5.1 Summary

Drip irrigation is the drop by drop application of water directly to roots. Its superior method of application of water in agricultural field. It has little or no water losses through conveyance and the on-farm irrigation efficiency of a properly designed and managed drip irrigation system can be as high as 90 per cent, compared with 35 to 40 per cent efficiency of surface method of irrigation (Narayanmoorthy, 1997). The area covered under drip irrigation systems has, the largest area under drip irrigation include Rajasthan 1.68 Mha, Maharashtra 1.27 Mha, Andhra Pradesh 1.16 Mha, Karnataka 0.85 Mha, Gujarat 0.83 Mha and Haryana 0.57 Mha.

Majority of the area covered under drip irrigation system comes under sprinkler irrigation with 56.4 per cent, and 43.6 per cent for drip irrigation. The area under drip irrigation has shown higher growth in recent years, growing at a CAGR of 9.85 per cent in the 2012-2015 period, while sprinkler irrigation has grown a pace of 6.60 per cent in the same time period. Overall, the area under micro-irrigation has grown at a CAGR of 7.97 per cent in this time frame (Anon., 2016a).

In field, drip line requires various field operations such as installation and retrieval of drip line. Installation and retrieval by mechanical method as well as manual method were used. Farmers have been using manual device for installation and retrieval operation, they were time consuming, laborious as well as boring, very tedious and costly also. These jobs are needed to be done carefully and skilfully to avoid the damages due to folding or twisting of tube during handling and to make the suitable bundle to store properly Therefore, the present study was carried out to design, development and to evaluate the performance of mini-tractor operated install and retrieve the drip line with the following objectives:

1. To design and develop a mini tractor operated drip line installer and retriever.
2. To evaluate the performance of the developed machine.
3. To work out economics of the developed machine.
Based on the available literature on drip line installation, retrieval practices and existing manual devices, a mini-tractor operated drip line installer and retriever was developed and its performance was evaluated.

Under this study, the 16 mm drip line was considered, to determine the installation and retrieval time and their respective fuel consumption. The physical properties of drip line like size, length and diameter of bundle were measured.

The main component of the machine were main frame, press wheel, guiding & shaft, transportation wheel, depth control wheel, chain & Chain sprocket mechanism, power transmission system with hydraulic motor, direction control valve & pressure control valve. The developed machine operated by mini-tractor was evaluated on the basis of various field parameter, operating parameter, performance parameter. The experiment was carried out in F-RBD design with two factors and four replication with three different levels of each factor. The factor namely spool rotation (35-53, 53-71 and 71-89 rpm) and forward speed (2.0-3.0, 3.0-4.0 and 4.0-5.0 kmph) were taken for the experiment. The performance of the machine was evaluated installing and retrieving of drip line by determining its installation time, retrieve time & both of fuel consumption.

Economic of operation of installation and retrieve of drip line was also worked out. The mechanical cost of operation calculated and compared with the cost of manual drip line installing and retrieving. Total saving of installation and retrieve cost was also calculated.

5.2 Conclusions

The mini-tractor operated installer and retrieve of drip line was tested in the field. These have led following conclusion:

1. For installation time for drip line, the effect of both spool rotation, forward speed and their interaction were significant at 5 per cent level. The minimum value (1.01 s/m) of installation time was obtained at 71-89 rpm of spool rotation and 4-5 kmph of forward speed. The maximum value (1.81 s/m) of installation time was obtained at 35-53 rpm of spool rotation and 2-3 kmph of forward speed. The mean values of installation time has shown reducing trend with increase in forward speed and spool rotation both.
2. In fuel consumption during installation, the effect of both spool rotation, forward speed and their interaction were significant at 5 per cent level. The minimum value (2.88 lit/ha) of fuel consumption was obtained at 35-53 rpm of spool rotation and 2-3 kmph of forward speed while installation. The maximum value (4.0 lit/ha) of fuel consumption was obtained at 71-89 rpm of spool rotation and 4-5 kmph of forward speed. The mean values of fuel consumption has shown increasing trend with increase in forward speed as well as spool rotation.

3. For retrieval time for drip line, the effect of both spool rotation, forward speed and their interaction were significant at 5 per cent level. The minimum value (0.94 s/m) of retrieval time was obtained at 71-89 rpm of spool rotation and 4-5 kmph of forward speed. The maximum value (1.71 s/m) of retrieval time was obtained at 35-53 rpm of spool rotation and 2-3 kmph of forward speed. The mean values of retrieval time has shown reducing trend with increase in forward speed and spool rotation both.

4. In fuel consumption during installation, the effect of both spool rotation, forward speed and their interaction were significant at 5 per cent level. The minimum value (3.25 lit/ha) of fuel consumption was obtained at 35-53 rpm of spool rotation and 2-3 kmph of forward speed. The maximum value (4.23 lit/ha) of fuel consumption was obtained at 71-89 rpm of spool rotation and 4-5 kmph of forward speed. The mean values of fuel consumption has shown increasing trend with increase in forward speed as well as spool rotation.

5. The theoretical field capacity, actual field capacity and efficiency of installation were 1.35 ha/h, 0.85 ha/h and 63.68 % and the same as for retrieval were 1.35 ha/h, 0.90 ha/h and 66.66 % respectively.

6. The time of installation and retrieval operation in case of mechanical method were calculated as 1.163 and 1.111 man-h/ha respectively, and in case of manual method were 6.92 and 7.24 man-h/ha respectively. That in mechanical method, there was a reduction of 83.19 % and 84.65 % in installation and retrieval time respectively, over the manual method.

7. The cost of installation and retrieval operation in case of mechanical method were calculated as ₹ 490.10/ha and 464.44/ha respectively, and in case of manual method were ₹ 431.50/ha and 447.48/ha respectively. It observed in
mechanical method, there was an increase of 13.58 % and 3.79 % in installation and retrieval operation cost respectively, over the manual method.

8. The energy consumption of installation and retrieval operation in case of mechanical method were calculated as 225.24 and 238.19 MJ/ha respectively, and in case of manual method were calculated as 23.22 and 28.40 MJ/ha respectively. It observed in mechanical method, there was an increase of 870.03 % and 738.70 % in installation and retrieval operation energy consumption respectively, over the manual method.

9. The payback period of installer and retriever was 6.06 years.

10. The Average net annual benefit of installer and retriever was ₹ 6842.25/-. 

11. The B:C ratio of installer and retriever of drip line was 2.24.