

Short Communication

## e-DID: an electronic device for Drip Irrigation Design

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### Abstract

Irrigated agriculture plays a vital role for a sustainable agricultural future. Drip irrigation has been proved to be an efficient method of water application, but one of the problems persisting is the sophisticated procedure of a precise design and estimation. e-DID software is an electronic tool to assist in drip-irrigation system design and cost estimation with much ease. The software is designed to be suitable for all districts of Kerala and ten major crops namely vegetables, banana, tapioca, pineapple, arecanut, coconut, pepper, tea, coffee and cowpea. The design is obtained through few simple procedures by the user; the input data include the field dimension, irrigation interval and duration, number of blocks etc. The result includes whole system design, materials required, cost, and pump selection, in three different layouts. The software is programmed in C# dot NET and uses only a minimum number of readily available input data which makes it simple and user friendly on one hand, and accurate and robust on the other. The result can be saved in pdf or excel format for further processing.

**Key words:** Drip design, e-DID software, Kerala

Water is the most precious and demanding natural resources which decides the existence of life on earth and economy of the country. Advances in science and technology have caused drastic changes in the life of people and also is the surrounding environments. With the consistent increase in population it has become necessary to carefully plan and manage this limited water resource. Drip irrigation, which is one of the recent innovations, has the highest water use efficiency and its use is increasing exponentially in recent years. In drip irrigation, water is applied directly to the root zone in required amount closely matching the consumptive use of the plant, through a network of pipes, valves, laterals and drippers (Michael, 2015). Drip irrigation enables a limited and effective soil volume to be irrigated with the required quantity of water, thus reducing the water losses through evaporation and deep percolation. Design of micro irrigation depends on several parameters including crop, field topography, soil type, weather,

technology available and financial resources (Rajput and Patel Neelam, 2003). Drip irrigation is capable of having more than 90% efficiency if properly designed, but the problem persisting is the sophisticated procedure of design and estimation. Design procedure of drip irrigation system involves calculation of water requirement, selection of emitters, laterals, sub mains and mains according to suitability, selection of filters, fertigation units and pump and cost estimation which is hard for an amateur. This situation has led to the development of e-DID software which aims at assisting the user in drip-irrigation system design, irrigation scheduling, pump selection and its cost estimation.

e-DID software works based on an interaction with the user at each stage of design and provides a solution, based on the user's capability and database available. The software is designed for ten major crops namely vegetables, banana, tapioca, pineapple, arecanut, coconut, pepper, tea, coffee and

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cowpea. Water requirement of crops vary with the reference crop evapo-transpiration ( $ET_0$ ) of that area, thus affecting the whole system design. The system is designed for all the districts of Kerala with reference to the maximum reference crop evapo-transpiration ( $ET_0$ ) of the area, established by Vardan (1997). e-DID software is programmed in C# dot NET and uses only a minimum number of readily available input data which makes it simple and user friendly on one hand, and accurate and robust on the other. The user can not only suit to his requirement, but also compare the design with several alternate design layouts and different possible inputs to select a economical hydraulic design. This software can help farmers, amateurs, industrialists, marketing executives, extension specialists and researchers in designing drip irrigation system. The calculations are performed based on different formulae and analytical solutions. Three layouts that suit most of the field and crop conditions are included as options in the design. The software has been tested at developer's level. Results obtained were compared with actual calculations and the performance was found satisfactory.

#### *Required input parameters and results*

The input parameters required to design the drip irrigation system include selection of district, crop, field, layout, crop/field details and fertigation, filter and pump selection. The design procedure of software with the input and output windows are given below.

#### *Step 1.*

The software opens up with a home page, as shown in Figure 1. In order to design the drip irrigation system for your field, click the "Continue" button at the bottom right of the screen.

#### *Step 2.*

The following screen that appears gives the map of Kerala, from which the district for design is to be selected (Fig. 2). The software is designed for all



Figure 1. e-DID software Home page

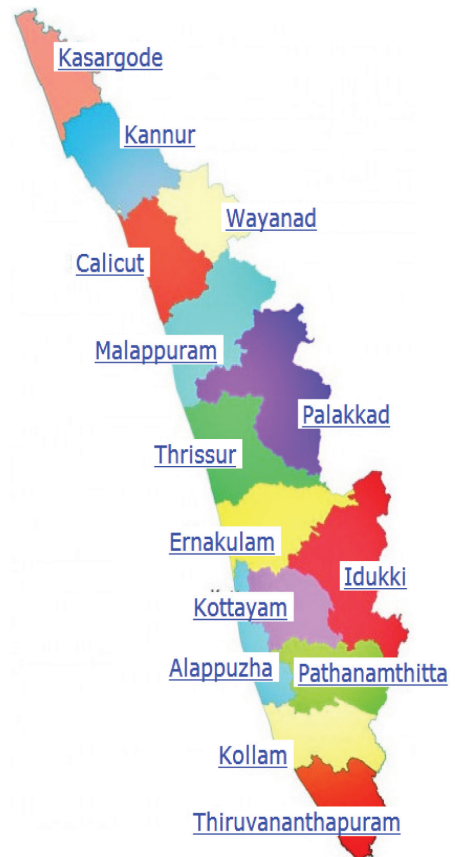


Figure 2. District wise map of Kerala for selecting the location

districts of Kerala with respect to the  $ET_0$  (reference crop evapo-transpiration) values. Selection of district is done by clicking on the names of district, that leads to the next page of selecting the crop.

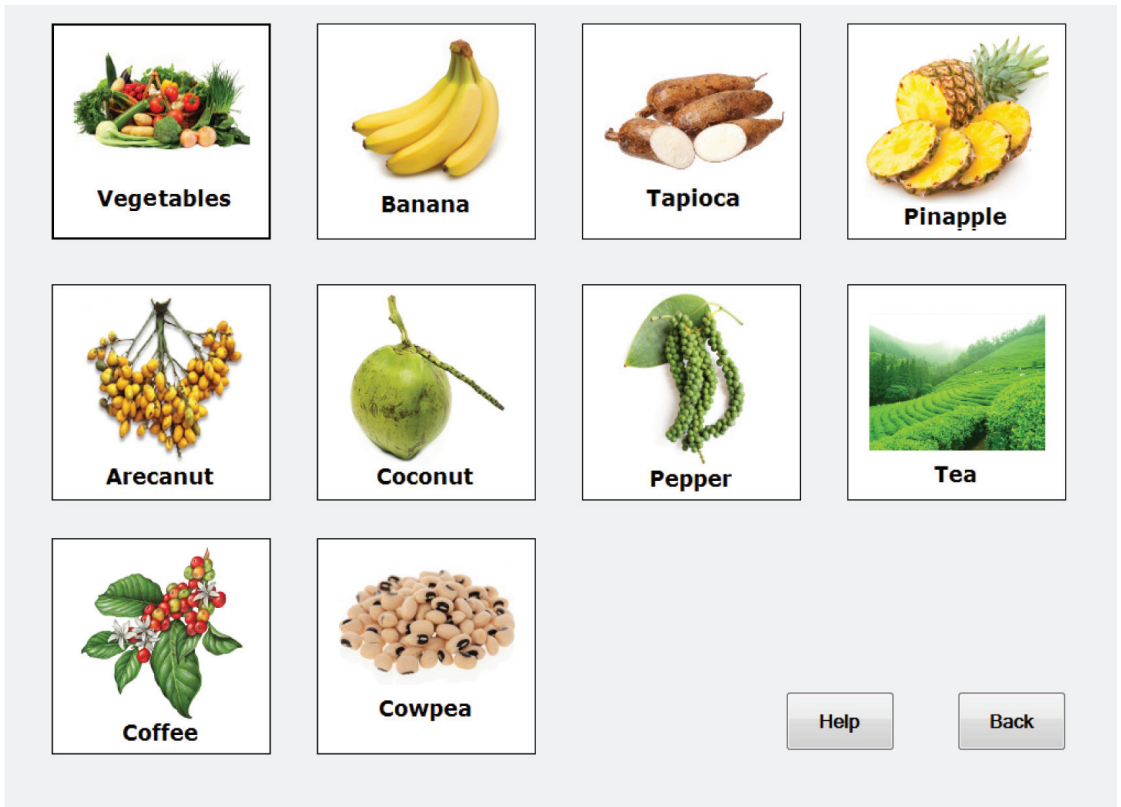


Figure 3. Page for crop selection

*Step 3.*

Ten major crops of Kerala have been included in the design namely vegetables, banana, tapioca, pineapple, arecanut, coconut, pepper, tea, coffee and cowpea. Click on the icons of representative crops to select the crop. The corresponding page is shown in Figure 3.

*Step 4.*

Selection of layout: There are three types of feasible layouts provided. The users have to select among these three only as shown in Figure 4. The selection of layout depends on the location of field shape, crop, water source etc. Each layout will affect the length of main, sub-main, lateral pipes and different

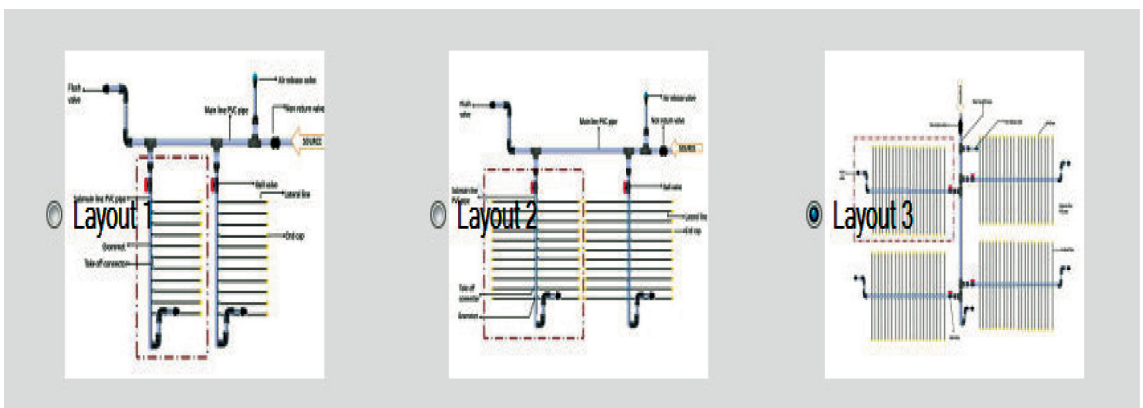


Figure 4. Different design layouts

accessories and henceforth will affect the cost of system.

*Step 5.*

This is followed by the input page, where the data required for drip irrigation design is to be entered (Fig. 5). Enter the values of field length, row spacing and plant spacing in the box provided. The irrigation interval is limited to 1, 2 and 3 days for drip irrigation; select any one from the drop down menu. The daily operating hours is to be entered in the box, minimum is fixed as 0.5 hrs and maximum as 4 hrs as it is not feasible to operate drip system for more than 4 hrs/day continuously. Drippers of different discharge rates i.e., 2, 4, 6 and 8 lph, that are commonly available in the market are provided, any one is to be selected. Selection of dripper should be made based on the water requirement of crop. If for a crop with high consumptive use, a higher discharge rate may be selected for an economical design.

For a more economic design it is advantageous to divide the field into different blocks for irrigation, as this will reduce the pump capacity required as well as the capacities of sub mains. To divide the field into blocks and irrigate the blocks separately, enter the number of blocks in the box provided and the number of blocks that is to be irrigated at a time in the next step.

The width and length of a single block will automatically appear in the next two boxes as per the number of blocks. The user can edit it if there is any change.

Clicking on the “Process” button will give the results.

*Step 6.*

The next screen that appears is the result page with

Field Length (m):	125
Field Width (m):	80
Row Spacing (m):	7.50
Plant Spacing (m):	7.50
Irrigation Interval (Days):	1
Daily Operating Hours (Hrs):	2
Dripper Discharge (lph):	8
No of Equal Sized Blocks (No):	2
No of Blocks Irrigated at a Time (No):	1
Width of Single Block (m):	80
Length of Single Block (m):	62

Figure 5. Input data page

the details of irrigation water requirement for the whole area, design of drippers, design of laterals, design of sub mains, design of mains etc (Fig. 6). The resultant values are necessary for further design of the system. To save the result in excel or word format, click on the “Save” button on the upper side of the screen.

Click on the “Proceed to Pump design” button at the bottom right of the screen for selection of filters, fertigation units and pump design.

#### Step 7.

There are four types of filters provided for the

design. Filters should be selected according to the causes of clogging, level of contamination of water and the particle size. Here, the preferred choices are also given to help for filter selection.

- Screen filter is selected if the water contains fine sand and dust.
- Hydro-cyclone filters are selected if the water contains more of soil and sand particles.
- Disc filters are selected when the water contains algae, organic material and fine particles.
- Sand filter is selected to remove suspended particles.

<b>Water Requirements</b>	
Total area (m <sup>2</sup> )	10000.00
Row Spacing (m)	7.50
Plant Spacing (m)	7.50
Plant Area (m <sup>2</sup> )	56.25
Total number of plants (No)	178.00
Consumptive Use (mm/Day)	4.35
Amount of Water Required per Plant ( Litres)	44.26
Required Discharge Rate per Plant (lph)	22.13
<b>Design of Drippers</b>	
Number of Blocks (No)	2.00
Number of Mains (No)	1.00
Number of SubMains (No)	2.00
Length of Main (m)	40.00
Length of SubMain (m)	62.00
Block Width (m)	80.00
Block Length (m)	62.00
Length of Lateral Line (m)	40.00
Number of Laterals per Block (No)	16.00
Total Number of Laterals in Field (No)	32.00
Plants per Lateral (No)	5.00
Dripper Discharge Selected	8.00
Number of Drippers Needed per Plant (No)	3.00
Number of Drippers Per Lateral (No)	15.00

Figure 6. Output data page

Selection of at least one filter is a must for drip system design; selection of multiple filters is also possible if the water contain more impurities. Selection of filter is done by clicking on the small box to the right of each filter icon.

*Step 8.*

*Selection of fertigation devices*

Selection is to be done from the following types of fertigation injection devices identified by pictures as shown in Figure 7.

- Venturi pump
- Fertilizer tank
- Injection pump

*Step 9.*

*Pump specification*

Enter the suction lift and elevation lift in metres in the respective boxes. Click on the “Process” button for results.

*Step 10.*

The next screen that appears give the pump design with details of head loss in laterals, sub mains, mains, fittings and accessories, filter, the required horse power and size of the motor (Fig. 8). Under the next heading on the same page the software gives the total cost estimation including all fittings and accessories, pump cost and labour cost. The total estimated cost may vary  $\pm 5\%$  according to the cost of items and other contingent expenses. The result can be saved as mentioned in step 6.

*Step 11.*

To view the layout of the design click on the “View Layout” button at the bottom right of the screen. To go back click on the “Back” button and to exit click on the “Exit” button on the bottom right. The final layout of the design is shown in Figure 9.

The objective of developing the e-DID software was to assist the farmers and other amateurs in making decisions regarding design of drip irrigation systems

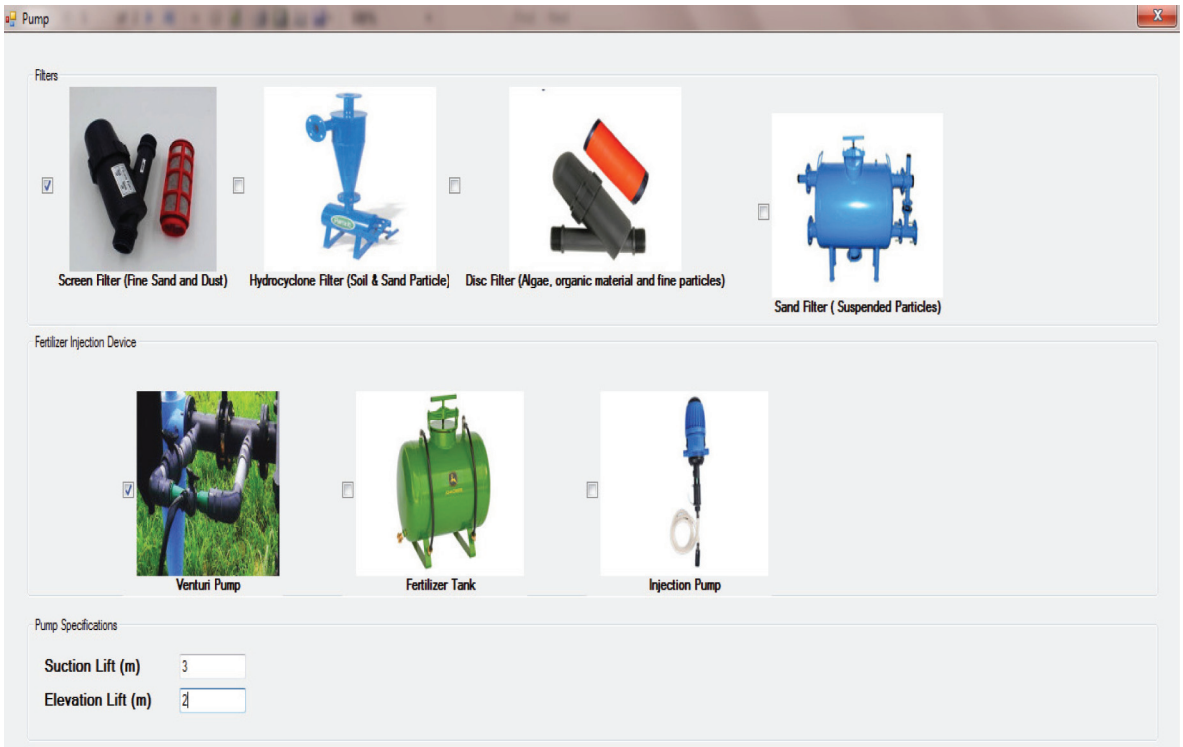


Figure 7. Pump data input page

Pump Design	
Suction Head (m)	5.00
Elevation difference (m)	2.00
Capacity of Drip system (lps)	0.53
Head loss in Lateral (m)	7.72
Head loss in Submain (m)	0.97
Head loss in Main (m)	0.74
Head loss in fittings and accessories (m)	2.00
Head loss in filter (2m/filter)	2.00
Head loss to operate fertigation system (5m)	5.00
Total head loss (m)	27.43
Total operating hours (hrs)	4.00

Cost Estimation				
<b>Cost of Layout</b>				
Item	Specification	Qty	Unit Price	Cost
Main (m)	32.00	46.00	41.90	1927.40
Sub main (m)	40.00	142.60	43.37	6184.56
Lateral (m)	12.00	1472.00	6.20	9126.40
Lateral ring (m)	12.00	1246.00	6.20	7725.20
Turbo key Dripper (lph)	8.00	480.00	2.65	1272.00
Sub Total				26236
<b>Cost of Accessories</b>				

Figure 8. Pump and cost estimation output page

and irrigation scheduling, and to provide an approximate estimate of the whole system before installation. The relevant system design parameters include crop water requirement, layout, number of emitters, laterals, sub mains, mains, types of fittings, filters, fertilizer injection system, pump capacity etc. In contrast to other available programs for designing drip system e-DID requires only a small number of parameters known to the user, and its operation is quite user-friendly and intuitive.

It is developed in C# dot NET, runs under Microsoft Windows and requires no special hardware or supporting software. The drip irrigation design is

performed within a few steps; it also has a database containing some of the input parameters required for design and provision to update it.

The computed design details and tabulated outputs can be saved to Microsoft excel or PDF for further processing. A help button tool support the user in using the software.

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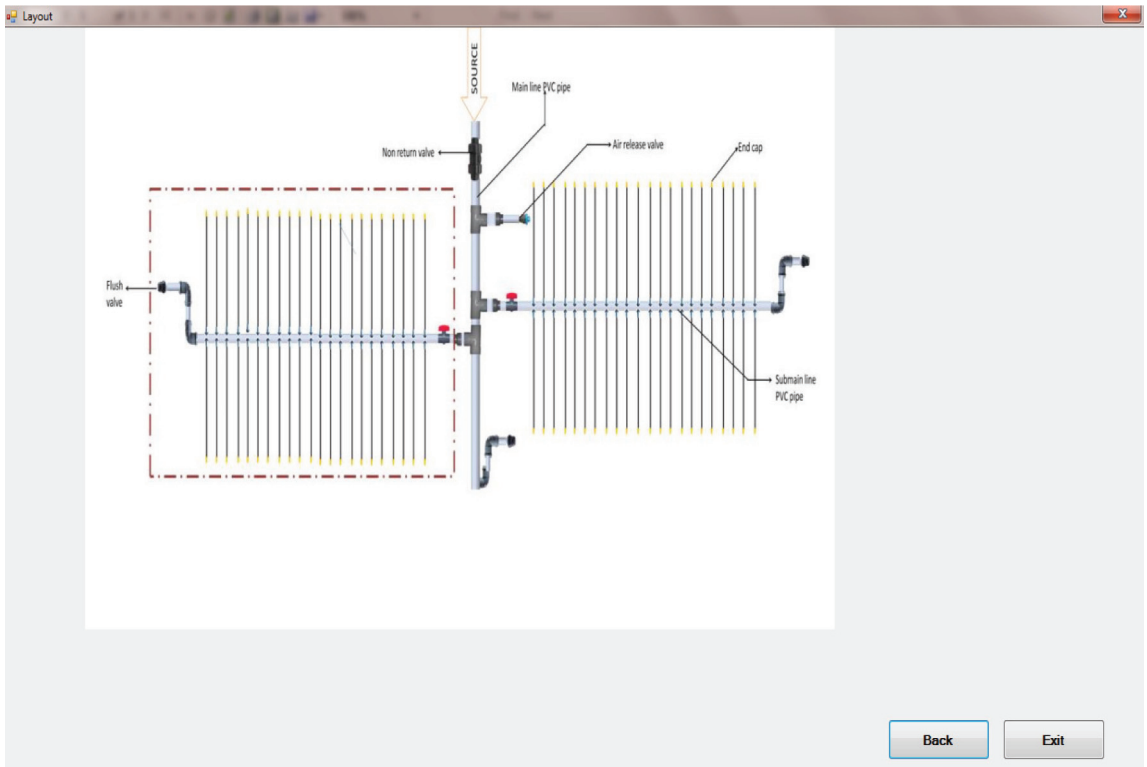


Figure 9. Final design layout

done, is greatly acknowledged. The authors are also thankful to the Centre for e-Governance for providing technical support for the development of the software.

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