

ROTATING MULTI-TIER RACK SYSTEM FOR AGRI/HORTI CULTURAL USE

TECHNICAL FIELD OF THE INVENTION

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This invention relates to a multi-tier rack system wherein the racks are used to grow agricultural and horticultural produce, the racks having been laid with portable planting beds, are rotatably movable upwards and downwards for sunlight, watering, maintenance and harvesting.

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BACKGROUND OF THE INVENTION

In land scarce city states like Singapore, competition for limited land space has driven the cost of land upwards. Land, being expensive, has been diverted from agricultural use to more valuable commercial and housing use. In the meantime, there remains a need for fresh vegetables and agricultural produce to be grown and harvested even in Singapore to meet local demand. To make economic sense, the agricultural produce grown must be high cash yield and be turned around quickly.

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Singapore's approach to utilize scarce land resources is to develop the land upwards. Hence, housing and office buildings alike, are built upwards. Attempts have been made to grow agricultural produce by use of hydroponics. Although hydroponics is efficient in a land scarce country, it is still not efficient use of land. There is therefore a need to grow agricultural produce upwards in order to utilize land resources more efficiently.

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There is also a trend worldwide towards growing organically herbs and vegetables without use of fertilizers and insecticides. Regular and close supervision of organically grown herbs and vegetables is also required to ensure such produce could be certified as organically grown. This can be achieved due to use of earth on elevated rack and does not attract crawling insects once it is treated.

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The inventor has come up with a solution to grow high cash value agriculture and/or horticulture produce with high yields per unit area as well as offering easy maintenance with less manpower as in normal farming operations. Such a solution would also be suitable for growing organic herbs and vegetables.

There have been patents directed at improving yields of agricultural produce. All these patents work on the premise of availability of land.

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There are also patents directed at automated crop production systems which aimed to achieve high agricultural yields in urban centers. US 6,243,987 describes a fully automated self contained farm using a closed unit such as a container, having within the closed unit, a seeding and germination zone, planting and growth zone and a zone for holding automatic seedling, planting and harvesting equipment. Since it is self-contained, the system has ancillary systems such as irrigation system, water conditioning system, system for regulating oxygen/carbon dioxide balance, system for regulating relative humidity, lighting system and a temperature control system. JP 2001 346450 describes another approach using a multistage nursery chamber with multistage shelves for growing seedlings equipped with artificial illumination system, air conditioning system, watering apparatus and the like in a closed space to automatically perform uniform watering in a small volume to grow uniform high quality seedlings. Also disclosed is a method of sprinkling water that inhibits the seedlings from extending their roots out of the shelves.

It is an object of the invention to provide a multi tier system for growing high yield agricultural and horticultural produce with fast turnover in land scarce environment. Another object is to have improved supervision of the growing of agricultural produce without having too many workers like a typical farm.

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SUMMARY OF THE INVENTION

The invention, in general terms, is to provide a multi-tier system of racks
5 containing portable planting beds for intensive cultivation using less
manpower and less land resources. These racks are suspended
horizontally and can be moved upwards for sunlight, watering, dosing
of chemicals and liquid fertilizers. These racks can also be moved
10 downwards to waist level, for maintenance, de-weeding, removal of
mature agricultural or horticultural produce in the portable planting beds
for harvesting and replacement with fresh planting beds.

A first object of the invention is a rotating multi-tier rack system for
agricultural and horticultural use, the system consisting of: -

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a first and second vertical metal support, each vertical metal support
mounted on a steel base plate fixed on a concrete floor or footing at
one end on the ground, and spaced apart;

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a horizontal beam connected to a top of the first and second
vertical metal support;

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a first roller chain, going round a bottom first sprocket of the first
vertical metal support, along the inner web of the first vertical metal
support, to a top second sprocket and back to the bottom first
sprocket;

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a second roller chain, going round a bottom third sprocket of the
second vertical metal support, along the inner web of the second
vertical metal support, to a top fourth sprocket and back to the
bottom third sprocket;

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a plurality of racks, each rack having a first vertical side connected
to the first roller chain by attachment means and a second vertical
side connected to the second roller chain by attachment means, the

racks suspended horizontally by said attachment means;

wherein portable planting beds are laid on the racks and the racks are rotated upwards and downwards for maintenance, watering, dosing of fertilizers, exposure to sunshine and harvesting of the portable planting beds.

Advantageously, the attachment means consists of a first rack arm, with a head and a bifurcated foot, said head of the first rack arm connected to a first spacer which fits perpendicularly into a hole in the top of the first vertical side of the rack thereby suspending the rack in a horizontal position and said bifurcated foot of first rack arm having a plurality of holes for the first roller chain movement, each hole fitting into a rivet pin on the roller chain, said rivet pins pulling the rack arm in the direction of movement of the roller chain.

Advantageously, the first roller chain is shielded by a first rack arm guide and chain guard, which is installed along the inner web of the first vertical metal support, the first rack arm guide and chain guard joined to a first vertical metal support by a first chain guard supporting plate.

Advantageously, the second roller chain is shielded by a second rack arm guide and chain guard, which is installed along the inner web of the second vertical metal support, the second rack arm guide and chain guard joined to the second vertical metal support by a second chain guard supporting plate.

Advantageously, the rack arm has a bifurcated foot with a roller guide stabilizer on each side of the bifurcated foot, said roller guide stabilizer in contact with the rack arm guide and chain guard.

Advantageously, the rack has a rectangular base and a vertical first side at one end and a vertical second side at the other end, the rectangular base having a V shaped upper surface, in cross section

along its width, with a first drainage hole at the end of the vertical first side and a second drainage hole at the end of the vertical second side for drainage of excess water flowing from the portable planting beds.

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Advantageously, the rack has a rectangular base for laying of blocks of portable planting beds, for horticultural and/or horticultural use.

10 Advantageously, the rotating multi-tier rack system has a motor with speed control, a gear mechanism, a first bottom and a first top sprocket on the inner web of the first vertical metal support, a second bottom sprocket and a second top sprocket on the inner web of the second vertical metal support, an axle between the first bottom sprocket and
15 second bottom sprocket, wherein the racks are moved upwards and downwards by movement of first roller chain and second roller chain, the first roller chain being turned by the motor and the gear mechanism and the second roller chain being turned by the motor and the axle.

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Advantageously, the one or more roller chains are mounted on one or more bottom sprockets and one or more top sprockets of the inner web of the first vertical support.

25 Advantageously, the one or more roller chains are mounted on one or more bottom sprockets and one or more top sprockets of the inner web of the second vertical support.

Advantageously, the number of racks can be adjusted to suit the type
30 of agricultural and horticultural produce grown on the racks.

Advantageously, the horizontal beam has a water pipe with a spraying system.

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BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention which is a rotating multi-tier
5 rack system for commercial use will now be described, by way of
example, with reference to the accompanying drawings.

Figure 1 is a front view of the rotating multi-tier rack system for
10 agri/horti cultural use according to the invention.

Figure 2 is a side view of the rotating multi-tier rack system for
agri/horti cultural use according to the invention.

Figure 3 shows a perspective view of the rotating multi-tier rack system.

15 Figure 4 shows a cross section view of the lower portion of the first
vertical metal structure with the gear/axle mechanism (motor not shown).

Figure 4A shows a section of the lower portion of the rotating multi-tier
20 rack system taken along the axis T1 – T1.

Figure 4B shows a detailed section of the rack arm, roller guide,
stabilizer and supporting plate.

25 Figure 5 shows a cross section of the upper portion of the second vertical
metal support.

Figure 5A shows a section of the adjustable sprocket seating on the
lower portion of the second vertical metal support taken along the axis
30 Y – Y.

Figure 5B shows a section of the upper portion of the second vertical
metal support taken along the axis X – X.

35 Figure 6 shows detailed side cross sectional side view of a tray pivotally

suspended from a rack arm, looking from the first support.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

5 For purpose of illustration of the invention, the system described herein refers to a rotating multi-tier rack system for agricultural/horticultural for commercial use. The invention can be suitably scaled down for use in domestic or school environments.

10 Figure 1 is a front view of the rotating multi-tier rack system for agricultural/horticultural use according to the invention. Fig. 2 is a side view of the rotating multi-tier rack system.

The rotating multi-tier rack system consists of two vertical metal
15 supports 1, 10, with the bottom of each vertical metal support fixed on a steel base plate and anchored onto concrete floor or footings in the ground. The first vertical metal support 1 and second vertical metal support 10 are spaced apart and connected at the top by an elongate horizontal beam 35. A motor 60 is installed at the lower
20 portion of the outer web 2 of the first vertical metal support. The motor 60 has speed controls to turn an gear/sprocket/axle mechanism which in turn moves a first roller chain 5 installed on the inner web 3 of the first vertical metal support and a second roller chain 14 installed on the inner web 12 of the second vertical metal support.

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The first roller chain 5 goes all the way up alongside the inner web 3 of the first vertical metal support, round a first top sprocket 47 on an adjustable sprocket seating 51 located near the top of the first vertical metal support 1 and down to the first bottom sprocket 46 at the
30 lower portion of the first vertical metal support 1. Likewise, the second roller chain 14 goes all the way up alongside the inner web 12 of the second vertical metal support, round a second top sprocket 49 on an adjustable sprocket seating 51 located near the top of the second vertical metal support 10 and down to the second bottom sprocket
35 48 at the lower portion of the second vertical metal support 10. The

first and second roller chains 5, 14 are protected on both sides by a chain guard/rack arm guide 52, 53, for safety reasons and to guide and stabilize the rack arm.

5 Affixed rigidly to the first roller chain 5 are attachment means for racks consisting of first rack arms 20A, 20B, etc spaced apart along the first roller chain. Affixed rigidly to the second roller chain 14 are attachment means consisting of second rack arms, 24A, 24B etc spaced apart along the second roller chain, aligned in corresponding positions
10 to the first rack arms, 20A, 20B, etc along the first roller chain.

A rack 20A is suspended horizontally from a first spacer 22 on the first rack arm 21A affixed on the first roller chain and from a second spacer 26 on the second rack arm 25A on the second roller chain. The first
15 spacer 22 is pivotally connected to the head 23 of the first side of the first rack 21 and the second spacer 26 is pivotally connected to the head 27 of the second side of the second rack arm 25.

A motor 60 (with speed control) is installed at the lower portion of the
20 outer web 2 of the first vertical metal structure to move a gear/sprocket/axle mechanism which in turn rotates the first roller chain 5 to bring the racks 20A, 20B etc upwards to the top of the rotating multi-tier rack system and then to bring the racks downwards. The axle 45 is connected to the second roller chain 14 which rotates
25 passively when the axle turns.

Referring to Figure 2 which is a side view of the rotating multi-tier rack system, it can be seen that the system has a plurality of racks 20A, 20B, etc suspended between the first roller chain 5 and second roller
30 chain 14. The rack 20A, 20B etc is connected pivotally to the first spacer 22A, 22B etc on the first rack arm 21A, 21B etc on the first roller chain 5 and to the second spacer 26A, 26B etc on the second rack arm 25A, 25B etc on the second roller chain. By virtue of the operation of the first pivotal connections 31A, 31B etc and second pivotal connection 32A,
35 32B, all racks 20A, 20B etc would remain in a horizontal position

irrespective of their position in the rotating multi-tier rack system. Therefore, the top rack facing the horizontal beam 35 and the bottom rack (at waist level) would remain in a horizontal position. This would ensure the racks 20A, 20B etc are not tilted nor unbalanced causing
5 accidental dumping of the contents from the rack. Upon rotation of the multi-tier rack system, each rack 20A, 20B etc can be brought down to the waist height of maintenance personnel for easy maintenance activities such installation of portable planting beds, weeding, loosening the soil near ground and other maintenance activities. After the
10 agriculture plants in the portable planting bed on the rack have been attended to, the rack can then be rotated upwards allowing another rack to be brought down for maintenance activities.

Figure 3 shows a perspective view of the rotating multi-tier rack system
15 from the front. Each rack 20A, 20B etc. has a first vertical side 29A, 29B etc facing the inner web 3 of the first vertical metal structure and a second vertical side 30A, 30B, etc facing the inner web 12 of the second vertical metal structure. Each rack 20A, 20B etc has a water collector 41A, 41B etc in the shape of a v shaped base (in cross section
20 along its width) with a first drainage hole 42 at the first end of the v shaped base and a second drainage hole 43 at the second end of the v shaped base. The rack 20A, 20B etc contains blocks of portable planting beds 40 for growing agricultural or horticultural produce. The blocks of portable planting beds 40 would allow easy removal of each
25 portable planting beds 40 from the rack 20A, 20B etc. All blocks of planting bed can then be removed from the rack (for subsequent harvesting) while the racks can be immediately replaced with fresh blocks of portable planting beds of a different type of agricultural produce. The portable planting beds 40 are constructed of durable
30 plastic which is known in the art. The use of blocks of portable planting beds would also facilitate easy laying onto the racks, during transplanting of seedlings from a nursery since the seedlings are already planted in the same blocks.

35 Once a rack 20A has been laid with blocks of portable planting beds,

the rack 20A would be moved upwards for the next rack 20B to be laid with blocks of portable planting beds. It should be noted that although different types of agriculture can be seen, it is up to the users to decide on the type of agriculture to be grown on the racks. As the
5 rotating multi-tier rack system is installed in outdoors, the amount of sunshine for each rack 20A, 20B etc could be regulated by moving the racks periodically.

The horizontal beam 35 has a watering pipe with spray system 61
10 whereby the rack 20 at the top of the rotating multi-tier rack system can be given sufficient water. Wastage of water and the construction of an extensive and costly watering system normally required for a normal farm is thereby avoided.

15 Figure 4 shows a cross section of the lower portion of the first vertical metal structure with the gear/axle mechanism (motor not shown). Figure 4A shows a cross section of the adjustable gear axle seating located at the lower portion of the rotating multi-tier rack system, the view taken along the axis T1 – T1. Figure 4B is a close up of cross section of
20 the bifurcated foot 24 of the rack arm with a roller guide/stabilizer 55 on each side of the bifurcated foot. The bifurcated foot 24 runs within the roller chain guard/rack arm guide 51. Slight swinging movements of the rack 20 could move the rack against the roller chain guard/rack arm guide. In order to absorb the force of the rack moving towards the roller
25 chain guard/ rack arm guide without damaging it, the bifurcated foot 24 of the rack arm 20 has a roller guide/stabilizer 55 on each side, to absorb the force and also to assist in the movement of the rack arm.

The first roller chain 5 is shielded substantially along its entire length
30 by a first chain guard/rack arm guide 52. The first chain guard/rack arm guide 52 is bolted to the inner web 3 of the first metal vertical support by a first chain guard supporting plate 57. Rack arms 21A, 21B etc are spaced lengthwise along the first roller chain 5. A first rack arm roller guide/stabilizer 55A, 55B etc is affixed to each foot of
35 the first rack arm 21A, 21B etc to ensure smooth movement of the rack

arms 21A, 21B etc along the entire length of the first roller chain 5. Adjustments can be made to the rotating multi-tier rack system e.g. to level the two bottom sprockets 46, 48 by adjustment of the adjustable gear axle seating 50.

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Figure 5 shows a cross section of the upper portion of the second vertical metal support with the adjustable sprocket seating. (The view of the upper portion of the first vertical metal structure is identical as therefore would not be shown.) Figure 5A shows a cross section of the adjustable sprocket seating on the lower portion of the second vertical metal support detail, the view taken along the axis Y – Y. Figure 5B shows a section of the upper portion of the second vertical metal support along X – X showing the sprocket seating and sprocket.

15 The second roller chain 14 is also shielded substantially along its entire length by a second chain guard/rack arm guide 53. The second chain guard/rack arm guide 53 is bolted to the inner web 12 of the second vertical metal support by a second chain guard supporting plate 58. Rack arms 25A, 25 B etc are spaced lengthwise along the second roller chain 14. A second rack arm roller guide/stabilizer 53 is affixed to the bifurcated foot of the second rack arm 24A, 24B etc to ensure smooth movement of the rack arms along the entire length of the second roller chain 14. Adjustments can be made to the rotating multi-tier rack system e.g. to level and tensioning of the sagging roller chains by adjustment of the adjustable sprocket seating 51. The number of racks can similarly be adjusted depending on the type of agriculture or horticulture grown by spacing out the rack arms 21, 25.

Figure 6 shows detailed side cross sectional side view of a rack 20 pivotally suspended from a first rack arm 21. The first vertical side 29 of the rack faces the inner web 3 of first vertical metal support and a second vertical side of the rack 30 faces the inner web 12 of the second vertical metal support. The first vertical side of the rack 29 is pivotally connected by a first pivotal connection 31 to a first spacer 22 on the rack arm, and the second vertical side of the rack 30 is also

- similarly pivotally connected by a second pivotal connection 32 to a second spacer 26 on the second vertical side of the rack, the first rack arm 21A, 21B etc spaced apart on the length of the first roller chain 5 and the second rack arm 25A, 25B etc spaced apart on the length of the second roller chain 14. The first rack arm 21A, 21B etc and the second rack arm 25A, 25B are arranged at the same distance along the first and second roller chains so that the rack is held in a horizontal position.
- 10 The first roller chain 5 has rivet pins 33 which fits into the holes 34 in the bifurcated foot of the rack arm. Once the rivet pins 33 fit into the holes, the rack arm would be pulled by the roller chain thus enabling the rack to move in the direction of the movement of the chain.
- 15 The bifurcated foot 28 of the second rack arm has a roller guide/stabilizer 55 on each side of the bifurcated foot. The bifurcated foot 24 runs within the roller chain guard/rack arm guide 52. Slight swinging movements of the rack 20 could move the rack against the roller chain guard/rack arm guide 52. In order to absorb the force of the rack moving towards the roller chain guard/ rack arm guide without damaging it, the bifurcated foot 24 of the rack arm 20 has a roller guide/stabilizer 55 on each side, to absorb the force and also to assist in the movement of the racks.
- 25 The first rack arm guide/chain guard 52 and second rack arm guide/chain guard 53 shields the first and second roller chain 5, 14 so as to prevent the hands of maintenance personnel from sliding into the roller chains. The first and second rack arm guide/chain guards 52, 53 are in turn bolted to the first and second vertical metal support 1, 10 by the first and second guard supporting plates 57, 58 which is welded to the vertical support 1, 10. To ensure the first rack arms 21A, 21B etc stays within the first rack arm guide/chain guard 52, and remains connected to the first roller chain 5, first rack arm roller guide stabilizers 55 are affixed to the first rack arm 21A, 21B etc. Similarly, to ensure the second rack arm 25A, 25B etc stays within the second rack arm guide/chain guard

53 and remains connected to the second roller chain 14, second rack arm roller guide stabilizers 58A, 58B etc are affixed to the second rack arm 24A, 24B etc.

5 Since the top of the first vertical side 29 of the rack is pivotally connected by the first spacer 22 to the head 23 of the first rack arm 21 and the top of the second vertical side of the rack 27 is pivotally connected by the second spacer 25 to the head 27 of the second rack arm 24, the rack would always be maintained in a horizontal position
10 irrespective of its position in the rotating multi-tier rack system.

The bottom cross section of the rack serves as a water collector 41 and is v shaped (in cross section along its width), with a first drainage hole 42 at the first vertical side of the rack and a second drainage 43 hole
15 at the second vertical side of the rack. This is to allow excess water (flowing down from the planting bed) to drain off the rack. The rack contains blocks of portable planting beds, for growing agricultural or horticultural produce. In Figure 6, the portable planting bed 40 is quite deep and would allow planting of vegetables or herbs. The portable
20 planting bed 40 can also be shorter for example, for planting of carpet grass or wheat grass which are short plants with relatively short roots. The use of blocks of portable planting beds 40 is to facilitate easy removal of the entire portable planting beds on each rack when the plants are ready for harvesting. The blocks of portable planting beds
25 are removed from the racks in its entirety so that the harvesting can be done elsewhere. The racks can then be immediately utilized for planting of a different type of agricultural produce by laying of blocks of portable planting beds of other types, using seedlings already growing on planting beds prepared in a nursery.

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When fresh blocks of portable planting beds are laid on the racks, these are arranged onto the racks in rows, again to facilitate easy removal at time of harvesting. The use of blocks of portable planting bed would also mean less manpower is taken up to remove the
35 portable planting beds.

Having described the various components of the remote maintenance monitoring system, an operational cycle of the multi-tier agricultural/horticultural system is described herein with reference to the
5 Figures.

Referring to Fig. 1, an empty rack 20A is moved downwards to the lowest level for laying of blocks of planting beds of agriculture or horticulture. At the lowest level, the rack 20A is approximately waist
10 height, thus allowing easy transfer of planting beds onto the rack 20A. The use of blocks of planting beds would mean that the racks are kept relatively clean, so that different types of agriculture and different types of horticulture could be grown without fear of cross-contamination of pesticides or fertilizers. Once the planting beds are
15 laid, the rack 20A is then moved upwards. This is done by switching on the motor at the side of the first metal vertical support. By moving the rack upwards, the next rack 20B can then be brought into position (at waist height) for laying of another row of portable planting beds. This goes on until the racks are all laid with portable
20 planting beds.

Since the rotating multi-tier rack system is installed outdoors, and being built vertically, there is a possibility that some racks would not get direct sunlight for long period while those near the top would get
25 direct sunlight most of the time. To avoid this, the racks are moved periodically upwards or downwards, by starting the motor (with speed controls) to rotate the roller chains 5, 14. By virtue of the first and second pivotal connection 31, 32 on each side of the rack to the spacer 22, 26 connected to first rack arm 21 and second rack arm 25 on
30 each side of the roller chain, the rack is always suspended horizontally. When the racks 20A, 20B etc are moved upwards, the watering pipe with spraying system 61 installed on the horizontal beam 35 at the top of the rotating multi-tier rack system is turned on periodically to water the top most rack. Excess water would flow
35 along the v shaped water collector 41 at the bottom of the rack and

this is drained off eventually through the first and second drainage holes.

While the top most rack is being watered, and the racks higher up are getting sunshine, maintenance work e.g. de-weeding, checking of the health of plants, checking of soil conditions could be carried out for the lowermost rack. An arrestor hook (not shown in the figures) is provided at front corner of the rack to secure the rack when it is at waist height, to minimize movement of the lower most rack when working on it.

With its speed controls, the motor 60 can bring the racks upwards or downwards faster or just move the racks, one at a time. Should the motor fail, the rotating multi-tier rack system has provision for manual rotating of the racks. This would avoid the racks being kept in one position for too long, thereby causing damage to the agriculture or horticulture planted on the planting beds.

Fig. 4 shows the safety features for use of the roller chain. The chain guard/rack arm guide 52, 53 running substantially along the width of the vertical metal support 1, 10 shields the roller chain 5, 14 so as to protect external objects from getting into the roller chain 5, 14 and top sprocket 47, 49 and bottom sprocket 46, 48. The chain guard/rack arm guide 52, 53 also prevent hands of maintenance personnel from getting into the path of the roller chains 5, 14 when the roller chains are moving.

The motor 60 turns the gear 46 and bottom sprocket 46 mechanism to move the first roller chain 5 to move the first rack arms 21A, 21B etc. etc on the first roller chain. The gear 46 also turns the axle 47 to move the second bottom sprocket 48 on the second roller chain 14, so as to move the second rack arms 24A, 24B on the second roller chain.

The racks can accommodate portable planting bed which are quite deep, for planting of vegetables or herbs. Alternatively, the racks can

accommodate portable planting bed which are shallow, for growing of carpet grass or wheat grass. The number of racks within the system can be adjusted for the height of the type of agricultural or horticultural produce grown. Although unlikely, it is conceivable that different
5 types of agricultural and horticultural produce could be separately grown on different trays.

Alternative embodiment

10 The rotating multi-tier rack system described above is a full height system for commercial agriculture and horticulture use, to take advantage of the expansive land costs in a country like Singapore. It can be fitted with one or more roller chains on each inner web as appropriate to meet the weight requirements of the agricultural produce
15 grown on the racks.

The rotating multi-tier rack system can be scaled down to be installed in schools and condominiums, for domestic use. For domestic installations, the number of racks and length of chain roller
20 would be lesser and the height and width of the system reduced. Consequently, the length and size of the racks would also be reduced to suit use in domestic installations.

While the invention has been described with respect to one preferred
25 embodiment, it will be appreciated that this is set forth merely for purposes of example, and that many variations, modifications and applications of the invention may be made therein by one skilled in the art without departing from the scope of the invention as defined in the appended claims.

30 **ADVANTAGEOUS EFFECTS OF THE INVENTION**

The use of multi-tier system of racks allows the growing of agricultural and horticultural produce in a efficient manner where land costs are expensive. Rotation of the racks ensures all racks receive
35 sunlight and water and liquid fertilizers adequately. Rotation of the

racks would also allow maintenance of the plants, laying of new portable planting beds, removal of mature portable planting beds for harvesting to be carried out easily at waist height of maintenance personnel. The multi-tier system of racks has a watering pipe with spray system at the top to water and provide plant nutrients to the plants when the racks are rotated to the top. Wastage of water and the construction of an extensive and costly watering system normally required for a normal farm is thereby avoided. The mulit-tier system of racks once treated does not attract insects since these are elevated. The mulit-tier system of racks would also require less manpower than a normal farm with land spread horizontally.

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CLAIMS

1. A rotating multi-tier rack system for agricultural and horticultural
5 use, the system consisting of:-

10 a first vertical metal support 1 and a second vertical metal support 10, each vertical metal support mounted on a steel base plate fixed on a concrete floor or footing at one end on the ground, and spaced apart;

a horizontal beam 35 connected to a top of the first and second vertical metal support 1, 10;

15 a first roller chain 5, going round a bottom first sprocket 46 of the first vertical metal support 1, along the inner web 3 of the first vertical metal support, to a top second sprocket 47 and back to the bottom first sprocket 46;

20 a second roller chain 14, going round a bottom first sprocket 48 of the second vertical metal support 10, along the inner web 12 of the second vertical metal support, to a top second sprocket 49 and back to the bottom third sprocket 48;

25 a plurality of racks 20, each rack having a first vertical side 29 connected to the first roller chain 5 by a first attachment means and a second vertical side 30 connected to the second roller chain 14 by a second attachment means, the racks 20 suspended horizontally by said attachment means;

30 wherein portable planting beds 40 are laid on the racks 20 and the racks 20 are rotated upwards and downwards for maintenance, watering, dosing of fertilizers, exposure to sunshine and harvesting of the portable planting beds.

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2. A first attachment means for a multi-tier rack system as claimed in Claim 1 consisting of a first rack arm 21 with a head 23 and a bifurcated foot 24, said head 23 of the first rack arm connected to a first spacer 22 by a first pivotal connection 31, said pivotal connection 31 fitting perpendicularly into a hole in the top of the first vertical side 29 of the rack 20 thereby suspending the rack 20 in a horizontal position and wherein said bifurcated foot 24 of first rack arm has a plurality of holes 34 for movement by the first roller chain 5, each hole 34 fitting into a rivet pin 33 on the first roller chain 5, said rivet pins 33 pulling the rack arm 21 in the direction of movement of the roller chain 5.

3. A second attachment means for a multi-tier rack system as claimed in Claim 1 consisting of a second rack arm 25 with a head 27 and a bifurcated foot 28, said head 27 of the second rack arm connected to a second spacer 26 by a second pivotal connection 32, said pivotal connection 32 fitting perpendicularly into a hole in the top of the second vertical side 30 of the rack 20 thereby suspending the rack 20 in a horizontal position and wherein said bifurcated foot 28 of second rack arm has a plurality of holes 34 for movement by the second roller chain 14, each hole 34 fitting into a rivet pin 33 on the second roller chain 14, said rivet pins 33 pulling the rack arm 25 in the direction of movement of the roller chain 14.

4. A rotating multi-tier rack system as claimed in Claim 1 wherein the first roller chain 5 is shielded by a first rack arm guide and chain guard 52, which is installed along the inner web 3 of the first vertical metal support 1, the first rack arm guide and chain guard 52 joined to the first vertical metal support 1 by a first chain guard supporting plate 57.

5. A rotating multi-tier rack system as claimed in Claim 1 wherein the second roller chain 14 is shielded by a second rack arm guide

and chain guard 53, which is installed along the inner web 12 of the second vertical metal support 10, the second rack arm guide and chain guard 53 joined to the second vertical metal support 10 by a second chain guard supporting plate 58.

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6. A rack arm as claimed in Claim 2 wherein the bifurcated foot 24, 28 of the rack arm has a roller guide/stabilizer 55, 56 on each side of the bifurcated foot, said roller guide/stabilizer 55, 56 in contact with the rack arm guide and chain guard 52, 53.

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7. A rack as claimed in claim 1 having a rectangular base and a vertical first side 29 at one end and a vertical second side 30 at the other end, the rectangular base having a V shaped upper surface, in cross section along its width, with a first drainage hole 42 at the end of the vertical first side 29 and a second drainage hole 43 at the end of the vertical second side 30 for drainage of excess water flowing from the portable planting beds 40.

8. A rack as claimed in claim 1 or 7 wherein the rectangular base can be laid with blocks of portable planting beds 40, for horticultural and/or horticultural use.

9. A rotating multi-tier rack system as claimed in Claim 1 having a motor with speed control 60, a gear mechanism 44, a first bottom sprocket 46 and a first top sprocket 47 on the inner web 3 of the first vertical metal support 1, a second bottom sprocket 48 and a second top sprocket 49 on the inner web 12 of the second vertical meal support 10, an axle 45 between the first bottom sprocket 46 and second bottom sprocket 48, wherein the racks 20 are moved upwards and downwards by movement of first roller chain 5 and second roller chain 14, the first roller chain 5 being turned by the motor 60 and the gear mechanism 44 and the second roller chain 14 being turned by the motor 50 and the axle 45.

10. A rotating multi-tier rack system as claimed in Claim 1 wherein

one or more roller chains are mounted on one or more bottom sprockets 46 and one or more top sprockets 47 on the inner web 3 of the first vertical support 1.

5 11. A rotating multi-tier rack system as claimed in Claim 1 wherein one or more roller chains are mounted on one or more bottom sprockets 48 and one or more top sprockets 49 of the inner web 12 of the second vertical support 10.

10 12. A rotating multi-tier rack system as claimed in Claim 1, wherein the number of racks can be adjusted to suit the type of agricultural and horticultural produce grown on the racks.

13. A rotating multi-tier rack system as claimed in Claim 1, wherein
15 the horizontal beam 35 has a water pipe 61 with a spraying system.

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