Simulation Techniques and Modelling of Optimized Pressurized Agriculture Pipe Network Suitable for Home Gardening in Vavuniya Area of Sri Lanka

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Home gardening is identified as one of the remedial measures for food security issues caused by the economic downfall in Sri Lanka. Home gardening contributes to household food security by providing direct access to food. Further, it is also an important source of supplementary income for households. The appropriate function of a pressurized agriculture pipe network system is vital to supply a sufficient quantity of water to the plants at sufficient pressure through the sprinkler output. Despite this, very few computer simulation techniques studied for optimization for the case of the home gardening agricultural pipe system. In this study, the WaterGEMS V8i software simulator was used and hydraulic analyses were conducted to design an optimal pressurized agriculture pipe network suitable for home gardening in the Vavuniya area. The water flow rate at sprinkler outlet points for chilli and onion were considered 600 L/h and 325 L/h respectively. The total available land area for home gardening was considered as 50 perches in this study. Fifteen models were developed for different combinations of land use for chilli and onion cultivation. The hydraulic parameters such as nodal pressure, flow velocity, flow rate and head requirement were analyzed under steady-state simulation by using the Hazen-Williams friction method. The proposed simulation model was calibrated and validated by using a previous study. The result revealed that all of the nodes in the system are operating above the threshold pressure limit of 2 bars. It was found that a combination of 20% land (10 perches) for onion and 80% land (40 perches) for chilli required the highest power pump capacity of 3.5 kW. The power of the water pump for chilli only and onion only was positively correlated with the cultivated land extent and R^2 values were observed to be 0.9991, and 1.0 for chilli and onion respectively. The flow velocity in all pipes was above the minimum level of 0.5 m/s eliminating silt deposition and below the maximum level of 2.0 m/s avoiding the water hammer issues. The proposed pressurized agriculture pipe network design shall be used for modelling of pipe network for home gardening with different crop types by changing the model input parameters by using the WaterGEMS V8i computer simulator.

Keywords: Home gardening, Optimal design, Sprinkler irrigation, WaterGEMS V8i