

DEVICE, SYSTEM, AND METHOD FOR FARMING**CROSS-REFERENCE TO RELATED APPLICATION**

[0001] This application claims the benefit of priority of Singapore Patent Application No. 10202300569V, filed 2 March 2023, the content of which is hereby incorporated by reference in its entirety for all purposes.

TECHNICAL FIELD

[0002] Various aspects of this disclosure relate to devices, systems, and methods for farming. In particular, the devices, systems, and methods may be suitable for growing plants in an indoor environment.

BACKGROUND

[0003] The following discussion of the background art is intended to facilitate an understanding of the present disclosure only. It should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known, or is part of the common general knowledge of the person skilled in the art in any jurisdiction as of the priority date of the disclosure.

[0004] Energy consumption is a main component of the operating cost of indoor farms. An indoor farm for growing plants typically requires artificial lighting for plant growth, such artificial lighting provided by one or more light-emitting diodes (LED) units or modules. The artificial lighting units may consume energy as well as generate heat. The cooling demands and lighting requirements may contribute significantly to energy consumption. There is thus a need to redesign indoor farms to achieve a sustainable balance between energy consumption and the yield of plants generated from such an indoor farm.

[0005] Conventionally, the design of a farming system may be open to the surroundings to allow for the free exchange of air between the plant growth environment and the surroundings. Although such an open concept may help to dissipate some of the heat and moisture generated, it also contributes significantly to the heat load in the surrounding environment. The diffused heat in the surroundings may make it more difficult to remove as it is spread over a larger

volume of air. An existing solution is to drive or dissipate the heat out of the surrounding air through heat exchange via an air conditioning system of the building in which the indoor farm is placed. However, this may not be an effective and efficient way of managing the heat that is generated in the indoor plant growth system.

[0006] An alternative approach may be to create an isolated environment or microclimate for plant growth in a modular growth chamber to mitigate the aforementioned heat dissipation problem. However, while the enclosed nature of the growth chamber may minimize heat from escaping into the surroundings, heat, and moisture may accumulate within the growth chamber.

[0007] Accordingly, there exists a need to provide a system and method for processing addresses to mitigate one or more of the aforementioned issues.

SUMMARY

[0008] Various aspects of the disclosure concern an apparatus, system, and method for farming, particularly in an indoor environment. The apparatus, system, and method may include several features that deal with the heat and moisture effectively through a heat exchange mechanism using the nutrient water as a heat transfer medium.

[0009] According to an aspect of the disclosure, there is provided a device for farming, the device comprising a growth tray, the growth tray shaped and dimensioned to receive one or more plants for growth and comprising a base portion for allowing flow of a fluid growth medium; a frame extending from the growth tray to define a roof portion; the roof portion configured to receive at least one artificial light source, the at least one artificial light source capable of providing illumination to the growth tray to facilitate plant growth; and a shield mechanism configured to generate an isolated environment within a volume defined by the growth tray, the frame, and the roof portion; wherein the at least one artificial light source is configured to provide contact to the base portion of another device in a manner such that in operation, the flow of the fluid growth medium dissipates heat from the at least one artificial light source.

[0010] In some embodiments, the shield mechanism comprises a plurality of cover panels, wherein each of the plurality of cover panels is configured to extend from the roof portion toward the growth tray to define the volume.

[0011] In some embodiments, the shield mechanism comprises an arrangement of pipes carrying the fluid growth medium, the arrangement of pipes comprising a plurality of outlets arrangement to generate a water wall.

[0012] In some embodiments, the plurality of cover panels comprises at least one of a flexible sheet, a semi-rigid sheet, or a rigid sheet

[0013] In some embodiments, the device further comprises a carrier to receive the at least one artificial light source, the carrier comprising a compliant material to urge the at least one artificial light source to maintain contact with the base portion of the another device.

[0014] In some embodiments, the device further comprises an electrical source attached to the frame, the electrical source connected to the at least one light source to provide electrical power thereto.

[0015] In some embodiments, the frame comprises a plate positioned proximate the roof portion to define a slot, the slot dimensioned to slidably receive at least one of the plurality of cover panels.

[0016] In some embodiments, the at least one light source is hingedly connected to the carrier via a plurality of hinge supports.

[0017] In some embodiments, the at least one artificial light source comprises a light-emitting diode (LED) assembly.

[0018] In some embodiments, the device further comprises a flow distributor positioned within the growth tray, the flow distributor comprises a pipe having a plurality of outlets to allow the fluid growth medium to flow into the growth tray.

[0019] According to another aspect of the present disclosure, there is provided a system for farming, the system comprising a plurality of devices, the plurality of devices comprising a first device and a second device, the second device stackable on the first device, each of the first and second device comprises: a growth tray, the growth tray shaped and dimensioned to receive one or more plants for growth and comprising a base portion for allowing flow of a fluid growth medium; a frame extending from the growth tray to define a roof portion; the roof portion configured to receive at least one artificial light source, the at least one artificial light source capable of providing illumination to the growth tray to facilitate plant growth; and a shield mechanism configured to generate an isolated environment within a volume defined by the growth tray, the frame, and the roof portion; wherein the at least one artificial light source of the first device is configured to contact the base portion of the second device in a manner

such that in operation, the flow of the fluid growth medium within the base portion of the second device dissipates heat from the at least one artificial light source of the first device.

[0020] In some embodiments, the system further comprises a growth medium delivery and collection network to deliver growth medium to the plurality of devices.

[0021] In some embodiments, the growth medium delivery and collection network includes a distribution tank, a pipe network, and a collection tank.

[0022] In some embodiments, the distribution tank and the collection tank are integrated, wherein the system further comprises a circulating/recirculating pump arranged in fluid communication with the integrated tank to pump growth medium from the integrated tank to the pipe network, and wherein the integrated tank is configured to receive growth medium from the pipe network.

[0023] In some embodiments, the pipe network comprises one or more flow control valves positioned within one or more pipes of the pipe network.

[0024] In some embodiments, the pipe network comprises a distribution network of pipes and a return network of pipes.

[0025] In some embodiments, the distribution network of pipes is arranged in a zig-zag configuration, and through a longitudinal axis and a transverse axis of at least one of the first device and the second device, the distribution network of pipes further include a plurality of outlets, the plurality of outlets configured as sprinklers to output fluid growth medium under pressure to generate at least one water wall to the first device and/or the second device.

[0026] In some embodiments, the shield mechanism comprises a plurality of cover panels, wherein each of the cover panels is configured to extend from the roof portion toward the growth tray to define the volume.

[0027] In some embodiments, the at least one artificial light source comprises a light-emitting diode (LED) assembly.

[0028] According to another aspect of the present disclosure, there is provided a method of providing a system for farming, the method comprises providing the first device and the second device of the system as described; stacking the second device on the first device; and contacting the at least one artificial light source of the first device with the second device in a manner such that in operation, the flow of the fluid growth medium within the base portion of the second device dissipates heat from the at least one artificial light source of the first device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The invention will be better understood with reference to the detailed description when considered in conjunction with the non-limiting examples and the accompanying drawings, in which:

- FIG. 1 is a schematic diagram of a device for farming, in the form of a modular farming unit;
- FIG. 2 shows an exploded perspective view of the modular farming unit of FIG. 1;
- FIG. 3 shows an embodiment of an LED assembly and carrier frame forming part of the modular farming unit;
- FIGS. 4A to 4E are schematic diagrams illustrating a plurality of modular farming units being stackable to form a farming system, in various views;
- FIG. 4F is a schematic diagram illustrating a support module to facilitate contact between an LED assembly of a first device for farming with the base portion of a second similar or identical device for farming;
- FIG. 4G is a schematic diagram illustrating the use of the support module to facilitate contact between the LED assembly of the first device for farming and the base portion of the second device for farming;
- FIG. 5A shows an exploded view of the farming system of FIG. 4A to 4G, with particular emphasis on the module-to-module connection and growth medium delivery and collection network;
- FIG. 5B shows the side views of the farming system, with particular emphasis of on the pipe network to supply and collect growth medium;
- FIGS. 6A to 6D show various embodiments of variations associated with the modular farming unit and/or the farming system;
- FIGS. 7A and 7B show another embodiment of the farming system comprising a water wall feature in a perspective view and a side view respectively;
- FIGS. 8A to 8D show a computational model of the farming system of FIGS. 7A and 7B and simulation results based on the computational model; and
- FIG. 9 shows a flow chart of a method of providing a system for farming.

DETAILED DESCRIPTION

[0030] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure. Other embodiments may be utilized, and structural and logical changes may be made without departing from the scope of the disclosure. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

[0031] Embodiments described in the context of one of the devices or methods are analogously valid for the other devices or methods. Similarly, embodiments described in the context of a device are analogously valid for a method, and vice-versa.

[0032] Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

[0033] In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a broad reference to one or more of the features or elements.

[0034] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0035] As used herein, the terms “first”, “second”, “third”, etc. are used to differentiate similar features or elements for clarity, and may not denote order unless otherwise stated.

[0036] As used herein, the term “farming” broadly refers to plant growth, crop, and livestock breeding and/or production. Non-limiting examples include agriculture, aquaculture, hydroponics, etc.

[0037] As used herein, the term “module” broadly refers to a device or unit that may be a standalone device, or may be suitable to be combined or joined with one or more other devices or units to form a system, and the term “modular” may be construed as capable of being combined or joined with the one or more other devices or units. For example, a plurality of

modular farming units may be combined or joined by stacking the units to form a farming system in the form of a shelf, or rack.

[0038] As used herein, the term “growth tray” includes at least one of the following: seed tray, nursery tray, cell tray that may be used in agriculture, horticulture, hydroponics, etc.

[0039] As used herein, the term “isolated environment” refers to the creation or generation of a microclimate region within a farming module or system for regulating an environmental parameter, for example, temperature or relative humidity, within the farming module or system. The isolated environment may also minimize heat flow out of the farming module or system to its surrounding. In some embodiments, generation of the isolated environment may placing or constructing one or more solid panels surrounding the farming module. In some embodiments, generation of the isolated environment may include generating a fluid-based barrier, for example, a water wall or water curtain.

[0040] In the following, embodiments will be described in detail.

[0041] FIG. 1 and FIG. 2 show a device 100 for farming. The farming may include growing plants in an indoor environment with artificial lighting, using a fluid-based growth medium.

[0042] The device 100 may be a modular farming unit comprising a growth tray 102, the growth tray 102 shaped and dimensioned to hold one or more plants for growth. The growth tray 102 may also allow growth medium to be distributed to the plants for growth. In some embodiments, the growth tray 102 may comprise one or more slots 104, the one or more slots 104 shaped and dimensioned to receive plants, which may be in the form of seeds or seedlings, for growth. The growth tray 102 may comprise a base portion 106 for holding growth medium, such as water infused with nutrients (hereinafter referred to as “nutrient water”) to facilitate plant growth. The base portion may be configured to allow flow of the growth medium therethrough, such that nutrients in the growth medium may be absorbed by the plants for growth. The nutrients may include macronutrients and micronutrients that may be essential for plant growth and development. Non-limiting examples of macronutrients may include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, and magnesium. Non-limiting examples of micronutrients may include iron, manganese, zinc, boron, molybdenum, chlorine, copper, and nickel.

[0043] In some embodiments, the base portion 106 may arranged such that the nutrient water will run through the root zone/regions of the one or more plants. In some embodiments,

the base portion 106 may comprise an inlet to receive circulating nutrient water and an outlet for directing nutrient water away from the base portion 106.

[0044] The device 100 may comprise vertical supports 108 extending vertically from the tray 102 to form a frame having a desired height h . The frame may comprise a roof portion 110, the roof portion 110 shaped and dimensioned to receive at least one artificial light source to provide light for plant growth. In some embodiments, the at least one artificial light source is in the form of a light-emitting diode (LED) assembly 112, the LED assembly 112 may comprise a plurality of LED arrays.

[0045] The roof portion 110 may comprise a plurality of connectors 114, each connector 114 interconnecting two vertical supports 108. The connectors 114 and the interconnected vertical supports 108 may define the shape of the frame and provide structural integrity to the frame. As shown in FIG. 1 and FIG. 2, the frame may be cuboidal.

[0046] Referring to FIG. 3, the LED assembly 112 may be attached to a carrier frame 118 to form a LED carrier module 116. The LED carrier 116 may comprise a carrier frame 118, the carrier frame 118 dimensioned to receive the LED assembly 112. The carrier frame 118 may comprise flanges 119 extending from the base of the carrier frame 118, the flanges 119 extending towards an opposing side of the carrier frame 118, and forming a support to receive the LED assembly 112.

[0047] A compliant material 120 may be layered on the flanges 119. The compliant material 120 may be shaped slightly smaller than the carrier frame 118 so as to fit snugly within the boundary or perimeter of the carrier frame 118. In some embodiments, the compliant material 120 may be a rubber gasket. The compliant material 120 may be arranged to provide a biasing force to urge the LED assembly 112 upward away from the flanges 119, when the LED assembly 112 is positioned therein. The compliant material 120 may further absorb compressive force between the LED assembly 112 and carrier frame 118.

[0048] The LED assembly 112 may be attached to the carrier frame 118 using a plurality of suitable fasteners, such as, but not limited to, pin hinges 122.

[0049] Referring back to FIG. 2, the LED carrier module 116 may be attached to the roof portion 110 using a plurality of suitable attachment devices, such as a plurality of LED carrier module supports 124. In the embodiment shown in FIG. 2, there comprises four LED carrier module supports 124 for each LED carrier module 116. Each carrier module support 124 may be positioned on the connectors 114 to receive a corner portion of the LED carrier module 116.

As may be seen in FIG. 2, there comprise two LED carrier 118, each with four carrier module supports 124.

[0050] Each carrier module support 124 may comprise a slot 124a along a longitudinal axis of the carrier module support 124, the slot 124a configured to receive a corner portion of the LED carrier module 116.

[0051] The device 100 may further comprise a shield mechanism. The shield mechanism may be operable to provide or create an isolated environment within the volume 160 defined by the growth tray 102, the frame, and the roof portion 110. The isolated environment may be at a different temperature, different humidity, and/or different illumination level relative to the environment outside the defined volume. The isolated environment may be regarded as a “local” climate zone within the defined volume, where environmental parameters within the volume 160 such as temperature, humidity and/or illumination can be controlled.

[0052] In some embodiments, the shield mechanism may include a plurality of cover panels 152. The plurality of cover panels 152 may be in the form of flexible sheets, semi-rigid sheets, or rigid sheets. The sheets may be made of plastic. As shown in FIG. 1 and FIG. 2, there comprise four cover panels 152 operable to cover four surfaces of a rectangular frame defined by the vertical supports 108 and connectors 114.

[0053] In some embodiments, there may comprise one or more supporting rods 154 positioned between two vertical supports 108 positioned along a transverse axis and/or a longitudinal axis of the frame. The supporting rods 154 may be arranged to provide support to the respective cover panels 152 when they are stowed or retracted.

[0054] In some embodiments, the device 100 may include one or more profile-securing locks to secure the LED carrier module 116 in place.

[0055] In some embodiments, each LED carrier module supports 124 may be attached to each of the four corners of the rack. The LED carrier module is attached to the carrier module support 124 at the provided slots 104. In other words, the whole LED carrier frame is supported by pin hinges 122 at the provided slots 124a at the LED carrier module supports 124.

[0056] It may be appreciable that the device 100 may be a standalone unit, or may be modular such that it is stackable with one or more other similar modules to form a farming system.

[0057] FIGS. 4A to 4E are schematic diagrams in various views (perspective view, front view, right side view, left side view, top view, respectively) illustrating a plurality of modular

farming devices 100 being stacked to form a farming system 200, the farming system 200 in the form of a multi-level shelf or rack. In forming the stackable farming system 200, the LED assembly 112 of a first device 100A is urged against and contacts (maintaining contact) the underside of growth tray 102 of a second device 100B, to enable nutrient water flowing within the growth tray 102 of the second device 100B (or another device) to dissipate heat away from the LED assembly 112 of device 100A.

[0058] FIG. 4F and FIG. 4G illustrates a possible contact of the LED assembly 112 of a device 100A and the underside of the growth tray 102, using a plurality of LED carrier module supports 124, each LED carrier module support as depicted in FIG. 4G. Each hinge support 124 may comprise a spring-loaded bolt 142, the spring-loaded bolt 142 arranged to urge the LED assembly 112 or part thereof (when received within slot 124a), upwards or towards the base portion 106 of another device 100, thus ensuring that contact between the LED assembly 112 of the device 100A and the growth tray 102 is maintained. It may be appreciable that the hinge pin 122 may be correspondingly urged upwards by the spring-loaded bolt 142.

[0059] In some embodiments as shown in FIG. 5A, to facilitate stacking, the vertical supports 108 of each modular farming unit/device may comprise one or more hollow portions (female portion) shaped and dimensioned to receive module-to-module connectors 202. Each module-to-module connector 202 may comprise two protrusions (male portions) for insertion into the corresponding hollow portions of the vertical supports 108 associated with device 100A and device 100B respectively. Such an arrangement may be used to facilitate stackability of the device 100A to device 100B, and may facilitate quick stacking and provide a secure connection.

[0060] The system 200 may comprise a growth medium delivery and collection network. The growth medium delivery and collection network may include a nutrient water distribution tank 204, a pipe network, in the form of a central piping connection 206, and a nutrient water collection tank 208.

[0061] The nutrient water distribution tank 204 may be positioned at a top portion of the multi-level shelf system 200. An arrangement of pipes or a pipe network, in the form of central piping connection 206, may be arranged to provide a supply of nutrient water from the nutrient water distribution tank 204 to each of the growth trays 102. The nutrient water collection tank 208 may be positioned at a bottom portion of the multi-level shelf system 200 to collect nutrient water from each of the growth trays 102. In some embodiments, one of more dimensions of the

pipe, for example pipe diameter, may be varied along the central piping connection 206 or channel flow path to facilitate the distribution of nutrient water flow and the collection of nutrient water. In some embodiments, one or more flow control valves (not shown) may be positioned within the central piping connection 206 and used to regulate the flow of the nutrient water. Such flow control valves may be used to facilitate the balancing of the flow rates in and out of each growth tray 102.

[0062] Referring to FIG. 5B, the central piping connection 206 may contain a piping feed to the growth trays 102, i.e. via distribution pipes 206A, and a return feed from the growth trays 102, i.e. via return pipes 206B.

[0063] FIGS. 6A to 6F show various embodiments of variations associated with the modular farming try unit 100 and/or the farming system 200.

[0064] Referring to FIG. 6A, the frame may comprise a plate 130 positioned proximate the roof portion 110, the plate 130 and a portion of the frame defining a slot, the slot dimensioned to slidably receive at least one of the plurality of cover panels. As illustrated in FIG. 6A, the slot may be defined to receive the front cover panel 152A. In operation, the installed front cover panel 152A may be pivotable about a longitudinal axis of the frame, and may be swung open and slidably received in the defined slot under the LED carrier module 116. This helps to facilitate access to the respective growth tray 102.

[0065] Referring to FIG. 6B, the at least one light source, i.e. LED assembly 112, may be hingedly connected to the LED carrier frame 118 via a plurality of hinge supports 140. The hinge supports 140 may provide a quick-release function should the need arise for the LED assembly 112 to be removed. As illustrated, the hinge supports 140 provide a slide and turn dual-action movement to unhinge the carrier from the LED assembly 112.

[0066] Referring to FIG. 6C, each farming module 100 may comprise its corresponding electrical supply module 176. The power supply 176 may be operable to convert useful direct current DC for the LED assembly 112 from an alternating current AC electrical supply from an electrical grid. The electrical supply module 176 can be installed at a distance away from the thermally controlled growth layers, such as on the top of the system 200. The DC 48V may be distributed to the different layers based on need. The size of the electrical power supply 176 may be increased or multiplied in numbers according to the size of the load layers. This DC 48V may be used to power the LED driver box(es) 170 of each layer. In some embodiments, one or more individual driver module 172 may be added to the LED driver box 170 based on

the desired number of LED light modules. In some embodiments, each driver module 172 may power a plurality of LED light modules. The DC electrical supply may come from a common voltage source that is available to every level of the system 200, supplied from the main AC source.

[0067] Referring to FIG. 6D, for a base portion 106 of a growth tray 102, a flow distributor may be incorporated in the growth tray to facilitate flow of the fluid-based growth medium within the growth tray. The flow distributor may comprise a pipe 180, the pipe 180 having a plurality of outlets 182 to allow the fluid growth medium to flow into the growth tray. The positioning of each outlet 182 with respect to other outlets 182 may facilitate the provision of a uniform flow distribution of the growth medium, which may minimize mineral build up in the growth tray 102 and improve heat transfer. Thermal energy (heat) from the LED assembly 112 contacting the base portion 106 of the growth tray 102 may be absorbed by the growth tray and transferred away by the relatively cooler nutrient water.

[0068] FIG. 7A (perspective view) and FIG. 7B (side view without return and supply pipes) show another embodiment of a system for farming, wherein a plurality of devices 330, each device 330 similar to device 100 with the exception of the cover panels 152. Similar to the device 100, the device 330 may be modular and stackable to form the system, in the form of a chamber 300. In the chamber 300, the shield mechanism comprising a water wall 302 may be formed in operation and created for each device 330, using a network of pipes 304. The network of pipes 304 may comprise a distribution network of pipes 304a and a return network of pipes 304b. The distribution network of pipes 304a may be arranged in a zig-zag configuration, and which passes through a longitudinal axis and a transverse axis of at least one of, but preferably each of the device 330 of the system 300. The portion of the pipes 304 that passes through the transverse axis of the system 300 may be configured to include a plurality of outlets 306, the plurality of outlets 306 configured as sprinklers to output nutrient water under pressure, such pressure may be controlled by one or more valves positioned within the pipes 304. The nutrient water under pressure, which is output from the plurality of outlets 306, may produce the resultant water wall 302 effect. The nutrient water output from the outlets 306 may drop, by virtue of gravity, to the growth tray 102, flow pass or through the growth tray 102, and be collected by the return network of pipes 304b.

[0069] The system 300 may comprise a nutrient water tank 308 and a circulating/recirculating pump 310. The circulating/recirculating pump 310 may be arranged in fluid communication with the nutrient water tank 308, and operable to pump nutrient water

from the nutrient water tank 308 to the network of pipes 304. The network of pipes 304 may therefore be understood to be configured for the delivery of nutrient water to each of the module 330 of the chamber 300, and provides a return path, via pipe network 304b, to the nutrient water tank 308.

[0070] In some embodiments, there may comprise a nutrient water holding tank (not shown), the nutrient water holding tank arranged to provide nutrient water to the network of pipes 304a for delivery to the modules 330.

[0071] In operation, nutrient water may be fed into the water wall from the holding tank which may be positioned at a top of the chamber (not shown) or pumped from the nutrient water tank 308 via the circulating/recirculating pump 310. The nutrient water may then be discharged through the pipe network 304a to each module 330 of the growth chamber 300 to create the water wall 302. It may be appreciable that the water wall 302 and flowing water arrangements may provide a greater surface area for heat to be removed by the nutrient water. In addition, dehumidification of the internal air defined within chamber 300 may be achieved through the direct absorption of water vapor in the air into the water wall 302. The nutrient water may be collected at the nutrient water tank 308. In some embodiments, the nutrient water within the nutrient water tank 308 may further be chilled using an external chiller (not shown) to reduce the temperature of the nutrient water, before returning the nutrient water to the nutrient water tank via the circulating/re-circulating pump 310.

[0072] It may be appreciable that the water wall 302 and the cover panels 152 are not mutually exclusive, and may be combined to form further embodiments.

[0073] FIG. 8A shows a computational model of a device 100 of the system 200. . The computational model may define a room environment, which may be subject to air-conditioning, with corresponding regulated temperature, and relative humidity. The computational model may further define the heat flow path of the heat generated by the LED assembly 112 via water, external walls, and air. The tray-LED interface defines the contact area between the LED assembly 112 of one device urged against and contacts the underside of a growth tray 102 of another device. The computational model may further define the nutrient water inflow and outflow pass the growth tray 102.

[0074] FIGS. 8B, 8C, and 8D show the simulation results, in the form of plots, from the analysis conducted with a computational model of the device. FIG. 8B is a plot of a temperature and relative humidity within the device 220 without the nutrient water flow and with the nutrient water flow.

FIG. 8C is a plot of temperature and RH versus flow rate of the nutrient water flow within the tray, i.e. plot of temperature and relative humidity variation, and FIG. 7D is the plot of heat outflow (W) versus flow rate (LPM) of different components, i.e. nutrient water, external walls, and air within the chamber.

[0075] The root zone air temperature may be maintained within about 1.2 degrees Celsius (°C) above the target 25 °C at a nutrient water flow rate of about 2.5 Litres per minute (LPM). Based on FIG. 8B, the relative humidity (RH) may be slightly elevated due to the lower air temperature but it is still within the 10% deviation from the targeted 60% RH level. The air temperature near the root zone (i.e. near the tray-LED interface) may be further reduced by increasing the nutrient water flow rate. There is also evidence that the recirculating water, when it is sufficiently chilled, is able to reduce the moisture content in the air. The simulation also shows that the nutrient water is able to capture up to about 90% of heat generated by the LED which would otherwise be transferred to the surrounding room air (represented by 820). This represents an energy-efficient way of cooling the growth environment by minimizing the heat transmitted to the surrounding environment which would otherwise needs to be removed by the room air conditioning system. In addition, the heat captured by the flowing water presents another opportunity for heat recovery as this heat can be repurpose for other uses within the same facility (e.g. for warm or hot water supply in a building).

[0076] In some embodiments, the vertical supports 108 and/or connectors 114 may be constructed or formed from materials such as aluminum, or composite materials.

[0077] In some embodiments, the growth tray may comprise one or more sections forming a lattice structure, said sections being attachable to and detachable from the base portion 106.

[0078] In some embodiments, the LED assembly each LED lighting unit comprising one or more light-emitting diodes (LEDs) configured to provide optimal light conditions for plant growth.

[0079] In some embodiments, there may comprise a control system, the control system configured to regulate the intensity and duration of light emitted by the LED lighting units. In some embodiments, the control system may be connected to sensors monitoring environmental conditions, and wherein the control system adjusts the light intensity and duration based on the sensed conditions.

[0080] In some embodiments, the device 100 may include adjustable height mechanism allowing users to vary the distance between the LED assembly and the growth tray 102. In

some embodiments, such adjustable height mechanism may include incorporating telescopic portions into the frame.

[0081] In some embodiments, each LED assembly 112 may be configured to emit electromagnetic radiation in specific wavelengths to optimize plant growth at different stages of development.

[0082] According to another aspect of the present disclosure, there is provided a method 500 of providing a system for farming, the method 500 comprises the steps

[0083] Step 502: providing a first modular farming device 100A and a second modular farming device 100B;

[0084] Step 504: connecting the second device 100B on the first device 100A; and

[0085] Step 506: contacting the at least one artificial light source of the first modular farming device 100A with the base portion 106 of the second modular farming device 100B in a manner such that in operation, the flow of the fluid growth medium within the base portion 106 of the second device 100B dissipates heat from the at least one artificial light source of the first device 100A.

[0086] It may be appreciable that although the system 200 have been described with reference to the stacking of a plurality of identical devices 100, the number of cover panels 152 or the shielding mechanism of each stackable device 100 may be varied without departing from the scope of the present disclosure.

[0087] While the disclosure has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

What is claimed is:

1. A device for farming, the device comprising
 - a growth tray, the growth tray shaped and dimensioned to receive one or more plants for growth and comprising a base portion for allowing flow of a fluid growth medium;
 - a frame extending from the growth tray to define a roof portion; the roof portion configured to receive at least one artificial light source, the at least one artificial light source capable of providing illumination to the growth tray to facilitate plant growth; and
 - a shield mechanism configured to generate an isolated environment within a volume defined by the growth tray, the frame, and the roof portion;wherein the the at least one artificial light source is configured to provide contact to the base portion of another device in a manner such that in operation, the flow of the fluid growth medium dissipates heat from the at least one artificial light source.
2. The device according to claim 1, wherein the shield mechanism comprises a plurality of cover panels, wherein each of the cover panels is configured to extend from the roof portion toward the growth tray to define the volume.
3. The device according to claim 1 or 2, wherein the shield mechanism comprises an arrangement of pipes carrying the fluid growth medium, the arrangement of pipes comprising a plurality of outlets arrangement to generate a water wall.
4. The device according to any one of the preceding claims, wherein the plurality of cover panels comprises at least one of a flexible sheet, a semi-rigid sheet, or a rigid sheet
5. The device according to any one of the preceding claims, further comprising a carrier to receive the at least one artificial light source, the carrier comprising a compliant material to

urge the at least one artificial light source to maintain contact with the base portion of the another device.

6. The device according to any one of the preceding claims, further comprising an electrical source attached to the frame, the electrical source connected to the at least one light source to provide electrical power thereto.

7. The device according to claim 2, wherein the frame comprises a plate positioned proximate the roof portion to define a slot, the slot dimensioned to slidably receive at least one of the plurality of cover panels.

8. The device according to claim 5, wherein the at least one light source is hingedly connected to the carrier via a plurality of hinge supports.

9. The device according to any one of the preceding claims, wherein the at least one artificial light source comprises a light-emitting diode (LED) assembly.

10. The device according to any one of the preceding claims, further comprising a flow distributor positioned within the growth tray, the flow distributor comprises a pipe having a plurality of outlets to allow the fluid growth medium to flow into the growth tray.

11. A system for farming, the system comprising
a plurality of devices comprising a first device and a second device, the second device stackable on the first device, each of the first and second device comprises:
a growth tray, the growth tray shaped and dimensioned to receive one or more plants for growth and comprising a base portion for allowing flow of a fluid growth medium;
a frame extending from the growth tray to define a roof portion; the roof portion configured to receive at least one artificial light source, the at least one artificial light source capable of providing illumination to the growth tray to facilitate plant growth; and

a shield mechanism configured to generate an isolated environment within a volume defined by the growth tray, the frame, and the roof portion;
wherein the at least one artificial light source of the first device is configured to contact the base portion of the second device in a manner such that in operation, the flow of the fluid growth medium within the base portion of the second device dissipates heat from the at least one artificial light source of the first device.

12. The system according to claim 11, further comprising a growth medium delivery and collection network to the plurality of devices.

13. The system according to claim 12, wherein the growth medium delivery and collection network includes a distribution tank, a pipe network, and a collection tank.

14. The system according to claim 13, wherein the distribution tank and the collection tank are integrated, wherein the system further comprises a circulating/recirculating pump arranged in fluid communication with the integrated tank to pump growth medium from the integrated tank to the pipe network, and wherein the integrated tank is configured to receive growth medium from the pipe network.

15. The system according to claim 14, wherein the pipe network comprises one or more flow control valves positioned within one or more pipes of the pipe network.

16. The system according to any one of claims 14 or 15, wherein the pipe network comprises a distribution network of pipes and a return network of pipes.

17. The system according to claim 16, wherein the distribution network of pipes is arranged in a zig-zag configuration, and through a longitudinal axis and a transverse axis of at least one of the first device and the second device, the distribution network of pipes further include a plurality of outlets, the plurality of outlets configured as sprinklers to output fluid growth medium under pressure to generate at least one water wall to the first device and/or the second device.

18. The system according to any one of claims 11 to 17, wherein the shield mechanism comprises a plurality of cover panels, wherein each of the cover panels is configured to extend from the roof portion toward the growth tray to define the volume.
19. The system according to any one of claims 11 to 18, wherein the at least one artificial light source comprises a light-emitting diode (LED) assembly.
20. A method of providing a system for farming, the method comprises
providing the first device and the second device of claim 11;
stacking the second device on the first device; and
contacting the at least one artificial light source of the first device with the second device in a manner such that in operation, the flow of the fluid growth medium within the base portion of the second device dissipates heat from the at least one artificial light source of the first device.