IMPROVE PERFORMANCE OF DRIP IRRIGATION IN OSSF SYSTEMS IN TEXAS

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ABSTRACT

Drip irrigation provides precise and uniform application of treated wastewater in soil, thus allowing for improved use of the soil treatment area. Because of this, its use in OSSF (On-Site Sewage Facility) industry is increasing in Texas in response to issues such as limited space and challenging site conditions. However, there is a lack of standard procedures needed by designers, installers, and maintenance providers. Professionals have frequently observed problems, and there is a potential for improving drip performance, especially in terms of effluent distribution uniformity and maintenance. Drip irrigation systems are quite common in central Texas and if successful use of drip is demonstrated in this region (in terms of better design guidance, reduced failure rate and improved abilities to operate and maintained systems after installation), it would encourage application of drip system in other parts of the state. In November 2021, Texas Commission on Environmental Quality (TCEQ) contracted with Texas A&M AgriLife Extension to gather and summarize information from surveys, existing literature, and original field experiments with focus on aspects specific to Texas conditions (i.e., dosing technique, application rate, effect of soil type, installation configuration, flushing method, filtering type and method, and tubing cleaning). This work will result in a unique compilation of recommendations and guidance document that will support license holders, regulators, and landowners to implement successfully drip irrigation. The research project is designed to identify gaps in current regulations and aid TCEQ when considering potential rule or policy change. This paper presentation will describe the project objectives, methods, and preliminary results.

INTRODUCTION

About three percent of the total permits issued during the last 30 years in Texas are for drip irrigation (Figure 1). The utilization of drip irrigation is expected to increase in OSSF systems installed in Texas, in response to issues such as limited space and challenging site conditions. Industry professionals have frequently observed problems with drip irrigation and there is potential for improving its performance, especially in terms of effluent distribution uniformity and maintenance. These improvements would substantially impact OSSF use in central Texas where use of drip irrigation systems is increasing since 1995 (Figure 2). Demonstrated success in using drip in central Texas would encourage use of drip as an alternative to spray for secondary effluent throughout Texas. Results from the field experiment from this research are expected to improve filter choice and irrigation line cleaning procedures which in-turn would improve the long-term performance of the system through better maintenance.

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This project is designed to gather and summarize information from surveys, existing literature, and field experiments with focus on aspects specific to Texas conditions (i.e., dosing technique, application rate, effect of soil type, installation configuration, flushing method, filtering type and method, and tubing cleaning). Information and data generated is expected to generate a unique compilation of recommendations and guidance document that will support license holders, regulators, and landowners to implement successfully drip irrigation configurations and design practices. The research will also identify gaps in current regulations and aid Texas Commission on Environmental Quality (TCEQ) when considering potential rule or policy change.

The goal of this project is to develop detailed guidance manual to assist Texas on-site sewage professionals regarding proper design, installation, operation, maintenance, and troubleshooting of drip irrigation systems. Specific objectives include: a) Create a survey instrument to query and interview regulators and license holders regarding the most common design, installation, operation, maintenance and troubleshooting procedures associated with drip irrigation systems in Texas; b) Conduct an extensive literature review of scientific articles and existing local, state, and federal publications regarding drip irrigation practices; c) Conduct field experiments at the Texas A&M RELLIS Campus, Bryan Texas, OSSF center (TAMU OSSF center) evaluating drip irrigation flushing and filtration performance and irrigation line cleaning solutions; d) Summarize gathered information and prepare a guidance document describing best practices for designing, installing, operating, maintaining, and troubleshooting drip irrigation systems in Texas.

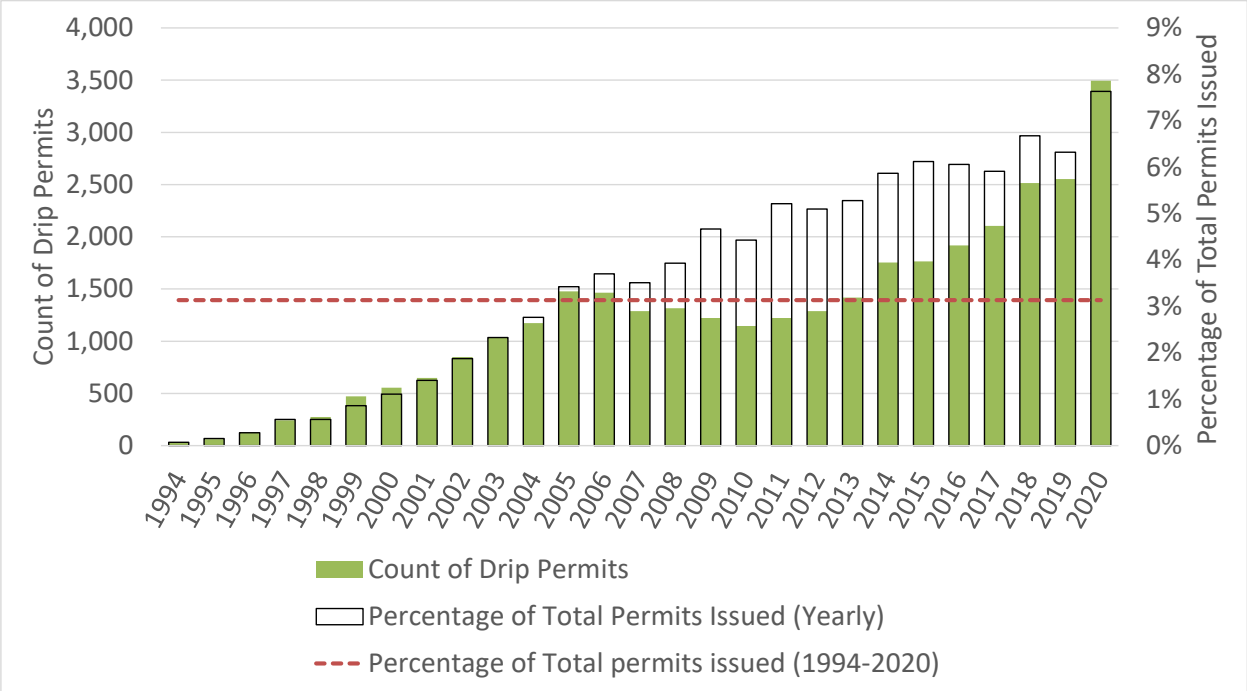

Figure 1. Drip irrigation permits (Aerobic Treatment Unit followed by Drip) issued as of 2020 in Texas: Yearly permits count (full column, left Y-axis), and percentage of total permits (empty column and dotted line, right Y-Axis). Data is compiled from TCEQ's annual permit dataset by TAMU OSSF Team.

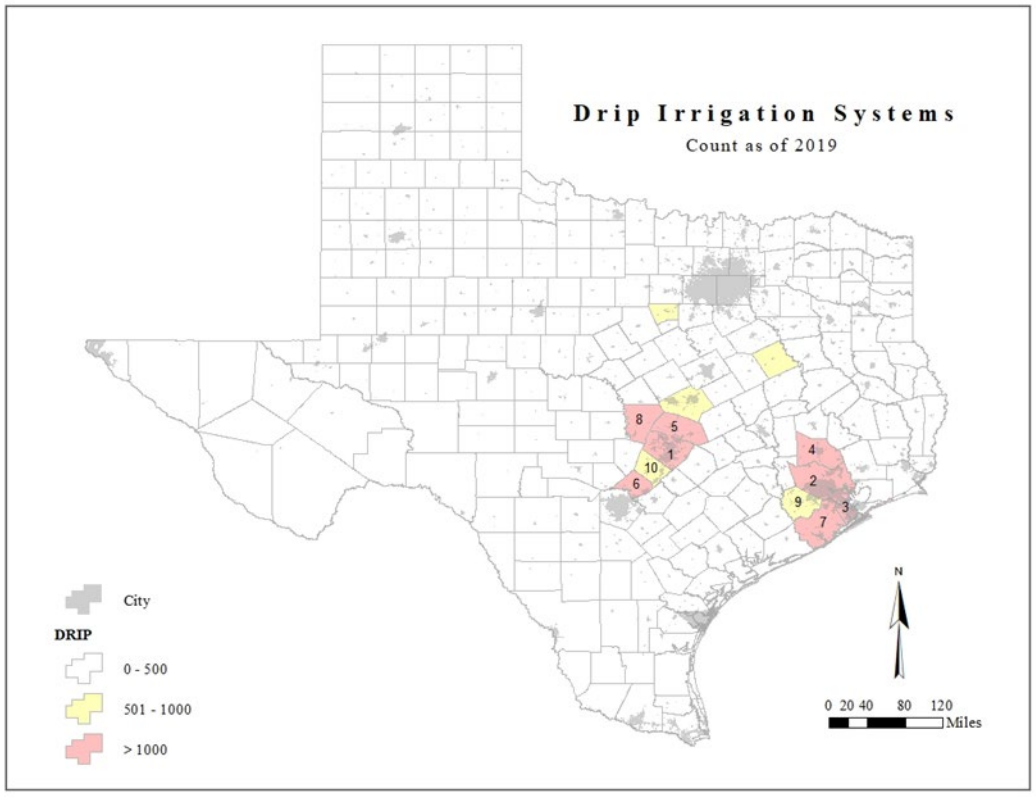

Figure 2. Number of drip irrigation permits issued in Texas between 1992 and 2019 (Source TAMU OSSF Inventory System). Labels indicate rank of top ten (10) counties, where 1 indicates the county with most permits

MATERIALS AND METHODS

In November 2021, Texas A&M AgriLife OSSF Team (TAMU OSSF Team) was awarded a research grant by the Texas On-Site Sewage Facility Research Grant Program (TOGP)[4], to address issues related to use of drip systems for dispersal of treated wastewater by means of a combination of data mining and field experimentation. While existing information on use of drip will be collected from the states where drip has been successfully used (e.g., Virginia and North Carolina), field experiments related to filter and drip clogging will be conducted at the TAMU OSSF center (Figure 5).

[4] Texas On-Site Sewage Facility Research Grant Program (TOGP), Request for Grant Applications (RFGA), 2nd cycle, 2021

The research project will include the following:

1) Study to proper dosing techniques (on and off times) and application rates relative to structure and texture of soil: Proper or successful techniques for dosing and application relative to soil characteristics will be determined through the survey and literature review process rather than through field experimentation. Survey respondents will be queried regarding on/off dosing times that have yielded best and worst results based on the soil. With the help of Texas regulators, the TAMU OSSF Team will identify the best design based on local conditions, including for a basic mound irrigation system. Monitoring and characterization procedures for failing systems (e.g., break out at the edges of mound systems) will be designed for best comparison of failing systems.

2) Study of installation configurations on properties with flat terrain, slopes, and depressions: Proper or successful techniques for dosing and application relative to terrain characteristics will be determined through the survey and literature review process rather than field experimentation. With the help of Texas regulators, the performance of failing drip irrigation systems will be characterized by slope (including depressions) and compared to successful design in terms of dosing techniques, applications rates, and depth of installation.

3) Study of continuous flushing vs periodic field flushing, effectiveness of screened filters vs disc filters, and the effectiveness of auto- backflushing both types of filters: Filtration technology will be experimentally manipulated using the drip irrigation facility at the TAMU OSSF Center. A minimum of two disc and screen filters configurations will be installed in conjunction with an automatic flushing device (Figure 3). Experiment design and monitoring will compare two filter types (disc vs screened) and the benefit of auto-backflushing. System performance will be determined by comparing measurements of Total Suspended Solids (TSS).

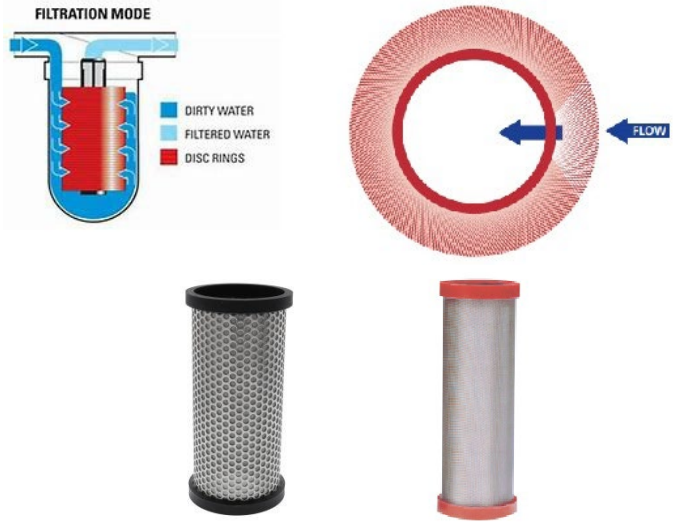

Figure 3. Disc (top) and screen (bottom) filters

4) Most effective techniques for cleaning and unclogging drip tubing: Information regarding drip irrigation emitter performance under low pressure is needed to test performance of drip irrigation systems. The distribution uniformity (DU) is a measure of how evenly water is applied to a zone, expressed as a percentage between 0 and 100%. DU of less than 70% is considered as poor, 70 - 90% is good, and greater than 90% as excellent (Rain Bird, 2021[5]). A field scale experiment will be conducted at the TAMU OSSF Center (see example of testing layouts in Figure 4). Irrigation drip tubing will be installed in an aboveground array and used to measure drip rate/volume at test pressures. Artificially induced clogging will be induced by adding septic tank sludge to the inflow. A clogged drip rate/volume measurement will be established prior to cleaning with bleach and peracetic acid. Following cleaning, drip rate and volume measurements will be measured again.

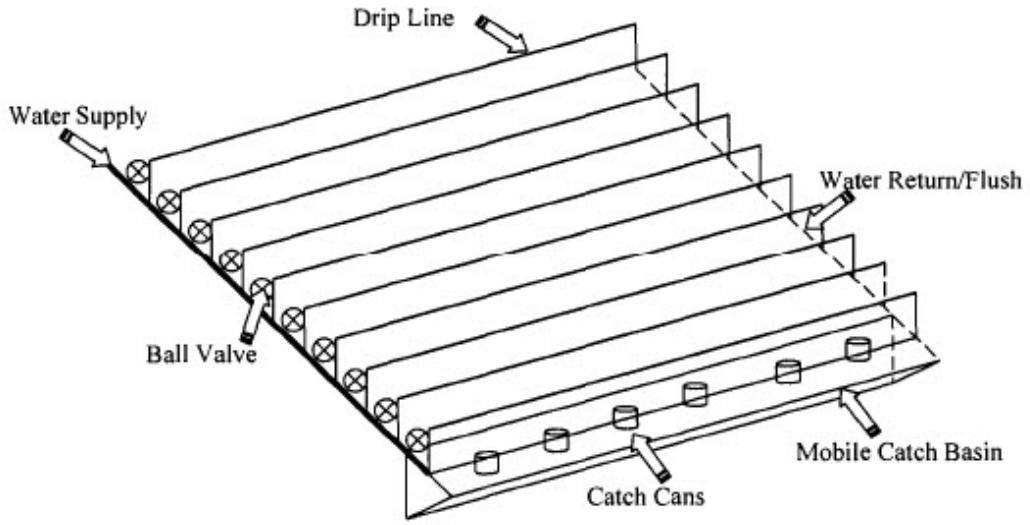

Figure 4. Emitter testing layout (Duan, 2006[6])

5) Guidance on drip design: All information gathered through data mining activities (i.e., surveys, interviews, literature reviews, etc.) and field experimentation at the TAMU OSSF center will be summarized to aid designers, installers, maintenance providers, and regulators regarding best practices for drip irrigation systems in Texas.

The OSSF Center located on the TAMU RELLIS Campus has been used for the three TOGP-funded research projects (Figure 5). Field experiments to conduct studies related to installation configuration, drip and filter clogging, and unclogging methods will be conducted at the Center. The Center currently has a drip irrigation system which supports an array of drip lines which will be used to evaluate different cleaning solutions and their application. The research team plans to study and compare two types of flushing methods (continuous v. periodic), two types of filters

[5] Rain Bird Irrigation website (http://www.rainbird.com). Last visit: 07/06/2021

[6] Duan, X. 2006. Characterization of wastewater subsurface drip emitters and design approaches concerning system application uniformity. MS thesis, Department of Biological and Agricultural Engineering, Texas A&M University, College Station

(screened v. disc), and to study effectiveness of cleaning and unclogging drip tubing using bleach using bleach v. peracetic acid. The research team is also discussing another concept for setting up the drip experiment, where new drip system is installed at a shallow depth (< 6 inches) in two wetland cells that will be used for another research project designed to study reduction in liquid discharge from wetlands with and without a climate control greenhouse installed to cover the wetland. Depending on the which option works the best within the budgetary constraints, drip layout is expected to be finalized before end of this year.

Figure 5. Aerial view of the Texas A&M RELLIS Campus, Bryan Texas, OSSF center (TAMU OSSF center). The callout shows the new Low-Pressure Dosing (LPD) drain field built within the RFGA 1st cycle, 2019

PRELIMINARY RESULTS

Preliminary analysis of the state-wide permitting data showed that an average of nearly 3% of the total permits issued between years 1994 and 2019 in Texas have been for drip irrigation (Source TAMU OSSF Inventory System, 2020). This trend has been steadily increasing, from 0 in 1994 to almost 8% in 2020 (Figure 1). According to the funding agency local regulators have frequently observed problems with drip systems in terms of premature failure (sewage on the ground) and there is potential for improving its performance, especially in terms of effluent distribution uniformity and maintenance. These improvements would substantially impact central Texas

(Figure 2) where use of drip irrigation systems is quite common. Success in this region would encourage application of drip irrigation solutions in other parts of Texas.

Table 1. List of top ten (10) Counties with drip irrigation permits issued between 1992 and 2019

County	Rank	Drip Irrigation	ATC[1)]	Percentage of Texas ATC
Travis	1	4,858	20,776	23%
Harris	2	4,391	27,930	16%
Galveston	3	3,059	9,186	33%
Montgomery	4	2,336	48,691	5%
Williamson	5	1,566	16,337	10%
Comal	6	1,315	28,552	5%
Brazoria	7	1,085	18,049	6%
Burnet	8	1,038	14,499	7%
Fort Bend	9	891	12,070	7%
Hays	10	744	20,425	4%
Total (Texas)		**29,911**	**1,020,047**	3%

[1)] Authorization to Construct

A survey instrument will be developed and used to query Texas license holders and regulators regarding their experience and knowledge with drip irrigation system design, installation and operation, and maintenance. The survey will also collect information regarding system characteristics (i.e., size, soil conditions, topography, dosing schemes, line installation depth, etc.). The form will be submitted to TCEQ for approval, and then will be presented and shared at face-to-face meetings (e.g., Texas Onsite Wastewater Association annual meeting, National Onsite Wastewater Recycling Association 2022 Mega-Conference), by email, and as an online form. An example of screen shots of a tentative online survey form to be designed using the Qualtrics software is reported in Figure 6.

A target of 100 surveys will be administered to summarize the state of Texas drip irrigation systems and specific environmental conditions of the installations. Follow-up interviews will be conducted, as possible, to further characterize system installation, operation, and solutions to problems encountered. This approach has been successfully used by the TAMU OSSF Team in the past and will allow the development and implementation of a guidance document based on knowledge and experience specific to Texas. This local information will be supplemented with an extensive scientific literature review and a critical assessment of existing local, state, and federal guidance documentation of drip irrigation systems

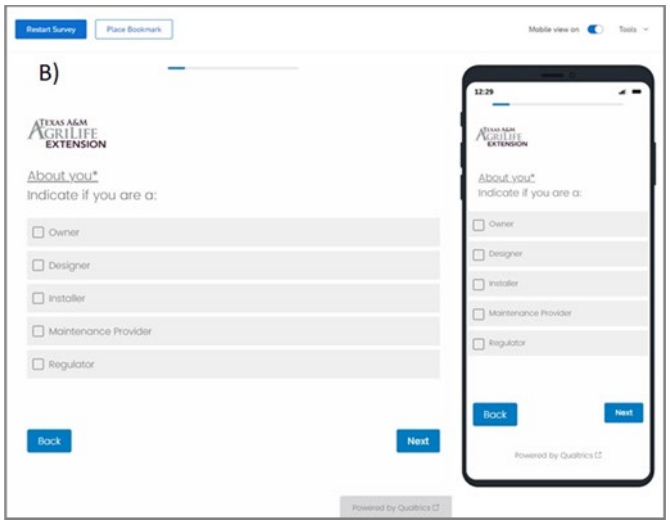

Figure 6. Example of screen shots of a tentative online survey form designed using the Qualtrics software: A) Opening page; B) Information about the person taking the survey

Literature includes existing regulation in other part of the country. North Carolina and Virginia regulation has started to be compared to Texas regulation. North Carolina regulation (https://ehs.dph.ncdhhs.gov/oswp/) includes subchapter 18E, Section 0908 Drip Dispersal Systems, with extensive details listed regarding soil requirements (Figure 7). Virginia regulation (https://www.vdh.virginia.gov/environmental-health/onsite-sewage-water-services-updated/) discusses drip dispersal system in paragraph 12 VAC 5 - 610 - 955 (Figure 8). Among other specifications, detailed requirements are listed regarding flushing and filtering procedures. Texas code discusses Drip Irrigation under Title 30 Texas Administrative Code, Chapter 285.33 §285.33(c)(3); subchapter 33 refers to Criteria for Effluent Disposal Systems, and section (c) to Proprietary Disposal Systems (Figure 9).

15A NCAC 18E .0908 DRIP DISPERSAL SYSTEMS

(a) This Rule provides for the permitting of drip dispersal systems receiving DSE. Drip dispersal systems shall comply with the provisions of this Rule and Section .1600 of this Subchapter.

(b) Drip dispersal systems with advanced pretreatment shall comply with Rule .1204 of this Subchapter.

(c) Drip dispersal systems shall meet the following soil and site criteria:

(1) A minimum of 18 inches of naturally occurring suitable soil above a LC, 13 inches of naturally occurring suitable soil above a SWC, and the minimum vertical separation to any LC shall be 12 inches. A groundwater lowering system may be used to comply with the vertical separation to a SWC when only Group I or II soils with suitable structure are present within 36 inches of the naturally occurring soil surface.

(2) For new fill, the soil and site shall meet the following criteria:

Figure 7. Extract from North Carolina regulation, discussing Drip Dispersal Systems

12VAC5-610-955. Drip dispersal.

A. Drip dispersal applies wastewater in an even and controlled manner over an absorption area. Drip dispersal system components may include treatment components, a flow equalization pump tank, a filtration system, a flow measurement method, supply and return piping, small diameter pipe with emitters, air/vacuum release valves, redistribution control, and electromechanical components or controls.

B. Drip dispersal system tubing shall be color coded and certified by the manufacturer as designed and manufactured for the dispersal of wastewater. All drip dispersal system tubing shall

Figure 8. Extract from Virginia regulation, discussing drip dispersal system

(3) Drip irrigation. Drip irrigation systems using secondary treatment may be used in all soil classes including Class IV soils. The system must be equipped with a filtering device capable of filtering particles larger than 100 microns and that meets the manufacturer's requirements.

(A) Drainfield layout. The drainfield shall consist of a matrix of small-diameter pressurized lines, buried at least six inches deep, and pressure reducing emitters spaced at a maximum of 30-inch intervals. The pressure reducing emitter shall restrict the flow of effluent to a flow rate low enough to ensure equal distribution of effluent throughout the drainfield.

(B) Effluent quality. The treatment preceding a drip irrigation system shall treat the wastewater to secondary treatment as described in §285.32(c) of this title unless

Figure 9. Extract from North Carolina regulation, discussing Drip irrigation, under Title 30 Texas Administrative Code, Chapter 285.33 §285.33(c)(3)

DISCUSSION

The challenges related to the proposed research include the ability to obtain sufficient responses from administered surveys and the amount of field experimentation that can be accomplished within the specified budget. Addressing each of the separate research topics related to drip irrigation and described in the RFGA strictly through field experimentation is not feasible. However, we believe that the application of a well-designed survey with follow-up interviews combined with a comprehensive literature review will provide a substantial and useful starting point in terms of standardized documentation for Texas license providers and regulators. For example, experience with similar surveys (i.e., Low Pressure Dosing survey conducted within RFGA 1st cycle, 2019) has been successful and provided useful information for regulatory guidance development. Additionally, the proposed project will be able to experimentally investigate several research items outlined on the solicitation (i.e., flushing methods, filters types, and cleaning and unclogging drip tubing techniques and limited field conditions) by utilizing the existing resources at the TAMU OSSF Center.

ACKNOWLEDGMENTS

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