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Is the Smart Irrigation the Right Strategy under the Global Water Crisis? A Call for Photographical and Drawn Articles

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WATER is the main limiting factor of our life and any human activity. In all our life activities including agriculture and industry, water has a vital role in these previous sectors. This reflects the importance of water especially under many global challenges (mainly climate changes, global explosion of population, soil degradation, desertification and hunger). The using of water in irrigation is a very common practice in agriculture because no agriculture without water. The management of irrigation water has become one of the urgent needs nowadays under the terrible progress of bioinformatic technology. The smart irrigation is considered one of the most common applications in smart or precision agriculture. The main components of smart irrigation system may include soil, weather and plant sensors such as soil moisture sensor controllers, evapotranspiration controllers, and rain sensors. This work is an attempt to answer one question about smart irrigation whether it is an important strategy to overcome the global water crisis or not. This is also a call by Environment, Biodiversity and Soil Security (EBSS) for receiving articles on smart irrigation, different applications of smart irrigation in smart agriculture, their challenges, their obstacles and the novel solutions in this concern. This topic has several open questions needs to be answered. The use of the Internet of Things is one of the important solutions for smart monitoring and control of the irrigation process.

Keywords: Smart farming, Precision agriculture, Soil moisture sensors, Internet of things (IoT).

1. Introduction

The global water crisis is global problem facing several countries all over the world as a great challenge due to many global problems such as climate changes, global warming and global population's growth (Salem et al. 2022). An increase in water shortage and its stress facing several countries worldwide is one of the main global challenges confronting practical progress (Yuan and Lo 2022). Water scarcity is a big challenge and a

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main limiting factor for several countries all over the world, particularly in arid and semi-arid regions (Tiyasha et al. 2021; Okasha et al. 2022). Using the advanced technology in agriculture is a crucial issue for controlling many agricultural practices and making the right decisions based on the continuous monitoring of fields using different sensors (Okasha et al. 2021). Irrigation practice is the largest consumer of the available global water budget in agriculture, which uses more than 75% of freshwater resources (Schulz et al. 2020). Due to expected climate changes and rapid population growth, it is expected that the increased demands for freshwater will be getting worse in the forthcoming decades (Okasha et al. 2021).

It is well known that irrigation water management is a crucial process that should be performed to increase global food production depending on crop per drop strategy (Ahmad et al. 2022). Using the advanced technology and smart irrigation systems can also increase irrigation management. This technology may include the automated crop irrigation, which supports the optimum supply of water amount without referring to labor to control valves or to analyze the plant growth status. The developmental phases in Internet of Things (IoT) and Wireless Sensor Network (WSN) technologies and the recent advances in sensors for the implementation of irrigation systems for agriculture, have sped up the evolution of smart irrigation systems (García et al. 2020). Several wireless communication technologies have been used in agriculture sector, such as IoT, Bluetooth, Wi-Fi, long-range wide area network (LoRaWAN), mobile communication (e.g., 2G, 3G, and 4G), and ZigBee (Kim et al. 2020). Under smart greenhouse conditions, many sensors could be used for greenhouse monitoring systems such as Supervisory Control and Data Acquisition (SCADA), and Programmable Logic Controller (PLC) system (Karanisa et al. 2022).

Therefore, this is a call for submitting articles by EBSS. This photographic call also is needed for the applications related to smart agriculture and irrigation. The answer of the main question in this work is the smart irrigation the right strategy under the global water crisis?

2. 2. What is the smart irrigation?

Smart irrigation technology could be defined as a precise in which data on both weather and soil moisture can be used to determine the irrigation need of certain cultivated plants (**Fig. 1 and Table 1**). Sustainable precision irrigation is a crucial agricultural practice toward the attainment of food security, as well as achieving water-saving measures for water scarcity as a result of drought in many parts of the world (Abioye et al. 2022). Precision irrigation scheduling is directed toward highly efficient water using by each plant with compensation water loss through erosion, evapotranspiration, or deep percolation, and preventing under- or over-irrigation (Devanand Kumar et al. 2020; Gu et al. 2020). Many benefits could be harvested from smart irrigation or proper management are presented in **Figs. (2 and 3).** Smart irrigation is an effective monitoring and optimal control of water can be saved, as well as providing a reduction in other indirect costs incurred from energy use in the form of fossil fuel or electricity for pumping, for optimal cost-effectiveness (Abioye et al. 2022). Smart irrigation can apply for optimum doses of pesticides and herbicides (Talaviya et al. 2020).

Fig. 1. The smart irrigation in the simplest meaning, how to apply the enough water amount through the irrigation to the cultivated plant in the right time for its growth, with saving the amount of water and a high deficiency system. This nice photo is the smart irrigation as we can imagine (from https://radiocrafts.com/applications/smart-irrigation/ accessed on 26.7.2022).

Table 1: The basic information about the smart irrigation, and recent published reviews

The main item and its meaning	References
Agriculture is the backbone of most economies in the world as it contributes significantly to the Gross Domestic Product (GDP) and provides food security	Bwambale et al. (2022)
Water use efficiency in irrigated agriculture is the ratio of estimated irrigation water requirements to the actual water withdrawal. Water use efficiency is dimensionless and can be applied to plant, field, scheme, as well on basin and country scale.	Bwambale et al. (2022)
A precision or smart irrigation system is "*a sustainable water saving method for maximizing crop yield and reducing the undesirable environmental impacts from irrigation*"	Mason et al. (2019); Touil et al. (2022)
The internet of things (IoT), "*a concept that joins wireless and mobile tools embedded via the internet, plays a vital role in many fields, especially in the agricultural sector*"	Mousavi et al. (2021a); Richa et al. (2021)
The main irrigation scheduling techniques are: soil moisture sensor (SMS) controllers, evapotranspiration (ET) controllers, and rain sensors (RS)	Touil et al. (2022)
Smart irrigation scheduling using machine learning approaches could be applied based on Decision Support System	Saggi and Jain (2022)
More efficient water and nutrient management using solar fertigation as a sustainable and smart IoT-based irrigation and fertilization system	Ahmad et al. (2022)
Management of irrigation under greenhouse conditions by designing low-cost capacitive-based soil moisture sensor and smart monitoring unit operated by solar cells	Okasha et al. (2021)
Smart greenhouses as the path towards precision agriculture in the food energy and water nexus	Karanisa et al. (2022)
Smart IoT and Machine Learning-based Framework for Water Quality Assessment and Device Component Monitoring	Bhardwaj et al. (2022)
Balancing between demand-and-supply based approaches of smart irrigation and hydropower investments for sustainable water conservation	Ilyas et al. (2022)
Precision Irrigation Management Using Machine Learning and Digital Farming Solutions	Abioye et al. (2022)
An Overview of Smart Irrigations Systems using IOT for a highly efficient water management	Obaideen et al. (2022)
Management based on smart irrigation using IOT system for environmental sustainability in India	Sangeetha et al. (2022)
Novel energy management scheme in IoT enabled smart irrigation system using optimized intelligence methods for much lesser energy consumption and improved network lifetime	Khan et al. (2022)
Zoning irrigation smart system based on fuzzy control technology (fuzzy logic controller or FLC) and IoT for water and energy saving and proposed system based on a Wireless Sensors Network (WSN)	Benyezza et al. (2021)

The main component of smart irrigation system may include (1) data acquisition by automatic weather station and the soil moisture sensor, (2) irrigation control by controlling various irrigation modes (e.g., timing irrigation, periodic irrigation, automatic irrigation, and manual irrigation), (3) cellular data communication using WLINK 4G/3G/NB-IoT modem/RTU to send meteorological and soil moisture data to data center over mobile network, and also provide data transmission channel to remotely control solenoid valves in data center, (4) data processing through system setup, data display and printing, send control command, automatic irrigation, (5) failure alarm, and (6) video surveillance by remote monitor the irrigation process and crop growth through video (**Figs. 4)**.

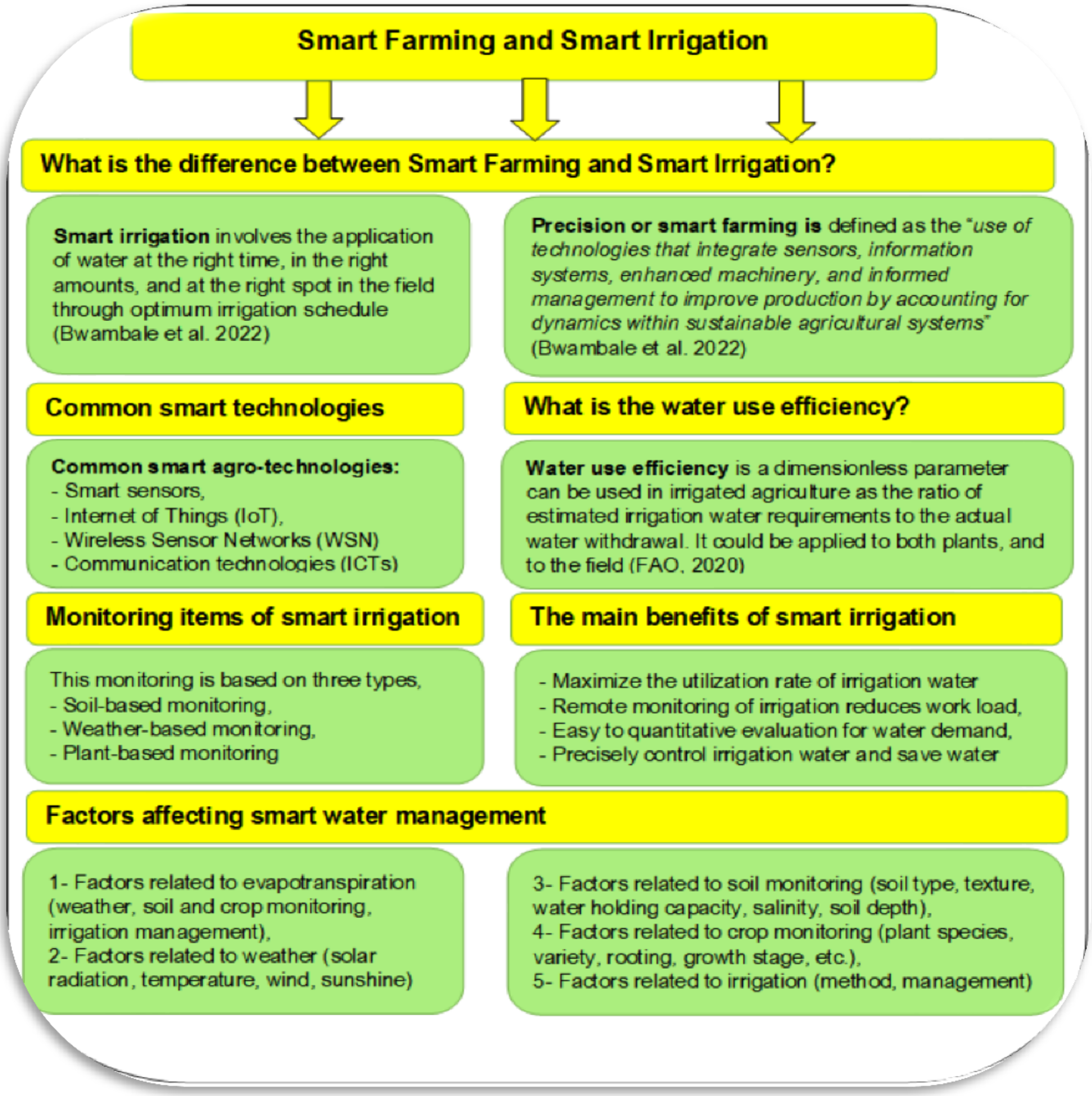

Fig. 2. The smart farming and smart irrigation, including some benefits of smart irrigation, factors affecting its management, and its monitoring.

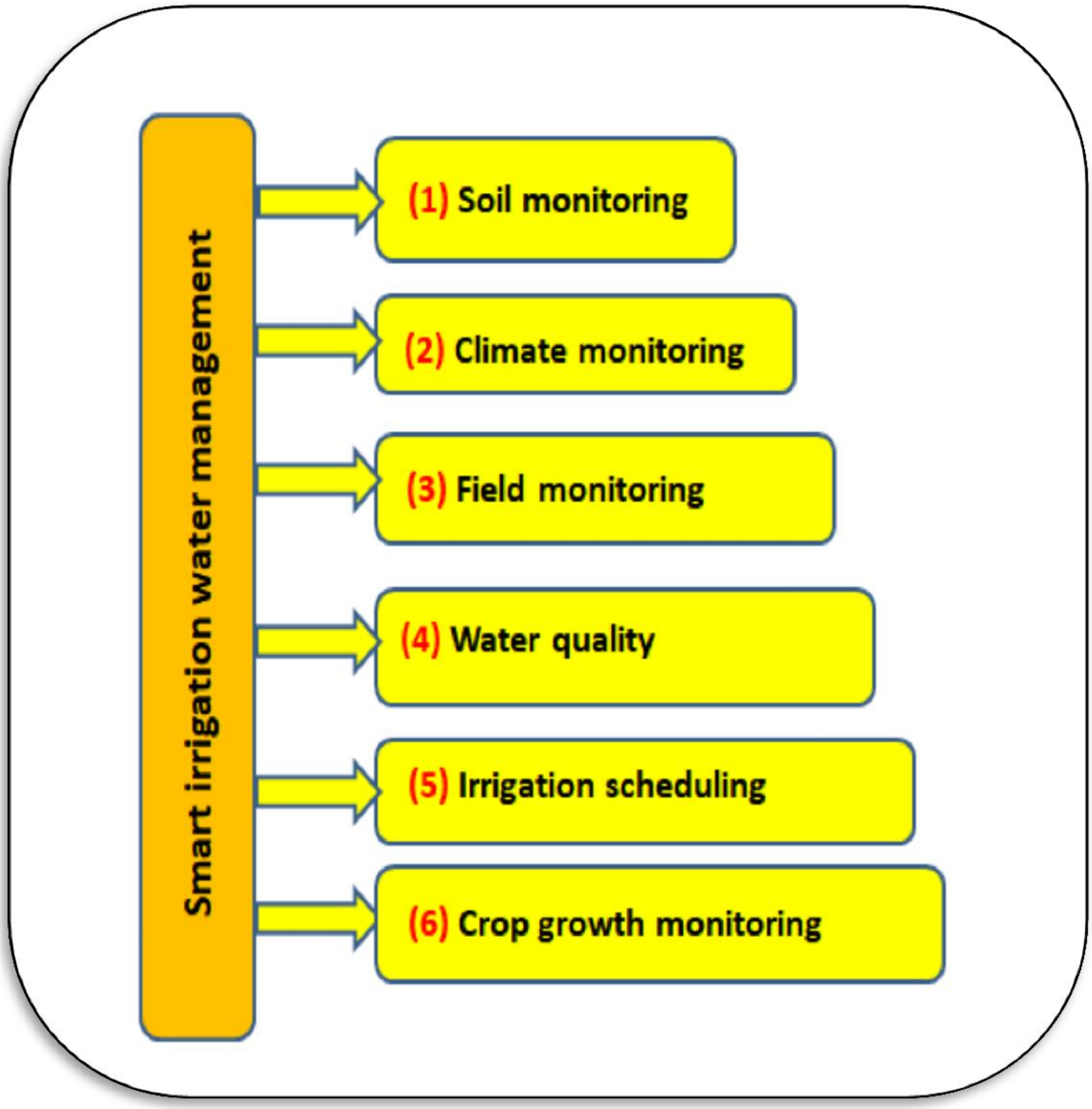

Fig. 3. The main six items in smart water management: crop water modelling, soil monitoring, water quality, drones field monitoring, weather forecasting, and irrigation scheduling (according to Saggi and Jain (2022).

3. Smart irrigation and water crisis

Water is an essential resource that we cannot live without it. The direct and crucial perspective of the importance of water is the nexus water–food–energy. This is triangle and its sides (water, food, and energy) that is essential for our life as essential resources for human society (Zhang et al. 2019). So, any management of water and farm irrigation management will reflect in increasing crop production, water-use efficiency and profits (Campana et al. 2022). Several studies reported on this nexus and its potential from different points of views as presented in **Table 2**. It is well documented that the nexus of Water-Energy-Food (WEF) and their security has gained great concern from the academia and the public since the Bonn Conference held in 2011 (Zhang et al. 2019).

It is expected that human reliance on food, energy and water resources will increase by 2030, by the following rate 35, 50, and 40%, respectively, on the global level (Zhang et al. 2019). These great challenges facing both governments and academia all over the world are securing safe and fresh water supply, global food security or sustainable food production, and fossil energy exhaustion or energy conservation (Liu et al. 2022). Thus, several studies reported about irrigation strategies in the recent decades that reduce water applications through "Deficit Irrigation strategies or DI" and allowing the irrigation efficiency use itself to be increased without any impacts on plant growth or harvested yield (Slamini et al. 2022). Partial Root-zone Drying (PRD) is a new form of DI, an effective irrigation method, and can improve yield per unit of water applied compared to traditional irrigation by saving amount of water (Slamini et al. 2022). The main limitations in the application of PRD and RDI may include, the frequency and of volume irrigation water, soil hydraulic properties, and seasonal precipitation and its occurrence (Slamini et al. 2022).

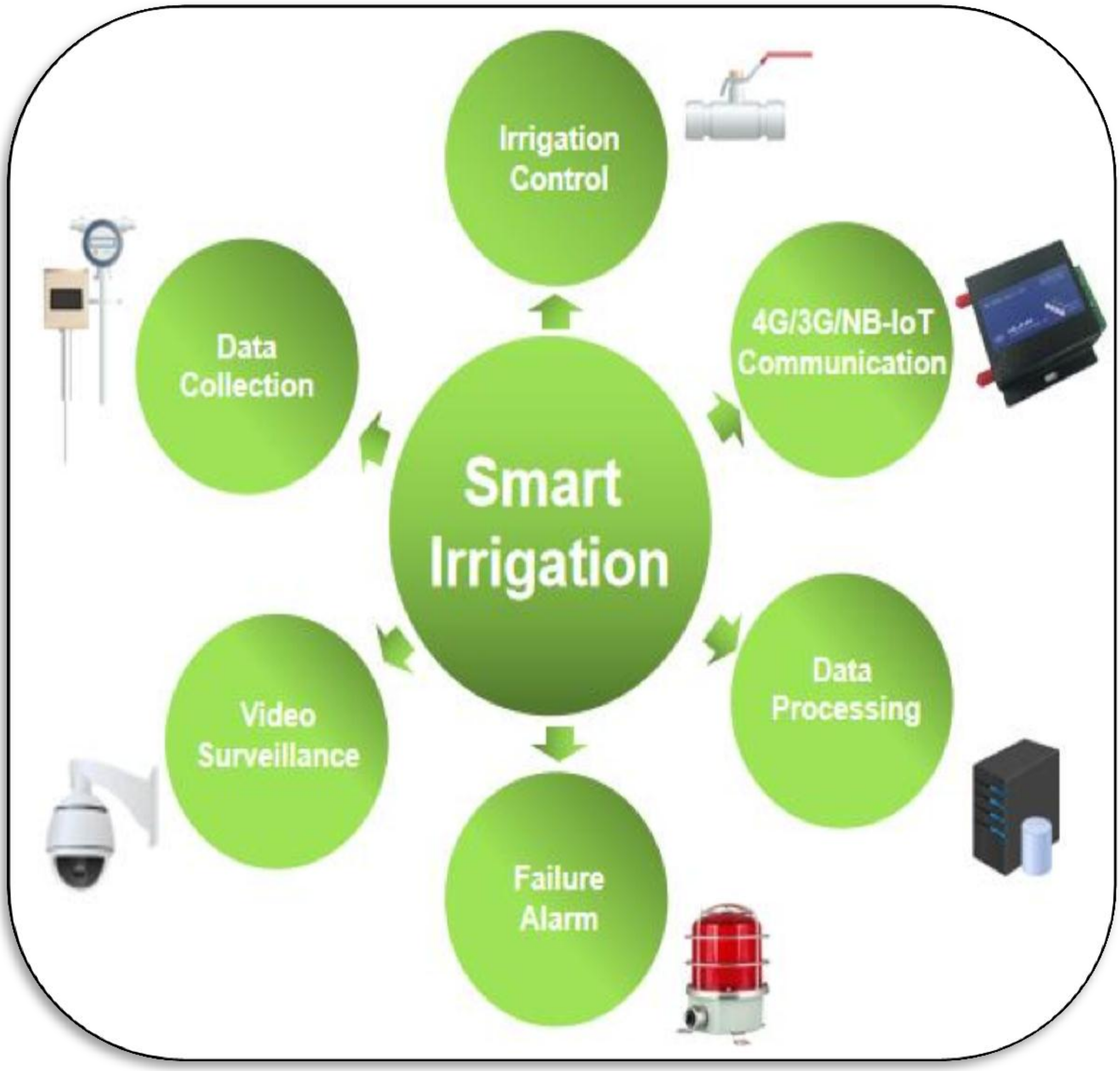

Fig. 4. The main features of the smart irrigation system, which include data acquisition, irrigation control, wireless communication, data processing and fault detection features (source: https://www.wlink-tech.com/smart-irrigation_d0045.html accessed on 26.7.2022).

Table 2: List of some important published studies concerning the water-food-energy nexus.

The main title of the study	Reference
Study on operational irrigation management system in Sweden with a focus on the water–food–energy nexus	Campana et al. (2022)
Study the food-energy-water nexus through investigate irrigation expansion in Guatemala to support development goals with focus on climate change and its impacts on spatial and temporal distribution of irrigation water availability	Wade et al. (2022)
This study focused on the optimization multi-objective model based on water-food-energy nexus for irrigated agricultural sustainable development as a novel robust solution method for handling multiple uncertainties	Guo et al. (2022)
Assessment and management of composite risk in irrigated agriculture under water-food-energy nexus and uncertainty	Zhang et al. (2022)
Analyzing the water-energy-environment nexus of irrigated wheat and maize production in Albania through calculation of specific energy, energy use efficiency, energy productivity, net energy gain, and footprint indicators	Canaj and Mehmeti (2022)
Using the model of WEAP-MODFLOW as a quantitative analysis framework for water-food-energy nexus in an agricultural watershed under different scenarios such as water-saving irrigation and drought	Liu et al. (2022)
Using Water-Energy-Food-Carbon Nexus in analysis of climate change impacts on resource intensity and carbon emissions in protected farming systems under heating temperature variables and climate change scenarios	Yoon et al. (2022)
Study climate change factors on irrigation water food yield, and, socio-economic development for the water-energy-food nexus through evaluation of energy production and water withdrawal, which need innovative technologies	Han et al. (2022)
Circularity in the Urban Water-Energy-Nutrients-Food nexus, where sustainable food production in cities could be achieved by management of urban water and wastes as a mutual reinforce of both	Mulier et al. (2022)
The energy-water-food nexus in combined with waste-land nexus using a GIS-based biofuel supply chain design: A case study in Fars province, Iran	Afkhami and Zarrinpoor (2022)
A novel modelling tool (based on integrating biophysical and socio-economic aspects) for unpacking the Water-Energy-Food-Environment nexus of agricultural development	Correa-Cano et al. (2022)

Automatic board used irrigation water scheduling

Solenoid valve used open and close irrigation water by timing of control board

Automatic board to control of irrigation water systems

Programing of Automatic fertigation system by solar energy

Programming board of irrigation scheduling

Irrigation controller unit with moisture sensor powered by solar energy

Small scale of automatic drip irrigation by solar energy

Motoring station of soil moisture content and soil temperature at different depth by sensors at plant development stage

Motoring some of soil properties such as EC, pH and temperature

Fig. 5. Some photos from the smart irrigation system, which includes different components.

4. A call for photographical articles

As planned this year in the Environment, Biodiversity and Soil Security (EBSS) journal, more calls for more new and hot topics. EBSS started by publishing a call for smart farming for developing sustainable agriculture (Fawzy and El-Ramady 2022), then move to a call on Soil-Water-Plant-Human Nexus (Brevik et al. 2022). At the same time, more calls for submission of photographic review or mini-review such as Global Soil Science Education (Koriem et al. 2022), Management of Salt-Affected Soils (El-Ramady et al. 2022), Soil-Water-Plant-Human Nexus (Brevik et al. 2022), Grafting of Vegetable Crops (Bayoumi et al. 2022), and on Nano-Farming of Vegetables (Fawzy et al. 2022). This is a call for more publications on smart irrigation or smart agriculture especially using the photographic reviews or mini-reviews.

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