Abstract

Sri Lanka is a tropical agricultural country with a total land area of 65,610 km^2. Home gardens play a vital role in the agricultural sector in Sri Lanka that provide substantial amount of food and other income throughout the year. The rainfall is one of the major physical factors influencing agriculture in Sri Lanka, especially in home gardens. The rainfall pattern has an uneven distribution temporally throughout the year and spatially over the whole island. It creates risks by making both dry and wet periods during cropping seasons, which adversely affects agriculture in Sri Lanka. However, the agro-climatic risk encountered during cropping seasons is a major problem for home garden crop production. The most popular, currently practiced irrigation method in home gardens is the manual irrigation, which involves high labor costs and low water use efficiency.

The main objective of the study was to design a low cost auto-irrigation system for home gardens to minimize the agro-climatic risk affecting the crop production. The study area covered nine regions of the Matara district in Southern Sri Lanka. To achieve the main objective, the study was carried out in the three following areas:

- To determine the optimum cropping calendar and planting time of vegetables for home gardens by minimizing the risk of having a dry period;
- To design an efficient, low cost sub-surface irrigation system; and
- To determine the optimum size of the roof runoff water tank to collect water for home garden irrigation.

Daily rainfall data over 45 consecutive years and pan evaporation data from the study region (9 rain gauge stations) were used for the analysis. The two periods per year, *Yala* (from April to September) and *Maha* (from October to March), were considered as

cropping seasons. Irrigation water requirement for tomatoes (***Lycopersicum esculentas***) and curry chillies (*Capsicum grossum)* were calculated using the CROPWAT program. Field experiments were carried out to investigate the efficiency of the auto irrigation systems and to determine the effect on the crop yield.

The rain gauging stations in the study region were categorized into new agro-ecological regions considering their current value of 75% expectancy of annual rainfall based on the agro-ecological map of Sri Lanka. The stations in WU1, WL2 and WL4 agro-ecological regions in the existing classification were in WU2, WL4 and IL2, IL1 agro-ecological regions respectively based on proposed classification.

The dry weeks were defined as rainfall with less than 10 mm of weekly rainfall at 75% probability or Hargreaves Weekly Moisture Availability Index value of less than 0.34. Over the years the pattern of occurrence of dry weeks was observed and results from the water balance analysis was used to identify the optimum-cropping calendar for vegetable crops to minimize the irrigation need. The pattern of occurrence of dry weeks from both above methods was consistent. During a calendar year there were more than 76% of dry weeks in Southeastern parts of the study area whereas there were only less than 30% dry weeks in the Northern part. In addition to above-two methods, the water balance analysis using CROPWAT program and 100 mm forward accumulation of rainfall at 75% probability methods were used to calculate the optimum crop commencement time. The calculated crop commencement times were compared with the currently practiced crop commencement times through a field survey of farmers. In order to minimize the irrigation requirement, during the *Yala* season an early crop establishment can be recommended in Northern and Western parts of the study region while late crop establishment in

Southeastern part. No difference found between the calculated crop commencement time and currently practiced crop commencement time during the *Maha* season.

Subsurface pot irrigation with round shaped clay pots (2.5 L) and drip irrigation with conical shaped clay emitters (20 ml) were designed for home garden irrigation. The lateral and downward movement of water with time from different shapes of pots to the soil was examined in the field. The results from the experiments were used to determine the spacing of pots in the irrigation system. The conical shaped clay emitters were especially designed and tested. The designed clay emitters for drip irrigation addresses the issues highlighted in the earlier findings. The yield and development of curry chilies, cultivated under the designed subsurface irrigation systems were compared with the yield and development of curry chilies cultivated under manual irrigation. The use of water by the crop under subsurface drip irrigation system was considerably less when compared with the subsurface pot irrigation. The yield obtained from the crop grown under designed irrigation systems is two times higher than the yield of crop grown under manual irrigation during dry seasons (*Yala*). The crop performance under the designed subsurface irrigation systems proved the suitability of the designed irrigation systems to use it for irrigating home gardens.

The study recognized the scarcity of water resources for the irrigation of scattered home gardens and recommends to use stored roof runoff water from farmer's own roof as a better irrigation water source. The optimum tank capacity was calculated using the behaviour analysis based on the roof water runoff and the irrigation water demand. Different roofing materials; asbestos and tiles; were used in calculating the roof runoff and designed subsurface irrigation systems; drip and pot for *Yala* and *Maha* seasons were used to calculate the irrigation demand. The average roof area was found by a field survey and the cultivable land area was determined based on the definition of home gardens. The tank capacities varied between 15 – 75 m^3 under the pot irrigation condition and 2 – 16 m^3 under the drip irrigation condition based on the accepted probability to fill the tanks from 0.8 to 1.

The findings from the study will recommend a method to identify the optimum crop commencing time depending on the rainfall distribution pattern and the crop water requirement. The paper will also present the design details of the subsurface irrigators. Further it will assist to calculate the optimum size of the roof water tank depending on the weekly rainfall, irrigation demand, roof cover and the cultivable land area.