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(54) Title: HERBICIDE SPRAYER ASSEMBLY

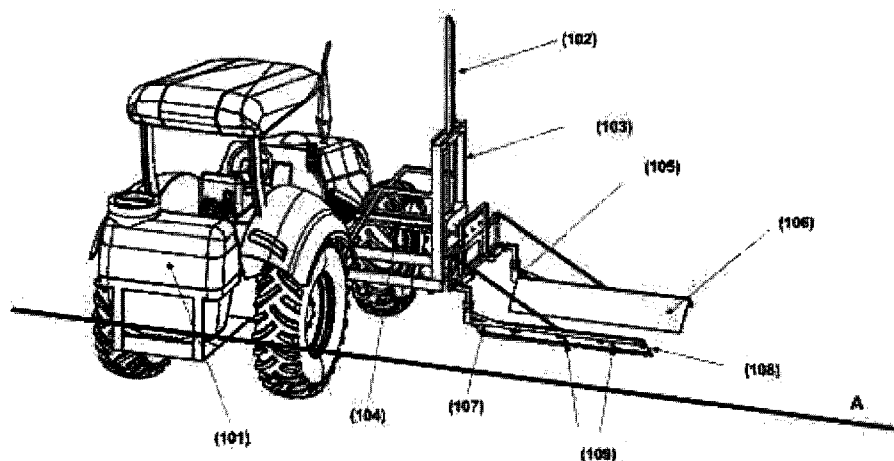


Figure 4

(57) Abstract: The present invention provides an herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicide solution on weeds, comprising at least one container (101) to hold the herbicide solution, at least one pump, a vertical arm frame (102), a main arm frame (103), a horizontal arm frame (104), a right arm frame (105), a right deflector surface (106), a left arm frame (107), a left deflector surface (108), a plurality of nozzles (109), at least one spray hose, a plurality of hydraulic cylinders and at least one hydraulic control lever.



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HERBICIDE SPRAYER ASSEMBLY

FIELD OF INVENTION

- 5 The present invention relates generally to an herbicide sprayer assembly for spraying herbicides solution for weed management purposes.

BACKGROUND

- 10 **The list of prior arts or published information in this specification should not be taken as an acknowledgement that this present invention is common general knowledge or is part of the state of the art.**

Weeds in oil palm are such as grasses, broad-leaf weeds, creeping and woody type weeds, ferns, epiphytes and others. Weed management is important for oil palm growth, hence, the area around the oil palm tree must be free of growth of weeds especially for young palms to ensure the roots are not in competition with the weed. Application of herbicides to control growth of weeds have become common over the years. Weed management is important as weeds can affect the growth of the oil palm trees by reducing its oil yield and growth as the oil palm trees are in competition with the weeds for nutrient, water, sunlight and space to grow. Weeds require substantial amounts of nutrients for growth as well. Good weed control around palms (*Elaeis guineensis* Jacq.) not only aims to reduce nutrients competition between the palms and surrounding weeds but could also facilitate effective fertilising, harvesting, and in-field fresh fruit bunch (FFB), and loose fruit collection-transportation operations in the plantations. The circle for weed control around the base of planted palm tree is usually 1.0 m radius at the time of planting and is gradually expanded to 2.0 m by the time the palm has reached 18 to 24 months. A new machine system has been designed, developed and evaluated for extensive circle spraying of oil palms (*Elaeis guineensis* Jacq.) in an effort to overcome the inefficient spraying problem with the conventional spraying system. The machine system consists of a four-wheeled drive 4WD prime mover with front mounted machine attachments for the circle spraying operation. The configuration of the circle spraying attachment consists of a hexagonal curved spray boom, lifting arm, opening-tilting mechanism unit, storage tank, spray pump, solid cone nozzles, and associate hydraulic system. Field performance tests on the machine system showed an average effective field capacity of 7.89 ha per man per day and when compared to the earlier reported effective field capacity of the walking spray-operated equipment using Serena LT16 knapsack sprayer; a difference of 1.97 time for circle spraying of mature palms grove. Reduction in the human energy expenditure of 101.28 kJ man⁻¹ h⁻¹ or

10.68 % but an increase in the spraying cost of 1.53 USD ha⁻¹ or 24.9 % were obtained with the machine system against the walking spraying-operated equipment using Serena LT16 knapsack sprayer. Justification for machine system to be cost effective could be satisfied if the present effective field capacity is increased to 1.263 time with good skilled operator or if the current R&D cost is reduced to 0.41 time. This is because the improved field capacity of new machine system could not rationalize its current R&D cost. Admittedly, the machine system has great potential to overcome the limitations with the current employed machine/equipment in the circle spraying operation of oil palms in the plantation. This machine is called a 'prime mover', more or less a utility vehicle with multiple attachments and applications. In this case they've equipped it with a 'circle sprayer', with six booms that can open and close around the tree for applying crop protectants such as weed control. **See Figure 1.**

[Source: *Scientia Agricola*, On-line version ISSN 1678-992X, *Sci. agric. (Piracicaba, Braz.)* vol.69 no.2 Piracicaba Mar./Apr. 2012, <https://doi.org/10.1590/S0103-90162012000200002>]

There are many big oil palm plantation groups which are using the Retained Pressure Manual Knapsack Sprayer with the various optional low volume nozzles.

[Source: <https://www.mycrop.com.my/weed-management/>]

The knapsack sprayer is conventional means of spraying herbicides / herbicides management. Most oil palm estates are slowly moving into mechanised means of spraying herbicides on young and mature oil palm trees. However, knapsack sprayers are still required for use at the field for immature oil palm trees. This is because after planting, the oil palm fronds will be close to the ground and hence not accessible for machines to drive through the paths for spraying purposes.

The ATTILA by RB Spray Tech Sdn. Bhd. is a spinning disc sprayer for the controlled droplet application of herbicides. [Source: <https://www.rbspraytech.com/our-products/handheld-cda-sprayers/atila-cda>]. **See Figure 2.**

Another type of herbicide sprayer machine currently used in the oil palm estates is as per **Figure 3.**

Chinese Utility Model CN212753947U describes a medicament application technology field, claims an agricultural herbicide spraying device, comprising a motor; a nozzle and a bottom plate; the output end of the motor is fixedly connected with the first bevel gear; the first bevel

gear is engaged with the second bevel gear; the lower side of the motor is fixedly connected with the mixing box; the left side of the mixing box is provided with a feeding port; the lower side of the mixing box is fixedly connected with the bottom plate; the right side of the upper end of the bottom plate is fixedly connected with a vertical plate; the left side of the vertical plate is fixedly connected with the second liquid outlet pipe; the right end pipeline of the second liquid outlet pipe is connected with the spraying frame; the left end pipeline of the second liquid outlet pipe is connected with the cylinder body; the left side pipeline of the cylinder body is connected with the first liquid outlet pipe; the left side of the first liquid outlet pipe is embedded in the mixing box; the lower side of the cylinder body is fixedly connected with the bottom plate; the inner wall of the cylinder body is slidingly connected with the piston. The utility model has simple structure, using mechanical structure to implement mixing and extruding spraying process of the herbicide, saving the administration time, and convenient to move, greatly reducing the physical strength of the worker, with available value in the medicine application technology field. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

Chinese Utility Model CN212728568U describes a chemical herbicide spraying device for forestry, comprising a spraying box, spraying box front side surface and left and right two side surfaces are respectively fixedly connected with vertical slide rail in the vertical direction; the vertical slide rail is slidingly installed with a vertical electric sliding cylinder, and each side of the spraying box surface is provided with two vertical electric sliding cylinder; the vertical electric sliding cylinder is located on the same horizontal height; the side surface of the vertical electric sliding cylinder is fixedly connected with a transverse sliding rail; the transverse sliding rail is surrounded on the front side of the spraying box and left and right two side surfaces; and two ends of the transverse sliding rail are respectively fixedly connected with a limiting block; the transverse sliding rail is slidingly installed with a transverse electric sliding cylinder; the outer side surface of the transverse electric sliding cylinder is fixedly connected with a spraying pipe; the outer side surface of the spraying pipe is fixedly installed with a nozzle; the lower part of the spraying box is fixedly connected with a liner; the right side in the liner is fixedly connected with a connecting pipe; the middle part of the connecting pipe is fixedly installed with a water pump. The utility model realizes spraying chemical herbicide in multiple directions; it saves time and labour; and the spraying range is wider; the effect is better and the practicability is strong. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

Chinese Utility Model CN212660930U claims a forestry chemical herbicide spraying device, belonging to the technical field of forestry treatment, comprising a base, the upper end of the

base is fixedly embedded with a medicine mixing tank, the medicine mixing tank is provided with a double-layer filter screen cloth, the inner side of the double-layer filter screen cloth is equipped with a mixing medicine mixing frame; the lower end of the medicine mixing tank is connected with a medicine conveying pump; two ends of the medicine conveying pump are
5 connected with a medicine conveying pipe; the front end of the medicine conveying pipe is connected with a spraying machine; the lower end of the spraying machine is connected with a medicine spraying disc. The utility model has novel design, convenient operation and good use effect; it can perform self-dispensing, and the dispensing speed is fast; the medicine is fully mixed enough, improving the dissolving rate of the medicine, and can uniformly spray
10 weeding agent in large area, improving the working efficiency; it also can fully filter the medicine slag generated after finishing the solid medicine dispensing, preventing the dregs from blocking the spraying hole. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

15 *Chinese Utility Model CN212260263U* claims a herbicide uniformly spraying device, comprising a bearing bottom plate; the left side surface of the top end of the bearing bottom plate is provided with a medicine box body; the middle surface of the top end of the medicine box body is provided with a stirring motor; one end of the stirring motor is rotatably connected with a stirring shaft; the outer surface of the stirring shaft is provided with a plurality of
20 stirring blades; one side of the stirring shaft is provided with a brush frame; the right side surface of the top end of the bearing bottom plate is provided with a supporting frame; the middle surface of the top end of the supporting frame is provided with a lifting motor; one end of the lifting motor is rotatably connected with a screw rod; two sides of the screw rod are provided with a light rod sliding rail; the outer part of the screw rod is connected with a lifting
25 base matched with the outer part of the polished rod sliding rail; the top part of the lifting base is provided with a spraying water pipe; the herbicide is uniformly spraying device, effectively preventing the herbicide precipitation and hanging wall; the herbicide proportion after stirring is more uniform, further improving the herbicidal effect; it is convenient to adjust the different herbicide spraying height matched with the height of the grass, improving the use
30 range. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

Chinese Utility Model CN211881881U relates to the technical field of herbicide and claims a forestry chemical herbicide spraying device, comprising a liquid storage box body, the right
35 side of the liquid storage box body is fixedly connected with a motor box. The forest chemical herbicide spraying device, the stirring motor drives the stirring rod to rotate, the stirring rod drives the stirring impeller to stir the herbicide, the stirring impeller is driven to rotate, the

stirring hopper is mainly used for stirring the sediments at the suspended part and the bottom of the top part of the liquid storage box body mixing the suspended substance and precipitate with the herbicide main body, reducing the production of suspended substance and precipitate; the stirring and mixing effect is better by rotating the horizontal spraying pipe and the centralized spraying pipe, making the joint or centralized spraying joint corresponding to the transfusion pipe and switching different spraying modes. It is suitable for large-sheet lawn, spraying suitable strip-shaped lawn belt, it can save herbicides, reduce wastage, the herbicide spraying device, stirring and mixing effect is good, and it is convenient to change the spraying mode. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

Chinese Utility Model CN211793970U claims an agricultural herbicide spraying device, comprising a base, a first motor and a second motor, the top end of the base is fixedly installed with a spraying box and the inner part of the spraying box is provided with a stirring mechanism, the right side of the spraying box is provided with a spraying water pipe, the left side of the top end of the spraying box is provided with a water inlet mechanism, the right side of the top end of the spraying box is provided with a discharging mechanism. The utility model is provided with a stirring mechanism, the effect of mixing the medicine and water is better, the efficiency of weeding is better, the discharging mechanism can be injected into the inner part of the spraying box by the medicine and then the water enters into the spraying box through the water inlet pipe. At the same time, when the water in the spraying box is full, the water faces the baffle to extrude, then the baffle is rotated, the baffle is closed to the water inlet pipe, the water is continuously injected into the interior of the spraying box, the water and the medicament can be mixed. The water and medicament can be automatically injected and it reduces the manual operation, and it is convenient to use. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

Chinese Utility Model CN210901115U relates to the technical field of agricultural machinery, and claims an agricultural mechanical equipment for herbicide spraying, comprising a mounting plate, the bottom of the mounting plate is fixedly connected with a combination plate, the left and right sides of the binding plate are fixedly connected with a driving motor, the driving motor is far away from output end of one side is fixedly connected with a rotating rod. The rotating rod is fixedly connected with a rotating wheel far away from one end of the drive motor, the top of the mounting plate is fixedly connected with a water storage tank, the top of the water tank is fixedly connected with a water injection pipeline, the water storage tank of left and right two sides are fixedly connected with the water pump. The utility model rod traction force by the driving motor controls the rotation cam to rotate, the rotation of the

force the cam intermittent stress block, so transmission plate under the action of the reset spring pulls out the water pipes to carry out reciprocating action, so as to improve the effect of the whole spraying quality and efficiency by reciprocating motion of the spraying structure. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

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Chinese Utility Model CN212087774U claims a weeding device for agricultural planting, comprising a barrel body, a spraying rod, the surface of the barrel body is symmetrically provided with a fixing beam, the other end of the fixing beam is provided with a fixing block, the fixing block is provided with a screw rod, the bottom end of the screw rod is provided with a fixing block, two ends of the fixing block are provided with a pulley, the fixing block surface is provided with a holding rod, the holding rod is provided with a fixing plate, the fixing plate is provided with a placing plate, pulley land, convenient for moving the sprinkler, the sprayer moves and sprays the herbicide, the sprayer moves more time-saving and labour-saving. It avoids the shoulder of the user when the knapsack sprayer is stressed for a long time and the pain, the toggle rod at the outer side of the end of the spraying rod is used for pulling the more tightly plant, opening the field of spraying and exposing the tightly covered weeds, convenient spraying herbicide and spraying uniformly, avoiding the condition of omission. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

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Malaysian Patent MY161952A describes a knapsack sprayer for spraying a liquid mixture comprising a tank to store the liquid mixture, a rigid tube, a pump mechanism mounted to the tank to draw the mixture out of the tank to the rigid tube at high velocity, a flexible connecting tube connecting the pump mechanism to the rigid tube - a nozzle screwed to a distal end of the rigid tube to release the mixture as dispersed droplets, characterized in that a containing means to contain a liquid substance is connected to the tank, a valve is provided at the connection of the tank and the containing means to control the amount of substance that flows into the tank, a cushioning means is attached to the side of the tank that faces the back of the user when the sprayer is in use, a handle and wheels assembly is mounted on the tank and the rigid tube is adjustable in length. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

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Chinese Utility Model CN214282978U provides a precise herbicide applying device. The precise herbicide applying device comprises a wheel driving structure, a frame, a three-dimensional measuring mechanism and a herbicide applying structure, the pesticide applying structure is arranged on the frame and comprises X-axis linear modules, a cross beam, Z-axis linear modules and nozzles, and the X-axis linear modules are fixedly mounted on the upper surfaces of the two sides of the frame; the cross beam is vertically arranged above the X-axis

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linear module; a plurality of X-axis linear modules are arranged on the cross beam, a plurality of Z-axis linear modules are arranged on the cross beam, sliding blocks of the Z-axis linear modules are fixedly connected with the cross beam, and nozzles are arranged at the bottoms of the Z-axis linear modules and driven by the X-axis linear modules and the Z-axis linear modules to move and apply pesticide. The three-dimensional measuring mechanism comprises a door-shaped support and a line laser three-dimensional measuring device and is used for recognizing the three-dimensional space position of weeds in the lawn. The device can identify the position and height of weeds, controls the movement of the spray head through the movement of the linear module, achieves the precise spraying of the herbicide, improves the utilization rate of the herbicide, guarantees the weeding effect and is convenient to operate and high in practicability. *This prior art does not describe the herbicide sprayer assembly of the present invention.*

SUMMARY OF THE INVENTION

The present invention relates generally to an herbicide sprayer assembly for spraying herbicides solution. More specifically, the present invention relates to an herbicide sprayer assembly for spraying herbicides solution for weeding management purposes in immature oil palm fields.

The present invention provides an herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicides solution on weeds, comprising at least one container to hold the herbicides solution, at least one pump, a vertical arm frame, a main arm frame, a horizontal arm frame, a right arm frame, a right deflector surface, a left arm frame, a left deflector surface, a plurality of nozzles, at least one spray hose, a plurality of hydraulic cylinders and at least one hydraulic control lever, wherein the vertical arm frame is pivotally coupled on top of the main arm frame, the main arm frame is pivotally coupled to the horizontal arm frame on a first side towards the movable apparatus, the main arm frame is coupled to the movable apparatus on the first side via connectors and on a second side to the left arm frame and right arm frame via plurality of couplings, the right arm frame comprises the plurality of nozzles on a first side and the right deflector surface on a second side, the left arm frame comprises the plurality of nozzles on a first side and the left deflector surface on a second side and the at least one pump is to produce pressurised herbicides solution, the at least one spray hose is to carry the pressurised herbicides solution from the at least one container to the plurality of nozzles and the pressurised herbicides solution is sprayed or discharged out from plurality of nozzles in the form of pressurised droplets.

The present invention provides a method for assembling a herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicides solution on weeds, comprising assembling together at least one container to hold the herbicides solution, at least one pump, a vertical arm frame, a main arm frame, a horizontal arm frame, a right arm frame, a right deflector surface, a left arm frame, a left deflector surface, a plurality of nozzles, at least one spray hose, a plurality of hydraulic cylinders and at least one hydraulic control lever, wherein the vertical arm frame is pivotally coupled on top of the main arm frame, the main arm frame is pivotally coupled to the horizontal arm frame on a first side towards the movable apparatus, the main arm frame is coupled to the movable apparatus on the first side via connectors and on a second side to the left arm frame and right arm frame via plurality of couplings, the right arm frame comprises the plurality of nozzles on a first side and the right deflector surface on a second side, the left arm frame comprises the plurality of nozzles on a first side and the left deflector surface on a second side and the at least one pump is to produce pressurised herbicides solution, the at least one spray hose is to carry the pressurised herbicides solution from the at least one container to the plurality of nozzles and the pressurised herbicides solution is sprayed or discharged out from plurality of nozzles in the form of pressurised droplets.

BRIEF DESCRIPTION OF THE DRAWINGS

Above recited features of the present invention may have been referred by embodiments, some of which are illustrated in the appended drawings. The appended drawings illustrate only typical embodiments of this invention and are therefore not considered limiting of its scope as the invention may perform effectively to other equally effective embodiments.

The components or parts of the herbicide sprayer assembly of the present invention are:

- at least one container (101) to hold the herbicides solution;
- at least one pump;
- a vertical arm frame (102);
- a main arm frame (103);
- a horizontal arm frame (104);
- a right arm frame (105);
- a right deflector surface (106);
- a left arm frame (107);
- a left deflector surface (108);
- a plurality of nozzles (109);

- at least one spray hose;
- a plurality of hydraulic cylinders; and
- at least one hydraulic control lever.

5 These and other features, benefits and advantages of the present invention will become apparent by reference to the following figures:

Figure 1 illustrates a machine system designed, developed and evaluated for circle spraying of oil palms (*Elaeis guineensis* Jacq.) [Source: *Scientia Agricola*, On-line version ISSN 1678-992X, Sci. agric. (Piracicaba, Braz.) vol.69 no.2 Piracicaba Mar./Apr. 2012, <https://doi.org/10.1590/S0103-90162012000200002>].

Figure 2 illustrates the ATTILA by RB Spray Tech Sdn. Bhd. is a spinning disc sprayer for the controlled droplet application of herbicides. [Source: <https://www.rbspraytech.com/our-products/handheld-cda-sprayers/atila-cda>].

Figure 3 illustrates another type of herbicide sprayer machine currently used in some of the oil palm estates.

20 **Figure 4** illustrates the isometric view of the herbicide sprayer assembly of the present invention.

Figure 5 illustrates the back view of the herbicide sprayer assembly of the present invention.

25 **Figure 6** illustrates the front view of the herbicide sprayer assembly of the present invention.

Figure 7 illustrates the top view of the herbicide sprayer assembly of the present invention.

Figure 8 illustrates the side view of the herbicide sprayer assembly of the present invention.

30 **Figure 9** illustrates the results from spraying herbicides solution using the herbicide spraying assembly of the present invention for weeding management purposes in the immature oil palm fields.

35 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION**

While the present invention is described herein by way of example using illustrative drawings and embodiments, it should be understood that the detailed description are not intended to limit the invention to embodiments of drawing or drawings described and are not intended to limit the invention to the particular form disclosed but in contrary the invention is to cover all
5 modifications, equivalents and alternatives falling within the scope of the present invention.

The present invention is described herein by various embodiments with reference to the accompanying drawing wherein reference numerals used in the accompanying drawing correspond to the features through the description. However, the present invention may be
10 embodied in many different forms and should not be construed as limited to embodiments set forth herein. Therefore, embodiments are provided so that this disclosure would be thorough and complete and will fully convey the scope of invention to those skilled in the art. Numeric values and ranges and materials as provided in the detailed description are to be treated as examples only and are not intended to limit the scope of the claims of the present invention.

15 Terminology and phraseology used herein is solely used for descriptive purposes and is not intended as limiting in scope. The words such as "including", "comprising", "having", "containing" or "involving" and other variations is intended to be broad and cover the subject matter as described including equivalents and additional subject matter not recited such as
20 other components or steps.

A. Background

Weeds in oil palm are such as grasses, broad-leaf weeds, creeping and woody type weeds, ferns,
25 epiphytes and others. Weed management is important for oil palm growth, hence, the area around the oil palm tree must be free of growth of weeds especially for young palms to ensure the roots are not in competition with the weed. Application of herbicides to control growth of weeds have become common over the years. Weed management is important as weeds can affect the growth of the oil palm trees by reducing its oil yield and growth as the oil palm trees
30 are in competition with the weeds for nutrient, water, sunlight and space to grow as weeds require substantial amounts of nutrients for growth.

Weeds are plants growing in areas where they are not wanted and are more harmful than useful, even after their possible beneficial effects have been taken into account - (*Koch et al*,
35 *1983*). *Chung (1997)* reported that since weeds can reduce crop growth and yield, interfere with harvesting, crop recovery and other agricultural operations, control measures are

necessary. According to *Corley et al. (1976)*, the following four types of weeding operations will be necessary in areas where legume covers are maintained:

- circle weeding of palm circles – for young palms, circle weeding is normally carried out to prevent weed competition;
- 5 • strip weeding to provide access for harvesting and other field operations – more relevant for mature palms;
- selective spot weeding to remove noxious weeds from the legume covers or natural ground covers; and
- periodic control of legume covers if growth is too vigorous – de-creeping for example.

10 [Source:

<http://www.aarsb.com.my/establishment-weeding-operations-in-immature-oil-palms>]

The agriculture sector remains a significant development factor in Malaysia. Oil palm and rubber are the two major crops contributing to national development in terms of export
15 earnings, and rice is vital for the national food consumption. However, weeds continue to be an important constraint for oil palm, rubber, and rice production. Weed management in Malaysia is highly reliant on herbicides; however, other control measures are integrated, including cultural, physical, biological, and mechanical methods. Thus, herbicides accounted for 83% of the total pesticide usage in the year 2014.

20 [Source: *Weed management issues, challenges, and opportunities in Malaysia, September 2017* Crop Protection 134, DOI:10.1016/j.cropro.2017.08.027]

The tropical climate zone which receives high rainfall and good sunlight is conducive for oil palm cultivation. At the same time these natural factors are also highly conducive for weed
25 growth. Weeds can affect crop in many ways such as nutrient and water competition, yield reduction and retarding palm growth. Several species of weeds have been reported to cause adverse effect on oil palm yields.

[Source: CABI, <https://www.cabdirect.org/cabdirect/abstract/20113086117>]

30 Issues currently faced by the industry pertaining to the manual means of herbicides spraying are as follows:-

- With current situation whereby the industry is facing shortage of workers, labour intensive works such as herbicides spraying has become an issue.
- Apart from that, the manual spraying requires the usage of 16L knapsack sprayers which
35 are carried on the backs of the workers for long time and distances.
- Worker's exposure to the herbicides is also a serious matter of concern to the health of the workers.

Oil palm estates in Malaysia and Indonesia mostly use herbicides as it the most cost- effective way to get rid of the weeds. Manual weeding is expensive and regeneration of the weeds are faster, hence, the high reliance on herbicides. Most common way for spraying herbicides are via lever-operated knapsack sprayers which are done manually by the workers. Herbicides can be obtained in either liquid or powder versions which are then mixed with water to obtain herbicide solution. Some machines have been tested for herbicides spraying in coastal estates, however, knapsack sprayers are still commonly used in inland estates due to its difficult / challenging terrains. However, no suitable mechanised means to-date are known to be used for spraying herbicide solution for weeding management purpose in immature oil palm fields due to the size of the oil palm trees.

The labour shortfall is adding urgency to longstanding plans for industry mechanisation. Sime Darby Plantation (SDP), the world's biggest palm oil company by land size, is hastening development and trials to deploy light machines that will aid in field upkeep, removing harvested crops and applying fertiliser. It is also turning to remote sensing and artificial intelligence to drive precision farming, making the most efficient use of farm inputs and field workers. IOI said it has a revitalised mechanisation plan and aims to mechanise fertilising and pesticide spraying as well as automate mill operations, while FGV Holdings plans to mechanise an extra 30,000 ha over the next three years. Malaysia on average allots one worker for every 8 ha, but the Malaysian Palm Oil Association (MPOA) wants a "quantum leap" in technology that would double the land area for each worker to 16 ha. This would reduce reliance on labour, which accounts for around 30 per cent of production costs.

[Source: Malaysia's palm oil industry trying to hire local workers, 19 August 2020]

The labour shortage issue faced by the domestic plantation industry is expected to reduce productivity and harvesting even further during the peak cycle season at the end of the year 2020. MPOA states that local planters have already lost up to about 25% of potential yield throughout the series of Movement Control Orders (MCOs) right to the current Recovery MCO (RMCO) in the year 2020, without the services of some 37,000 foreign workers who had been sent home during the peak of the Covid-19 pandemic.

[Source: Labour shortage heightens losses in palm oil yield, 14 September 2020]

The persistent Covid-19 situation continues to affect the rising crude palm oil (CPO) yields of the palm oil producers in the country due to labour shortage. The labour shortage issue remains unresolved and is getting worse, resulting in production losses. To-date, there has been a freeze on the intake of foreign workers since the first movement control order which was imposed on March 18 2020. CGS-CIMB Research pointed out that SDP's workforce in

Malaysia hovers between 75% and 80% of its total requirement. Meanwhile, FGV Holdings Bhd's workforce stands at only 75% of requirement, which is a significant decline from 90% at the end of the third quarter last year, it added. According to a pre-MCO survey by the Malaysian Palm Oil Board, there was a shortage of 31,021 harvesters among its respondents, which represents 76% of the industry players. CGS-CIMB Research said it was estimated that the shortage of workers translated into a production loss of 3.4 million tonnes and 0.86 million tonnes of CPO and palm kernel, respectively.

[Source: Labour shortage getting worse in palm plantations, Star, 2 June 2021]

10 *B. Objectives of the present invention*

The oil palm industry is very dependent on labour and requires many workers for its operations. Complete reliance on foreign workers is not an ultimate solution but only a temporary measure. In the face of raising labour issues such as labour costs, mechanisation and automation programmes are being ramped up by industry players to tackle the associated labour issues. The mechanisation of the oil palm sector is not considered as a luxury, but an imperative and is vital for industrial players to pursue further as the oil palm sector could be helped with more efficient use of labour and reduced dependence on foreign workers. *[Source: theedgemarkets.com]*

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The oil palm industry is labour-intensive which requires many workers for the various parts of operations in the oil palm estates. This present invention focuses on the improvement or mechanisation of herbicides spraying and application in the oil palm estates. The conventional method of herbicides spraying is very much labour intensive which requires a gang of workers to perform the herbicides spraying operations on a daily basis.

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Weeding is important to ensure no competition for soil nutrients, water and sunlight between the weeds and oil palm trees. It is also important to ensure circles around the palms are free for crop recovery and accessibility. As the oil palm industry is very dependent on labour, it is crucial to contribute in solving the current issue with regards to shortage of the workers in the oil palm estates as labour issues will reduce productivity and harvesting. This present invention provides a means to address the labour issue to allow the oil palm industry to operate as how it should without being heavily dependent on labour.

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35 All prior arts as listed and referred to above do not specifically describe the herbicide sprayer assembly of the present invention. Apart from that, it is also not obvious by just reading the prior art documents or information as listed above for experts in the field of interest to derive

the herbicide sprayer assembly of the present invention as the parameters for the herbicide sprayer assembly have been determined by the inventors based on numerous trials conducted, observations and discussions with combined expertise and experience in this field, which parameters and/or combination could not be determined without much efforts, testing and/or analysis or by just reviewing prior art documents in this field of interest. Hence, there remains a need in the art to provide an herbicide sprayer assembly per present invention with benefits and objectives as further described below which cannot be found from the prior art documents, hence, the inventors believe that this invention is novel and inventive.

10 A first object of the present invention is to provide a mechanised means for spraying of herbicide solution (herbicides mixed with water) on targeted areas (in the oil palm estates focusing on immature oil palm fields with immature oil palm trees between the ages of 1 to 3 years.

15 A second object of the present invention is to provide an herbicide sprayer assembly for efficient and effective weeding management via circle weeding and/or strip weeding based on needs and requirements of individual oil palm estates.

20 A third object of the present invention is to provide an efficient circle weeding means for weeding management purposes at immature oil palm fields to replace the conventional way of using knapsack sprayers.

A fourth object of the present invention is to provide an herbicide sprayer assembly which is suitable for use at coastal estates (which consist of flat and undulating terrains).

25 A fifth object of the present invention is to provide a means of increasing productivity from 2 to 3 ha/day/worker per conventional means to 14 to 15 ha/day/worker using the herbicide sprayer assembly of this present invention with a tractor as the movable apparatus with the at least one container (101) or tank having capacity of between 600 L to 800 L and potentially more than 14 to 15 ha/day/worker using a more efficient movable apparatus with larger tank capacity at flat and undulating terrains in the estates.

35 A sixth object of the present invention is to provide an herbicide sprayer assembly which is able to discharge the herbicide solution on the weeds to a width range of at least 5 m to 6 m wide from the immature oil palm trees.

A seventh object of the present invention is to provide a safe means for herbicides spraying as the workers will be safe from exposure to hazardous chemicals (herbicides) during preparation of the herbicide solution and also from the herbicides drift during spraying which is common to happen during manual spraying of herbicides.

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An eighth object of the present invention is to provide an herbicide sprayer assembly which is easy to maintain, safe to use, stable, can operate smoothly and is sustainable.

A ninth object of the present invention is to provide a ratio of workers using the herbicide sprayer assembly with a tractor as the movable apparatus with tank capacity of between 600 L to 800 L on flat and undulating terrains in the estates vs. the knapsack sprayer (manual means) of a minimum (of at least) 1: 7 workers and this ratio is greater if a more efficient movable apparatus with larger tank capacity is used.

A tenth object of the present invention is to provide a mechanised means for spraying herbicide solution for weeding management purposes which ultimately is able to eliminate manual means of doing so.

C. Benefits of the present invention

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Based on the expertise, observation and testing by the inventors to operate the herbicide sprayer assembly of the present invention for spraying herbicide solution for weeding management purposes in the most efficient way as possible based on intended results, practicality of ground conditions and cost effectiveness, the following were observed:-

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The herbicide sprayer assembly of the present invention is able to provide a means of increasing productivity from 2 to 3 ha/day/worker per conventional means to 14 to 15 ha/day/worker with a tractor as the movable apparatus with the at least one container (101) or tank having capacity of between 600 L to 800 L and potentially more than 14 to 15 ha/day/worker using a more efficient movable apparatus with larger tank capacity.

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The herbicide sprayer assembly of this present invention is suitable for spraying herbicide solution around the immature oil palm trees (oil palm circle per **Figure 9**) without damaging the immature trees as the trees are small and fragile at this stage.

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The herbicide sprayer assembly of this present invention is able to discharge herbicide solution on the weeds to a width range of at least 5 m to 6 m wide from the immature oil palm trees for weeding management purposes.

- 5 The herbicide sprayer assembly of this present invention is able to provide a safe means for herbicides spraying as the workers will be safe from exposure to hazardous chemicals (herbicides) during preparation of the herbicide solution and also from herbicides drift during spraying which is common to happen during manual spraying of herbicides.
- 10 The herbicide sprayer assembly of the present invention is able to provide a ratio of workers of at least 1: 7 using the herbicide sprayer assembly with a tractor as the movable apparatus with tank capacity of between 600 L to 800 L on flat and undulating terrains in the estates vs. the knapsack sprayer (manual means).
- 15 The herbicide sprayer assembly of the present invention is safe, user friendly and ergonomic for use by the workers in the oil palm estates for spraying herbicide solution.

- Only 1 worker is sufficient to perform the weeding operations as required by the oil palm estates on a daily basis using 1 herbicide sprayer assembly of the present invention. 1 herbicide
- 20 sprayer assembly of this present invention is able to replace at least 7 workers per day to cover 12 to 15 ha per day of herbicide solution spraying.

Any types of movable apparatus can be used with the herbicide sprayer assembly of the present invention depending on individual estates' requirements.

- 25 It is also easy and cheap to manufacture and modify the herbicide sprayer assembly of the present invention according to the needs and preference of the user of the present invention.

- 30 The herbicide spraying assembly provides a mechanised means for spraying herbicide solution for weeding management purposes which ultimately is able to eliminate manual means of doing so.

- 35 The right arm frame (105) and left arm frame (107) moves inwards or outwards at an angle of 90° relative to the longitudinal horizontal axis A while the herbicide solution is sprayed or discharged from the plurality of nozzles (109) which creates an efficient circle weeding with 180° around the immature oil palm trees.

The angles of the right deflector surface (106) and left deflector surface (108) are more than 5° but not more than 90° relative to the longitudinal horizontal axis A, functions as a deflector to deflect the herbicide solution from being discharged onto the trees which could cause damage to the oil palm fronds of the immature oil palm trees.

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The plurality of hydraulic cylinders is to control the movements of the vertical arm frame (102) upwards or downwards at an angle of 90° relative to a longitudinal horizontal axis A, the horizontal arm frame (104) inwards or outwards along the longitudinal horizontal axis A provides flexibility to the operator of the assembly of the present invention to adjust the assembly accordingly depending on the different sizes of the immature oil palm trees so that the spraying can be done without damaging the oil palm fronds.

Based on the expertise, observation and testing by the inventors of the present invention, any type of spraying nozzles (109) can be used depending on preference and needs of the user as long as it is able to withstand discharge or spraying of pressurised herbicide solution such as copper cone jet nozzle, plastic cone jet, fat jet or others based on preference of the user of the present invention.

The spray application rate is in a range of between 80 L/ha to 100 L/ha to achieve the required spraying efficiency. This spray application rate provides sufficient wetting or drenching of the weeds with the herbicide solution as determined by numerous testing and trials by the inventors of the present invention. However, the spray application rate per hectare (L/ha) may vary per estate basis depending on each estate's requirements and as determined by the user of the herbicide sprayer assembly of the present invention. Based on this application rate, 3 to 5 seconds is enough for sufficient spraying of the herbicide solution for weeding purposes to drench the weeds with adequate amount required.

The spraying can be controlled by means of at least on hydraulic lever as contained in the movable apparatus to be continuous as long as required and to stop spraying at vacant areas where there are no weeds present to prevent wastage of the herbicide solution. At least one control lever or on/off button or valve is required for the present invention to control the spraying of the herbicide solution from the plurality of spraying nozzles (109) on the weeds. The herbicide sprayer assembly of the present invention reduces wastage of herbicide solution sprayed at vacant area or randomly as the spraying is controlled by the operator of the present invention when the right arm frame (105) and left arm frame (107) are firstly adjusted to be at the sides of the immature oil palm trees before the spraying begins. The spraying of the

herbicide solution via the assembly of the present invention also improves spraying uniformity.

The proposed herbicide sprayer assembly of the present invention is a breakthrough invention in the oil palm industry focusing on mechanising circle weeding management for the immature oil palm fields which is conventionally done manually using knapsack sprayers. Immature oil palm trees (1 to 3 years after planting) is small, short and fragile and there is no suitable mechanised herbicide sprayer assembly in the market for this purpose. With the assembly of the present invention, productivity of 2 to 3 ha/day/worker per conventional means is increased to 14 to 15 ha/day/worker.

D. The Present Invention

The present invention generally relates to a herbicide sprayer assembly for weeding management purposes. The present invention provides an improved means for spraying herbicides, rather than manual means or conventional means of using knapsack sprayers to do the spraying. More specifically, the present invention relates to an herbicide sprayer assembly for spraying herbicide solution for weeding management purposes in immature oil palm fields.

According to **Figures 4 to 8**, the present invention provides an herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicide solution on weeds, comprising:

- at least one container (101) to hold the herbicide solution;
- at least one pump;
- a vertical arm frame (102);
- a main arm frame (103);
- a horizontal arm frame (104);
- a right arm frame (105);
- a right deflector surface (106);
- a left arm frame (107);
- a left deflector surface (108);
- a plurality of nozzles (109);
- at least one spray hose;
- a plurality of hydraulic cylinders; and

- at least one hydraulic control lever,

wherein the vertical arm frame (102) is pivotally coupled on top of the main arm frame (103), the main arm frame (103) is pivotally coupled to the horizontal arm frame (104) on a first side towards the movable apparatus, the main arm frame (103) is coupled to the movable apparatus on the first side via connectors and on a second side to the right arm frame (105) and left arm frame (107) via plurality of couplings, the right arm frame (105) comprises the plurality of nozzles (109) on a first side and the right deflector surface (106) on a second side, the left arm frame (107) comprises the plurality of nozzles (109) on a first side and the left deflector surface (108) on a second side; and the at least one pump is to produce pressurised herbicide solution, the at least one spray hose is to carry the pressurised herbicide solution from the at least one container (101) to the plurality of nozzles (109) and the pressurised herbicide solution is sprayed or discharged out from plurality of nozzles (109) in the form of pressurised droplets.

The at least one hydraulic control lever is to regulate the plurality of hydraulic cylinders to control movements of the vertical arm frame (102), the horizontal arm frame (104), the right arm frame (105) and the left arm frame (107). The plurality of hydraulic cylinders is to control the movement of the vertical arm frame (102) upwards or downwards at an angle of 90° relative to a longitudinal horizontal axis A. The plurality of hydraulic cylinders is to control the movement of the horizontal arm frame (104) inwards or outwards along the longitudinal horizontal axis A. The plurality of hydraulic cylinders is to control the movement of the right arm frame (105) and left arm frame (107) inwards or outwards at an angle of 90° relative to the longitudinal horizontal axis A while the herbicide solution is sprayed or discharged from the plurality of nozzles (109).

The right deflector surface (6) and left deflector surface (8) are to deflect the herbicide solution from being sprayed or discharged onto trees, specifically the immature oil palm trees to prevent damage on the oil palm fronds.

The distance between the right deflector surface (106) and left deflector surface (108) is in a range of between 1,300 mm to 1,500 mm (closest position) and between 4,000 mm to 4,500 mm (furthest away) as determined sufficient and efficient by numerous testing and trials by the inventors of the present invention. The minimum distance (closest position) is sufficient for the immature trees to contain within the right deflector arm (106) and left deflector arm (108) before spraying begins and to the maximum distance (furthest away) to provide sufficient circle weeding to a width range of at least 5 m to 6 m wide from the immature oil palm trees for weeding management purposes.

The angles of the right deflector surface (106) and left deflector surface (108) are more than 5°, preferably between 15° to 45° but not more than 90° relative to the longitudinal horizontal axis A as determined by numerous testing and trials by the inventors of the present invention which functions as a deflector to deflect the herbicide solution from being discharged onto the trees which could cause damage to the oil palm fronds of the immature oil palm trees.

The length of the right arm frame (105) and left arm frame (107) is in a range of between 1,800 mm to 2,100 mm. The distance between one nozzle to a next nozzle on the outer sides of the right arm (105) and left arm frame (107) is in a range of between 300 mm to 400 mm as tested by the inventors of this present invention to provide effective and efficient weeding management with herbicide solution being sprayed for about 3 to 5 seconds on the weeds.

The vertical arm frame (102) 90° relative to the longitudinal horizontal axis is in a range of between 1,500 mm to 1,700 mm. The length of the horizontal arm frame (104) relative to the longitudinal horizontal axis is in a range of between 1,300 mm to 1,400 mm. The length of the main arm frame (103) 90° relative to the longitudinal horizontal axis is in a range of between 1,300 mm to 1,600 mm. These lengths have been determined by numerous testing and trials by the inventors of the present invention to be effective and efficient for the purposes of the present invention.

The herbicide sprayer assembly is contained on one side (left or right) or on both sides (left and right) of the movable apparatus. The herbicide sprayer assembly is for spraying herbicide solution on weeds in immature oil palm fields, specifically immature oil palm trees between the ages of 1 to 3 years. The herbicide sprayer assembly can be used for circle and/or strip spraying of the herbicide solution.

Any type of movable apparatus can be used for the present invention. The movable apparatus of the present invention can be a three-wheeler or four-wheeler and can be selected based on ground conditions, accessibility and affordability of individual estates based on needs and preference of the user of the sprayer assembly of the present invention, such as the mechanical buffalo, tractor and others.

Any and all types of herbicides can be used for this present invention in the form of liquid or soluble powders. Herbicides are firstly mixed with water and added into the at least one container (101). The tank capacity will depend on the movable apparatus used for the present invention depending on the preference and user. The calibrated dosage and amount of the herbicide solution is based on requirements of each individual estates as determined by the

type of herbicides used, manufacturers and experts in the field of interest. Calibrated amount means predetermined amount of herbicides mixed with water required for the purposes of the present invention – for application of herbicide solution at the specified rate to the target surface where the weeds are present. Calibrated amount is important to ensure correct amount is sprayed without wastage and also that the herbicides dosage is effective to kill / poison the weeds. This will depend on the recommendation of expertise depending on types and brands of herbicides to be used depending on the preference of the user of the sprayer assembly of the present invention.

The herbicide sprayer assembly of the present invention is preferably to be calibrated prior to being used (on a daily basis or as when required based on preference and needs of the user of the present invention) to ensure the correct dosage, amount of herbicide solution required and spraying application rate per hectare (L/ha) are determined and set for the most effective and efficient spraying of herbicides to the targeted areas in the oil palm estates. Based on the expertise, observation and testing by the inventors of the present invention, the spray application rate is in a range of between 80 L/ha to 100 L/ha to achieve the required spraying efficiency. This spray application rate provides sufficient wetting or drenching of the weeds with the herbicide solution as determined by numerous testing and trials by the inventors of the present invention. However, the spray application rate per hectare (L/ha) may vary per estate basis depending on each estate's requirements and as determined by the user of the herbicide sprayer assembly of the present invention. Based on this application rate, 3 to 5 seconds is enough for sufficient spraying of the herbicide solution for weeding purposes to drench the weeds with adequate amount required.

For the purposes of the present invention, at least one water pump is used to pump the herbicide solution in a pressure range of between 1 kg/cm² to 5 kg/cm² (14 psi to 70 psi), to be carried via the at least one spray hose from the at least one container (101) to the plurality of nozzles (109) to spray or discharge herbicide solution on the weeds. At least one water pump is sufficient, preferably a pressurised water pump but 2 or more can be used based on the preference and needs of the user of the present invention.

The ATTILA by RB Spray Tech Sdn. Bhd. (**Figure 2**) is a spinning disc sprayer for the controlled droplet application of herbicides is the closest prior art to the sprayer assembly of the present invention [Source: <https://www.rbspraytech.com/our-products/handheld-cda-sprayers/atila-cda>]. The spinning disc sprayer here uses batteries and gravity flow mechanism with ultra-low volume (ULV) (25L/ha) calibration to reduce water usage which results in 1 worker having 10L per sprayer. 1 worker can cover about 6 ha/day for an 8-hour

working period. The ULV dispersions is very fine about 50 microns which is easily drifted by the wind. This prior art does not describe the sprayer assembly of the present invention.

This present invention also provides a method of assembling an herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicide solution on weeds, comprising assembling together at least one container (101) to hold the herbicide solution, at least one pump, a vertical arm frame (102), a main arm frame (103), a horizontal arm frame (104), a right arm frame (105), a right deflector surface (106), a left arm frame (107), a left deflector surface (108), a plurality of nozzles (109), at least one spray hose, a plurality of hydraulic cylinders and at least one hydraulic control lever wherein the vertical arm frame (102) is pivotally coupled on top of the main arm frame (103), the main arm frame (103) is pivotally coupled to the horizontal arm frame (104) on a first side towards the movable apparatus, the main arm frame (103) is coupled to the movable apparatus on the first side via connectors and on a second side to the right arm frame (105) and left arm frame (107) via plurality of couplings, the right arm frame (105) comprises the plurality of nozzles (109) on a first side and the right deflector surface (106) on a second side, the left arm frame (107) comprises the plurality of nozzles (109) on a first side and left deflector surface (108) on a second side and the at least one pump is to produce pressurised herbicide solution, the at least one spray hose is to carry the pressurised herbicide solution from the at least one container (101) to the plurality of nozzles (109) and the pressurised herbicide solution is sprayed or discharged out from plurality of nozzles (109) in the form of pressurised droplets.

The at least one hydraulic control lever is to regulate the plurality of hydraulic cylinders to control movements of the vertical arm frame (102), the horizontal arm frame (104), the right arm frame (105) and the left arm frame (107). The plurality of hydraulic cylinders is to control the movement of the vertical arm frame (102) upwards or downwards at an angle of 90° relative to a longitudinal horizontal axis A.

The plurality of hydraulic cylinders is to control the movement of the horizontal arm frame (104) inwards or outwards along the longitudinal horizontal axis A. The plurality of hydraulic cylinders is to control the movement of the right arm frame (105) and left arm frame (107) inwards or outwards at an angle of 90° relative to the longitudinal horizontal axis A while the herbicide solution is sprayed or discharged from the plurality of nozzles (109).

The right deflector surface (6) and left deflector surface (8) are to deflect the herbicide solution from being sprayed or discharged on trees. The distance between the right deflector surface (106) and left deflector surface (108) is in a range of between 1,300 mm to 1,500 mm (closest

position) and between 4,000 mm to 4,500 mm (furthest away). The angles of the right deflector surface (106) and left deflector surface (108) are more than 5° but not more than 90° relative to the longitudinal horizontal axis A.

- 5 The length of the right arm frame (105) and left arm frame (107) is in a range of between 1,800 mm to 2,100 mm. The distance between one nozzle to a next nozzle is in a range of between 300 mm to 400 mm. The length of the vertical arm frame (102) 90° relative to the longitudinal horizontal axis is in a range of between 1,500 mm to 1,700 mm. The length of the horizontal arm frame (104) relative to the longitudinal horizontal axis is in a range of between 1,300 mm
10 to 1,400 mm.

The length of the main arm frame (103) 90° relative to the longitudinal horizontal axis is in a range of between 1,300 mm to 1,600 mm. The herbicide sprayer assembly is contained on one side (left or right) or on both sides (left and right) of the movable apparatus.

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E. Summary

All prior arts as listed and referred to above do not specifically describe the herbicide sprayer assembly of the present invention. Apart from that, it is also not obvious by just reading the
20 prior art documents or information as listed above for experts in the field of interest to derive the herbicide sprayer assembly of the present invention as the parameters for the herbicide sprayer assembly have been determined by the inventors based on numerous trials conducted, observations and discussions with combined expertise and experience in this field, which parameters and/or combination could not be determined without much efforts, testing and/or
25 analysis or by just reviewing prior art documents in this field of interest. Hence, there remains a need in the art to provide an herbicide sprayer assembly per present invention with benefits and objectives as further described below which cannot be found from the prior art documents, hence, the inventors believe that this invention is novel and inventive.

30 To the best of the knowledge of the inventors of the present invention and based on prior arts available, there is no known apparatus per present invention in the market currently. The novel and unique aspects of the herbicide sprayer assembly of the present invention focuses weeding management at the immature oil palm fields using flexible main arm frame (103) which is able to move up and down (vertically), in and out (horizontally) provides flexibility to
35 the operator of the assembly of the present invention to adjust the assembly accordingly depending on the different sizes of the immature oil palm trees so that the spraying can be done effectively and efficiently. The right arm frame (105) and left arm frame (107) moves

inwards or outwards at an angle of 90° relative to the longitudinal horizontal axis A while the herbicide solution is sprayed or discharged from the plurality of nozzles (109) which creates an efficient circle weeding with 180° around the immature oil palm trees. This allows for efficient and effective spraying of herbicide solution at the immature oil palm trees for effective weeding management purposes. The angles of the right deflector surface (106) and left deflector surface (108) are more than 5° but not more than 90° relative to the longitudinal horizontal axis A, functions as a deflector to deflect the herbicide solution from being discharged onto the trees which could cause damage to the oil palm fronds of the immature oil palm trees.

The proposed herbicide sprayer assembly of the present invention is a breakthrough invention in the oil palm industry focusing on mechanising circle weeding management for the immature oil palm fields which is conventionally done manually using knapsack sprayers. Immature oil palm trees (1 to 3 years after planting) is small, short and fragile and there is no suitable mechanised herbicide sprayer assembly in the market for this purpose. With the assembly of the present invention, productivity of 2 to 3 ha/day/worker per conventional means is increased to 14 to 15 ha/day/worker.

It can be appreciated that the parameters for the present invention are not obvious for a person skilled in the art and have been tested and determined by the inventors based on numerous trials conducted, observations, discussions and combined expertise, which would not be able to be determined without much efforts and analysis. All prior arts as listed and referred to above do not specifically describe the herbicide sprayer assembly of this present invention.

Based on the knowledge of the inventors of the present invention, there is no known prior art or herbicide sprayer assembly per present invention, hence the inventors believe that this present invention is novel. Apart from that, it is also not obvious by just reading the prior art documents or information as listed above for experts in the field of interest to derive the sprayer assembly of the present invention without much efforts, testing and/or analysis. The parameters for the present invention have been determined by the inventors based on numerous trials conducted, observations, discussions with combined expertise and experience in this field which parameters and/or combination could not be determined without much efforts, testing and/or analysis or by just reviewing prior art documents in this field. Hence, to the best of knowledge of the inventors, the present invention is novel and inventive.

Various modifications to these embodiments as described herein are apparent to those skilled in the art from the description and the accompanying drawings. The description is not

intended to be limited to these embodiments as shown with the accompanying drawings but is to provide the broadest scope possible as consistent with the novel and inventive features disclosed. Accordingly, the invention is anticipated to hold on to all other such alternatives, modifications and variations that fall within the scope of the present invention and appended
5 claims.

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CLAIMS

1. An herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicide solution on weeds, comprising:

- 5
- at least one container (101) to hold the herbicide solution;
 - at least one pump;
 - a vertical arm frame (102);
 - a main arm frame (103);
 - 10 • a horizontal arm frame (104);
 - a right arm frame (105);
 - a right deflector surface (106);
 - a left arm frame (107);
 - a left deflector surface (108);
 - 15 • a plurality of nozzles (109);
 - at least one spray hose;
 - a plurality of hydraulic cylinders; and
 - at least one hydraulic control lever,

20 wherein

the vertical arm frame (102) is pivotally coupled on top of the main arm frame (103);

the main arm frame (103) is pivotally coupled to the horizontal arm frame (104) on a first side
25 towards the movable apparatus;

the main arm frame (103) is coupled to the movable apparatus on the first side via connectors
and on a second side to the left arm frame (105) and right arm frame (107) via plurality of
couplings;

30 the right arm frame (105) comprises the plurality of nozzles (109) on a first side and the right
deflector surface (106) on a second side;

the left arm frame (107) comprises the plurality of nozzles (109) on a first side and the left
35 deflector surface (108) on a second side; and

the at least one pump is to produce pressurised herbicide solution, the at least one spray hose is to carry the pressurised herbicide solution from the at least one container (101) to the plurality of nozzles (109) and the pressurised herbicide solution is sprayed or discharged out from plurality of nozzles (109) in the form of pressurised droplets.

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2. The assembly of Claim 1, wherein the at least one hydraulic control lever is to regulate the plurality of hydraulic cylinders to control movements of the vertical arm frame (102), the horizontal arm frame (104), the right arm frame (105) and the left arm frame (107).

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3. The assembly of Claim 2, wherein the plurality of hydraulic cylinders is to control the movement of the vertical arm frame (102) upwards or downwards at an angle of 90° relative to a longitudinal horizontal axis A.

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4. The assembly of Claim 2, wherein the plurality of hydraulic cylinders is to control the movement of the horizontal arm frame (104) inwards or outwards along the longitudinal horizontal axis A.

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5. The assembly of Claim 2, wherein the plurality of hydraulic cylinders is to control the movement of the right arm frame (105) and left arm frame (107) inwards or outwards at an angle of 90° relative to the longitudinal horizontal axis A while the herbicide solution is sprayed or discharged from the plurality of nozzles (109).

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6. The assembly of Claim 1, wherein the right deflector surface (6) and left deflector surface (8) are to deflect the herbicide solution from being sprayed or discharged onto trees.

7. The assembly of Claim 1, wherein the distance between the right deflector surface (106) and left deflector surface (108) is in a range of between 1,300 mm to 1,500 mm and between 4,000 mm to 4,500 mm.

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8. The assembly of Claim 1, wherein an angles of the right deflector surface (106) and left deflector surface (108) are more than 5° but not more than 90° relative to the longitudinal horizontal axis A.

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9. The assembly of Claim 1, wherein length of the right arm frame (105) and left arm frame (107) is in a range of between 1,800 mm to 2,100 mm.

10. The assembly of Claim 1, wherein distance between one nozzle to a next nozzle is in a range of between 300 mm to 400 mm.

11. The assembly of Claim 1, wherein length of the vertical arm frame (102) 90° relative to the longitudinal horizontal axis is in a range of between 1,500 mm to 1,700 mm.

12. The assembly of Claim 1, wherein length of the horizontal arm frame (104) relative to the longitudinal horizontal axis is in a range of between 1,300 mm to 1,400 mm.

13. The assembly of Claim 1, wherein length of the main arm frame (103) 90° relative to the longitudinal horizontal axis is in a range of between 1,300 mm to 1,600 mm.

14. The assembly of Claim 1, wherein the herbicide sprayer assembly is contained on one side (left or right) or on both sides (left and right) of the movable apparatus.

15. A method of assembling an herbicide sprayer assembly detachably coupled to a movable apparatus for spraying or discharging herbicide solution on weeds, comprising:

assembling together at least one container (101) to hold the herbicide solution, at least one pump, a vertical arm frame (102), a main arm frame (103), a horizontal arm frame (104), a right arm frame (105), a right deflector surface (106), a left arm frame (107), a left deflector surface (108), a plurality of nozzles (109), at least one spray hose, a plurality of hydraulic cylinders and at least one hydraulic control lever,

wherein the vertical arm frame (102) is pivotally coupled on top of the main arm frame (103), the main arm frame (103) is pivotally coupled to the horizontal arm frame (104) on a first side towards the movable apparatus, the main arm frame (103) is coupled to the movable apparatus on the first side via connectors and on a second side to the right arm frame (105) and left arm frame (107) via plurality of couplings, the right arm frame (105) comprises the plurality of nozzles (109) on a first side and the right deflector surface (106) on a second inner side, the left arm frame (107) comprises the plurality of nozzles (109) on a first side and the left deflector surface (108) on a second side and the at least one pump is to produce pressurised herbicide solution, the at least one spray hose is to carry the pressurised herbicide solution from the at least one container (101) to the plurality of nozzles (109) and the pressurised herbicide solution is sprayed or discharged out from plurality of nozzles (109) in the form of pressurised droplets.

16. The method of Claim 15, wherein the at least one hydraulic control lever is to regulate the plurality of hydraulic cylinders to control movements of the vertical arm frame (102), the horizontal arm frame (104), the right arm frame (105) and the left arm frame (107).

5 17. The method of Claim 16, wherein the plurality of hydraulic cylinders is to control the movement of the vertical arm frame (102) upwards or downwards at an angle of 90° relative to a longitudinal horizontal axis A.

10 18. The method of Claim 16, wherein the plurality of hydraulic cylinders is to control the movement of the horizontal arm frame (104) inwards or outwards along the longitudinal horizontal axis A.

15 19. The method of Claim 16, wherein the plurality of hydraulic cylinders is to control the movement of the right arm frame (105) and left arm frame (107) inwards or outwards at an angle of 90° relative to the longitudinal horizontal axis A while the herbicide solution is sprayed or discharged from the plurality of nozzles (109).

20 20. The method of Claim 15, wherein the right deflector surface (6) and left deflector surface (8) are to deflect the herbicide solution from being sprayed or discharged on trees.

21. The method of Claim 15, wherein the distance between the right deflector surface (106) and left deflector surface (108) is in a range of between 1,300 mm to 1,500 mm and between 4,000 mm to 4,500 mm.

25 22. The method of Claim 15, wherein an angles of the right deflector surface (106) and left deflector surface (108) are more than 5° but not more than 90° relative to the longitudinal horizontal axis A.

30 23. The method of Claim 15, wherein length of the right arm frame (105) and left arm frame (107) is in a range of between 1,800 mm to 2,100 mm.

24. The method of Claim 15, wherein distance between one nozzle to a next nozzle is in a range of between 300 mm to 400 mm.

35 25. The method of Claim 15, wherein length of the vertical arm frame (102) 90° relative to the longitudinal horizontal axis is in a range of between 1,500 mm to 1,700 mm.

26. The method of Claim 15, wherein length of the horizontal arm frame (104) relative to the longitudinal horizontal axis is in a range of between 1,300 mm to 1,400 mm.

27. The method of Claim 15, wherein length of the main arm frame (103) 90° relative to
5 the longitudinal horizontal axis is in a range of between 1,300 mm to 1,600 mm.

28. The method of Claim 15, wherein the herbicide sprayer assembly is contained on one side (left or right) or on both sides (left and right) of the movable apparatus.

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Figure 1

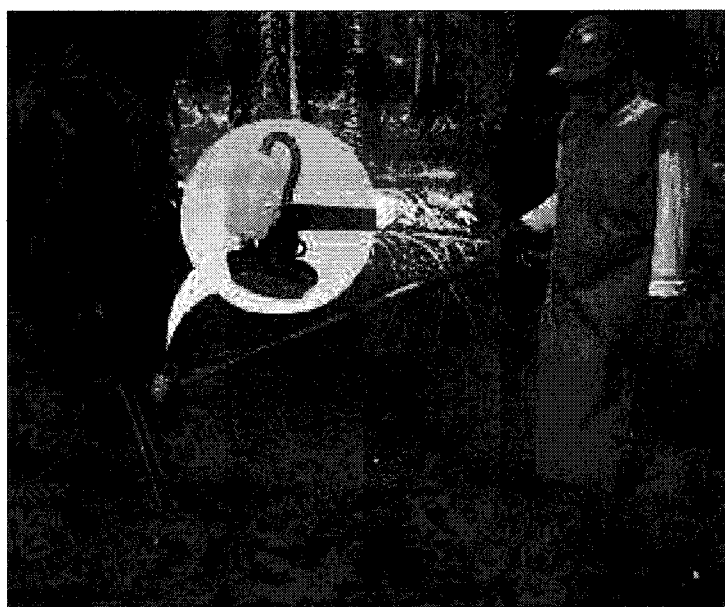


Figure 2

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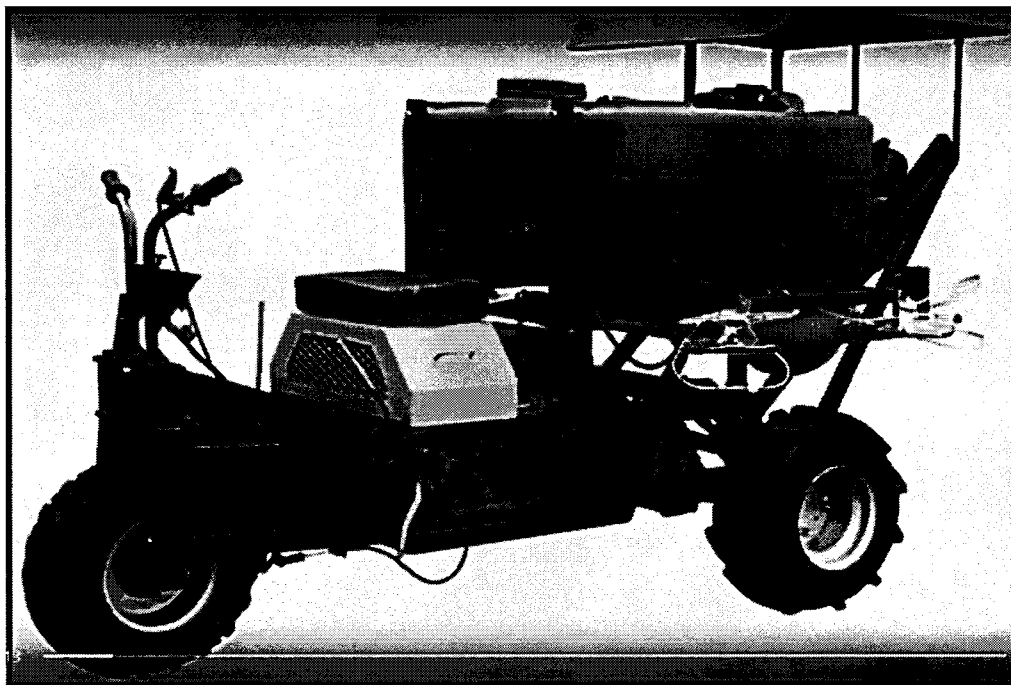


Figure 3

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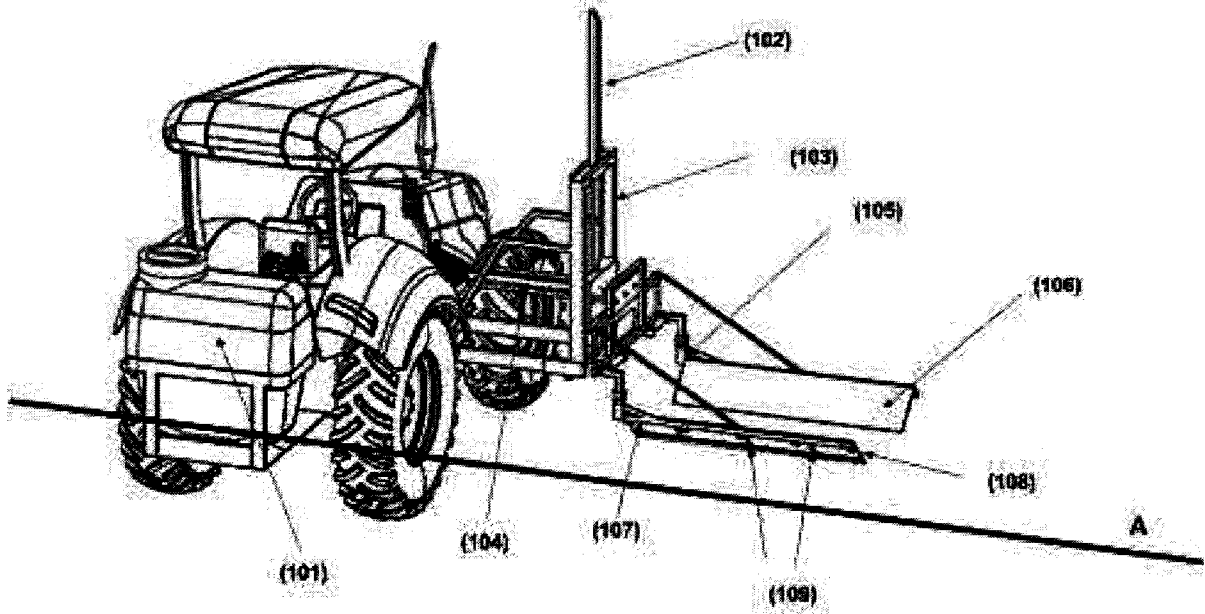


Figure 4

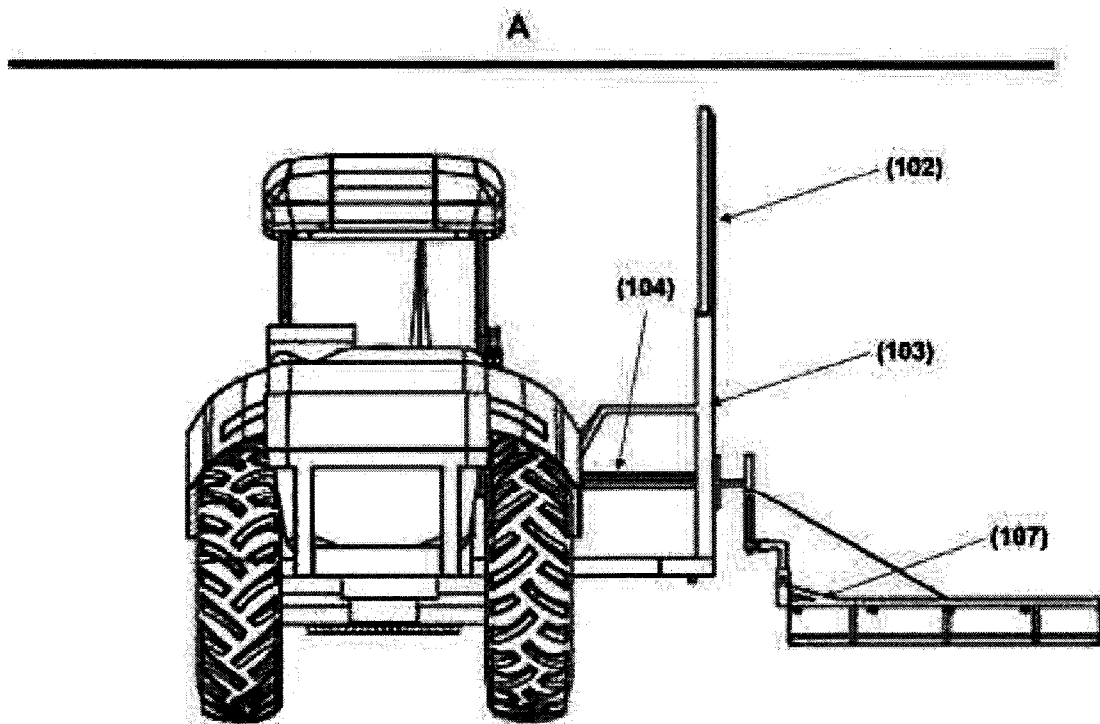


Figure 5

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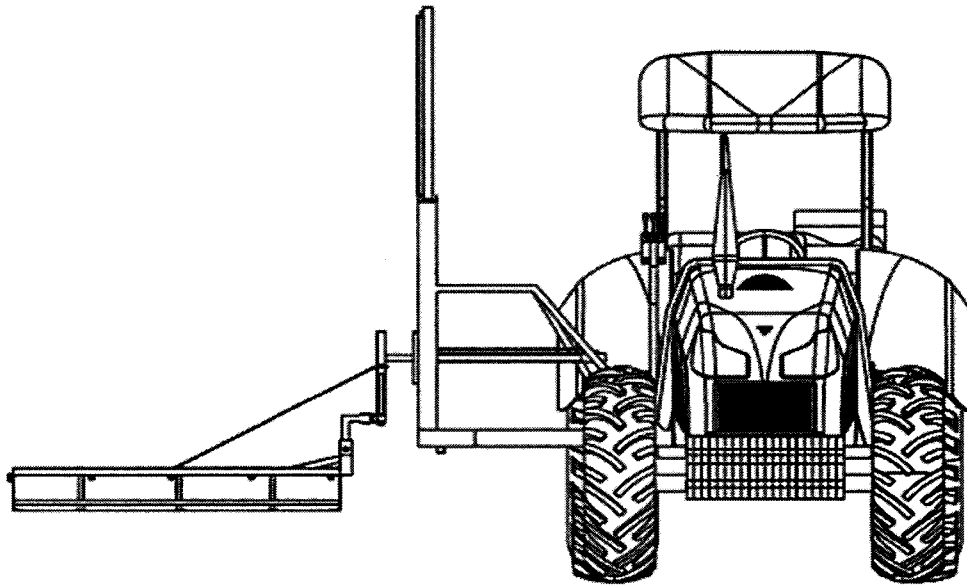


Figure 6

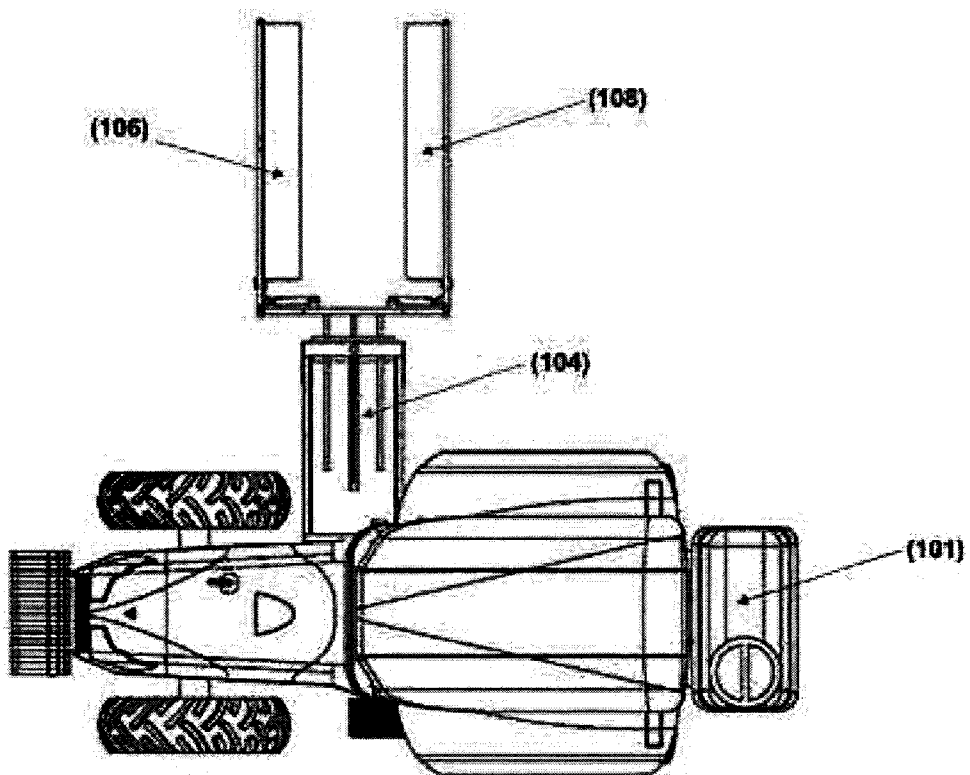


Figure 7

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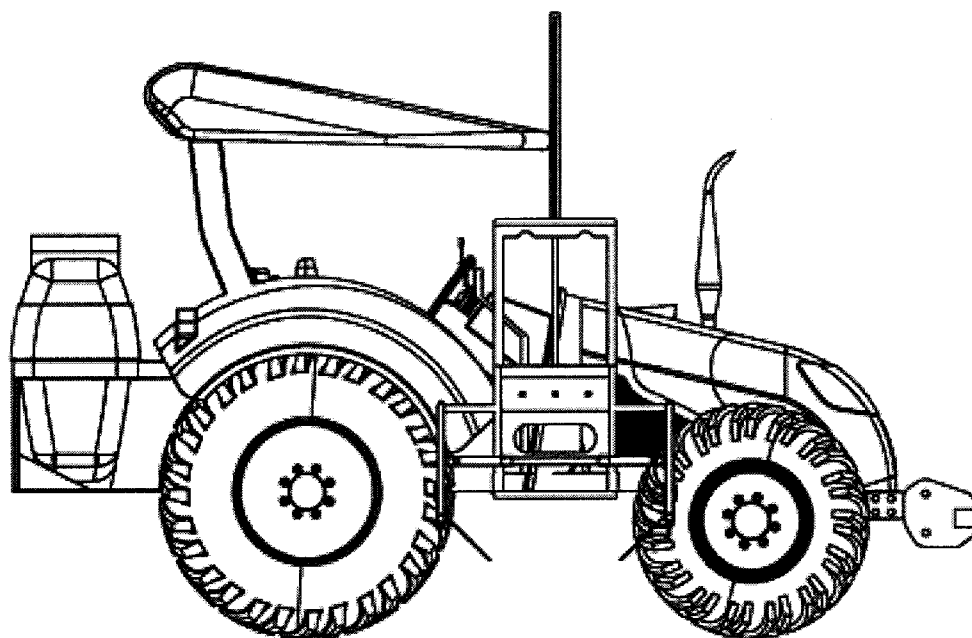


Figure 8

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Figure 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2022/050088

A. CLASSIFICATION OF SUBJECT MATTER INV. A01M7/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) A01M		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 606 672 A1 (BOURGEOIS GERARD [FR]) 20 May 1988 (1988-05-20)	1-5, 7-19, 21-28
A	figures 2, 3, 5, 6 page 3, line 19 - page 6, line 4 -----	6,20
A	DE 39 01 463 A1 (JOHN & CO [DE]) 26 July 1990 (1990-07-26) figure 1 -----	1-28
A	EP 0 549 058 A1 (MUNCKHOF MATHIJS R M DEN [NL]; DEN MUNCKHOF PETER MARIE JOSEF [NL]) 30 June 1993 (1993-06-30) figure 5 -----	1-28
A	FR 1 566 395 A (OGER, ERNEST [FR]) 9 May 1969 (1969-05-09) the whole document -----	1-28
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 20 January 2023		Date of mailing of the international search report 31/01/2023
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Ketelheun, Anja

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/MY2022/050088

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 2606672	A1	20-05-1988	NONE	

DE 3901463	A1	26-07-1990	NONE	

EP 0549058	A1	30-06-1993	NONE	

FR 1566395	A	09-05-1969	NONE	
