Harvest System and Method

Field of Invention

The present invention relates to a plant harvest system and a method for harvesting plants, in particular, tall plants.

Background

In densely populated cities, land is scarce, so plants are grown in vertical spaced arrangement to minimise footprint. However, harvesting plants grown in such an arrangement can be problematic. When tall plants are grown, a worker needs to climb a ladder or scissor lift to cut plants grown at heights at more than 2 metres from ground level, this kind of vertical farming makes harvesting difficult and dangerous. In addition, such a harvesting method is capital and labour intensive.

Therefore, there is a need for an improved system and method of harvesting plants at different heights.

Summary of Invention

In a first aspect, the invention provides a planting system, the system comprising: a frame; a plurality of planters spaced vertically within the frame, each planter arranged to receive one or more plants; and a cutting station moveable vertically along the frame to cut plants in planters positioned at different heights.

The planters are stacked vertically, to minimise the footprint of the system. This is particularly useful in urban farming, where space is limited. By using this system, workers do not need to climb ladders or use a scissor lift to harvest plants grown at different heights. In some areas, such equipment may not be available. Therefore, this system enables a worker to harvest plant matter grown at height safely, efficiently, and with less need for expensive bulky equipment.

In an embodiment, the cutting station may comprise a guide and a cutter engageable with the guide and moveable along the guide. Advantageously, the cutter can move along the guide to cover the entire area of the planter to maximize the harvest.

In an embodiment, the cutter may be selected from the group comprising: rotating blade, rotating chain with teeth, curved blade, shears, secateurs, strimmer wires. The cutter may be chosen to suit the plants to be harvested. The cutter may be replaceable and interchangeable to allow a wide variety of applications.

In an embodiment, the vertical movement of the cutting station may be through a mechanism selected from the group comprising: electric motor, vertical worm drive, pulley system, a chain drive. The mechanism may be chosen to suit the application. For example, the mechanism may be manual, automated, or semi-automated.

In an embodiment, the system may further comprise a counter weight to stabilize the system. The weight of the system on the front and back of the frame, due to the weight of the cutting station and distribution of the plants. A counter weight may be adjusted and attached to the system for additional stability.

In an embodiment, the system may further comprise shock absorbers to dampen vibration. The system may generate significant vibration when the cutting station is in operation. Dampening the vibration would reduce the noise level and increase smooth operation of the cutting station.

In an embodiment, the system may further comprise a sweeper and/or blower configured to push cut plant matter out of the planters. The plant matter may be leaves, stem, roots, fruit, vegetables, or other plant material. The sweeper may be a bristle brush or a similar gadget. The blower may be a leaf blower or a similar gadget. This ensures efficient clearance of the plant matter from the planters, ready for growing a new batch of plants.

In an embodiment, the system may further comprise a web to catch cut plant matter. Since the plant matter may fall out of the planters at a height, the plant matter may scatter as they fall to the ground. A web would reduce the scattering of the plant matter, and make collection more efficient. The web may also be a net. The plant matter may be delicate plant material.

In an embodiment, the system may further comprise a chute to collect cut plant matter. The chute can provide easy and efficient collection of the cut plant matter. It can also be configured to keep the plant matter in a compact shape, suitable for transportation.

In a second aspect, the invention provides a method of harvesting plants, the method comprising the step of: moving a cutting station vertically along a frame to cut plants in planters spaced vertically within the frame.

In some farming methods, plants are grown vertically spaced apart. This method increases the safety and efficiency of harvesting plants grown in such planters.

In an embodiment, wherein the cutting station comprises a guide and a cutter engageable with the guide, the method further comprises the step of moving the cutter along the guide.

The guide enables the cutting station to cover the whole planter to maximize cutting efficiency and even level of cutting.

In an embodiment, the method further comprises the step of sweeping and/or blowing cut plant matter out of the planters.

This facilitates fast and easy clearance of plant debris from the planters.

In a third aspect, the invention provides a cutting station for cutting plants in a plurality of planters spaced vertically, wherein the cutting station is moveable vertically to cut plants in planters positioned at different heights. This cutting station is a standalone unit independent of the vertical frame, such that the same unit can be used to harvest plants in several sets of vertically spaced planters.

In an embodiment, the planters may be vertically spaced within a frame, and the cutting station may be moveable vertically along the frame. This configuration minimizes the footprint occupied by the planters.

In an embodiment, the cutting station may comprise a guide and a cutter engageable with the guide and moveable along the guide. Advantageously, the cutter can move along the guide to cover the entire area of the planter to maximize the harvest.

In an embodiment, the cutter may be selected from the group comprising: rotating blade, rotating chain with teeth, curved blade, shears, secateurs, strimmer wires. The cutter may be chosen to suit the plants to be harvested. The cutter may be replaceable and interchangeable to allow a wide variety of applications.

In an embodiment, the cutting station may further comprise a moveable arm connecting the cutter to the guide, the arm configured to extend to cut plants further from the guide. The moveable arm enables the cutter to reach further into a planter, so that wider planters can be used. More plants can be planted in a wider planter, thereby maximizing the utility of the planting space and increasing harvest.

In an embodiment, the moveable arm may be configured to retract towards the guide after cutting. This prevents the arm and cutter from colliding with other planters when they move to other planters.

In an embodiment, vertical movement of the cutting station may be through a mechanism selected from the group comprising: electric motor, vertical worm drive, pulley system, a chain drive.

In an embodiment, the cutting station may further comprise a support frame and wheels. The support frame allow for stable operation and easy monitoring of the height adjustment. The support frame may comprise one, two, or more vertical beams connected to the guide. Wheels allow for movement of the cutting station, so that the same cutting station may be easily moved between several sets of vertically spaced planters, thus saving cost, labour and harvest time.

Brief Description of Figures

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Fig. 1 is a side view of a system comprising planters stacked vertically.

Fig. 2 is a side view of the system according to an embodiment of the present invention.

Fig. 3A is a side view of a planter.

Fig. 3B is a top view of the planter in Fig. 3a.

Fig. 4A is a side view of another planter.

Fig. 4B is a top view of the planter in Fig. 4a.

Fig. 4C is a top view of the planter in Fig. 4a with an anchor plate.

Fig. 5A to 5D are top views of examples of cutting stations according to the present invention.

Fig. 6A is a perspective view of a cutting station.

Fig. 6B is a plan view of a cutting station.

Fig. 6C is a perspective view of another cutting station.

Fig. 7 is a side view of planters in vertical spaced arrangement, in which some planters are raised at one end.

Detailed Description

In Figure 1, a plant growth system 1 includes a frame 11 and planters 12 engaged and stacked vertically. The frame 11 contains tracks, indicated by dotted lines. The planters 12 may be spaced apart to accommodate plants of different heights. Nutrient solution is moved upwards 15 from a sump tank 14 by a pump, to the top 10 of the stack of planters, then flow downwards through each planter 12 to the bottom 13. The nutrition is then collected in the sump tank 14 for recirculation. The nutrient supply may flow from above.

Figure 7 shows that the planters may be raised at one end in some instances. In this arrangement, the nutrient solution or water flows from a raised planter end 71 downwards by gravity to the lower planter end 72 where there is an exit spout. This design ensures that the nutrient solution or water flows through the entire length of the planter. There is only one exit point to maintain consistent flow rate and for ease of cleaning.

In Figure 2, a cutting station 20 is attacheable to the frame 11. The cutting station 20 may be moveable to different heights along the frame manually, automatically, or semi-automatically. A worker may control the cutting action remotely from the ground. For example, the cutting station 20 may be moved vertically using an electric motor, and stops at each planter to cut grown plants. Other possibilities include: vertical worm drive, pulley system, or a chain drive. The cutting station can move along the frame to cut plants grown in planters 12 at different

heights, so that a worker does not need to climb up and down to harvest the plants, thus saving labour cost and harvest time. The cutting station can also move along the frame to cut tall plants at different heights, so cut plants into shorter lengths for easy transportation.

Alternatively, the cutting station 20 may be attached to a belt slidable along the frame 11. As the belt slides along the frame 11, the cutting station 20 may be moved to different heights along the frame. The belt may be operated by a pulley mechanism, horizontal worm drive or chain drive.

As shown in Figures 3A and 3B, a planter 31 may be rectangular, or of any suitable configuration. The planter 31 contains drainage holes 30 at its base. These features also shown in Figures 4A and 4B.

In Figure 4C, an anchor plate 34 is placed within a planter. This anchor plate may be attachable to the planter and can be locked in place by engaging complementary notches 35 on the planter. The anchor plate 34 serves as a substrate from which the plants grow and are held in place. Since the plants can grow to a height before being harvested, their weight would be very heavy and risk toppling from the planters without a counter weight holding their roots down.

The cutting station comprises a cutter, such as a blade, and a set of guides configured to allow the cutter to move along the length of the planter to cut all the plants grown in the planter.

Figure 5A shows an example of a cutting station comprising a cutter 51 on a platform. In this example, the cutter contains a chain saw mechanism containing a set of teeth attached to a rotating chain. The cutting station also includes at least one guide 52 engageable with the cutter. The cutter comprises a platform having a blade mounted thereto. The cutter can be moved

horizontally 53 along the planter 54. The guide can move vertically along the frame 55 to different heights. The guide may span along the length of the planter or extend beyond the dimensions of the planter for better coverage. The guide may be a horizontal rail, a guide rail, slotted plate, or rack and pinion. Alternatively, the cutter may be a strimmer wire. It is cheap to replace strimmer wires. Strimmer wires are also easy to maintain because there is no need for sharpening, unlike a knife blade.

Figure 5B shows a cutting station comprising a rotating blade 56. The blade spins at a high speed as it moves 57 along the planter. The system can contain at least one web 58 for catching and funnelling the cut plant matter into a chute (not shown) for collection. This web and chute may move vertically along the frame. Although the blade is shown to be mounted on top of the guide, the blade can also be mounted below the guide in a different arrangement of the embodiment. Plant matter may comprise leaves, stems, roots, fruits, flowers, and other plant material. The plants may also be vegetables. The plant matter may be delicate plant material.

Figure 5B shows an example of guides comprising a plurality of segments. The guides may comprise a short segment 59 where the cutting mechanism docks when not cutting plants, and a long segment 600 positioned at a fixed height. The short segment 59 is moveable along the frame, while the long segment 600 is stationary. When the short segment 59 stops at the same height as a long segment, it attaches to the long segment 600 so that the cutting mechanism can move across the planter to cut plants. After cutting plants, the cutting mechanism can return to the short segment 59, or stop at another short segment 610, before moving to the next planter. Therefore, the plants may be cut from the same side of the planter, or from the opposite side of the planter.

Figure 5C shows a cutting station comprising a different rotating blade 71. Since the weight distribution on the front and back of the cutting station are unequal, a counter weight 72 may be attached to the system to ensure even weight distribution, reduced vibration, and smoother operation of the cutter. In this embodiment, the guide is positioned on one side of the system.

The blade may move at an angle to the guide to cut the plants for harvest. For example, Figure 5D shows two shears 73 moving towards each other to apply shear forces on the plants like a secateurs or pruning clippers. The shears move in the general direction 74 along the planter to cut all the plants.

Figure 6A shows an example of a cutting station that can be used on a plurality of vertical frames. This cutting station may have motorised height adjustment, such as through a forklift mechanism. A cutter 66 may move 65 across a planter, along a cutting beam 64 mounted on a pair of vertical beams 61. The cutting beam 64 may be raised 62 or lowered 63 along the vertical beams 61 to reach planters of different heights. For planters that are shorter (1 to 2 metres in length), one vertical beam may be used to hold the cutting beam securely. For longer planters (2 to 4 metres, or more), the cutting beam may be longer so two vertical beams can be used to provide better stability. The cutter can take many designs, such as serrated blades (saw mechanism), spinning strimmer plastic lines, rotating blades, etc. If the cutter has a spinning mode of cutting, the cutting action will depend on the length of the blade or the strimmer wire length. Alternatively, the cutter may be a serrated blade with a sawing motion, or a mini moving chainsaw where it moves like a chainsaw where the cutting teeth on a chain moves around a chainsaw blade.

This cutting station may have wheels 67 for moving between frames, so that only one unit is needed to cut and harvest multiple sets of vertically spaced planters, thus reducing space and capital investment on these cutting stations.

During operation, the cutting beam first moves to the desired height just above the first planter, the cutter starts from one end, to cut at the plant base using the attached cutter. At the end of harvesting the planter, the cutter stops and moves to one end of the cutting beam. After the plants are harvested, the cutting beam moves up to the next planter and repeats the process until the entire vertical frame of planters are completely harvested. If there is only one vertical planter frame in the greenhouse, the cutting beam can be attached to the tracks (dotted lines) on each side of the vertical frame (labelled as 11 in Figures 1 and 2). After harvesting, the cutting beam may raise to a new height, and cut plants at the new height. In another embodiment, the cutting station may attach to the frame, cut plants grown in a planter, detach from the frame, reattach to the frame to cut plants grown in another planter or the opposite side of the planter. In this way, the plants may be harvested from both sides of the vertical frame.

Figure 6C shows a cutting station comprising a cutter attachable to a retractable arm 69 that may extend from its position towards the planter, and then start cutting as the cutter moves along the planter. When finished, the entire arm with the cutter retracts back to the start position so that the cutting beam can move to a new height without the cutter colliding with the planter, vertical beam, or frame. This system with a retractable arm is beneficial when the planter has a wide footprint because the arm enables the cutter to reach across the planter for cutting.

The system may further include a blower (not shown) configured to blow cut plant matter out of the planters, for easy collection at ground level. This blower may positioned at one end of

the cutting station, and moveable vertically along the frame. Plant matter may comprise leaves, stems, roots, fruits, flowers, and other plant material. The plants may be vegetables.

The system may further include a sweeper configured to sweep cut plant matter out of the planters. This may work in isolation or with the blower. The sweeping mechanism may contain brushes moving in a curve. The brush bristles may be stiff or soft, depending on the plant matter. The sweeper may be coupled to the cutting station to sweep plant matter right after the plants are cut. Alternatively, the sweeper can move horizontally twice (back and forth) across the planter after the cutter has moved once across the planter. The sweeper is also moveable vertically along the frame.

Alternatively, a shaking or vibrating mechanism may be used to move plant matter out of the planters.

In addition, the system may further include shock absorbers 21 to dampen vibration. The shock absorbers may operate like an engine mount to reduce shaking of the cutting station and frame. This could ensure safety during operation, reduce noise level, increase the durability of the system, and increase efficiency of the cutting process.

It will be appreciated that the features of the various embodiments may be combined to create different systems. The cutting station may be interchangeable and replaceable during operation as needed.

The type of plants used in this system include sugar cane and other tall and fibrous plants for biomass. It will be appreciated that other types of plants are also applicable, such as flowers

for aesthetic appeal, edible vegetables or fruit. The cutting station enables fast, easy and safe harvest of the plants grown in the planters.

Claims

1. A planting system, the system comprising:

   a frame;

   a plurality of planters spaced vertically within the frame, each planter arranged to receive one or more plants; and

   a cutting station moveable vertically along the frame to cut plants in planters positioned at different heights.

2. The system according to claim 1, wherein the cutting station comprises a guide and a cutter engageable with the guide and moveable along the guide.

3. The system according to claim 2, wherein the cutter is selected from the group comprising: rotating blade, rotating chain with teeth, curved blade, shears, secateurs, strimmer wires.

4. The system according to any one of claims 1 to 3, wherein vertical movement of the cutting station is through a mechanism selected from the group comprising: electric motor, vertical worm drive, pulley system, a chain drive.

5. The system according to any one of claims 1 to 4, further comprising a counter weight to stabilize the system.

6. The system according to any one of claims 1 to 5, further comprising shock absorbers to dampen vibration.

7. The system according to any one of claims 1 to 6, further comprising a sweeper and/or blower configured to push cut plant matter out of the planters.

8. The system according to any one of claims 1 to 7, further comprising a web to catch cut plant matter.

9. The system according to any one of claims 1 to 8, further comprising a chute to collect cut plant matter.

10. A method of harvesting plants, the method comprising the step of:
moving a cutting station vertically along a frame to cut a plurality of plants in planters spaced vertically within the frame.

11. The method according to claim 10, wherein the cutting station comprises a guide and a cutter engageable with the guide, and the method further including the step of moving the cutter along the guide.

12. The method according to claim 10 or 11, further including the step of sweeping and/or blowing away cut plant matter out of the planters.

13. A cutting station for cutting plants in a plurality of planters spaced vertically, wherein the cutting station is moveable vertically to cut plants in planters positioned at different heights.

14. The cutting station according to claim 13, wherein the planters are vertically spaced within a frame, and the cutting station is moveable vertically along the frame.

15. The cutting station according to claim 13 or 14, wherein the cutting station comprises a guide and a cutter engageable with the guide and moveable along the guide.

16. The cutting station according to claim 15, wherein the cutter is selected from the group comprising: rotating blade, rotating chain with teeth, curved blade, shears, secateurs, strimmer wires.

17. The cutting station according to claim 15 or 16, further comprising a moveable arm connecting the cutter to the guide, the arm configured to extend to cut plants further from the guide.

18. The cutting station according to claim 17, wherein the arm is configured to retract towards the guide after cutting.

19. The cutting station according to any one of claims 13 to 18, wherein vertical movement of the cutting station is through a mechanism selected from the group comprising: electric motor, vertical worm drive, pulley system, a chain drive.

20. The cutting station according to any one of claims 13 to 19, further comprising a support frame and wheels.