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Choosing Between Sock-Wrapped and Sand-Slot Pipes

Ehsan Ghane,
Michigan State University

1. Overview of sock-wrapped and sand-slot pipes

If fine sand or silt gets into subsurface (tile) drain pipes, it can remain near the entry point, build up over time, and cause drain clogging. If drain sedimentation is a problem, use either sock-wrapped or sand-slot pipe (Figure 1). A sand-slot pipe is also known as narrow-slot, knife-cut, or fine-slot. A sand-slot pipe has a narrow slot width of about 0.015 inches to keep sediment out of the drain pipe. Typically, a regular-perforated rectangular-slotted pipe is wrapped with a knitted-sock envelope. Other pipes can also be wrapped with a knitted sock to give the same drainage performance. For more information about regular-perforated pipes, see Ghane (2022b).

This bulletin describes the condition where sock-wrapped and sand-slot pipes are needed. The bulletin also compares the properties of three 4-inch diameter pipes: sock-wrapped, 8-row sand-slot, and 4-row sand-slot pipes. The evaluated properties include water entry into the pipe, water-table drawdown, drain spacing, and cost effectiveness. This bulletin is based on scientific research conducted on CARRIFF Type A circular-knitted-sock geotextile envelope and commonly manufactured sand-slot pipes in the Midwest USA (Ghane, 2022a; Ghane et al., 2022).

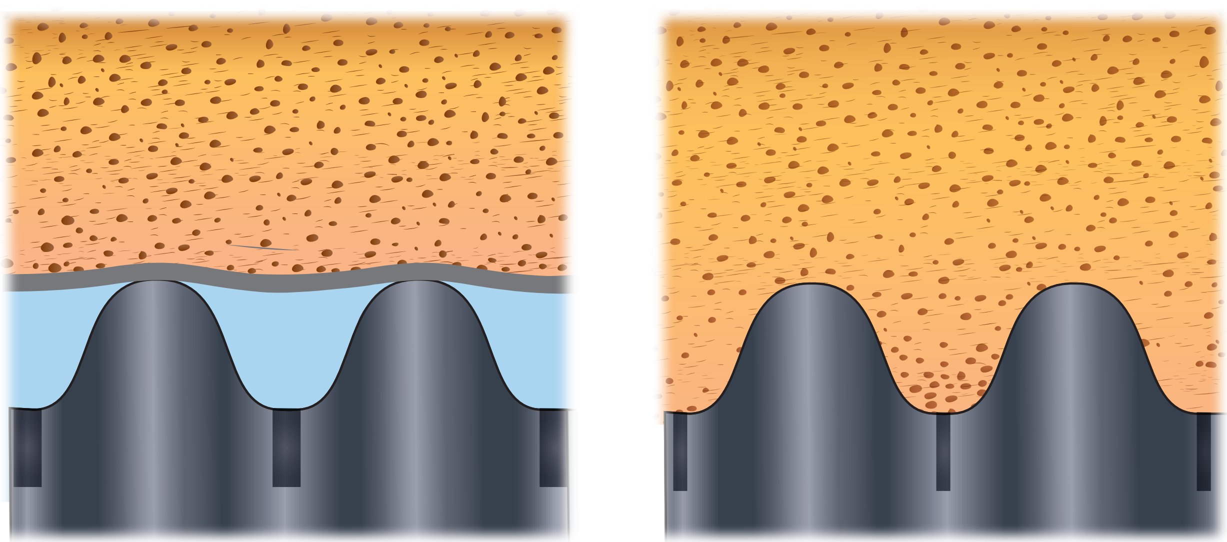


Figure 1- Left: A regular-perforated pipe wrapped with a knitted-sock envelope. Right: A sand-slot pipe with narrow slot width.

2. Where is a sediment preventive measure needed?

Sediment clogging of subsurface drain pipes can be a problem in soil with low clay and organic matter content. These soils have non-cohesive or weakly cohesive particles that do not stick together, so flow of water can wash them into the drain pipe. Example soils that may cause a sedimentation problem are sand, loamy sand, sandy loam, loam, silt loam, and silt (Stuyt et al., 2005). After fine sand or silt washes into the drain pipe, it remains near the entry point, builds up over time, and causes drain clogging (Figure 2).

If clay content at the drain depth is less than 30%, drain sedimentation may be a problem. In that case, use the Drain Sedimentation Tool (www.egr.msu.edu/bae/water/drainage/tools) to determine if sedimentation is a problem. The tool evaluates the resistance of the soil to being washed into the perforations. For more information about the tool, see Ghane (2022c). For more information about sedimentation occurrence and mitigation strategies, see Ghane (2022e).

Figure 2- A 6-inch main, installed in 2013. The pipe was 2/3 filled with sand in 2020. The use of a regular-perforated pipe without a knitted-sock envelope in sandy loam soil was the cause of the drain sedimentation (photo credit: William Word).

3. A knitted-sock envelope maximizes water entry into the pipe

A knitted-sock envelope has two key properties that make it suitable as a drain envelope. It keeps fine sand and silt out of the drain pipe and considerably increases water entry into the pipe. Water enters a sock-wrapped pipe much more quickly than a sand-slot pipe. In fact, a sock-wrapped pipe maximizes water entry because it functions as a completely open conduit without walls, like mole drains.

The percent increase in drain inflow of a sock-wrapped pipe compared to a sand-slot pipe depends on the drain depth, drain spacing, and depth to restrictive layer. For example, a 4-inch diameter sock-wrapped pipe has 16% higher drain inflow than an 8-row sand-slot pipe and 29% higher drain inflow than a 4-row sand-slot pipe, when installed at 30-ft spacing and 2.5-ft depth in soils with varying saturated hydraulic conductivities and a 6.5-ft depth to restrictive layer (Figure 3). These differences grow to 18% and 32% when installed at 20-ft spacing, while other conditions are the same. Overall, the trend of higher drain inflow for a sock-wrapped pipe than a sand-slot pipe will remain the same for other combinations of conditions.

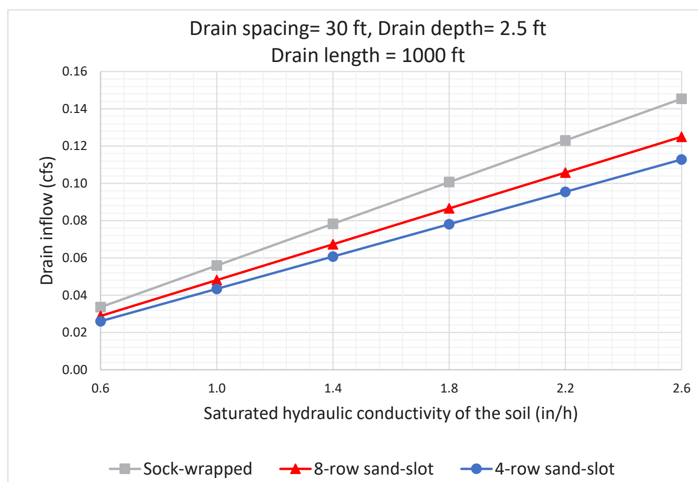


Figure 3- A sock-wrapped pipe has 24% higher drain inflow than a 4-row sand-slot pipe, when installed at 30-ft spacing and 2.5-ft depth. Depth to restrictive layer is 6.5 ft.

4. A sock-wrapped pipe lowers the water table most quickly

A sock-wrapped pipe lowers the water table most quickly because it maximizes water entry into the pipe.

When installed at the same depth and spacing, a sock-wrapped pipe lowers the water table more quickly than a sand-slot pipe. The time to lower the water table from the soil surface to 1-ft depth depends on the pipe material, drain depth, drain spacing, and soil properties. For example, a sock-wrapped pipe lowers the water table 3.2 hours more quickly than a 4-row sand-slot pipe, when installed at 30-ft spacing and 2.5-ft depth in a sandy loam soil with a saturated hydraulic conductivity of 1.8 in/h, depth to restrictive layer of 6.5 ft, and drainable porosity of 0.1 (Figure 4).

When installed at the same depth and spacing, research showed that corn yield increase with a sock-wrapped pipe ranges from 0.2% to 2% compared to a 4-row sand-slot pipe over 30 years across the Midwest USA in a sandy loam soil (Ghane et al., 2021). While a sock-wrapped pipe provides a higher crop yield, the unit cost of a sock-wrapped pipe material is higher than a sand-slot pipe on a per-foot basis. The cost effectiveness of the pipes depends on site-specific conditions including soil, climate, drain depth, drain spacing, crop yield, crop price, and pipe cost.

The quicker lowering of the water table with a sock-wrapped pipe reduces the risk of crop damage from waterlogging after heavy rainfalls. It also reduces the risk of delayed planting because of wet soil.

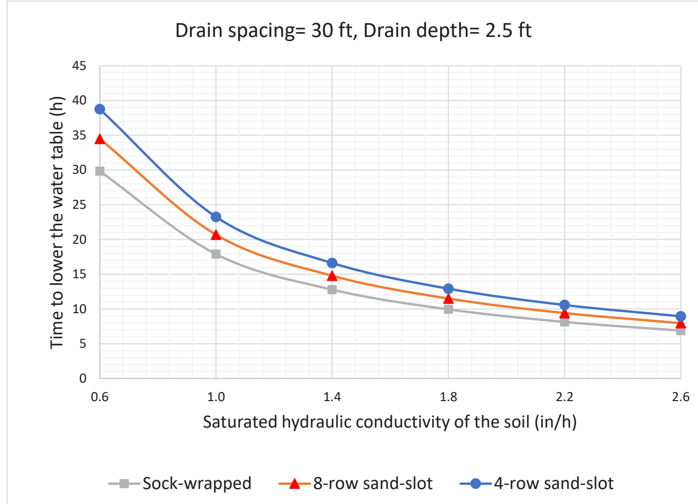


Figure 4- A sock-wrapped pipe lowers the water table from the soil surface to 1-ft depth, 24% more quickly than a 4-row sand-slot pipe, when installed at 30-ft spacing and 2.5-ft depth. Drainable porosity is 0.1 and depth to restrictive layer is 6.5 ft.

5. A sock-wrapped pipe allows for a wider spacing than a sand-slot pipe

Water enters a sock-wrapped pipe much more quickly than a sand-slot pipe. As a result, when installed at the same depth, a sock-wrapped pipe allows for a wider drain spacing to achieve the same water removal rate as in a system with a narrower-spaced sand-slot pipe (Figure 5). The wider drain spacing of a sock-wrapped pipe reduces the total length of lateral drain pipe needed for drainage design (Ghane 2022a). When installed at the same depth and designed at an equal water removal rate, both pipes provide similar crop yield (Ghane et al. 2021).

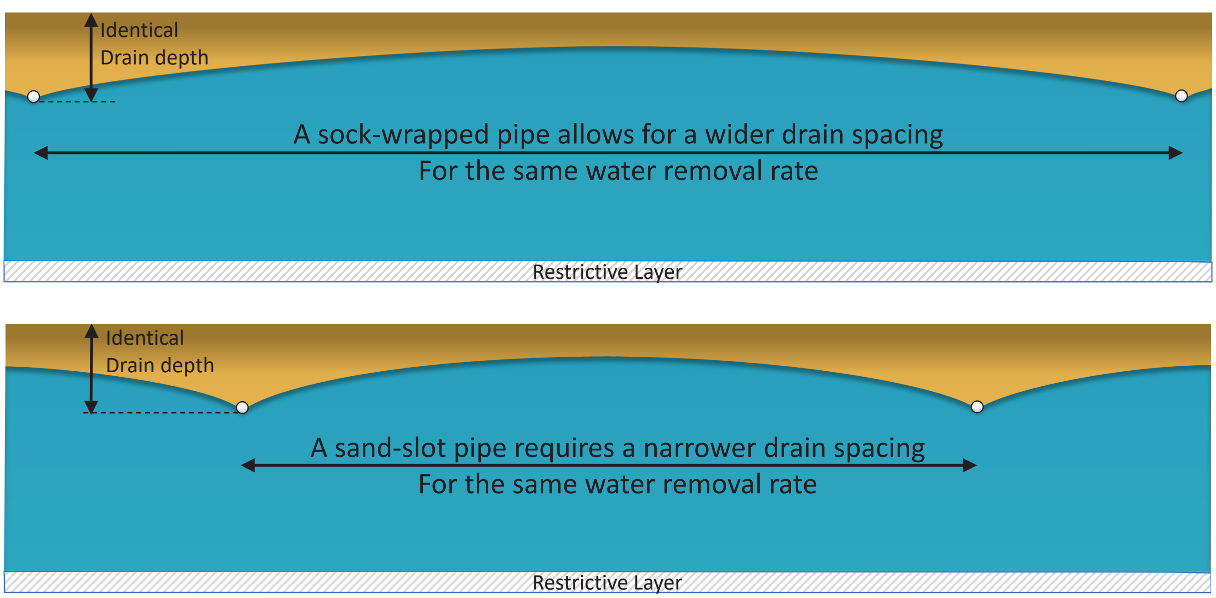


Figure 5- A sock-wrapped pipe allows for a wider drain spacing to achieve the same water removal rate as in a system with a narrower-spaced 4-row sand-slot pipe, when installed at the same depth.

6. Installation considerations for knitted-sock and sand-slot pipes

6.1. Installation issues and solutions

Not even the best envelope or drain pipe can work well under poor installation conditions. Both sock-wrapped and sand-slot pipes need good installation conditions to work efficiently and extend the life of the drainage system (Figure 6). The ideal installation condition is when the ground is driest and the water table is as deep as possible, usually during summer. Typically, there is limited control over installation timing because conditions may be less than ideal when the drainage contractor is available to work during normal installation windows (before and after planting). To reduce the risk of drainage under-performance due to installation under wet conditions, one option is growing crops with an early harvest (wheat, barley, oats, rye, and corn silage) during the year planned for installation to provide ideal installation conditions after harvest. Another option is installing through a standing crop when the ground is driest.

Avoid installation or any other fieldwork during wet soil surface conditions because it leads to soil compaction, which is one of the causes of impeded infiltration and percolation. For more information about impeded infiltration and percolation, see Ghane (2022e).

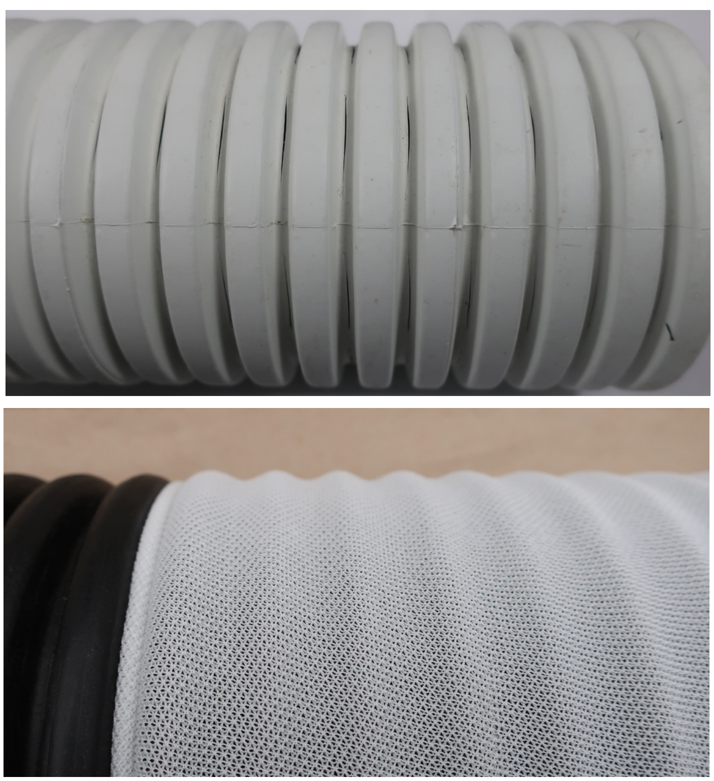


Figure 6- Top: A photo of a sand-slot pipe. Bottom: A photo of a knitted-sock envelope wrapped around a regular-perforated pipe.

When the water table is above or near the drain installation depth, there is more risk of smearing the soil adjacent to the drain pipes, especially in heavy clay soil. Smearing slows down water entry into the drain pipes, so the system will not work well at first. It may take up to 3 years for the drainage system to work efficiently as the ground goes through cycles of drying, wetting, and frost to break up the compaction around the pipe.

In some fields, there is a mix of sand and clay where the sandy soil has a drain sedimentation problem. In that case, it is unfeasible to change the pipe material from one soil to the other over a short distance. The solution is to use a sock-wrapped or sand-slot pipe throughout the field. Sock-wrapped pipes have been used in fields with a mix of sand and clay in parts of Michigan without causing any problems.

6.2. Early period after installation

A knitted-sock envelope is designed to retain sediment and allow passage of clay particles through the sock openings (Figure 7). During installation of the drainage system, the soil around the pipe gets disturbed. In the early period after installation, some sediment may pass through the knitted sock and enter the pipe (Stuyt et al., 2005). Once the soil around the pipe stabilizes, only a limited amount of clay particles will pass through the sock openings, and water will carry them to the system outlet.

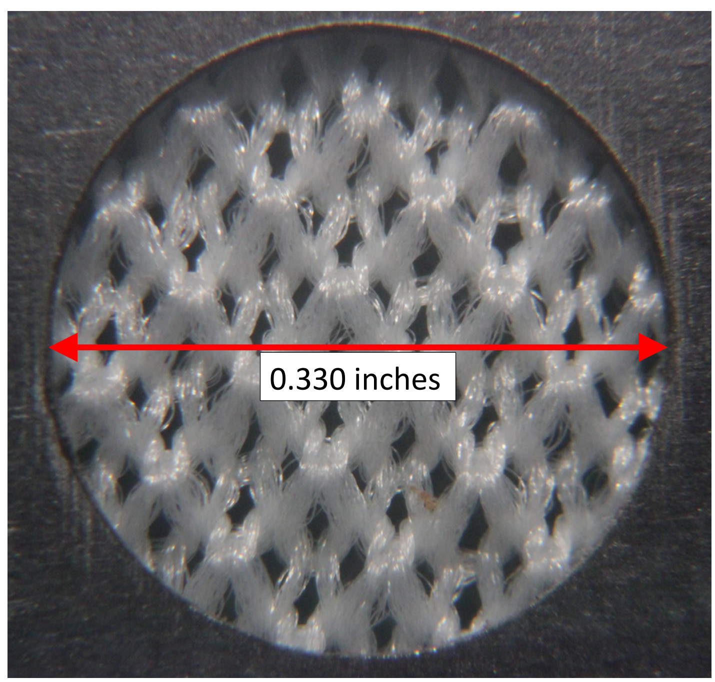


Figure 7- A microscope image of a knitted-sock envelope that keeps fine sand and silt out of the pipe, and allows clay particles to pass through.

6.3. Overstretching of the sand-slot pipe during installation

If black sand-slot pipes are exposed to the sun for too long during the summer, they get stretched (slot width gets wider) during installation and lose their sedimentation protection. If a power feeder is not used when installing sand-slot pipes, the slot widths can get overstretched and lose their sedimentation protection.

6.4. UV resistance of the knitted sock

If sock is exposed to the sun for too long during the summer, it degrades and may tear apart during installation. If you need to store the sock-wrapped pipe, use black sock to extend the life of the sock. This is because black sock is much more resistant to UV degradation than white sock (Figure 8).

7. Anti-clogging feature of the knitted-sock envelope

A geotextile fabric has an anti-clogging feature when sediment does not clog the fabric openings, such that flow is impeded. A knitted-sock envelope is designed to retain sediment and allow passage of clay particles through the sock openings. Scientific research showed that knitted-sock openings did not clog in a silty clay loam soil after three years (Rollin et al., 1987). In another research, knitted-sock envelopes did not clog in a wide range of soils: medium sand, fine sand, fine sandy loam, very fine sandy loam, and silt loam (Broughton et al. 1987).

If a sock-wrapped pipe is properly installed in a soil with a drain sedimentation problem, the sock openings will not clog. The exception is chemical clogging (iron ochre and calcium carbonate).

In a sandy soil with an iron ochre problem, use a muck pipe wrapped with a knitted-sock envelope along with proper mitigation and removal methods. Synthetic thin envelopes perform better than sand-slot pipes with iron ochre (Gameda et al., 1983). Among all synthetic envelopes, a knitted-sock envelope performs better with iron ochre (Stuyt et al., 2005).

Overall, a muck pipe wrapped with a sock is better than a sand-slot pipe with an iron ochre problem. For information about iron ochre mitigation and removal methods, see Ghane (2022d).

8. Soil retention of the knitted sock compared to the sand-slot pipe

When a geotextile fabric retains soil, it keeps sediment from clogging the pipe. In a scientific research, sock-wrapped and sand-slot pipes were compared in a wide range of soils: medium fine sand, fine sandy loam, very fine sandy loam, and silt loam (Broughton et al. 1987). The research showed that even though some sediment entered both sock-wrapped and sand-slot pipes, both pipes provided adequate protection against sediment clogging of the pipe. However, the sock-wrapped pipe consistently kept more sediment out of the pipe than the sand-slot pipe in each of the tested soils.

Manufacturers make knitted socks with a filtration opening size of 0.018 inches. However, depending on the manufacturer, sand-slot pipes are made with a narrow slot width ranging from about 0.020 to 0.035 inches. Pipes with a slot width closer to the lower end of that range can keep more sediment out of the pipe than those with a slot width closer to the higher end of that range.

Overall, both sock-wrapped and sand-slot pipes prevent sediment clogging of the pipe. Sock-wrapped pipes keep more sediment out of the pipe than sand-slot pipes.

Figure 8- The black sock is much more resistant to UV degradation than the white sock.

9. Explanation for the faster water entry into a sock-wrapped pipe compared to a sand-slot pipe

The white lines in Figure 9 show how water moves into the pipe. In the sand-slot pipe, flowlines have to come together as they get close to the perforation. When flowlines come together, they slow down because there are limited openings available on the pipe for water to enter.

Imagine the sand-slot pipe in Figure 9 is a sport stadium with three entrance gates. Because there are only three entrance gates, the fans need to wait in line to get in. The fans standing in line resemble the flowlines. Because of the limited number of entrance gates, the fans will enter the stadium slowly.

In the sock-wrapped pipe, flowlines do not come together as they get close to the sock. Because the entire surface of the sock is permeable, flowlines can enter the sock from any location. That is why flowlines go straight without coming together, and they do not slow down.

Imagine the sock-wrapped pipe in Figure 9 is a sport stadium with no walls. The entire boundary of the stadium is open for entry. This means that the fans can enter the stadium without coming together to stand in line. Instead, fans will approach the stadium by going straight and entering the stadium. The movement of the fans in that case resembles flowlines.

In a sock-wrapped pipe, flowlines do not come together to enter the pipe, so they do not slow down. After water passes through the sock, flowlines come together to enter the perforations, but this process does not slow down the water because it is occuring away from the soil. When flowlines come together in water, they do not slow down.

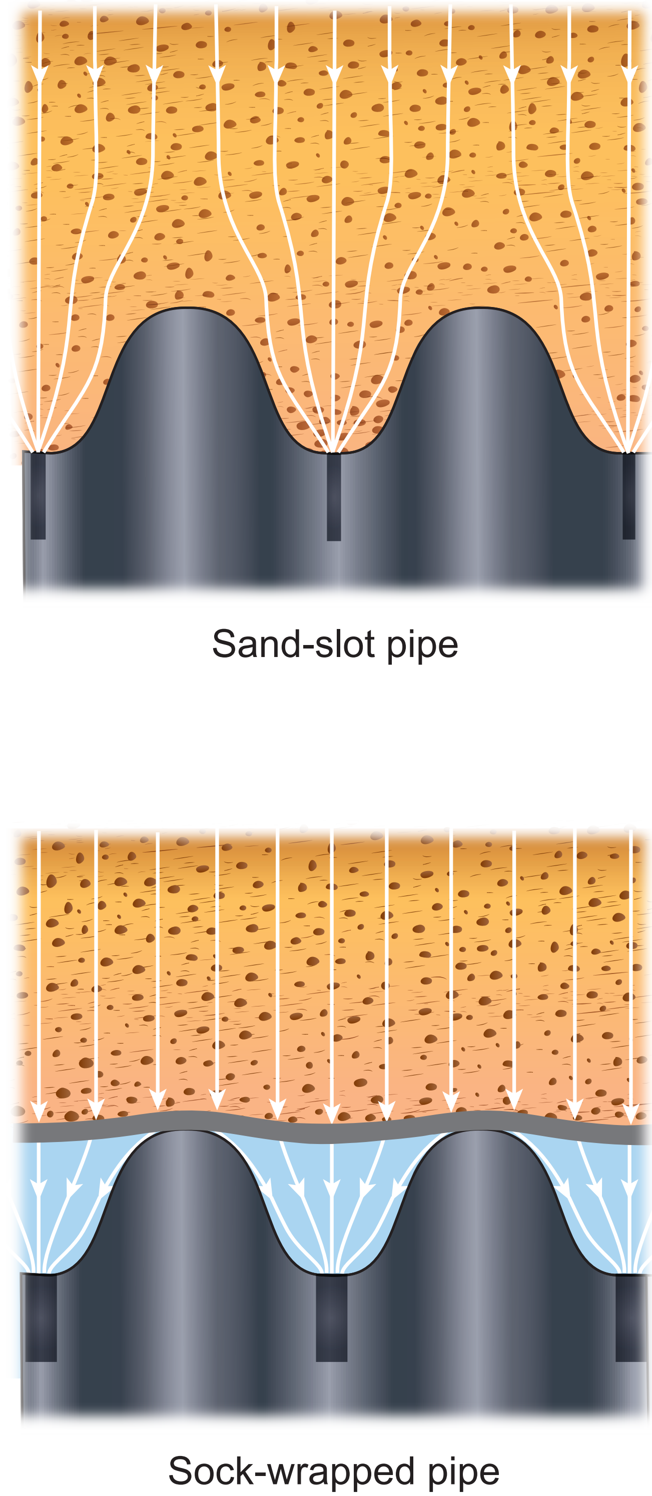


Figure 9- A diagram showing how water enters a sock-wrapped and sand-slot pipe.

10. Conclusions and recommendations

A sediment preventive measure is needed in non-cohesive or weakly cohesive soils. Example soils that may cause a sedimentation problem are sand, loamy sand, sandy loam, loam, silt loam, and silt.

Even though some sediment enters both sock-wrapped and sand-slot pipes, both pipes provide adequate protection against sediment clogging of the pipe. Sock-wrapped pipes keep more sediment out of the pipe than sand-slot pipes.

Depending on the manufacturer, sand-slot pipes are made with a narrow slot width ranging from about 0.020 to 0.035 inches. Those pipes with a slot width closer to the lower range keep more sediment out of the pipe than those with a slot width closer to the higher range.

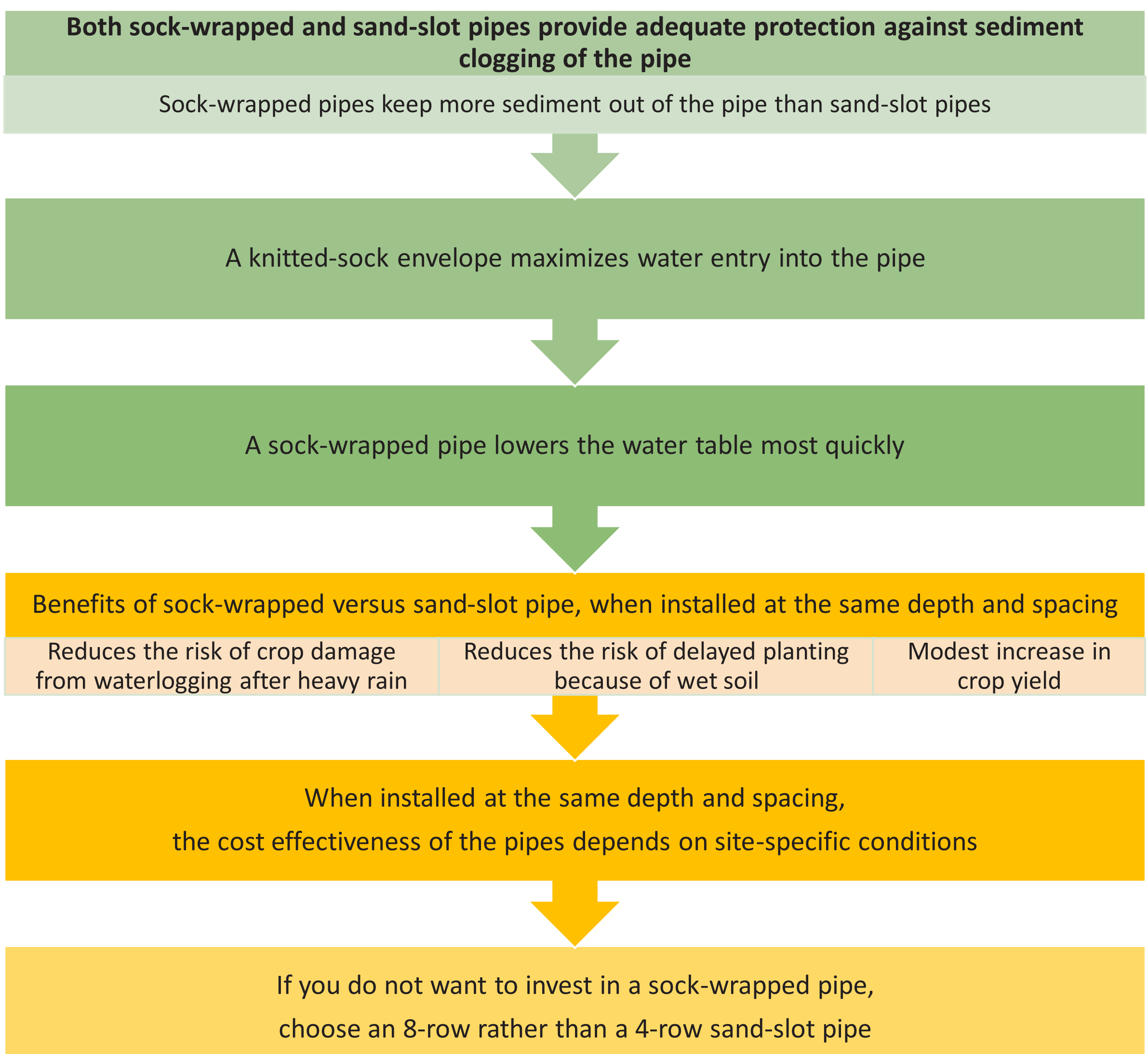
A sock-wrapped pipe maximizes water entry because it functions as a completely open conduit without walls, like mole drains. As a result, a sock-wrapped pipe lowers the water table most quickly.

When installed at the same depth and spacing, a sock-wrapped pipe provides a modest increase in crop yield compared to a sand-slot pipe. The cost effectiveness of the pipes depends on site-specific conditions including soil, climate, drain depth, drain spacing, crop yield, crop price, and pipe cost.

The quicker lowering of the water table with a sock-wrapped pipe reduces the risk of crop damage from waterlogging after heavy rainfall. It also reduces the risk of delayed planting because of wet soil.

If you do not want to invest in a sock-wrapped pipe, choose an 8-row rather than a 4-row sand-slot pipe. An 8-row sand-slot pipe removes water more quickly than a 4-row sand-slot pipe for the same pipe material cost.

Finally, a good drain installation is essential for the proper performance of both the sock-wrapped and sand-slot pipes.



Expert Reviewed

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