There is disclosed a system and method of reducing draft forces when working soil with agricultural soil working implements creating draft forces, the soil working implements being operable connectable to a frame and moveable in a working direction, the frame having a working width, the method comprising working the soil in a first part of the width, the first part of said width being smaller than the width, and hereafter working the soil in a second part of the width, the second part of the width comprising an other part of said width than the first part, so as e.g. to reduce draft forces compared to working both first and second parts at the same time.
SYSTEM FOR IMPLEMENT DRAFT REDUCTION

FIELD OF THE INVENTION

5 The present invention relates to implement draft reduction in connection with farming.

BACKGROUND OF THE INVENTION

10 The need of soil to be worked or tilled such as cultivated, fertilized or other similar soil working operations in connection with e.g. planting of crops or in connection with farming in general has been accomplished since the earliest days of civilization.

15 More recently, soil working devices have increased in complexity and size, depending on factors such as the type of farming operation, the crops, the quantity and type of soil being operated on or the agricultural tractors available. There has also been an increased emphasis on conserving natural resources resulting in these concerns being integrated in modern tillage systems and methods.

Furthermore environmental considerations are taken into account such as when having to spread a given amount of fertilizer or slurry to a given area of soil.

25 EP 0 838 139 discloses that in the field of agricultural tillage, there is a need for accurate, automated control of the widths of tilling implements, such as ploughs. EP 0 838 139 concerns methods of controlling a plough operatively combined with a vehicle such as a tractor, the methods including logging a series of values of the strength of soil encountered during a pass along a field; selecting the most frequently occurring soil strength value; and, for a subsequent pass of the tractor/plough combination along the field in the same direction, setting the width of the plough in dependence on the most frequently logged soil strength value. The disclosure also concerns a microprocessor arranged to carry out the methods of the invention.
In the view of the present inventors the system and methods in EP 0 838 139 may be seen to present disadvantages. As an example it may be seen as a disadvantage of the system and method that the width of the tilling device is adjusted prior to a second pass following a measurement of the soil strength value during a first pass.

Although the system and method in EP 0 838 139 is a way of reducing draft forces experienced by a dragging device such as a tractor and created when using a soil working implement, the inventor of the present invention has appreciated that an improved method and system for reducing draft forces is of benefit, and has in consequence devised the present invention.

DE 2820407 discloses a soil working apparatus behind a tractor used in a first run over the land to loosen soil in a strip which is narrower than the width of the tractor. The apparatus is then adjusted to be of a width to loosen the soil in the wheel tracks of the tractor and the apparatus is run over the land for a second time. The tools of the soil loosening apparatus built onto the tractor are affixed to the frame of the working apparatus in a laterally adjustable manner, so that they can be fitted between the wheel tracks of the tractor in the first run and behind the said wheels in the last run, being thus enabled to loosen a strip of ground enclosing the wheel track of the tractor.

Although the apparatus in DE 2820407 also is a way of reducing draft forces experienced by a dragging device such as a tractor and created when using a soil working implement, the inventor of the present invention has appreciated that an improved method and system not only for reducing draft forces, but also for reducing system costs.

DE 3424250 discloses a method for soil tilling and seedbed preparation, with deep loosening of the entire soil and fine crumbling of the uppermost soil layer, in a common operating procedure, or in two separate operating procedures. Use is made of a combined machine consisting of a tractor and several add-on appliances. Supports for the tools for deep loosening of the soil are arranged both at considerable lateral distances on the frame of the first working machine as well as on the frame of the second working machine, and the supports on the frame
are arranged with a gap between them and the front supports and are staggered behind the latter in the direction of travel.

The apparatus in DE 3424250 is a way of displacing soil working implements, but the drag forces of the apparatus remains the same during all operating procedures. The inventor of the present invention has appreciated that an improved method and system not only for possible displacing the soil working implements, but also for reducing system costs.

10 SUMMARY OF THE INVENTION

It may be seen as an object of the present invention to provide a method and system for reducing draft forces. It is also an object of the invention to reduce cost related to manufacture and/or related to the performance of a method for soil working and related to a system for soil working. It may also be seen as an object of the present invention to reduce weight and/or to reduce wear of the system according to the invention. Preferably, the invention alleviates, mitigates or eliminates one or more of the above or other disadvantages singly or in any combination.

Accordingly there is provided, in a first aspect, a method of reducing draft forces when working soil with agricultural soil working implements creating draft forces, the soil working implements being operable connectable to a frame and moveable in a working direction, the frame having a working width, the method comprising

- working the soil in a first part of the width, the first part of the working width being smaller than the working width, and hereafter
- working the soil in a second part of the working width, the second part of the working width comprising an other part of the working width than the first part, so as to reduce draft forces compared to working both first and second parts at the same time, said method furthermore comprising one of the following steps:
  - either selecting a first number of soil working implements for the first part (222) of said working width (212), and selecting a second number of soil working implements for the second part (222) of said working width (212), each of said first and second number of soil working implements being less than the total number of soil working implements,
- or selecting a total number of soil working implements for the first part (222) of said working width (212), and selecting said total number of soil working implements for the second part (220) of said working width (212), said total number of soil working implements being displaced transverse to a centre axis of the frame and/or a dragging device, and
- said method furthermore comprising the step, at least when working both the first (222) and second part (220) of said working width (212), of providing and maintaining a fixed mutual distance between the number of soil working implements.

Thus a method is provided which among other has as a possible advantage that it reduces the draft forces when working soil with agricultural soil working implements creating draft forces. The reduced draft force is among others due to the soil being worked in sections or parts of the working width. Also, the method has the advantage that the number of soil working implements being in engagement with the soil is limited, either resulting in the advantage of a reduced weight of the agricultural soil working implements or resulting in the advantage of a reduced wear of the agricultural soil working implements.

In particular, a possible advantage of the present invention and its embodiments is that the use of soil working implements, creating relative large draft forces when used, and using the same track lines as used with implements creating less draft forces is provided. Hereby, a possibility of e.g. spreading slurry by or while using implements creating relative large draft forces, possibly using the same tracks in a field as with other implements creating less draft forces, is provided. The method and system is therefore, as an example, a possible improved alternative to spreading slurry using a system with a frame with hoses provided along the frame and spreading the slurry more or less on top of the soil, creating less draft forces, however such hose system creating other problems prevented by the present invention.

When the word 'draft forces' is used herein it is to be understood that the draft forces are forces created, and having a direction mainly in the working direction, when e.g. dragging or pushing soil working implements through the soil.
It is to be understood that in accordance with a method step in accordance with the invention and its embodiments the working width is a fixed width of the frame when working both the first and second part. Not a width which is changed, e.g. after a first pass, but the width can be a substantially fixed width where the soil is worked in sections during different passes. In particular, working the soil in a first and second part of the working width is provided in a first and second passing of a field in the same tracks on the field.

In a second aspect of the invention there is provided a draft force reducing system for working soil, the system comprising a frame being moveable in a working direction by a dragging device, the frame being provided for attaching agricultural soil working implements, the soil working implements creating draft forces when used and the frame having a working width, wherein the soil working implements are arranged to work the soil in a first part of the width, the first part of the width being smaller than the width, followed by arranging the soil working implements to work the soil in a second part of the width, the second part of the width comprising an other part of the width than the first part, so as to reduce draft forces compared to working both the first and second parts at the same time.

According to one aspect of the invention, working the soil in the first part and the second part of the working width is provided by arranging the soil working implements in one or more positions relative to a centre line of the frame and/or the dragging device.

According to the one aspect of the invention, working the soil in the first and second part, respectively, of the working width is provided by a frame having a number of soil working implements along the total working width of the frame being less than the number of working implements needed for working both the first part and the second part of said working width of the frame, and wherein working of the soil in the first part and the second part, respectively, is performed by the same number of working implements.

Thus, the number of working implements being in contact with the soil during a pass of either the first part or the second part of the total working width is reduced, preferably to half the number needed for working both the first part and
the second part. Thereby, the weight of the soil working implements is reduced because of only a limited number of soil working implements is provided, i.e. soil working implements are “missing”.

An embodiment of an apparatus for performing the one aspect of the invention may be soil working implements being capable of being displaced laterally along a horizontal or otherwise non-vertical axis, and where the total set of soil working implements are in contact with the soil during working the first part, and where the total set of soil working implements also are in contact with the soil during working of the second part, however, displaced laterally in relation to a centre line of the frame and/or the dragging device, in comparison with a position when working the first part, during working of the second part.

According to another aspect of the invention, working the soil in the first and second part of the working width is provided by arranging the soil working implements in one or more positions relative to an axis transverse to a centre line of the frame and/or a dragging device.

According to the other aspect of the invention, working the soil in the first and second part, respectively, of the working width is provided by a frame having a number of soil working implements along the total working width of the frame being equal to the number of working implements needed for working both the first part and the second part of said working width of the frame, and wherein working of the soil in the first part and the second part, respectively, is performed by a reduced number of working implements.

Thus, the number of working implements being in contact with the soil during a pass of either the first part or the second part of the total working width is reduced, preferably to half the number needed for working both the first part and the second part. Thereby, the wear of the soil working implements is reduced because of a number of soil working implements not being in contact with the soil during pass of either the first part or the second part.

An embodiment of an apparatus for performing the one aspect of the invention may be soil working implements being capable of being pivoted around a
horizontal or otherwise non-vertical axis, and where a first subset of a limited number of soil working implements are in contact with the soil during working the first part, and where a second subset of a limited number of soil working implements are in contact with the soil during working of the second part, at the same time as the first subset of soil working implements are pivoted out of contact with the soil during pass of the second part, and vice versa.

The frame is provided for being connected to a dragging device which can be selected among the following group of dragging devices: a frame carrier, a self propelled frame, a self propelled frame carrier, an agricultural tractor, a frame carrier to be drawn by an agricultural tractor or a winch or the like powering means moving the frame in a working direction.

A connection between the frame and the dragging device can be selected among the following group of connections: a pivotable connection, a non-pivotable but releasable connection, a fixed non-releasable connection, a hitching device, a three point hitching device.

It is to be understood that the frame can be any kind of device arranged to provide a given positional configuration of the soil working implements. The frame does not have to be a single beam to be mounted such as to be extending side wards behind the dragging device. The frame may be provided in more beams either in front and/or behind the dragging device. The frame may also or additionally comprise a system of wires connected in one end to one or more points of the dragging device and which wires are connected in the other end to one or more soil working implements. The distance between the soil working implements in such a system may be controlled by a beam or the alike positioned adjacent to the soil working implements for providing a certain positional relation between the implements. A side wards displacement of such a system may as an example be provided by a side wards displacement of the one or more points on the dragging device.

According to a first embodiment of the system there is provided a tiltable frame and hereby the frame is arranged so that a tilt of the frame around an axis of the working width of the frame enables working the soil in the first part of the width,
and a tilt of the frame around the axis enables working the soil in the second part of the width. A possible advantage of a frame system with all implements mounted is that with such configuration it is possible to work e.g. both first and second parts during one pass if e.g. the soil strength is adequately low to enable this.

According to a second embodiment of the system in accordance with the invention there is provided a displaceable frame and/or displaceable soil working implements and hereby the frame and/or the soil working implements are arranged so that a displacement of the frame and/or a displacement of the implements along an axis of the working width of the frame enables working the soil in the first part of the width, and a displacement of the frame and/or a displacement of the implements along the axis enables working the soil in the second part of the width.

According to a third embodiment of the system in accordance with the invention there is provided a frame with displaceable soil working implements and hereby arranged the soil working implements are so arranged that a displacement of a subset of the soil working implements in a direction perpendicular to an axis of the working width of the frame enables working the soil in the first part of the width, and a displacement of another subset of the soil working implements in the direction enables working the soil in the second part of the width. A possible advantage of a frame system with all implements mounted is that with such configuration it is possible to work e.g. both first and second parts during one pass if e.g. the soil strength is adequately low to enable this.

According to a fourth embodiment of the system in accordance with the invention there is provided a permanent displaced frame and/or permanent displaced soil working implements, displaced or offset relative to a centreline, in a direction of the working width and hereby arranged so that dragging the soil working implements in a direction enables working the soil in the first part of the width, and dragging the implements in the opposite of the direction enables working the soil in the second part of the width.
In accordance with a further embodiment the system is so operated that working the soil in the first and second parts of the width is provided by the dragging device using a same track in the soil, and in a further embodiment the soil working implements are provided with the same soil working function when working both the first and second parts of the width, and in still further embodiments the frame is being provided for extending in a complete working width when working both the first and second parts of the width.

In a third aspect of the invention there is provided a dragging device further including a frame system as described.

The use of the phrase 'it is an advantage' of the present invention, is to be understood such that this advantage may be seen as a possible advantage provided by the invention, but it may also be understood that the invention is particularly, but not exclusively, advantageous for obtaining the described advantage.

In general the various aspects and advantages of the invention and the embodiments of the invention may be combined and coupled in any way possible within the scope of the invention. As an example a combination of the first and second embodiments e.g. in order preferably not to have the implements touching the soil while being displaced, may be provided.

These and other aspects, features and/or advantages of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be described, by way of example only, with reference to the drawings, in which

FIG. 1, 3b, 4b and 5b are known systems.
FIG. 2 is a first embodiment of a system for working soil in accordance with the present invention. The system frame has a tilt function.
FIG. 3a is a second embodiment of the system for working soil in accordance with the present invention. The system has an offset function.

FIG. 4a is a third embodiment of the system for working soil in accordance with the present invention. The system has a lifting and lowering function.

FIG. 5a is a fourth embodiment of the system for working soil in accordance with the present invention. The system has a permanent displacement function.

FIG. 6 shows an embodiment of a system in accordance with the present invention. The frame of the system is front and rear mounted.

FIG. 7 shows an embodiment of a system in accordance with the present invention. A displacement of the soil working implements is provided by turning the implements.

DESCRIPTION OF EMBODIMENTS

In FIG. 1 a known two way slurry spreader 102, where the slurry spreader is laying out a main hose 104 and the slurry is pumped from a stationary pumping station (not shown) towards the slurry spreader. The slurry is spread on the ground using a number of spreading hoses 106 dispersed along a frame 110 mounted on the slurry spreader 102. The spreading hoses 106 are possibly dispersed on both sides of a dragging device 108. From the shown side view only the spreading hoses on one side of the slurry spreader can be seen.

While the slurry spreader is moving in a forward direction, the slurry spreader is laying out the main hose 104, and when the slurry spreader is moving backwards, preferably along the same track in the soil, the slurry spreader is rolling the main hose up again.

FIG. 2 shows a first embodiment of a system 202 for working soil in accordance with the present invention. FIG. 2 shows a top view 224 and a side view 226 of a frame 204 being dragable by a dragging device, the frame 204 being provided for attaching agricultural soil working implements 206, 208 and 211, the soil working implements creating draft forces when used and the frame having a working width 212.
The frame 204 is based on a strong boom or frame construction suitable for mounting on a dragging device. The soil working implements are in this example tines 210 for opening the soil and injecting slurry into the soil instead of spreading the slurry on the soil as described in FIG. 1. Other types of soil working implements than tines 210 may be connected to the frame.

The number of needed soil working implements are dispersed with a substantial equal distance between them along the width 212 of the frame. When having to open the soil an increased amount of draft forces are created compared to the system in FIG. 1. This may have a possible disadvantage that only a lower working width can be obtained and/or a more powerful and/or heavier dragging device and/or heavier frame construction is needed in order to obtain a similar working width as for the system described for FIG. 1. In accordance with the shown embodiment of the invention a frame construction and method is provided which reduces the draft force needed when working a predetermined working width 212 e.g. with a certain amount of dragging power being obtainable.

In particular, FIG. 2 shows the frame in three different situations. These three situations are when the frame is provided for moving in a forward or backward transport direction 214, when provided for moving the frame in a forward direction 218 and when provided for moving the frame in an opposite backward direction 216.

It follows from the figure that the frame is tiltable around an axis of the working width of the frame. This axis follows the frame and hereby a direction as shown for the working width 212.

When the frame 204 is provided for being moved in the transport direction 214, the frame is non-tilted and hereby both the implements are positioned so as to be above a soil level in an inactivated position 208. When moving the frame in the forward direction 218 half of the implements along the frame are in an activated position 206, working a first part 222 of the soil along the width of the frame, while the other half of the implements are in an inactivated position 208. Similarly, when moving the frame in the backward direction 216 half of the implements along the frame are in an inactivated position 208 while the other half
of the implements are in an activated position 206, working the soil in a second part 220 of the width. Hereby e.g. a reduction of the draft force to 50% is possible while still being able to work the soil along the complete working width 212.

5 The first part 222 and second part 220 of the soil are worked in first and second passes of the soil. In this example the first part of the width is substantially equal to 50% of the width and the second part is the remaining part of the width. Other parts of the width can be workable in each part as well as this may require further parts and/or passes than two. The number of passes, and hereby the number of implements activated during each pass, can be suited factors such as the dragging device, a needed working width such as due to a wish of keeping the same track lines for different implement types, the type of implements and/or how good the tracks in the soil are and/or follow calculations of which number of passes is the best when also or additionally considering fuel consumption.

10 The tilt function may be ideal when the tine/implement is heavy or advanced and when the dragging device is not turning but only going in the other direction. Such an example is the two way slurry injector such as the one described in FIG. 1, where the spreading hoses is replaced with slurry injectors and the frame 110 is replaced with the frame 204 and used in accordance with the described. Using the principles described is making it possible for the same dragging machine to operate a twelve meter working width, with only a draught force of six meter, or to convert a nine meter grass slurry spreader to a eighteen meter grass slurry injector only by doubling the distance between the tines or discs, or a fifteen meter wheat slurry spreader to a thirty meter wheat slurry injector.

20 Preferably the parts of the soil being worked are equally dispersed on both sides of the frame relative to a centreline 236 of the frame, so as to obtain a substantially equal draft force from each side of the frame. Off course, in stead of providing alternating active and inactive implements each working a small section of the soil, several implements next to each may be inactive and followed by several active implements. Though an aim may be to provide a system and method where the draft force is substantially similar during each pass so as e.g. to fit the dragging device, the strength of the frame, and/or how well founded the
track line is - preferably along with the frame being fitted in total working width to the width between existing track lines.

Furthermore a dragging device 228 including the frame as described is shown in the three different situations.

FIG. 3 shows an embodiment of a system 302 in accordance with a second embodiment of the present invention. The frame is in this embodiment provided with half the number of needed implements 211. These implements are displaceable along an axis of the working width of the frame. The figure shows that each soil working implement has a displacement direction along the frame as indicated with the two way arrow 314. The displacement distance is also indicated with the two way arrow 314 and in the example the distance equals half of the distance between the implements 211.

In order to work the first part of the soil 220, shown with the grey sections, the implement are all positioned with an equal distance between them such as shown on the figure. In order to work the second part of the soil 222, all implements are displaced or offset the distance 314. Hereby the complete working width of the frame is worked.

In stead of or in addition to all the implements being displaceable along the frame, the frame itself may have a displaceable connection to the dragging device in order for the frame to be displaced the distance 314 relative to a centreline 312. Still further, and e.g. in order preferably not to have the implements touching the soil while being displaced, the frame and/or the implements may be provided with lifting/lowering devices and/or the frame is tiltable so as to extract the implements from the soil during the displacement.

An advantage of covering the full width with only half the implements or tines may be to save expenses on the implements. With larger flexibility in the sideways displacement it is possible to cover a given working width with only a third of fourth of the tines normally used for covering the full widths.
As indicated in the picture 306 the displacement function can be used for mechanical row weed control on a row crop cultivator, where the soil working tool is working on one side of the crop when the implement is moving along the soil in one direction, and the tool is cultivating the other side of the crop when the implement is moving along the soil in the other direction.

Furthermore, and as a further example shown in 308, the displacement function can be used on a seeder implement to increase the working width. This can be accomplished by moving the tines sideways combined with precision planting/seeding with a positioning GNSS (Global Navigation Satellite Systems) system possibly and preferably combined with a local positioning system for local navigation of each implement relative to a crop row or a previous furrow.

FIG. 4 shows an embodiment of two systems 402 in accordance with a third embodiment of the present invention. The soil working implements 211 are each displaceable the distance 408 in a direction perpendicular to an axis of the working width of the frame as indicated with the two way arrow 408 in the side view of the frame system 402.

By this displacement a subset of the soil working implements are enabled to work the soil in the first part 220 of the frame width, and a displacement of another subset of the soil working implements in direction 408, while having extracted the first subset from the soil, enables working the soil in the second part of the width. In the system 404 the displacement in the described direction is provided by a tilt or rotation of the implements approximately thirty degrees around the frame. In the system 406 the displacement between an inactive non-working position shown with the dashed lines and the active working position is provided by a linear movement of the implement.

In a normal harrow the tines has an overlay in their working widths. This overlay is provided to ensure an adequate average tilled depth. This increases the draught force on the first tines that is tilling a larger soil volume than the tine next to it, because the tines are not placed on a straight row but further back on the frame. Accordingly, having only a a third of the tines working the soil in a first pass could result in an equal draught force as the second pass where two thirds of the tines
are cultivating the soil. Shifting between a lifted or lowered single tine could be done using a hydraulic piston.

When an implement is used for deep tillage, such as shown in the picture 412 showing a chisel plough, the more advanced displacement function of the implements can be used to increase working widths and/or to decrease draft force during one pass by working the soil in portions or parts. This can also be combined with a system that can identify the needed draught force and then activate the number of tines that fit the tractor. Then the driver has to go over the same area, preferably along the same track, until all of the working width is treated.

FIG. 5 shows an embodiment of a system 502 in accordance with a forth embodiment of the present invention. The principal of the permanent displacement function shown in figure 5 is based on a boom or frame where the tines are placed such that half of the tines can work the full working width at two passes, each pass moving in the direction 218 and 216. The tines are permanently displaced relative to a centreline 510 along an axis of the working width of the frame (304) and in relation to a symmetrical position in relation to a plane parallel with a dragging direction. In the embodiment shown, the permanent displacement is provided with half the distance that should have been between the tines at a normal frame and/or implement and then the number is reduced to the half. In the example the permanent displacement 514 is substantially 25% of the distance between the implements from the centreline 510. This distance can be chosen as wanted but is chosen to 25% in this example in order to have substantially no overlap when working the soil and in order to have the complete part of the soil, workable with the given frame working width, worked in two passes with the frame.

The frame has the same configuration and the implements have the same position when mowing in each direction, the only difference is that the implement is moving in the opposite direction.

To increase working widths of a disc harrow as shown in the picture 506 showing a disc cultivator, the permanent displacement system can be used. The disc tillage system often consists of two or more rows with discs. Reducing the implement to
only having one row of discs and then treating the same area from the other side
would give the same result. By reducing the number of discs, the working widths
can be increased.

The permanent displacement system is a simple system and method to increase
the working widths of a simple implement for shallow tillage as shown in 508. This
can be obtained by having the half of the tines needed for treating the whole
area, and then going forward and backward in the same track with the tines
placed so that they will treat the whole area.

FIG. 6 shows an embodiment of a system 602 in accordance with a fifth
embodiment of the present invention. The figure shows that the first 222 and
second 220 parts of the soil are worked by a frame 602 which is split in a front
mounted section and a rear mounted section. During a first pass of the soil in the
direction 216, or in the opposite direction, along the centreline of the dragging
device either the front part of the frame or the rear part of the frame works the
soil in one of the parts. During a second pass the other part of the frame works
the second part of the soil within the working width 212 of the system 602. From
the figure an example of a frame which is provided in an alternative configuration
is shown. Such an alternative configuration and method may also be provided for
or combined with the other embodiments of the system and method described
herein.

FIG. 7 shows an embodiment of a system 702 in accordance with a sixth
embodiment of the present invention. It is shown that the offset function as
described in figure 3a can also be provided by turning the tine around a centre
point axis 706 related to an activated tine 206, hereby providing a system with
the ability to work in both directions without turning the entire implement frame
704. In the side view 708 one of the tines are shown in the two different
situations. Furthermore, the figure shows an example of a frame 702 which is
self-propelled or drawn by a winch, but which may alternatively be connected to a
dragging or pushing device for moving the frame.

Although the present invention has been described in connection with preferred
embodiments, it is not intended to be limited to the specific form set forth herein.
Rather, the scope of the present invention is limited only by the accompanying claims.

In this section, certain specific details of the disclosed embodiments are set forth for purposes of explanation rather than limitation, so as to provide a clear and thorough understanding of the present invention. However, it should be understood readily by those skilled in this art, that the present invention may be practised in other embodiments which do not conform exactly to the details set forth herein, without departing significantly from the spirit and scope of this disclosure. Further, in this context, and for the purposes of brevity and clarity, detailed descriptions of well-known apparatus, circuits and methodology have been omitted so as to avoid unnecessary detail and possible confusion.

In the claims, the term "comprising" does not exclude the presence of other elements or steps. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. Thus, references to "a", "an", "first", "second" etc. do not preclude a plurality. Reference signs are included in the claims, however the inclusion of the reference signs is only for clarity reasons and should not be construed as limiting the scope of the claims.
CLAIMS

1. A method of reducing draft forces when working soil with agricultural soil working implements (206, 211) creating draft forces, the soil working implements (208, 206, 211) being operable connectable to a frame (204, 304, 404, 504, 604, 704) and moveable in a working direction, the frame having a working width (212), the method comprising
- working the soil in a first part (222) of said working width (212), the first part of said working width being smaller than said working width (212), and hereafter
- working the soil in a second part (220) of said working width, the second part of said width comprising an other part of said working width (212) than the first part (222), so as to reduce draft forces compared to working both first and second parts at the same time, said method furthermore comprising one of the following steps:
  - either selecting a first number of soil working implements for the first part (222) of said working width (212), and selecting a second number of soil working implements for the second part (222) of said working width (212), each of said first and second number of soil working implements being less than the total number of soil working implements,
  - or selecting a total number of soil working implements for the first part (222) of said working width (212), and selecting said total number of soil working implements for the second part (220) of said working width (212), said total number of soil working implements being displaced transverse to a centre axis of the frame and/or a dragging device, and
- said method furthermore comprising the step, at least when working both the first (222) and second part (220) of said working width (212), of providing and maintaining a fixed mutual distance between the number of soil working implements.

2. A method according to claim 1, wherein the working width (212) is a fixed width of the frame (204, 304, 404, 504) when working both the first (222) and second part (220).
3. A method according to any of claim 1 or 2, wherein working the soil in the first part (222) and the second part (220) of the working width (212) is provided by a dragging device in a first passing and a second passing of a field, said first passing and second passing taking place in the same tracks (310) of the dragging device on the field.

4. A method according to any of claim 1-3, wherein working the soil in the first part (222) and the second part (220) of the working width (212) is provided by arranging the soil working implements (208, 206, 211) in one or more positions relative to a centre line (236, 312, 410, 512) of the frame and/or the dragging device.

5. A method according to any of claim 1-3, wherein working the soil in the first (222) and second (220) part of the working width (212) is provided by arranging the soil working implements (208, 206, 211) in one or more positions relative to an axis transverse to a centre line (236, 312, 410, 512) of the frame and/or a dragging device.

6. A method according to claim 4, wherein working the soil in the first (222) and second (220) part, respectively, of the working width (212) is provided by a frame having a number of soil working implements along the total working width of the frame being less than the number of working implements needed for working both the first part (222) and the second part (220) of said working width (212) of the frame, and wherein working of the soil in the first part and the second part, respectively, is performed by the same number of working implements.

7. A method according to claim 5, wherein working the soil in the first (222) and second (220) part, respectively, of the working width (212) is provided by a frame having a number of soil working implements along the total working width of the frame being equal to the number of working implements needed for working both the first part (222) and the second part (220) of said working width (212) of the frame and wherein working of the soil in the first part and the second part, respectively, is performed by the a reduced number of working implements.
8. A draft force reducing system (202, 302, 402, 502, 602, 702) for working soil, the system comprising
- a frame (204, 304, 404, 504, 604, 704) being moveable in a working direction by a dragging device, the frame being provided for attaching a number of agricultural soil working implements (208, 206, 211), the number of soil working implements creating draft forces when used and the frame having a working width (212), and wherein the soil working implements of the frame are arranged in order to
- work the soil in a first part (222) of said working width (212) of the frame, the first part (222) of said working width (212) being smaller than said working width (212), followed by arranging the soil working implements in relation to the frame in order to
- work the soil in a second part (220) of said working width (212) of the frame, the second part (220) of said working width (212) being smaller than said working width (212) and comprising another part of said working width (2119 than the first part (222), and
- wherein the total number of soil working implements along the total working width of the frame is less than the number of working implements needed for working both the first part (222) and the second part (220) of said working width (212) of the frame.

9. A system according to claim 8, wherein the frame (304) and/or the soil working implements (208, 206, 211) are displaceable and hereby arranged so that a displacement (314) of the frame (304) and/or a displacement of the implements along an axis of the working width of the frame (304) enables working the soil in the first part of said width, and
a displacement (314) of the frame (304) and/or a displacement of the implements along said axis of the working width of the frame enables working the soil in the second part of said width.

10. A system according to claim 9, wherein the displacement (314) is substantially the same for all the implements and a mutual distance between each of the implements is the same after the displacement.
11. A system according to claim 8, wherein the soil working implements (208, 206, 211) are displaceable and hereby arranged so that a displacement of a subset of numbers of the soil working implements in a direction (212) perpendicular to an axis (212) of the working width (212) of the frame (404) enables working the soil in the first part of said width, and a displacement of another subset of numbers of the soil working implements in said direction (212) perpendicular to an axis (212) of the working width (212) of the frame (404) enables working the soil in the second part of said width.

12. A system according to claim 8, wherein the frame (504) and/or soil working implements are permanently offset positioned in a direction along an axis of the working width of the frame (304) and in relation to a symmetrical position in relation to a plane parallel with a dragging direction, and the frame (504) and/or the solid working implements hereby being arranged so that dragging the soil working implements in a first dragging direction enables working the soil in the first part of said working width, and dragging the implements in a direction opposite of said first direction enables working the soil in the second part of said working width.

13. A draft force reducing system (202, 302, 402, 502, 602, 702) for working soil, the system comprising
- a frame (204, 304, 404, 504, 604, 704) being moveable in a working direction by a dragging device, the frame being provided for attaching a number of agricultural soil working implements (208, 206, 211), the number of soil working implements creating draft forces when used and the frame having a working width (212), and wherein the soil working implements of the frame are arranged in order to
- work the soil in a first part (222) of said working width (212) of the frame, the first part (222) of said working width (212) being smaller than said working width (212), followed by arranging the soil working implements in relation to the frame in order to
- work the soil in a second part (220) of said working width (212) of the frame, the second part (220) of said working width (212) being smaller than said working width (212) and comprising another part of said working width (2119 than the first part (222), and
- wherein the number of soil working implements along the total working width of
  the frame is less than the number of working implements needed for working both
  the first part (222) and the second part (220) of said working width (212) of the
  frame, and

5  - wherein the frame (204) is tiltable and hereby arranged so that
   - a tilt of the frame (204) around an axis of the working width of the frame
     enables working the soil in the first part of said width, and
   a tilt of the frame (204) around said axis enables working the soil in the second
   part of said width.

10

14. A system according to claim 13, wherein the frame (504) and/or soil working
  implements are permanently offset in a direction of the working width (212) and
  hereby arranged so that
   - dragging the soil working implements in a direction enables working the soil in
     the first part of said width, and
   - dragging the implements in the opposite of said direction enables working the
     soil in the second part of said width.

15. A system according to any of the claims 8-14, wherein working the soil in the
    first (222) and second (220) parts of said width (212) is provided by the dragging
    device using a same track (310) in the soil.

16. A system according to any of the claims 8-15, wherein the soil working
    implements are provided with the same soil working function (210) when working
    both the first and second parts of said width.

17. A system according to any of the claims 8-16, wherein the frame (204, 304, 404, 504) is being provided for extending in a complete working width (212) when working both the first (222) and second (220) parts of said width (212).

30

18. A dragging (228) device for working soil, the dragging device comprising a
    system (202, 302, 402, 502) according to any of the claims 8-17.
**INTERNATIONAL SEARCH REPORT**

**INTERNATIONAL APPLICATION NO**
PCT/DK2008/050026

**A. CLASSIFICATION OF SUBJECT MATTER**

<table>
<thead>
<tr>
<th>Inv.</th>
<th>A01B63/02</th>
<th>A01B63/24</th>
<th>A01B63/28</th>
<th>A01B63/30</th>
<th>A01B63/32</th>
</tr>
</thead>
</table>

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)**

A01B

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 practical, search terms used)**

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>DE 28 20 407 AI (WEICHEL ERNST) 8 November 1979 (1979-11-08) cited in the application page 11, paragraph 4 - page 12, paragraph 3; figures 1,2</td>
<td>1-10,18</td>
</tr>
<tr>
<td>X</td>
<td>DE 34 24 250 AI (WEICHEL ERNST) 9 January 1986 (1986-01-09) cited in the application page 57, line 5 - line 21; figures 2b,3c</td>
<td>1-10,18</td>
</tr>
<tr>
<td>X</td>
<td>DE 817 828 C (CHEMISCHE WERTE A G GES) 22 October 1951 (1951-10-22) page 1, line 29 - page 2, line 63; figures</td>
<td>8,9,18</td>
</tr>
<tr>
<td>X</td>
<td>US 2 127 579 A (ALTGEIT HERMAN E) 23 August 1938 (1938-08-23) page 2, line 56 - page 3, line 50; figures</td>
<td>8,11,12,18</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

**Date of the actual completion of the International search**

17 April 2008

**Date of mailing of the International search report**

28/04/2008

**Name and mailing address of the IS...**

European Patent Office, P.B. 5618 Patentlaan 2 NL - 2280 HV Rijswijk
Tel: (+31-70) 340-2040, Tx: 31 051 epo nl, Fax: (+31-70) 340-3016

Authorized officer

Bunn, David

Form PCT/ISA/15 (second sheet) (April 2008)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 2 409 228 A (SILVER WALTER H) 15 October 1946 (1946-10-15) column 5, line 48 - column 6, line 52; figures</td>
<td>8,11,12, 18</td>
</tr>
<tr>
<td>X</td>
<td>US 4 248 310 A (MCWILLIAMS WILLIAM R) 3 February 1981 (1981-02-03) column 2, line 50 - column 4, line 25; figures</td>
<td>8,11,18</td>
</tr>
<tr>
<td>X</td>
<td>FR 511 134 A (RENEE-MARIE PETARD) 17 December 1920 (1920-12-17) page 1, line 40 - page 2, line 50; figures 1,2</td>
<td>8,12,13, 15-18</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 342079 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH 641317 A5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2053632 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 61081705 A</td>
</tr>
<tr>
<td>DE 817828 C</td>
<td>22-10-1951</td>
<td>NONE</td>
</tr>
<tr>
<td>US 2127579 A</td>
<td>23-08-1938</td>
<td>NONE</td>
</tr>
<tr>
<td>US 2409228 A</td>
<td>15-10-1946</td>
<td>NONE</td>
</tr>
<tr>
<td>US 4248310 A</td>
<td>03-02-1981</td>
<td>NONE</td>
</tr>
<tr>
<td>FR 511134 A</td>
<td>17-12-1920</td>
<td>NONE</td>
</tr>
</tbody>
</table>