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FIELD EVALUATION OF TOMATO CROP PRODUCTION UNDER SLECI IRRIGATION

SUMMARY

Ghana's diverse agroecological zones support a wide range of crops, with tomato ranking among the most cultivated vegetables due to market demand and quick sell. However, during cultivation, tomato has high water consumption and this sometimes poses a challenge in the face of erratic rainfall patterns and climate change. The daily water needs of a single tomato plant can range up to 6 litres during dry and hot days. Therefore, methods and techniques that can improve water use efficiencies are very important for their production. This study, conducted by the University of Cape Coast under the EU-funded DIVAGRI project, evaluated the performance of self-regulating, low-energy, clay-based irrigation (SLECI) compared to conventional surface drip irrigation (CSDI) for tomato cultivation. The obtained results show that SLECI treatment delivered 78% more tomato yield in comparison with CSDI. SLECI recorded 285.12 m^3/ha water applied during the season and 4.5 kilograms of fresh tomato yield with each m^3 of used water. Furthermore, results showed close values in leaf length, plant height, leaf width, and stem diameter for tomato plants irrigated using both SLECI and CSDI for the duration of 14 to 42 days after transplanting.

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Finally, the results obtained in this study will be useful for all interested parties from the agricultural sector in Ghana and beyond.

Keywords: clay emitters, low-energy irrigation, surface drip irrigation, tomato yield response, water productivity

INTRODUCTION

Water is the critical limiting resource for sustainable food production. Globally, agriculture is the largest consumer of freshwater, and many productive agricultural areas already experience physical water scarcity or high seasonal variability in water availability. The FAO has estimated that billions of people live in agricultural regions with high or very high-water shortages, and projected increases in demand for water (driven by population growth and higher irrigation needs under warming climates) mean that competition for freshwater between agriculture, urban use and ecosystems will intensify in coming decades. Without improvements in water governance, efficiency, and allocation, water scarcity is expected to reduce crop production and undermine rural livelihoods in many vulnerable regions Biswas *et al*., 2025; FAO, 2020).

Water scarcity harms agricultural production through several pathways: reduced soil moisture and plant water stress (lowering yields and quality), changes in planting dates and cropping patterns, increased risk of crop failure during droughts, and degraded soils from unsustainable groundwater extraction and salinization in irrigated areas. Climate change is already amplifying these risks by increasing the frequency and severity of droughts and by altering rainfall seasonality in many regions, making water scarcity worse in the near future (Alotaibi *et al*., 2023). Water scarcity is a prevalent issue, even in nations with sufficient supplies of water (Mishra, 2023). To ensure the sustainability of this vital resource in agricultural production, it is crucial to use water properly. Moreover, it is essential to adopt certain strategies to manage agricultural water use effectively. This includes adopting various water-efficient techniques such: micro-irrigation, irrigation scheduling, drip fertigation (Tanaskovik *et al*., 2016; Tekinel and Kanber, 2002; Howell, 2001; Papadopoulos, 1996), conservation agriculture by use of mulch (Bian *et al*., 2024), use of deficit irrigation practices (Yang *et al*., 2020; Comas *et al*., 2019), innovative water management practices (Biswas *et al*., 2025), etc.

Vegetable production in sub-Saharan Africa is mainly dependent on rainfall and thus highly sensitive to climate variations (Guodaar *et al*., 2016). In recent years, droughts, heavy rains, and increasing temperatures have strongly contributed to a reduction of water availability, soil quality, and increased crop diseases (Asante and Amuakwa-Mensah 2015, Williams *et al*., 2019). In general, Africa has minimal irrigation outside of a few countries, and, in total, only 6 percent of farmland in Africa is irrigated (Zhang and Borja-Vega 2024). Ghana's agriculture is predominantly rainfed, and the country's water resource endowment is uneven in space and time. Literature data indicate substantial untapped irrigable land but a very small proportion under reliable water-managed agriculture. Seasonal rainfall variability, recurrent droughts in some regions, and increasing demand from non-agricultural sectors create localized water stress that constrains crop production, particularly where farmers lack access to irrigation infrastructure or storage to buffer dry spells (Baldwin and Stwalley, 2022; MoFA, 2023; FAO Aquastat, 2010). However, for Ghana condition, supplemental irrigation and irrigation scheduling can significantly enhance productivity, particularly during the growing season when rainfall deficits are most severe (MoFA, 2023; Nalumi *et al*., 2021; Kyei-Baffour and Ofori, 2006).

Tomato is an important horticultural crop in Ghana, produced for both local markets and processing. Yields in Ghana vary widely by region and management, reflecting differences in varieties, pest and disease pressure, access to inputs, and water management. Recent surveys report regional mean yields in the order of several to more than 20 Mt/Ha depending on management intensity and whether production is rainfed or irrigated. Officially, tomato average yield in Ghana is around 8.20 Mt/Ha (MoFA 2023). Tomato's growth stages—especially flowering and fruit set—are highly sensitive to soil moisture deficits; therefore, reliable water supply during these windows is key to securing marketable yield. A mature tomato plant may require up to 6 liters of water per day during hot conditions (Tanaskovikj *et al*., 2014; Đurovka, 2008). Conventional surface drip irrigation (CSDI) has been promoted as a water-saving technology (Tanaskovik *et al*., 2011; Tekinel and Kanber, 2002; Papadopoulos, 1996) but efficiency is often reduced due to surface evaporation and uneven distribution in comparison with sub surface drip irrigation (Ayars *et al*., 1999).

Irrigation development in Ghana has historically been limited by infrastructure, finance, and institutional capacity. Studies that examine the potential to scale up irrigation identify large areas suitable for irrigation but emphasize that realizing this potential requires investment in small-scale, farmer-centred schemes, strengthening water governance, and deploying water-saving technologies that match local socio-economic conditions. Furthermore, studies and extension experience indicate that farmers adopt diverse irrigation practices including small-scale bucket irrigation, motorized pump irrigation, surface flooding, and localized drip systems (Benabderrazik *et al*., 2022; Baldwin and Stwalley 2022; MoFA, 2023; Nalumi *et al*., 2021; Kyei-Baffour & Ofori, 2006).

Effective water management practices are essential for maximizing tomato yield while mitigating the risks associated with climate change. One of the solutions recommended within the DIVAGRI project, which could help growers to achieve respectable yields while using only a fraction of the usual water is SLECI irrigation system. The SLECI technology is a self-regulating subsurface irrigation system that uses the actual suction force of the surrounding soil for regulation of the system's water release. In this technology, water is transferred to the soil via cylindrical clay elements that are hollow inside. The consequence of the self-regulating effect is an efficient, economical, intelligent and innovative use of water (Technical Report on SLECI Pilot Sites Installed within the DIVAGRI Project, 2025; Malchev *et al*., 2022). By delivering water gradually through clay emitters buried below the soil surface, SLECI reduces water loss from evaporation and deep percolation compared to surface irrigation techniques (Agbesi *et al*., 2025; Elmajetni *et al*., 2025). In several studies with different crops, the benefits of SLECI irrigation technologies are presented, including cucumber and mango (Hansmann and Siering, 2018), cherry orchards (Malchev *et al.*, 2025; Malchev *et al.*, 2022), pepper (Osei *et al.*, 2025), lavender, rosemary, maize, gem-squash, cowpea and moringa (Technical Report on SLECI Pilot Sites Installed within the DIVAGRI Project, 2025). This study aims to assess the performance of SLECI compared with a conventional surface drip irrigation for tomato production under Ghana's humid tropical climate. The main objective was to evaluate the effects of SLECI on crop yield. Furthermore, this study aims to advance understanding of SLECI efficacy for smallholder farmers in semi-arid Africa agroecological regions and other similar regions globally.

MATERIAL AND METHODS

The experimental field

The experimental study was conducted with Tomato crop (Solanum lycopersicum) cultivated for one growing season (29 of May to 14 of September, 2023) located at University of Cape Coast's Alexander G. Carson Technology Centre, Central Region, Ghana (5°07' 48.1"N, 1°17' 24.2"W). The demonstration site consisted of two treatments, namely the SLECI sub-surface treatment and conventional surface drip irrigation (CSDI), which serves as the control.

Figure 1. The experimental field showing dug trenches for installing the SLECI emitters (left), and sections of the CSDI treatment (right)

Each treatment covered 19.8 m^2, arranged in ten rows of 22 plants. Tomato seedlings were transplanted at 0.30 m between and within rows, achieving a stand density of 111 000 plants per hectare. The SLECI line with clay emitters was installed under soil, while the control plot received 16 mm tape. Although two flowmeters where available for irrigation measuring, only the AXIOMA Q1 battery-powered device could be used for SLECI treatment. The irrigation water in the CSDI treatment was not measured by flowmeter due to unavailability of a power source. As an alternative solution, CSDI plots were irrigated twice a day (early morning and late evening) by application of about 4.3 liters per day per plant. Furthermore, soil moisture content was measured in both treatment before each irrigation.

Weather and soil conditions

The climate of Ghana is tropical. The eastern coastal belt is warm and comparatively dry. The southwest corner is hot and humid, and the north is hot and dry. Annual average temperatures range from 26.100C in places near the coast to 28.9 0C in the extreme north. It is usually breezy and sunny. Daytime temperatures may rise above 400C in the north. There are two rainy seasons in the south from March to July and from September to October (bimodal rainfall system). The northern part of the country, on the other hand, has only one rainy season (uni-modal rainfall system) from May to October (MoFA, 2023).

Weather steers both plant demand and irrigation supply, while soil properties dictate how long that water remains available. Table 1 summarizes the weather conditions in 2023 recorded from station Nkanfoa, near by the pilot site established at University of Cape Coast Technology Village, Central Region, Ghana. The region where our experimental site was established falls within the tropical savanna climate (Osei *et al*., 2025).

Table 1. Average climate data for Cape Coast for 2023 (Station: Nkanfoa)

Month	Avg Temp (°C)	Humidity (%)	Wind (m/s)	Sun (hours)	Rad (MJ/m²/day)	ETo (mm/day)
January	26.9	75	2.2	5.2	16.1	3.85
February	27.5	76	2.5	5.3	17.1	4.14
March	27.4	80	2.5	5.4	17.8	4.11
April	27.0	84	2.4	5.2	17.4	3.82
May	26.4	87	2.4	4.8	16.2	3.43
June	25.3	88	2.7	4.2	14.9	3.10
July	24.2	88	2.9	4.1	14.9	2.99
August	23.9	87	2.8	4.0	15.2	3.06
September	24.5	87	2.7	4.1	15.6	3.15
October	25.4	86	2.4	4.7	16.2	3.32
November	26.3	83	2.1	4.9	15.8	3.41
December	26.8	78	2.0	4.9	15.3	3.55
Average	26.0	83	2.5	4.7	16.0	3.49

The obtained results showed that the average daily temperatures, keeping the annual mean near 26 °C, while relative humidity rarely drops below 75 %, with an average solar radiation of 16 MJ /m²/day, and an average reference evapotranspiration (ETo) of 3.5 mm/day. The average monthly temperatures are in the frame of the optimum values recommended for tomato crop (Tanaskovikj *et al*., 2014) and vary from 23.9 in August up to 26.4oC in May. Data for relative air humidity during the vegetation season were over the recommended values (Đurovka, 2008) favoring possibilities for fungal diseases appearing. Average seasonal referent evapotranspiration in our research varies from 2.99 in July to 3.43 in May, emphasizing the need for supplemental irrigation even during rainy spells. According to the literature data, the crop demands around 600 mm of seasonal evapotranspiration, with critical moisture periods during flowering and first cluster fruit swell. The soil moisture deficit during flower and fruit stage is reported to have a negative influence on tomato yield (Tanaskovik *et al.*, 2016b; Sagheb and Hobbi 2002; Doorenbos *et al.*, 1986).

The water physical and chemical properties of the soil at the experimental site are present in Table 2. According to texture classification (USDA-NRCS), the soil at pilot site is loamy sand with 74.6% composition of sand, 11.3% of clay and 14% silt. The results for the soil water capacity (Evett, 2007; ICARDA, 2001) show a wide range between field capacity and wilting point or from 44.2 to 7% volume. The total available water capacity for plants is pretty high or 36.7 % volume. The slightly pH near to neutral reaction is suit for growing tomato crop. The low content of organic matter by 1.28 show need for additional fertilization by organic manure. Therefore, 132 kg of poultry manure was applied per treatment field once before transplanting.

Table 2. Chemical and physical characteristics of the 0-60 cm soil layer

Chemical properties	
Reaction (pH in water)	7.2
Organic matter %	1.28
Physical properties	
Total sand in %	74.6
Silt in %	14.0
Clay in %	11.3
Permanent wilting point (soil moisture retention at 15 bars) in volume %	7.50
Field capacity (soil moisture retention at 0.33 bars) in volume %	44.2
Bulk density in g/cm^3	1.34

RESULTS AND DISCUSSION

The influence of irrigation on tomato yield

Number of fruits per treatment, average yield per harvested plant (g) and total yield (kg/ha) are presented in Table 3. The first date of tomato harvest was 23rd of August while last harvest was at 14th of September 2023. From the obtained results can be concluded that SLECI irrigation treatment produced 79, while conventional surface drip irrigation returned 29 fruits per treatment. From the other hand, SLECI recorded lover average yield per plant or 24.7 vs. 37.7 g. Finally, drip irrigation showed 1.42 t/ha or almost 78% lower tomato fresh yields in comparison with 2.53 t/ha in SLECI irrigation treatment. Our results are below the average range for the country from 8 Mt/Ha, probably due to the absence of chemical fertilizer in both plots and where the irrigation techniques in reality were the dominant factor. The literature data shows that tomato yields were significantly higher when fertilizers were injected through the drip system (Tanaskovik *et al.,* 2011; Cukaliev *et al.,* 2008; Sagheb and Hobbi 2002;

Papadopoulos, 1996). Haynes (1985) reported that if nutrients are applied outside the wetted soil volume, they are generally not available for crop use. The fruit yield of tomato was 28% higher in drip irrigation over furrow irrigation (Shedeed *et al.,* 2009). In other research tomato fruit yield per unit of water supplied was on average one-third better in drip irrigation than in the furrow irrigation. In addition, drip irrigation has resulted in a yield advantage over furrow irrigation (Tanaskovik *et al*., 2016b; Malash *et al.,* 2007). Furthermore, our result implies that buried emitters can sustain respectable yields even in the humid tropics where evaporation losses from conventional drip are assumed to be small. These findings resonate with evidence that subsurface systems buffer crops against extreme evaporative demand (Malchev *et al.,* 2022).

Table 3. Number of fruits per treatment, average yield per harvested plant (g) and total tomato yield (kg/ha)

Treatment	Number of fruits	Average yield per harvested plant (g)	Yield (kg/ha)
SLECI	79	24.7	2534
CSDI	29	37.7	1421

Tomato yields reached 87.6–114.2 t/ha with surface drip, 107.5–128.1 t/ha with subsurface drip at 20 cm, and 105.0–124.8 t/ha with subsurface drip at 40 cm, respectively (Machado et al., 2003). Additionally, in other research, the highest yield in SLECI system has recorded in bell pepper treatment under a burying depth of 5 cm (Osei *et al.,* 2025). Regarding the influence of SLECI irrigation techniques on crop yield performances, our results concur with literature reporting that SLECI exceeded drip yields in maize crop, than almost equaled in gem-squash and moringa crop. From the other hand, in rosemary, lavender and cowpea experiments, results showed that drip better yielding than SLECI (Technical Report on SLECI Pilot Sites Installed within the DIVAGRI Project, 2025). Comparable improvements have been shown for related ceramic emitter systems with melon, wolfberry and apple trees, where subsurface irrigation with ceramic emitter (SICE) was compared with sub-surface or surface drip irrigation, results shown that SICE significantly improved fruit yield (Han *et al*., 2025; Han *et al*., 2023; Cai *et al.,* 2021).

Irrigation water use and soil water content in tomato crop irrigated by SLECI

The results about irrigation water use during the vegetation season in the experimental site are present originally only for SLECI treatment. The total volume of water used in irrigating plants of the SLECI field was 285 m^3/ha. The rainfall recorded by the nearest weather station located at Nkanfoa between the cropping seasons was 406.24 mm. From the other hand, the water consumption for CSDI treatment field has not quantified due to unavailability of a power source.

Anyhow, CSDI treatment was irrigated twice a day (early morning and late evening) by application of about 4.3 liters per day per treatment. Figure 2 present the water consumption volume (in m^3) of tomato plants on the SLECI field. The data on water consumption was recorded by using an ultrasonic water meter (Qalcosonic W1, Axioma Metering, USA).

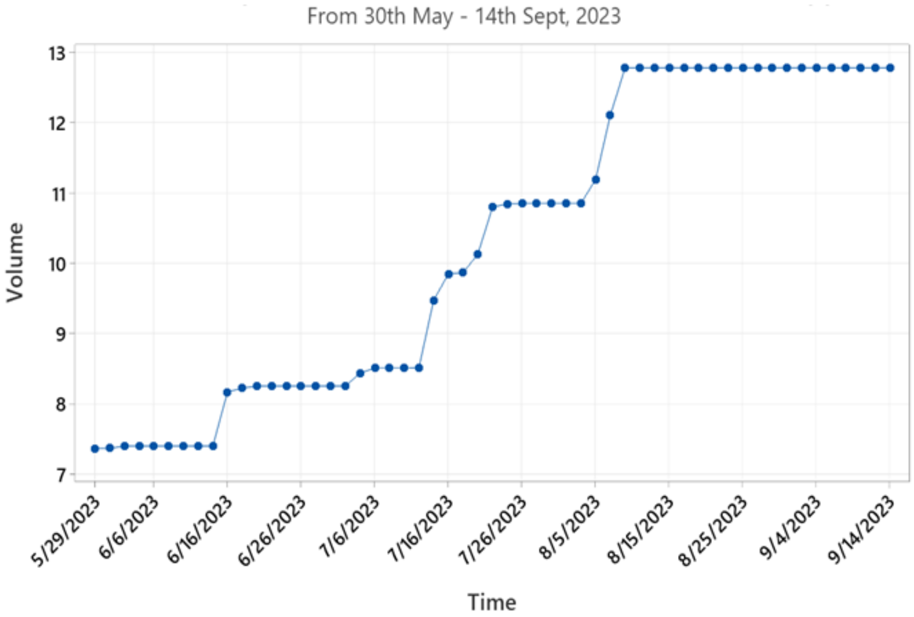

Figure 2. Water consumption for tomato for SLECI field during vegetation (m^3)

In Figure 3 is present time series of soil-water content throughout the first sixty days after transplanting of plants. Soil volumetric water content was measured before irrigation in three times per week. The results showed that volumetric content in the drip irrigation shows higher oscillation compared with SLECI treatment. Furthermore, SLECI values hovered a stable oscillation and never approached close to the wilting point threshold. Similar results for stable soil water contents in SLECI in comparison with surface and subsurface drip irrigation are noted in several other research (Technical Report on SLECI pilot sites installed within the DIVAGRI Project, 2025; Malchev *et al.,* 2025; Malchev *et al.,* 2022). In study with apple trees where subsurface irrigation with ceramic emitter's (SICE) was compared with sub-surface drip irrigation (SDI), the variations in soil water contents for SICE were smaller than those for SDI (Cai *et al.,* 2021). Additionally, in other investigations is noted that frequent drip irrigation with small irrigation application rates can obtain best conditions regarding the content of soil moisture, as well as highest yields (Tanaskovik *et al.*, 2016a: Tanaskovik *et al.,* 2016b; Cukaliev *et al.,* 2008; Agele *et al.,* 2006; Tekinel and Kanber, 2002; Papadopoulos, 1996). In other research is evident that irrigation water was utilized more efficiently under the ET controller treatment than under the watermark sensor and control treatment (Al-Ghobari, 2014). The surface drip irrigation controlled by soil moisture sensor treatment resulting in 15–51% less irrigation water applied compared to fixed time irrigation (TIME) treatments (Zotarelli *et al*., 2009).

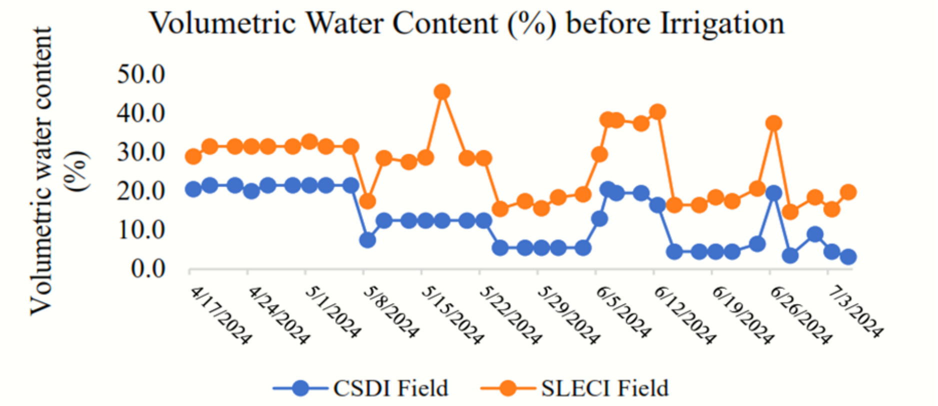

Figure 3. Volumetric water content measured on CSDI and SLECI fields before irrigation

Irrigation water productivity

Irrigation-water productivity (IWP) links the previous two results about obtained yield and applied irrigation water during the season, or simple expressing how many kilograms of crop emerge from each cubic meter poured onto the field. In agriculture, irrigation water productivity is defined as the ratio between the actual crop yield achieved and the water use, expressed in kg/m^3 (Gang *et al*., 2025; Fernandez *et al*., 2020; Cetin and Kara, 2019; Pereira *et al*., 2012). In our analysis, we have used the following equation for estimating the IWP:

$$IWP = \frac{Ya}{Iwa}$$

Where IWP is irrigation water productivity in kg/m^3, Ya is crop yield in kg/ha, while Iwa is irrigation water applied in m^3/ha.

Table 4 lists the values for tomato crop only for SLECI irrigation treatment. The irrigation water productivity (IWP) in tomato crop irrigated by SLECI system show 8.9 kilograms of fresh tomato yield with each m^3 of used water. SLECI is a highly water-efficient system, supplying only small but steady rates of water (Agbesi *et al.,* 2025; Elmajetni *et al.,* 2025; Malchev *et al*., 2022; Hansen and Siering, 2018). The positive influence on SLECI on IWP or water use efficiency is present in several studies with different crops established across Africa (Technical Report on SLECI Pilot Sites Installed within the DIVAGRI Project, 2025; Malchev *et al.,* 2025; Osei *et al*., 2025). Clay-based irrigation reviews emphasize reductions in soil-surface evaporation and deep percolation as the principal drivers of improved IWP (Mahler, 2024). A global meta-analysis of subsurface irrigation reported consistent increases in water productivity across crops and climates (Guo *et al*., 2023). In this context, Rego et al., (1988) indicated that suitable irrigation increasing soil water content as well as nutrient availability, which result in better yield and water use efficiency (Bar-Tal *et al*., 2015; Kafkafi and Tarchitzky 2011; Tanaskovik et al., 2011; Cukaliev *et al*., 2008; Sagheb and Hobbi, 2002; Burt *et al.,* 1998; Papadopoulos, 1996). Compared to conventional drip irrigation (CDI), alternate partial root-zone drip irrigation (ADI) decreased tomato yield slightly, but increased water use efficiency (WUE) by 7.8%, while fixed partial root-zone drip irrigation (FDI) reduced tomato yield and maintained water use efficiency (WUE) (Luo and Li, 2018). Furthermore, results shows that irrigation cut in tomato production did not affect the yield, enhanced fruit quality, and maximized water use efficiency (Lovelli *et al.,* 2017). Greater savings of water for irrigation, the increase in irrigation water use efficiency (IWUE) and the maintenance of yield in cultivars Cedrico, and earlier Amati indicate that regulated deficit irrigation (RDI) could be the more promising strategy for future irrigations of tomato than classical FI approaches (Savic *et al*., 2011).

Table 4. Irrigation water productivity in tomato crop irrigated by SLECI system

Treatment	**Tomato yield (kg/ha)**	**Irrigation water use (m³/ha)**	**IWP (kg/m³)**
SLECI	2534	285.12	8.89

The influence of irrigation techniques on leaf length, plant height, leaf width and stem diameter

The average crop performance parameters for plant height, leaf length, leaf width and stem diameter for tomato plants at 14, 28 and 42 days after transplanting (DAT) are presented in Table 5.

Table 5. Crop performance parameters at 14, 28 and 42 DAT for tomato plants under SLECI and CSDI

Crop parameter	**14 DAT**		**28 DAT**		**42 DAT**	
	SLECI	CSDI	SLECI	CSDI	SLECI	CSDI
Plant height (cm)	47.3	57.1	75.9	92.1	93.1	108.7
Leaf length (cm)	11.9	10.0	11.7	11.4	13.2	12.6
Leaf width (cm)	6.7	5.5	5.8	5.3	7.6	6.9
Stem diameter (mm)	9.6	6.3	12.2	11.6	12.9	12.4

Generally, SLECI produced smaller plants, thicker stems, and larger leaves throughout the season. There were noted differences in plant height, leaf length, leaf width, and stem diameter for tomato plants established on both SLECI and CSDI treatments across the 14 DAT, 28 DAT and 42 DAT. However, our results for plant height partially corresponded with those reported in maize, moringa and cowpea present in Technical Report on SLECI pilot sites installed within the DIVAGRI Project (2025), where irrigation technique have not strong influence on plant height.

The best growth parameters for bell pepper plants have achieved with a burying depth of SLECI lines at 10 cm and 80% recommended application fertilizer dosage. This combination resulted in the highest plant height and leaf area (Osei *et al.*, 2025). Antony and Singandhupe (2004) indicated that drip irrigation pepper had more plant height and more number of branches compared with surface irrigated crops. As the plant height and branches increased, new nodes for flower and fruit development appeared resulting in an increase in number of fruits and total yield. In other study, drip irrigation enhanced tomato growth more, early in the growing season, than did furrow irrigation, but at later stages, there was little difference between the two irrigation systems (Malash *et al.,* 2005). The tensions of 30 and 60 kPa applied at 10 days after transplanting were the ones that most intensified yield and water productivity without significantly affecting the agronomic development of the crop (Mesquita *et al.,* 2019). Xiao *et al.,* (2023) reported that under aerated drip irrigation, the maximum plant height of tomatoes was 1.1%, 3.4%, and 4.7% higher than that of the control treatments (non-N fertilization, 2/3 of conventional N fertilizer and conventional N fertilization - 210 kg ha^{-1}). Furthermore, drip irrigation recorded significantly higher leaf area index (LAI) (3.15) over furrow irrigation (2.27), reported Shedeed *et al.,* (2009). In other studies, water deficit reduced leaf length and width by 21% and 20% relative to plants irrigated under standard practices (Medyouni *et al.,* 2020). Ullah *et al.,* (2021) obtained better results in spring summer season for plant height and stem diameter of tomato when there was 100% ETc water applied (130.88 cm and 11.29 mm).

Furthermore, a simple linear regression for crop performance parameters at 14, 28 and 42 DAT was fitted in our investigation. The results for linear regression parameters are presented in Table 6.

Table 6. Linear regression parameters for each variable and irrigation technique

Parameter	Slope	Intercept	R²	p-value
Plant Height – SLECI	1.6357	26.3000	0.9798	0.0909
Plant Height – CSDI	1.8429	34.3667	0.9593	0.1293
Leaf Length – SLECI	0.0464	10.9667	0.6369	0.4117
Leaf Length – CSDI	0.0929	8.7333	0.9980	0.0283
Leaf Width – SLECI	0.0464	10.9667	0.6369	0.4117
Leaf Width – CSDI	0.0929	8.7333	0.9980	0.0283
Stem Diameter – SLECI	0.1179	8.2667	0.9005	0.2043
Stem Diameter – CSDI	0.2179	4.0000	0.8465	0.2563

The linear regression analysis shows strong linear growth trends for tomato plants under both irrigation systems. Plant height increased faster under CSDI (1.84 cm/day) compared to SLECI (1.64 cm/day), with R^2 values above 0.95. Leaf length and width also grew more rapidly and consistently under CSDI (0.093 cm/day, $R^2 \approx 0.998$) than under SLECI, which displayed moderate variability (0.046 cm/day, $R^2 \approx 0.637$). SLECI consistently produced thicker stems, which may be favorable for mechanical stability under field conditions.

Overall, the regression analysis confirms clear treatment-driven differences in growth dynamics, supporting agronomic interpretations relevant for water-saving irrigation systems.

CONCLUSIONS

The results obtained in experimental sites established in Technology Village at UCC showed that SLECI irrigation produced almost 78% higher tomato fresh yields in comparison with 1.42 t/ha in conventional drip irrigation treatment. The results for soil volumetric content showed that the drip irrigation performed higher oscillation compared with SLECI treatment. Furthermore, SLECI values hovered a stable oscillation and never approached close to the wilting point. Generally, SLECI showed significant potential to minimize water loss by evaporation, runoff, and percolation and can be considered a promising new irrigation technology that can increase efficient use of water. Therefore, smallholder farmers are encouraged to use an SLECI irrigation system because it reduces water use and increases yield, allowing water to be available to other economic sectors. Future research should include replicated blocks to nail statistical confidence, test mixed fertilizer programs and monitor multi-year durability of clay emitters under different soil conditions. The SLECI system should also be tested in a greenhouse environment in order to assess its suitability under controlled crop microclimates and weather conditions.

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