of four fields. The land surface in each field is to be made dead level and each field irrigated by surface flooding from one corner of the field. Size of fields would depend primarily on soil infiltration rates. For research plots to be grown in the fields, a gated pipe system would be used, in addition, for water distribution.

Dead level irrigation with an underground delivery system has a number of advantages. Canals with their weed and other problems and seepage losses are eliminated. Labor requirements are considerably reduced. Water delivery rates and amounts are easily determined. However, this sytem also has disadvantages. First is the high cost of materials. The pipe lines must be pressurized which requires pumps and fuel or electricity for power. The power requirements for the EMCIP project areas will be relatively small but if this practice were to have wide-spread application, there would be an apparent large increase in power requirements in Egypt. However, this would not be likely to be greater than what is presently practiced by farmers lifting water from canals lower than fields being irrigated. This sophisticated irrigation method can provide good economical irrigation but to date is used on a relatively small part of the irrigated lands in the USA. Dead level irrigation can also have some problems. In my very limited research experience on dead level irrigation on heavy soils with similar infiltration rates in an 8 acre field and a 40 acre field, I have found considerable problems. The water delivery amount must be precisely measured. Too much water will result in excessive surface flooding time with plant damage or even killing of parts of the stand. Slight imperfection in leveling will cause the same effects. Rank crop growth can interfere with water movement across the land. Accurate soil moisture measurements are required to accurately determine the amount of water to be added at each irrigation - these are proposed. Some increase in technical skill is required to operate this irrigation method over many other simpler methods. However, the underground pipe delivery system combined with dead level irrigation does have merit and is worthy of consideration for evaluation in comparison with other irrigation methods in Egypt. My recommendation is to include the underground pipe delivery system on 1/3 to 1/2 of each EMCIP area. Dead level irrigation should be included as one of several irrigation treatments on each project area for evaluation for effectiveness, economic value and practicality.

Improvements in irrigation methods are almost always slow to occur. This is true in the USA and will be more so in Egypt for a variety of reasons. Most improvements will be made on a step basis and not in a giant leap forward. Emphasis should be placed on rather simple improvements that can be adapted rather easily by the farmer. Practices that include furrow length change, changes in field canal arrangement, and regulating irrigation water application amounts and frequency can provide considerable increase in water use efficiency. An important improvement would be a simple inexpensive device for measuring water delivery to a field where fields are well levelled. Better irrigation methods that reduce labor requirements or increase yield will be of direct benefit to the farmer and will be readily adopted if feasible and economically sound. However, increasing water use efficiency by reducing the amount of water for irrigation or the number of irrigations may have little effect on yield and be of little benefit to the individual farmer in particular, but may be of great benefit the Egyptian society as a whole because of the water saved. In this case, when water is a free commodity to the farmer, the force of law through regulation or a subsidy program will be necessary for the practice to be adopted.

The statement has been made that the EMCIP project areas should have a unifor water application method so that soil moisture conditions do not interfere with test results of plant breeding, fertility, tillage and other treatments. This statement may be true for a relatively small area of 40 to 60 feddans required for these tests. However, the EMCIP project areas are 180 to 400 feddans in size and should include several water management treatments. Also, the underground pipe delivery system with dead level irrigation method will generally provide 85 to 90% water distribution efficiency except in very small fields where it should approach 100%.

The statement may also be made that the EMCIP project areas should be treated the same in regard to drainage and several drainage treatments installed instead of a single treatment or design on each project area. However, here the situation is different. Measurements of water table levels and soil and crop conditions at all sites except Shandaweel clearly indicate the need for drainage in these areas based on considerable experience in this field. At the Sakha and Sids locations at nearby fields on the same farms, large scale PL-480 tests of different tile depths and spacing and concrete and plastic drains with and without envelopes have produced results that can reliably be used when combined with soil tests in the project area for the design of good tile drainage systems in the project areas.

Additional Comment

The EMCIP project areas are located on Government Farms. The farm directors have responsibilities to produce designated areas of given crops each year. Crop production on the EMCIP project areas affects the total farm production. Successful operation of the EMCIP requires that EMCIP personnel control or agree on the assignment of crops to be grown during the term of the project. A small area up to 40 to 60 feddans for small pilot tests may be exempted but the large areas will have a significant effect on farm production. Agreement or understanding should be made soon between the Farm Director or other responsible officials and a responsible person with EMCIP on these arrangements and also for interrelated use of irrigation water, farm labor and machinery.

The opinions, discussion and recommendations in this report are my own and based on reading EMCIP Project and other reports, visits to Sakha, Gemmeiza and Sids sites, discussions with interested parties and my previous experience in Egypt. There will likely be some difference of opinion on parts of this report. However, it is essential that the responsible officials reach agreement on some of the items discussed for the success of EMCIP.

High-Pressure Water Jet Cleaning of Subsurface Drains

L. B. Grass, L. S. Willardson
MEMBER
ASAE

DRAIN failure, or even a decrease in the efficiency of subsurface drains, is very serious in irrigated arid regions. Inefficient drainage may cause waterlogging and soil salinity increases, resulting in reduced crop yields. Roots, silt, and chemical deposits or iron (Fe), manganese (Mn), gypsum and various forms of calcium carbonate have all been reported to cause drain failure (Grass 1969, Sutton 1952).

Several methods of cleaning subsurface drainage systems to restore them to full efficiency have been used in Imperial Valley, California, with various degrees of success. The method used depends on the nature of the obstruction. Long flexible rods with cutting blades (Houston 1961) have been used with limited success to remove roots and silt. A wire brushing technique (Houston 1961) for removing deposits of Fe and Mn was unsuccessful. A 2 percent sulfur dioxide gas and water solution effectively removed Fe and Mn deposits from drains (Grass and MacKenzie 1970, 1972 and MacKenzie 1962).

High-pressure water jetting has been successfully used for removing silt, roots, and mineral deposits from clay, concrete and plastic drains in the Imperial Valley. The high-pressure jetting method of cleaning drains is also used in the Netherlands, where it is referred to as "syringing" (Zuidema and Scholten 1970). Two types of nozzles, referred to as "spoutnoses", have been used in the Netherlands. One type, which had one forward directed jet and three backward directed jets for removing silt and iron deposits was operated at a low pumping pressure, 176 to 294 psi at the pump and 59 to 88 psi at the nozzle. A second type of nozzle had one forward jet, two side (90 deg) jets and three backward directed jets. This nozzle was used at high pressure, 1029 to 1176 psi pump pressure and 441 psi at the nozzle, which enabled it to clean drains containing larger amounts of sand or more seriously sealed joints.

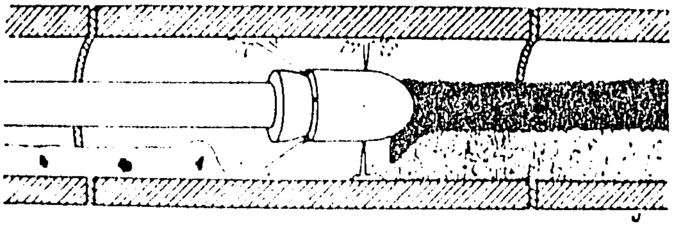

FIG. 1 Scouring and removal of silt and mineral deposits in a subsurface drain with a high pressure jet nozzle.

This paper describes high pressure jetting equipment and procedures for cleaning subsurface drains in the Imperial Valley of California.

EQUIPMENT

High-pressure jetting equipment utilizes the macerating action of high velocity water jets to dislodge and move obstructions. Water turbulence created within the drain pipe by jets of water exiting at varying angles around the circumference of a nozzle and at points along its longitudinal axis, stirs and moves silt or mineral compound deposits. Water exiting from the backward directed jets of the nozzle creates enough force to propel the nozzle and hose up the drain.

Two nozzle types are commonly used to clean drain lines, the "cleaning nozzle" and the "penetrator nozzle". The cleaning nozzle has five jets located midway between the nose and rear of the nozzle. The jets are located around its circumference and are aimed 90 deg to the logitudinal axis (Fig. 1). These jets have a scouring effect on the interior surfaces of the pipe, as well as on the joints and openings. An additional five jets, located around the rear of the nozzle, at points circumferentially midway between the forward jets, are aimed 30 deg to the logitudinal axis to give good cleaning coverage. The diameters of orifices in the rear and midway jets are: 0.1990 and 0.0995 in. respectively. The purposes of the rear jets are to propel the nozzle forward, to create high turbulence within the drain, and to provide a sufficient volume of water to suspend the dislodged material until it arrives at the access opening in the drain.

The nose of the penetrator nozzle has a single jet that is effective in disrupting silt and mineral deposits and cutting through accumulations of roots. The penetrator nozzle has only five additional rear jets pointed at 15 deg (Fig. 2). This low jet angle gives the nozzle greater forward thrust and a flatter cutting angle to penetrate accumulation of roots, silt, etc.

At a nozzle pressure of 500 psi, these penetrator nozzles can macerate root plugs containing roots up to 1/2 in. in diameter. The roots of palm trees, salt cedars, eucalyptus trees, mesquite, sage and creosote bush have been encountered in drains. Alfalfa and sugarbeet roots also enter the drain lines, but they do not clog drains until after the crop has been removed and the roots die. Then they break off and accumulate to form a plug where they encounter a break, a patched or roughened surface, a bend in the drain, or a change in the grade.

The cleaning water and dislodged

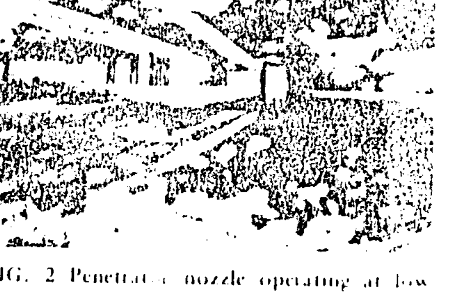

FIG. 2 Penetrator nozzle operating at low pressure.

Article was submitted for publication in April 1974, reviewed and approved for publication by the Soil and Water Division of ASAE in June 1974.

Contribution of the Imperial Valley Conservation Research Center, Western Region, ARS, USDA, Brawley, Calif.

The authors are: L. B. GRASS, Soil Scientist, and L. S. WILLARDSON, Agricultural Engineer, Imperial Valley Conservation Research Center, Western Region, ARS, USDA, Brawley Calif.

This article is reprinted from the TRANSACTIONS of the ASAE (Vol. 17, No. 5, pp. 886, 887, 888, and 891, 1974)
Published by the American Society of Agricultural Engineers, St. Joseph, Michigan

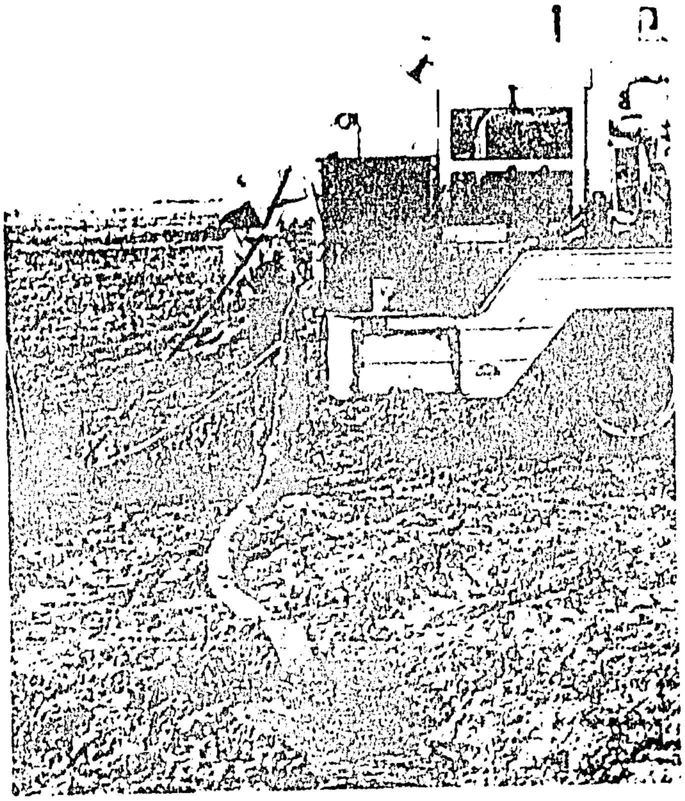

FIG. 3 Water and solid materials dislodged by the jet nozzle are pumped from the access hole by a dewatering pump located directly beneath the hose reel.

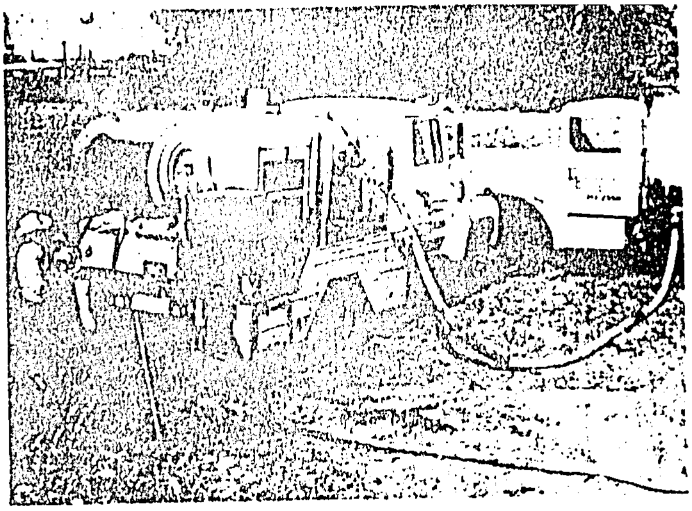

FIG. 4 Pumper truck (foreground) supplies water under high pressure to jet nozzle through hose on power operated reel at rear of truck. A tanker supply truck (backround) pumps water through filter system of pumper truck to refill its 1000 gal storage tank.

material is removed from the access hole of the drain with a dewatering ("mud-hog" type) pump (Fig. 3). The pump capacity should be three or four times that of the main pressure pump to enable it to keep up with the increased drainage water flow entering the cleaned drain line. The mud-hog pumps currently used have a 2-in. suction hose and a 3-in. discharge hose. The pump delivers 250 to 300 gal per min and has a lift capacity of approximately 12 ft.

A 1,000-gal water supply on the pumper truck (Fig. 4) provides an adequate reserve for continuous operation while a self-loading, self-unloading tanker truck (Fig. 4) goes to reload with water. The pumper truck should be equipped with filters to remove sand, silt, and trash which can quickly damage the pumps and other equipment.

The gasoline or diesel engine pump supplying jetting water (Fig. 4) delivers about 60 gal per min through a 1-in. inside diameter hose rated at 3000 psi bursting pressure. With a cleaning nozzle a 1250-psi pump pressure and 700-psi nozzle pressure are usually used and with a penetrator nozzle pressures are usually 1000 psi at the pump and 500 psi at the nozzle. Optimum length of hose is about 700 ft. The hose is stored on a power-operated reel which controls the nozzle advance in the drain and withdraws the hose, while the jets are operating to provide water movement and turbulence. Continuous operation is necessary, since without turbulence and water movement sediments could settle around the hose and make it impossible to withdraw it. Thus, the hose would be lost and that part of the drain would have to be replaced.

Jet cleaning equipment can be made mobile by mounting it on a truck or trailer. Commercially available equipment is usually mounted on a 2-1/2 ton truck. Custom-built units usually are mounted on 1/2 or 3/4 ton pickup trucks. Some operators of custom built equipment use the dewatering pump as a separate unit.

OPERATIONAL PROCEDURE

A cleaning operation begins by exposing the drain lines by excavation at approximately 650-ft intervals along the line. Excavations should be started at the lower end of the laterals, or at the point of intersection with the baseline or collector line. This allows inspecting and cleaning a section of the lateral and the baseline from one location. Cleaning proceeds upstream. Successive excavations, at 650-ft intervals along the laterals, may be made before the jetting equipment arrives at each location; however, openings should not be made in the drain pipe until the cleaning operation at a point actually begins. This prevents the water blast from escaping the drain pipe at an opening and washing soil into the drain as the nozzle passes the location.

After the drain line has been exposed, a section of drain is carefully scored and cut so that the top 1/3 to 1/2 of the drain can be lifted out to provide an access opening to the drain pipe. An adjustable metal frame with a guiding roller (Fig. 5) at one end is clamped into the open tile section to prevent unnecessary and excessive hose wear against sharp or jagged edges of the drain. An inflatable plug, placed in the pipe immediately downstream of the ac cess opening keeps debris from entering the cleaned downstream sections.

The first stage of the cleaning opera tion begins at the lower ends of each lateral and continues upstream in suc cessive stages until the entire system has been cleaned. The baseline should be cleaned last to remove any materia washed into it while cleaning the lateral

The nozzle and hose are inserted into the open drain line and the water pump ing operation begins (Fig. 5). The nozzle

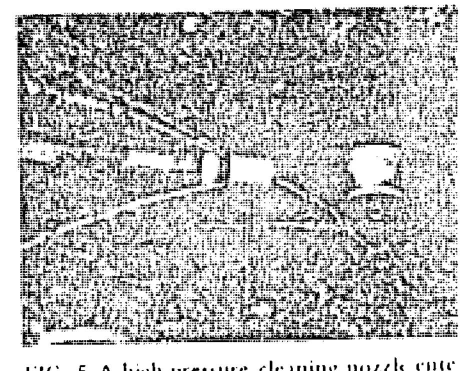

FIG. 5 A high-pressure cleaning nozzle ente the drain access opening. A metal fran equipped with a guiding roller surrounds t rough edges of the drain opening to preve hose damage.

will proceed upstream at rates up to 45 fpm depending upon the amount of clogging material in the pipe. When the entire length of hose has been dispensed, the operator then withdraws the hose immediately while continuing the water pumping and jetting action. Additional cleaning is provided by scouring and turbulence as the nozzle is withdrawn. The vacuum created in the drain by the aspirating effect of the water jets draw into the drain any water standing over the drain and this causes additional cleaning. The operator continues to repeat the jet cleaning operation on the drain until the water returning to the access opening becomes clear. Often, five or six complete jetting passes are needed to clear a seriously clogged line of all foreign material.

Jet cleaning drains also permits discovery of misalignments or breaks in lines where soil and envelope material may enter the drain. The first indication that a line is broken is the appearance of envelope sand at the access opening of the drain line. This can be confirmed by allowing the nozzle to proceed slowly up the drain after the return water has become fairly clear. Sudden appearance of muddy water indicates that the nozzle has arrived at a break and is washing soil into the line.

To locate a break, the hose is marked at the access hole when the muddy water appears and then withdrawn. The hose is extended to the marked length, along the ground surface and the line is excavated for immediate repair. After repairs have been completed and any cement work has hardened, this section of line is again jetted to remove any soil or sand that entered the line during the repair work.

Safety Precautions

Personnel engaged in the tile cleaning operation should follow the common safety rules used with all types of machinery. The pump should be shut off before the nozzle reaches the drain opening. The nozzle location may be determined by the amount of turbulence in the water in the drain access opening, by marks on the hose to indicate the amount of hose remaining in the drain, or by using different colors of hose sections.

Care should also be used to prevent cave ins of the access hole excavation. Soils vary in stability, depending on the soil texture, moisture content, and the depth of the excavation. Caving in can be controlled to some extent by adequately sloping the sides of the access excavation.

Post-Cleaning Operations

After the drain has been cleaned, access sections removed from the drain should be firmly replaced and a structurally sound patch completed with plastic portland cement. The envelope material should be replaced around the entire length of exposed drain line and sufficient soil should be placed over the envelope material by hand to insure that the envelope material and patch will not be displaced during backfilling. The backfill material should be resettled carefully to avoid a resumption of particle movement into the drain.

The farmer should observe the discharge at the drain outlet frequently, especially during the first irrigation, as a gauge of future performance. He should also measure the discharge rate while the drain system is functioning best and the rate of discharge is highest. The discharge rates will usually reach a peak flow about 24 hrs after irrigation begins, depending upon the type of soil and irrigation method used. This peak discharge rate can be used to evaluate continuing drain performance. Mineral deposits may recur if water management conducive to waterlogging continues. Roots may also re-enter the drain periodically, however, silt should not present any further problems unless the system is disturbed.

Cost of High-Pressure Jet Cleaning

The cost of high pressure jet cleaning of drain systems varies somewhat between operators. In the Imperial Valley, the standard fee is 15 cents per foot. However, one firm uses a sliding scale, depending upon the type of work and the kinds of equipment required which results in average charges of 12 to 17 cents per foot.

Jetting Effectiveness

The high pressure water jetting operation cleans the inside of the drain and it also cleans the joint and the material immediately outside the joint. The operation is similar to "developing" a water well. Removal of fine, often encrusted, material inside and immediately outside the joint by the jetting operation improves the hydraulic conductivity of the remaining material. As a result, resistance to water inflow is reduced and drainage efficiency is increased.

In an experiment in Coachella Valley, California (Willardson et al. 1973), six drains with faulty envelopes in a 12 drain experiment were jet cleaned ap-

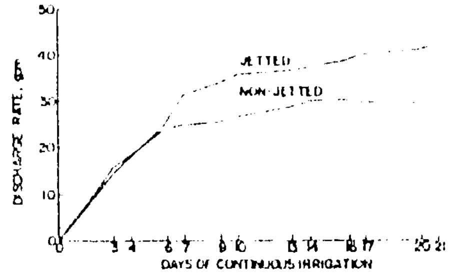

FIG. 6 Average discharge rate from jetted and non-jetted drains.

proximately 14 months after installation. The 12 drains were installed purposely with faulty envelopes, which resulted in joint plugging with particulate matter. Data were obtained on drain performance with and without jetting. Fig. 6 shows the average discharge rates during 21 days of continuous water application. At 21 days, the jetted drains discharged at a rate 45 percent higher than the nonjetted drains. Fig. 7 shows the water table behavior directly over three drains before and after jetting. After jetting, the maximum water table over the drains was nearly 3 ft lower as a result of increased drain discharge rates. This illustrates the effectiveness of jetting in removing particulate matter from inside drains and in the joints between tile sections.

SUMMARY

High-pressure jetting equipment utilized the macerating action of high velocity water jets and vigorous water turbulence to clean roots, silt, and chemical deposits from subsurface drains. Water exiting from the rear jets propels the nozzle and hose up the drain.

Two types of nozzles are most commonly used in Imperial Valley: (a) the cleaning nozzle used mainly for removing silt and mineral deposits requiring a pump pressure of 1250 psi and a nozzle pressure of 700 psi; and (b) the penetrator nozzle, used mainly for removing root plugs and the larger, more difficult,

(*Continued on page 891*)

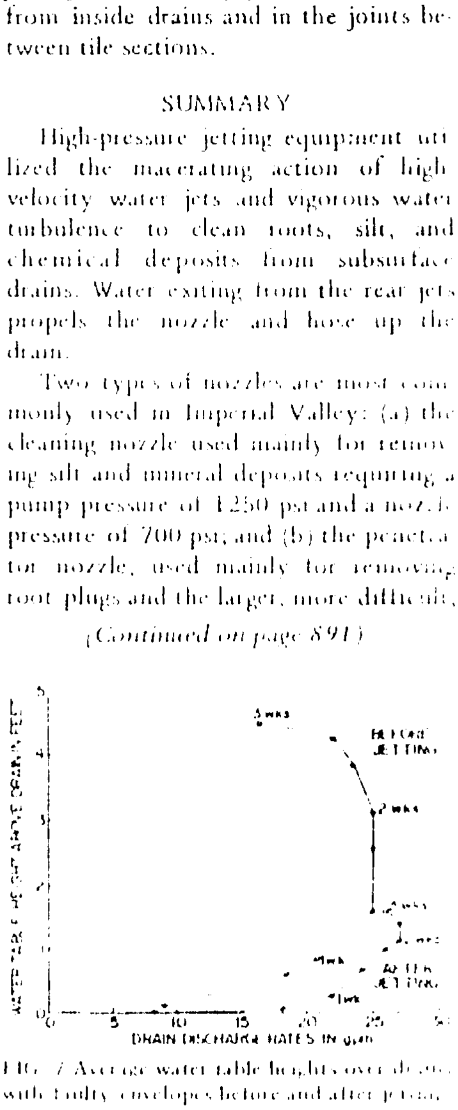

FIG. 7 Average water table heights over drains with faulty envelopes before and after jetting.

Cleaning of Subsurface Drains

(Continued from page 888)

accumulations of silt requiring pump pressure of 1000 psi and a nozzle pressure of 500 psi. A dewatering pump is used to remove the dislodged material arriving at the tile opening. The jet cleaning operation also can locate breaks in subsurface drain lines so that they can be repaired.

References

1 Grass, L. B. 1969. Tile clogging by iron and manganese compounds in Imperial Valley, California. Jour. Soil & Water Cons. 24:135-138.

2 Grass, L. B. and A. J. MacKenzie. 1970. Reclamation of tile drains by sulfur dioxide treatment. The Sulfur Institute Jour. 6:1: 8-13.

3 Grass, L. B. and A. J. MacKenzie. 1972. Restoring subsurface drain performance. Jour. Irrig. & Drng. Div. ASCE 98 (IR1), Proc. Paper 8759, pp. 97-106.

4 Houston, C. E. 1961. Drainage of irrigated land. Calif. Agr. Expt. Sta. Bull. No. 504.

5 MacKenzie, A. J. 1962. Chemical treatment of mineral deposits in drain tile. Jour. Soil and Water Cons. 17:124-125.

6 Sutton, J. G. 1952. Maintaining drainage systems. USDA Farmer's Bull. No. 2047.

7 Willardson, L. S., S. Davis, D. Mulder, and J. R. Spencer. 1973. Drain envelope response to field treatments. ASAE Paper 73-2513, ASAE, St. Joseph, Mich. 49085.

8 Zuidma, Ir. F. C. and J. Scholten. 1970. Maintenance of drainage systems. Intern'l Commission of Irrigation and Drainage, Seventh Intern'l Congr. 25. 309-325, 320.

REFERENCES

1. Fifth Annual Report - Field Evaluation of Pipe Envelope Materials for Effective Drainage. PL-480-FG-Eg-151. July 1979 to July 1980.

1-A. Depth and Spacing of Tile Drains for Proper Drainage - Fifth Annual Report. PL-480-FG-EG-149 dated July 1979-80.

2. First Annual Report of the Soil Group by N.M. El Mowelhi and B.C. Williams, EMCIP Publication No. 14.

3. Evaluation and Development Plan for Irrigation, Drainage and Road Systems at the Four Research/Extension Centers - by Dale Henry, EMCIP Publication No. 22.

4. Drainage Evaluation and Recommendations by Dale Henry et al, May 29, 1981.

5. High Pressure Water Jet Cleaning of Subsurface Drains, L.B. Grass and L.S. Willardson, Transactions of ASAE, 17: 5: 886 - 891, 174.

Current as of 8/81

EMCIP PUBLICATIONS

PUBLICATION TITLE	PUBLICATIONS No.
- Research Report First Annual Report of Soil Group By B. Williams & N. Mowelhi	14
- Research Report Maize & Sorghum Program 1981 By A.H. Shehata & Co-Workers	15
- Legal Paper Project Paper EGYPT: Major Cereals Improvement 263-0070	No Number
- Legal Paper EMCIP Technical Report Prepared by CID Project Design Team Project Design Team Jan. 17 - March 2, 1979	No Number
- EMCIP Egyptian Newsletter Vol. I No.1. - March 1981 By I. Abdel Aal & K. Austin	No Number
- Quarterly Report (Oct. 1 through December 31, 1980)	16
- Technical Report Design & Construction of Facilities for EMCIP. Jan. 11 - March 10, 1981 By Clair Huntington	17
- Technical Report Development of the EMCIP Stations By R.B. Hulsman & D.J. Minehart	18
- Technical Report The National Cereals Laboratory Feb. - March 7, 1981 By William T. Yamazaki	19
- EMCIP Egyptian Newsletter Vol. I No.2 - June 1981 By I. Abdel Aal & K. Austin	No Number
- Quarterly Report (January 1, 1981 to March 31, 1981)	20
- Technical Report Seed Cleaning Plant Design & Needs for Cleaning Foundation Seed By Loren Wiesner	21

X

EMCIP PUBLICATIONS (cont'd)

D I S T R I B U T I O N

5.	Dr. S. Dessouki	Director General
5.	Dr. E. Everson	Co-Director EMCIP
1.	Dr. A. Serry	Deputy Director General
1.	Mr. I. Abdel Aal	Assistant to Director General & Project Editor
1.	Dr. J. Graves	Deputy Chief of Party
1.	Mr. C. Huntington	Deputy Chief of Party
2.	Dr. A. Gomaa	Program Leader
2.	Dr. A. Shehata	" "
1.	Mr. A. Fawzi	" "
1.	Dr. A. Abdel Aziz	" "
1.	Dr. A. Momtaz	" "
1.	Mr. Abdalla Nassib	" "
1.	Dr. R. Abu-El-Enein	Asst. Program Leader
1.	Dr. M. Abu-El-Fadl	" "
1.	Dr. A. El-Rafei	Deputy Program Leader
1.	Dr. A. Basheer	Agricultural Economist
1.	Dr. C. Harvey	Seed Specialist
1.	Dr. B. Williams	Soil Science Specialist
1.	Dr. E. Foerster	Irrigation Specialist
1.	Dr. V. Small	Research Agronomist
1.	Mr. R. Foote	Economist/Statistician
1.	Mr. R. Marek	Extension Education Specialist
1.	Dr. M. Khalifa	Director - Gemmeiza Center
1.	Dr. M. Bishr	" Sakha "
1.	Mr. M. Selim	" Sids "
1.	Mr. M. Guirguis	" Shandaweel "
1.	Mr. N. Illsley	Farm Mechanization Specialist
1.	Mr. K. Austin	Agricultural Training Advisor
1.	Mr. C. Wengreen	Business Manager
2.	Mr. J. Rogers	AID Agricultural Officer
1.	Dr. H. Matteson	N M S U
3.	Author	-
10.	Information Service	FAO Building

EMCIP

PUBLISHED BY THE EMCIP INFORMATION SERVICE

KEITH AUSTIN - AGRICULTURAL TRAINING ADVISOR

SOHA FADEL - PROGRAM ASSISTANT-INFORMATION