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# Assessment of Estimated Design Discharge with Physical Need Based Installed Drip Irrigation Systems in Selected Sites of Peshawar Valley

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## ABSTRACT

The study was conducted to assess the performance of drip irrigation systems installed at Charsadda, Malakand Agency and Nowshera. The performance parameters of the drip irrigation system included the coefficient of variation of emitters flow rate with respect to design of manufacturer, hydraulics, plugging were compared with physical need based CROPWAT software estimation were evaluated. The emitters discharge was collected at the beginning, 1/3 down, 2/3 down and end of each selected lateral by volumetric method. The soil texture and infiltration data was also determined for the efficiency and adequacy of drip irrigation system. The head loss along the laterals was determined for uniformity of the drip irrigation system. These collected values were averaged for each plot and water requirement was determined by using CROPWAT computer software. Results of the study revealed that the head loss in Malakand Agency (0.6 m) irrigation systems remained uniform while these are varying in Nowshera and Charsadda (0.4-1.5 m). Theoretical discharges are mostly less than actual discharges with a maximum of 55 % increase in Malakand Agency and a minimum at Charsadda with 3.3 % increase in actual discharge. Due to increased laterals length with more emitters per lateral gives fluctuation in discharge and pressure. Discharge variation was more due to low-pressure head in Nowshera.

**Keywords:** Coefficient of variation, Design, Plugging, Head Loss, Theoretical Discharge

## INTRODUCTION

The drip or trickle irrigation is one of the best methods with frequent, slow application of water either directly on the land or into the root zone of the crops rather than the entire land surface and maintaining the water content of the root zone at optimum level. The assessment of an irrigation system aims to understand the system adequacy and determining the necessary procedures for improving the system performance. The assessment is always carried out soon after the system's establishment in the field, and then periodically repeated, especially when considering trickle irrigation systems, due to their sensitivity to operational conditions with the passage of time (Keller and Blisner, 1990). In an overall assessment, many aspects are taken into account, resulting, in a new project and system calculations, based on real rather than empirical data (Martín-Benito, 1993). Tests to determine functional attributes, related to resistance and durability, are generally defined through technical specification rules. The uniformity and general performance of micro irrigation systems are affected by hydraulic design, emitter manufacturer’s coefficient of variation, grouping of emitters and emitter clogging among other factors (Frizzone, 1997). Uniform application of water along a fruit trees row with trickle irrigation depends on three requirements; emitters manufactured from same design must achieve initially uniform discharge; must not clog due to raw material or chemical deposition in water; and should be designed to compensate for pressure variations along the lateral (Bucks and Myers 1973). Some system elements which were badly designed, filters were not able to prevent emitter clogging and system layout & operation were inefficient (Yildirm and Orta, 1993)

## MATERIALS AND METHODS

Three sites varying in soil types and crop grown were selected for studying the performance assessment of drip irrigation system, at Malakand, Charsadda and Nowshehra. The soil samples were collected from different sites at Harichand, Charsadda and Nowshera for soil textural analysis by Hydrometric method. Hydrometer readings were adjusted according to the change in temperature. USDA textural triangle was used to assign a textural class to the soil samples from the equations for different textural classes. (Bouyoucos, 1936). The detail design of the drip irrigation systems of the three sites were collected from the DADEX ETERNIT Limited. The online pressure compensating J type drippers were used having a discharge of (8 l/h) and spaced by 1.2 meters. Average Laterals length was 42 m in plot no 1 and 2 while it was 50 m in plot no 3 with an inner diameter of 16mm. The space between any two laterals was 2.5m with a two laterals/row. The number of rows per plot was 10, each having 9 plants per row. Main and submain in the system were mainly PVC pipes having inner diameter ranging from 2 to 2 ½" with a length of 345 m for main while for submain the inner diameter was 2" and length of 245m. The system was controlled by two valves at a well supported by 15Hp pump gives a discharge of 12 l/sec. The ground water level in this area was 42 m. The flow rate of emitters was assessed by using volumetric method.

## RESULTS AND DISCUSSION

The results have been derived from the analysis of basic data, head losses, performance parameters, uniformity, efficiency and adequacy degree. However the results for comparison of routine data with need based and dadex model have also been analyzed and discussed.

### Basic Data for Drip Irrigation System Analysis

Without having any information on the soil; data of the study area and the fruit trees grown on it will make it impossible to reach to the realistic approach for this purpose the data on soil texture and fruit trees grown is given.

### Soil Texture

Data pertaining to soil texture revealed that soils of each site varied from silt loam to sandy loam with sand contents from 16.8 to 67.2%, silt contents from 30 to 80.4% and clay from 2 to 9.2% (appendices, Table 2). The lowest sand contents (16.8%) were recorded at the site in Charsadda plot No.1 and the highest in plot No.2 as compared to Malakand Agency and Nowshera. In Malakand Agency farm the sand contents were less (26%) when compared with Nowshera farm (61%). Silt contents were more in Malakand Agency farm (80.4%) and lowest (30%) in Nowshera farm. While in Charsadda farm it was between the ranges of 30.4 to 80.4%. Clay contents were highest in Malakand Agency farm (9.6%) and lowest in Charsadda farm 2%. However in Nowshera farm the range is from 4.8 to 5.2%.

### Plant and its Components

During the growing period height and canopy of each plant was determined by measuring tap and planimeter respectively. The average plant height and canopy in Charsadda and Nowshera farms was 3 to 4 meter. The number of branches per plant was 14 and 15. While in Malakand farm it was 1.5 and 0.7 meter and 4 to 6 branches per plant. Fruit data was not available

### Theoretical Discharges in Charsada Drip Irrigation Systems

According to the design it is expected that each emitter will give a discharge of 8 l/h at 1 bar pressure in whole system. But in some cases the variation was observed. These variations in discharge are due to turbulent flow of water in laterals at the beginning of operation. These discharges are taken for more than five minutes to reach a uniform discharge. The theoretical discharges are calculated from the pressure head at each emitter and that gives an idea about the performance of the drip irrigation system. The Charsadda farm having 10 meter head with theoretical discharge of 6.8 l/h which gives an actual of 8 l/h with 20% increase in actual discharge at plot No.1. The plot No.2 is having 9.1 l/h of theoretical discharge which gives an actual discharge of 7.9 l/h with 10% decrease in actual discharge. While in plot No.3 there is no variation in theoretical and actual discharge of 8 l/h.

### Theoretical Discharges in Malakand Agency Drip Irrigation Systems

The Malakand Agency farm having 7.5 meter pressure head and theoretical discharge in plot No.1 is 4.5 l/h with 50% increase in actual discharge (6.8 l/h), while in plot No.2 the actual discharge is 7.2 l/h with theoretical discharge of 4.5 l/h with (60% increase in actual discharge). The plot No.3 is also having 7.1 l/h of actual discharge which is 55% more than theoretical discharge of 4.5 l/h.

### Theoretical Discharges in Nowshera Agency Drip Irrigation Systems

In Nowshera farm the pressure head is 7 meter in plot No.1 with 3.8 l/h of theoretical discharge and 5.6 l/h of actual discharge having 20% increase in actual discharge, while in plot No.2 the pressure head is 9 meters having 3.5 l/h of theoretical discharge and 6.5 l/h of actual discharge with 80% increase in actual discharge. The plot No.3 is having 10 meters of pressure head that gives 6.8 l/h of theoretical discharge and 8.4 l/h of actual discharge with 20% increase in actual discharge. Pressure compensating devices have the provision for precise flow control with specific lateral length, diameter and emitters per lateral. Simply adjusting the number of emitters on required length of lateral will deliver the calculated discharge.

**Head Losses in the Study Area at Charsadda**

Figure 1a shows that head losses in Charsadda farm plot No.1 is 1.35 meters at the beginning, middle and last laterals. In plot No.2 there is 0.76 meter of head loss at the beginning, 1/3 down, end and 0.74 meter at the 2/3 down of beginning lateral. The middle lateral is having 0.73 meter of head loss at 1/3 down and 0.76 meter at beginning, 2/3 down and end. There is uniform head loss of 0.76 meter approximately on last lateral. Figure 1b is having 0.02 meter of head loss variation at the beginning lateral and 0.03 meter head loss at middle while at the end lateral there is 0.01 meter head loss. The head losses in figure 1c are 1.38 meter at beginning, 1/3 down and 1.36 meter at 2/3 down and end of the first lateral. The middle lateral is having uniform head loss of 1.38 meter. There is 1.36 meter of head loss at the beginning, 2/3 down and 1.38 meter at 1/3 down and end of the last lateral. These results show that there is equal head loss throughout the laterals. These head losses were calculated from three laterals at four positions on each lateral

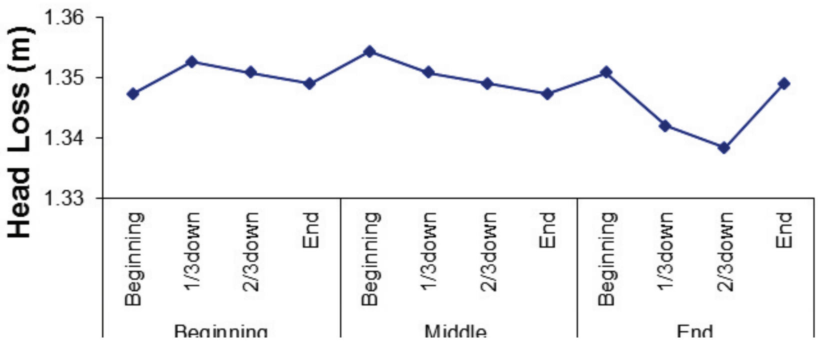


**Figure 1a Head Loss against Lateral's Positions in Plot No.1 of the Study Area in Charsadda**

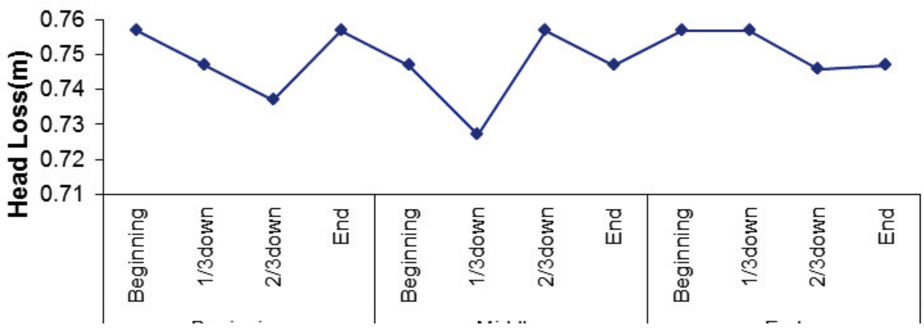


**Figure 1b Head Loss against Lateral's Positions in Plot No.2 of the Study Area in Charsadda**

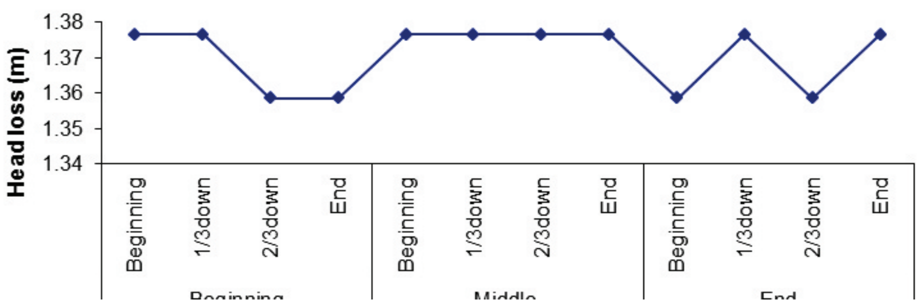


**Figure 1c Head Loss against Lateral's Positions in Plot No.3 of the Study Area in**

**Head Losses in the Study Area at Malakand Agency**

Fig 2a shows that head losses in Malakand Agency area are nearly uniform in all the three laterals of plot No.1. However when all the three laterals are compared, the head losses in the first lateral at the beginning of plot No.1 is comparatively less by an amount of 0.06m only from other two laterals at the middle and end of the plot. As much as the individual lateral along its length is concerned, it is the same in section of the lateral (beginning, one third down, two third down and end).

Fig 2b shows the head losses at the same area in plot No.2 having similar laterals configuration. The first lateral on the left side of the plot No.2 at its head has 0.05 more head loss at entrance from submain due to turbulent flow of sudden contraction. However pressure compensating on-line emitters of the system reduces that to normal at the lateral position in the downstream. The lateral in the middle of plot No.2 at the third down offering comparatively greater resistance may be due to some problem of on-line emitters during its installation. The head loss in the third lateral at the right shows greater resistance at its tail position.

Fig 2c shows the head losses in the third lateral of the same area in the plot No.3 due to the increased pressure and little bit higher elevation. Due to the drop in pressure in its second and third laterals at the middle and right side, the head losses give the same pattern as the plot No.1 and plot No.2.

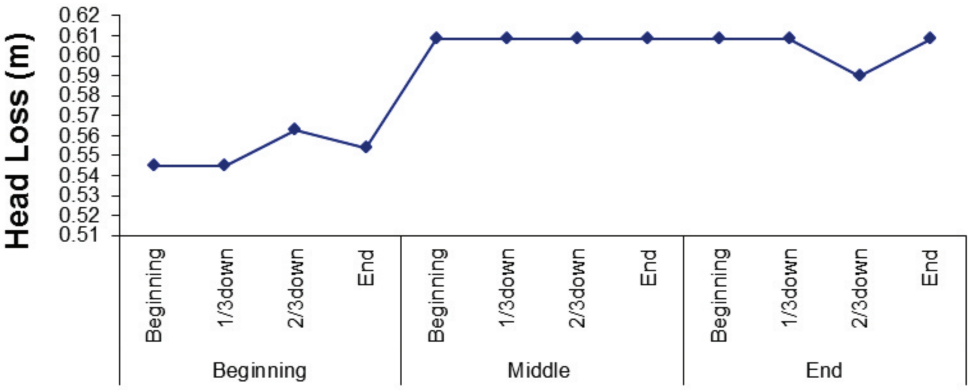


**Figure 2a Head Loss against Lateral's Positions in Plot No.1 of the Study Area in Malakand Agency**

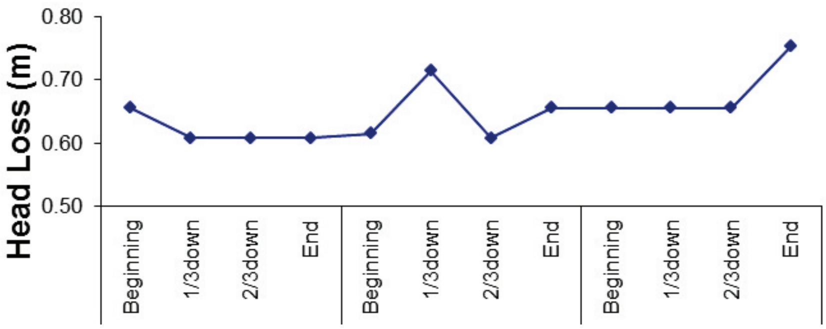


**Figure 2b Head Loss against Lateral's Positions in Plot No.3 of the Study Area in Malakand Agency**

 

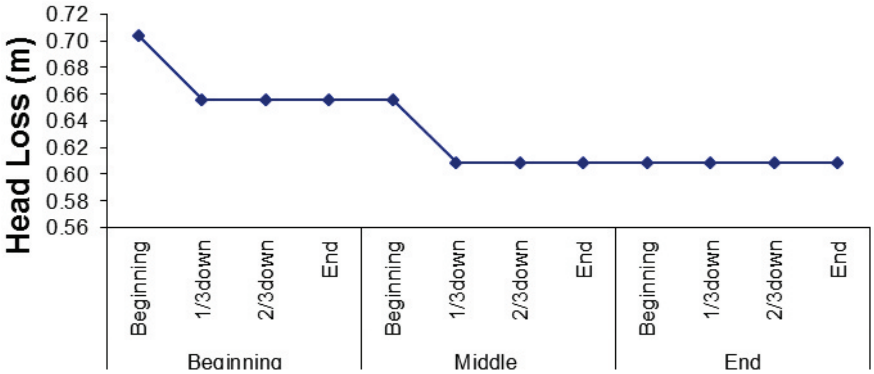


**Figure 2c Head Loss against Lateral's Positions in Plot No.3 of the Study Area in Malakand Agency**

**Head Losses in the Study Area at Nowshera**

The head losses in plot no.1 in the figure, 3a of Nowshera in the study area are totally different from the other two plots. The variations in the first lateral at the left side of the plot at three locations and in the middle at the end are due to the improper design which in turn result from uneven topography and high horse power pump selected for lower sized irrigation system to the given area.Figure.3b shows highest head losses only due to highest topographic level in the study area. As much the uniformity is concerned the pressure head shows highest and ideal situation.Figure. 3c shows lowest head losses with ideal conditions of pressure distribution in the whole irrigation system of plot No.3 of all lateral at each position.

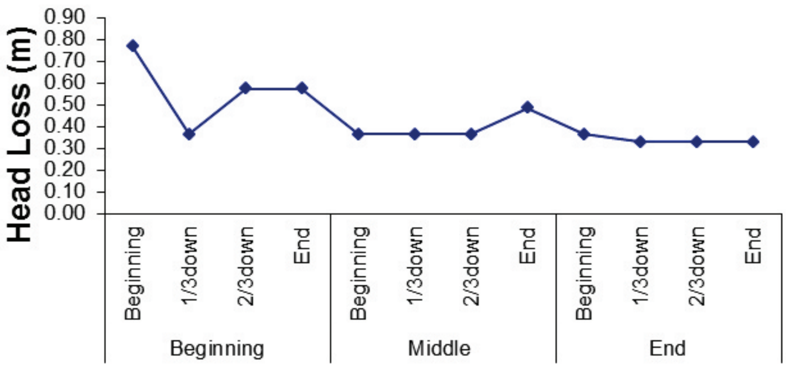


**Figure 3a Head Loss against Lateral's Positions in Plot No.1 of the Study Area in Nowshera**

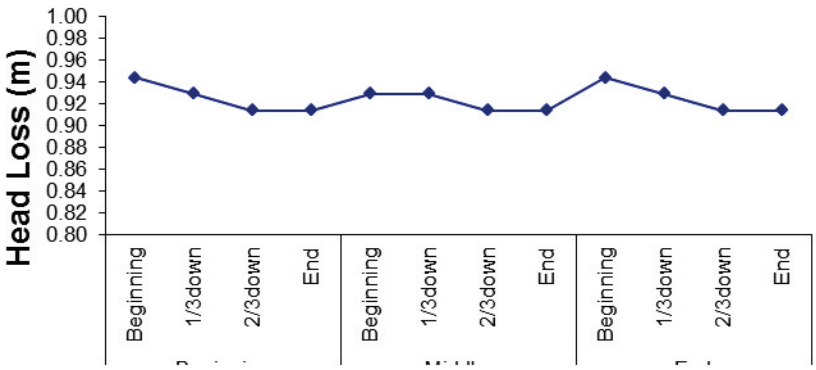


**Figure 3b Head Loss against Lateral's Positions in Plot No.2 of the Study Area in Nowshera**

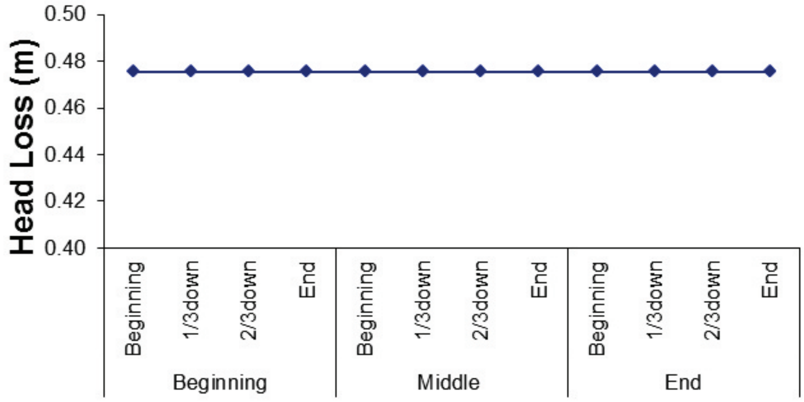


**Figure 3c Head Loss against Lateral's Positions in Plot No.3 of the Study Area in Nowshera**

**Head Losses and Theoretical Discharges in Three Drip Irrigation Systems**

The calculated head losses at the emitter centerlines and the theoretical and actual discharges for all plots of all the study areas. Fig 4 shows the trends in the head loss of each plot in three selected sites. The head losses for each plot of different sites are averaged from 12 data points taken at the head, 1/3 down, 2/3 down and at the end of each selected lateral. For comparisons among head losses, different plots from each site vary from 0.5 to 1.5.

It has been pointed out that the lesser losses in Malakand Agency drip irrigation system compare to other irrigation system of the study area are due to its uniformity throughout its system. Hence the lateral lengths are appropriate as pre design criteria and the number of emitters on each lateral is right in number. The variation in head losses in Charsadda drip irrigation system is more due to the mismatch of pressure distribution within the plots. However varying laterals length in each plot contribute to this factor. In Nowshera farm the head losses in first plot are less than second plot due to the difference in elevation (5 feet) and varying laterals' lengths. It is due to the variation in the numbers of plants. Each lateral is provided with given number of emitter's. The plot No.1 and No.3 are at the same elevation. Hence there is no variation in loss in these plots.

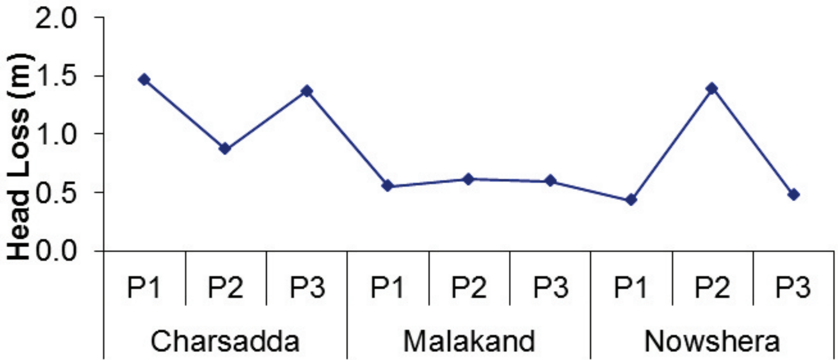


**Figure 4 Average Head Losses in Three Selected Plots at Each Site of the Study Area**

 

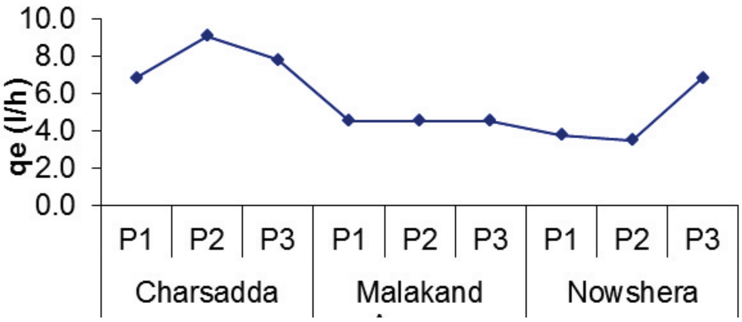


**Figure 5 Average Theoretical discharges in Three Selected Plots at Each Site of the Study Area**

**Conclusion**

The head loss in different irrigation systems range from 0.5 to 1.5m with uniform head losses in Malakand Agency (0.6 m), while varying in Nowshera and Charsadda (0.4 – 1.5 m).Design theoretical discharges in all systems are mostly less than actual measured discharges. The maximum (55 %) increase in actual discharge is in Malakand Agency while this increase is minimum (3.3%) at Charsadda. The increased laterals length with more emitters per lateral gives fluctuation in discharge and pressure. Discharge variation was more in plot1 due to low-pressure head in Nowshera.

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