

A SYSTEM OF FARMING IN AN INDOOR ENVIRONMENT

FIELD OF INVENTION

The invention generally relates to agriculture and farming. Particularly, the invention is a system
5 of farming in an indoor environment.

BACKGROUND OF THE INVENTION

The tremendous growth of the world's population is believed to be one important key point that
has driven the popularity and demand for urban agriculture, especially industrial scale urban
10 farming. It is believed that by the year of 2050, human population will grow by another 2 billion.
This growth will occupy lands for industrial development and urbanization purposes, leaving
arable land to be scarce. At the same time, the global food system is severely challenged by the
rise of demand from the tremendous growth of population. With this, urban agriculture has risen
and has been receiving ample attention due to its yield and advantages over conventional farming.

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Industrial scale urban farming is also commonly known as vertical farming, where plants or crops
are grown on vertically stacked layers integrated in infrastructures such as factories, warehouses,
buildings and even shipping containers. This type of farming is known to have higher yield as
compared to conventional farming since the crops are grown under controlled environments,
20 where farming conditions such as lighting, growing medium, moisture content and etc. are
optimized. Advantages that arise from controlled environment include all-season farming and
increased crop production, lesser water consumption, lesser exposure of chemicals and disease
and more. In order to optimize the farming conditions, most of these vertical farming companies
rely heavily on technologies that they developed. For example, sophisticated lighting and
25 moisture systems are customarily built to supply optimized amount of light and moisture to the
crops. Vertical farming can also be growing crops in a variety of ways such as soil, hydroponic,
aeroponic or aquaponic. Hydroponic and aeroponic vertical farming methods are those that are
more popular and commonly used in the field.

30 Despite the promising advantages of vertical farming, it has also been criticised based on a load
of disadvantages. One of the known disadvantages of vertical farming, especially aeroponic, is the
extremely high building costs. Most of these costs are used in either building the infrastructure,
or the sophisticated technology and systems to optimize the farming conditions. Hydroponic

planting, on the other hand, requires the planning and building of complicated piping systems in order to supply water and nutrient to the crops, to irrigate used water from the crops and to process the used water so that they can be recycled and reused. Besides the building cost, it also relies heavily on human labour such as technologists and specialists in the field that are required

5 to monitor and study the growth of the crops. The maintenance of these technologists and specialists is often expensive to pay in view of their skill and knowledge in the field. Further, the high-tech machines and technologies used in maintaining and running the vertical farm also require maintenance effort and costs. For example, sensing apparatuses require timely review, maintenance and upgrade in order to ensure their workability and accuracy. Another

10 disadvantage is the instability of artificial environments since it relies heavily on energy usage to support technological systems such as lighting and movements of the plants. Any energy shortage in the infrastructure would affect the growth of the crops, eventually decreasing the yield of the production. One other disadvantage is the environmental and energy implication. Vertical farming requires large amount of energy to run the high-tech machines and technologies, as compared to

15 conventional farming. Some vertical farming methods claim that they employ renewable or alternative sources, but it is believed that there are still considerable carbon footprints generated by these vertical farms.

US 2017/0027112 A1 is a patent application that discloses an indoor farming module system for growing plants and crops. The system comprises a housing and a plurality of working components

20 including an airflow management lighting system arranged within the housing, in which the housing further comprises a high-density racking system having a plurality of vertical levels within the housing, and that the airflow management lighting system provides airflow and lighting to each level of the plurality of vertical levels. According to the disclosure, the racking system is

25 integrated with the airflow management lighting system together with an irrigation system and a recirculation system. Both the irrigation system and recirculation system are a series of pipes used to deliver water, nutrients, oxygen and other agents to the plants and crops, and to recapture excess water supply for recirculation purposes.

30 CN 204168858 U is a utility model document that discloses indoor growing system for plants. The indoor growing system provides an automatic planting system for plant cultivation and plant production, in which the system focuses on objectives such as simple and inexpensive equipment, easy automation management, and efficient and feasible cultivation. Despite the objectives

mentioned, the features mentioned therein utilizes a series of pipes to supply and return liquid, or more specifically circulating the liquid between plants and the system.

The use of pipes to circulate liquid amongst crops in an indoor farming environment is a common practice. However, such practice attracts a number of disadvantages such as incurrence of extra cost in building, managing and maintaining these pipes. Apart from the pipes, common water reservoirs and oxygenators are also often seen to pair with these pipes in order to work efficiently in delivering and circulating water and nutrients. Besides the construction costs for these features, cross contamination is also prone to happen since the crops share the same piping system in delivering and circulating water and nutrients. In view of these disadvantages in the prior arts, there is therefore a need for the present invention to provide a system for farming in an indoor environment that is capable of addressing the drawbacks of the prior arts.

SUMMARY

The present invention discloses a system of farming in an indoor environment. The system comprises a housing means having first and second compartments, at least a racking means arranged within the first compartment of the housing means to position crops, a first farming means arranged within the second compartment of the housing means for the preparation of nutrients and water for the crops, a second farming means arranged within the housing means to provide essential components to the crops, and a third farming means arranged within the housing means to control and monitor conditions of the indoor environment and the crops, characterized in that the system utilizes non-circulating hydroponic means in planting, wherein crops are planted in canisters where water and nutrients are provided until harvest, thereby eliminating the need of pipes within the housing means to provide and irrigate water and nutrient to and from the crops.

It is an object of the present invention to provide an indoor farming system that eliminates the need in replenishing or replacing water and nutrients in the canister, since sufficient water and nutrients are provided in the canister for the growth of the crop until it is harvested. At the same time, there is therefore no need in monitoring the water and nutrient levels in the canisters.

It is another object of the present invention to provide an indoor farming system that also eliminates the need of common water reservoirs and oxygenators since the system utilizes non-circulating hydroponic means in planting and that no pipes are required.

- 5 It is still an object of the present invention to provide an indoor farming system that eliminates cross contamination since there is no supply and irrigation of water and nutrient through any shared piping system among the crops.

It is further an object of the present invention to provide an indoor farming system that enables
10 crop diversification since the crops are individually and separately planted and grown in canisters. The diversification herein refers to different types and growth patterns of the crops.

It is still further an object of the present invention to provide an indoor farming system that allows staggering growths among the crops within the same tier or rack, therefore no need in scheduling
15 harvest cycles according to the growth of the crops in different tiers or racks.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described with reference to the drawings wherein:

Figure 1 illustrates one embodiment of the system of farming in an indoor environment according
20 to the present invention.

Figures 2(a) and 2(b) illustrates front and perspective views of a racking means according to one embodiment of the present invention.

25 Figure 3 illustrates canisters that are arranged on a series of racking means, according to one embodiment of the present invention.

Figure 4 illustrates a canister where a crop is planted, according to one embodiment of the present invention.

30 Figures 5(a) and 5(b) illustrates perspective and side views of the first farming means, according to one embodiment of the present invention.

DETAILED DESCRIPTION

The following description is presented to enable a person of ordinary skill in the art to make and use the various embodiments. Descriptions of specific devices, techniques, and applications are provided only as samples. Various modifications to the examples described herein will be readily apparent to those of ordinary skill in the art, and the general principals defined herein may be applied to other examples and applications without departing from the scope of the various embodiments. Thus, the various embodiments are not intended to be limited to the examples described herein and shown, but are to be accorded the scope consistent with the claims.

One preferred embodiment of the present invention discloses a system (1) of farming in an indoor environment, in which the system (1) comprises a housing means having first (11) and second compartments (12), at least a racking means (20) arranged within the first compartment (11) of the housing means to position crops, a first farming means (30) arranged within the second compartment (12) of the housing means for the preparation of nutrients and water for the crops, a second farming means arranged within the housing means to provide essential components to the crops, and a third farming means arranged within the housing means to control and monitor conditions of the indoor environment and the crops. Particularly, the system (1) utilizes non-circulating hydroponic means in planting where crops are planted in canisters (40) where water and nutrients are provided until harvest. One of the most significant advantage of the system (1) is the elimination of pipes within the housing means to provide and irrigate water and nutrient to and from the crops. It is common in prior indoor farming systems that pipes, together with common water reservoirs, oxygenators and other water and nutrient providing means, are requisite features in order to support the growth of the crops. Whilst these features are useful in providing and irrigating water and nutrient to crops efficiently, they are often difficult to plan and construct within an indoor environment. Another drawback of using piping system is space consumption. Most indoor farmers would prefer planting as many crops as possible in their indoor farms to maximise yield, but such piping system requires particular spaces within the indoor farm in order to properly provide and irrigate water and nutrients to the crop. Also, the elimination of pipes dismisses the possibility of cross contamination between the crops since there is no supply and irrigation of water and nutrient through any shared piping system among the crops. Another advantage of not utilizing pipes, common water reservoirs and oxygenators is the saving of cost in terms of purchase of the these materials, construction and maintenance charges of these features.

Figure 1 illustrates one embodiment of the present invention in a manner where the system (1) is divided into a first compartment (11), a second compartment (12) and a third compartment (13). More particularly, the first compartment (11) is placed at one end of the housing means while the second compartment (12) is placed at another end of the housing means. According to the present embodiment, the third compartment (13) is sandwiched between the first and second compartments (11, 12). The first compartment (11) is preferably used to house and place at least a racking means (20) for the growth of crops. The housing means, as illustrated in the embodiment herein, comprises a number of racking means (20), in which each of the racking means (20) has a plurality of tiers (21) and each tier (21) has designated placements for the canisters (40). In different embodiments, the racking means (20) may preferably be a cultivation rack, a germination rack, or a combination of both. In other words, the first compartment (11) may house and place at least a cultivation rack, at least a germination rack or a combination of both. The system (1) in figure 1 illustrates the first compartment (11) that houses a plurality of cultivation racks and a plurality of germination racks, where the cultivation racks are placed at one end of the first compartment (11) and the germination racks are placed at another end of the first compartment (11). Such arrangement of the cultivation and germination racks eases the workflow from germination to cultivation, as well as the monitoring of the crops in these two stages.

Figures 2(a) and 2(b) illustrate front and perspective views of the racking means (20), particularly the plurality of tiers (21) and the designated placements for the canisters (40) of the racking means (20). As shown in the figures, the designated placements for the canisters (40) are constructed from a plurality of longitudinal dividers (22). The width between the longitudinal dividers (22) is constructed in a manner where they are wide enough to allow the canisters (40) to be placed on the tiers (21). The placement of the canisters (40) on the racking means (20) are illustrated in Figure 3 for better understanding of the racking means (20). Particularly, the canister (40), according to one embodiment of the present invention, comprises a cover (41) and a main body (42), in which the main body (42) is responsible in holding water and nutrients for the crop and the cover (41) is responsible in holding the crop in position. The main body (42) of the canister (40) is filled with sufficient water and nutrient for the growth of the crop until it is being harvested. As illustrated in Figure 4, the cover (41) of the canister (40) comprises an opening to hold the crop in position. The canisters (40), depending whether the crops are in the germination or cultivation stage, are then arranged accordingly on the tiers (21) of either the germination rack or the

cultivation rack. According to the embodiments mentioned herein, the system (1) utilizes non-circulating hydroponic means, where crops are planted in these canisters (40) using sufficient amount of water and nutrient until the crops are being harvested. One advantage of using these canisters (40) in planting the crops is that it eliminates the need in replenishing or replacing water and nutrients in the canisters (40), since sufficient water and nutrients are provided in the canister (40) for the growth of the crop until it is harvested. At the same time, there is no need in monitoring the water and nutrient levels in the canisters (40), thereby saving time and effort of the farmers. The use of these canisters (40) also eliminate the need of common water reservoirs and oxygenators since there is no need of these items and their pipes to deliver and irrigate water and nutrients to and from the crops.

The second compartment (12) houses the first farming means where it is used for the preparation of nutrients and water for the crops. According to one embodiment of the present invention, the first farming means (30), as illustrated in figures 5(a) and 5(b), comprises a nutrient mixing tank (31), a waste management tank (32), a water capturing tank (33), and a plurality of filtering devices (34). In the second compartment (12), the waste management tank (32) and the water capturing tank (33) are placed adjacent to each other and the nutrient mixing tank (31) is placed above these tanks (32, 33). Particularly, the waste management tank (32) is responsible of collecting wastewater from the system (1) and filtering the wastewater through the filtering devices (34). The filtering devices (34) used in the present invention may be, but not limited to, a membrane filter using ceramic, activated carbon or activated alumina filters, or an ultraviolet filter. It should be obvious to the skilled addressee that the filtering devices (34) mentioned herein are not limited and any other filtering devices capable of filtering water to a level that is suitably used in the growth of crops may also be used. At the same time, water recapturing tank (33) recovers water generation from the system (1) and recycles the use of the water. In one embodiment of the present invention, the water recapturing tank (33) may recover water generation from air-conditioning units within the system (1). The nutrient mixing tank (31), on the other hand, is responsible of producing water and nutrient mixture so that they can be dispensed into the canisters (40) to assist in the growth of the crops. The water used in the nutrient mixing tank (31) is pumped via a water pump from the water recapturing tank (33) in which they are mixed with an electrical mixer.

The third compartment (13) is optionally included in the system (1), where it serves as a utility room housing a working desk with a wash basin as well as a fuse box at the top portion of the third compartment (13). As previously mentioned, the third compartment (13) is preferably placed between the first compartment (11) and second compartment (12). Such arrangement of the third compartment (13) allows farmers to conveniently work in an indoor environment especially in the dispensing of nutrient and water into the canisters (40) and placing the canisters (40) on the racking means (20). It should particularly be mentioned that pipes may optionally be constructed so that clean water is supplied to the wash basin from the water recapturing tank (33). Further, wastewater from the wash basin may exit through pipes that are connected to the waste management tank (32) so that this wastewater can be filtered through the filtering devices (34) and be recycled back into the system (1). The features herein therefore reduce the use of fresh water in the system (1) and the waste production from the system (1).

In one embodiment of the present invention, the second farming means is responsible in providing essential components to the crops apart from water and nutrient, such as light, air and temperature of the environment where the crops are grown. Specifically, the second farming means comprises a lighting module (51), an airflow module (52) and a temperature controlling module. The lighting module (51) is an arrangement of lights preferably on the top of each tier (21), as illustrated in figure 3. The type of lighting used in the lighting module (51) may be chosen from, but should not be limited to fluorescent grow lights, HPS grow lights and LED grow lights. The way the lighting module (51) is constructed on the top of each tier (21), whether parallel, horizontally or vertically to each other, should not be limited to those illustrated in the figure. Instead, they should be constructed in a manner where the lighting module (51) provides light recipes to optimize the growth of the crops. Besides lights, airflow also plays an important role in the growth of the crops. In the present embodiment, the airflow module (52) comprises multiple aeration fans to increase air turbulence within the indoor environment and improve transpiration rate for the seedlings. At the same time, the airflow module (52) is also capable of managing heat release from the lighting module (51). The airflow modules (52) are constructed on the top of each tier (21), particularly between the racking means (20), in order to ensure crops on each tier (21) get even air distribution. Another component that affects the growth of crops is the temperature within the indoor farming environment. The capability in controlling temperature of the indoor farming environment allows crops to grow all year round, without the need to consider the change of seasons. It is disclosed in the present embodiment that the temperature controlling

module is preferably a heating, ventilation and air-conditioning, HVAC, system. Specifically, the HVAC system ensures that the temperature of the indoor farming environment stays between 18°C and 25°C, and the humidity level stays between 50% and 90%. It should be obvious to the skilled addressee that the temperature and humidity level of the indoor farming environment are not limited to such ranges, and they can be adjusted accordingly to optimize the environment for the growth of the crops. It should also be mentioned that the housing means is constructed in a manner where it is layered with insulation material in order to help in holding the temperature and humidity within the indoor farming environment.

Besides providing the crops with the essential components to grow, it is also important to monitor the growth of the crops and to ensure that their growth is optimized. As mentioned earlier, the preferred embodiment discloses that the system (1) comprises third farming means that are used particularly for controlling and monitoring conditions of the indoor farming environment and the crops. In a more preferred embodiment, the third farming means comprises an operating dashboard to control parameters of the indoor environment, a real-time monitoring dashboard to monitor the conditions of the indoor environment and the growth of the crops, and a plurality of sensors to detect and collect data from the indoor environment and the growth of the crops. In this embodiment, each of the operating dashboard and the real-time monitoring dashboard has their own graphical interface where farmers can operate the system (1) efficiently. Both of these dashboards are connected to the plurality of sensors so that data are shared through the dashboards where farmers is capable of analysing the growth of the crops and adjusting the lighting module (51), airflow module (52) and temperature controlling module accordingly. The plurality of sensors may include, but they should not be limited to, carbon dioxide sensors, temperature and humidity sensors and air velocity sensors for monitoring essential components in the indoor environment, and laser scan sensor and imaging sensor for scanning the crop and identifying the dimensions and shapes of the crops. In a further embodiment of the present invention, the third farming means further comprises a mobile access module and a storage module where farmers can control parameters of the indoor environment and monitor the conditions of the indoor environment and the growth of the crops on a mobile device, and to store data from the system (1) respectively. The mobile access module is specifically useful to farmers that are not able to be constantly and physically there at the indoor farm to monitor the growth of the crops. The storage module, on the other hand, allows data to be stored either in a local server unit or in a cloud server unit so that collected data can be used for further analysis.

From the features mentioned above, the system (1) as disclosed herein enables crop diversification since the crops are individually and separately planted and grown in canisters (40). The diversification herein refers to different types and growth patterns of the crops. At the same
5 time, the system (1) allows staggering growths among the crops within the same tier (21) or racking means (20), and therefore there is no need in scheduling harvest cycles according to the growth of the crops in different tiers (21) or racking means (20). It should also be mentioned that the term housing means used throughout the specification refers to any housing that is capable of forming an indoor environment that may be insulated to maintain and control the indoor
10 environment in order to optimize the growth of the crops. Accordingly, the housing means may be selected from any one of the intermodal or shipping containers, buildings, or underground tunnels or mine shafts.

Although only certain exemplary embodiments have been described in detailed above, those
15 skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Additionally, aspects of embodiments disclosed above can be combined in other combinations to form additional embodiments. Accordingly, all such modifications are intended to be included within the scope of this invention.

CLAIMS

1. A system (1) of farming in an indoor environment, the system (1) comprises:
 - a housing means having first (11) and second compartments (12);
 - at least a racking means (20) arranged within the first compartment (11) of the housing
 - 5 means to position crops;
 - a first farming means (30) arranged within the second compartment (12) of the housing means for the preparation of nutrients and water for the crops;
 - a second farming means arranged within the housing means to provide essential components to the crops; and
 - 10 a third farming means arranged within the housing means to control and monitor conditions of the indoor environment and the crops;
 - characterized in that the system (1) utilizes non-circulating hydroponic means in planting, wherein crops are planted in canisters (40) where water and nutrients are provided until harvest, thereby eliminating the need of pipes within the housing means to provide and irrigate water and
 - 15 nutrient to and from the crops.
2. The system (1) according to claim 1, wherein the canister (40) of the non-circulating hydroponic means comprises a main body (42) and a cover (41), in which the main body (42) is responsible in holding water and nutrients for the crop and the cover (41) is responsible in holding
- 20 the crop in position.
3. The system (1) according to claim 2, wherein the cover (41) of the canister (40) comprises an opening to hold the crop in position.
- 25 4. The system (1) according to claim 1, wherein the racking means (20) is preferably a cultivation rack, a germination rack, or a combination of both.
5. The system (1) according to claim 1, wherein each racking means (2) has a plurality of tiers (21) and each tier has designated placements for the canisters.
- 30 6. The system (1) according to claim 1, wherein the first farming means (30) comprises a nutrient mixing tank (31), a waste management tank (32), a water capturing tank (33), and a plurality of filtering devices (34).

7. The system (1) according to claim 6, wherein the nutrient mixing tank (31) allows the dispense of nutrient and water mixture into the canister (40) to assist in the growth of the crop.
- 5 8. The system (1) according to claim 1, wherein the second farming means comprises a lighting module (51), an airflow module (52) and a temperature controlling module.
9. The system (1) according to claim 1, wherein the temperature controlling module is preferably a heating, ventilation and air-conditioning, HVAC, system.
- 10 10. The system (1) according to claim 1, wherein the third farming means comprises:
an operating dashboard to control parameters of the indoor environment;
a real-time monitoring dashboard to monitor the conditions of the indoor environment and the growth of the crops; and
15 a plurality of sensors to detect and collect data from the indoor environment and the growth of the crops.
11. The system (1) according to claim 10, wherein the third farming means further comprises a mobile access module to control parameters of the indoor environment and to monitor the
20 conditions of the indoor environment and the growth of the crops on a mobile device, and a storage module to store data from the system (1).
12. The system (1) according to claim 1, wherein the housing means further comprises a third compartment (13) that is sandwiched between the first and second compartments (11, 12) for
25 utilities purposes.