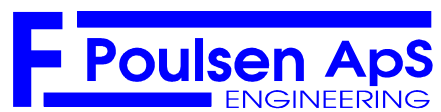


**Manual  
For**

**Mechanical Weeding Robot**

# **ROBOVATOR**

Version 05 -2011



Manual  
ROBOVATOR

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side

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## **Before you start**

When fitting the Power Take Off shaft connecting the machine to the tractor, take care that this shaft is cut to the correct length. Please be aware that the hydraulic cylinder at the top of the 3-point linkage will automatically move the machine closer to the tractor when the machine is lifted. If the shaft is too long, there will be serious damage to the machine the first time the machine is lifted!

Check if the bolts holding the implements are tight. Do not over tighten.

The machine must be vertical when fitted on the tractor.

Check oil level. Surface should be in the middle of the window.

## **Driving to and from the field**

By transport and driving to and from the field, driving from one end of the field to the other etc. The protection covers for the lenses should be turned into position. This is necessary in order to protect against dirt being thrown on the lenses from the tyres of the tractor.

(not on all models)

**Be very careful when driving over bumps or dents in the road.  
Too high speed will cause damage to the sensitive cameras because of the chocks.**

### **Drive carefully!**

It is also important that the lift is blocked against side movements. The shocks when the swing of the machine is stopped can cause damage to the machine.

When driving in the field it can be advantageous that the lift is freely moving approximately 10 cm from side to side.

When the machine is working, the automatic side movement will make sure that the machine is perfectly aligned over the row even if the tractor is 5 to 10 cm off track.

## Start and Stop

### START:

First: lift the machine off the ground. **It is not advisable to lift the machine as high as possible because this will cause unnecessary strain on the PTO-shaft.**

FIRST: Start the machine by turning the red switch.

SECONDLY: Start the PTO and make sure that the speed of the shaft is at least 420 rpm.  
(too slow speed will cause excessive wear on the driving belt and lack of cooling)

If the speed falls below 320rpm the lamps and the hydraulic pressure are switched off and a warning message is displayed in the control box.

After the computers has finished boot, wait additionally 10 sec before you press the “ESC” button.  
(this is to make sure that all the computers are ready)

### STOP:

Before you stop the machine you must decide if you want to save some parameters you might have changed.

To save the values: choose **other, commands, save values** press “enter”

Stop the PTO from turning. Wait one minute.

Turn the red switch off.

### PAUSE:

You can at any time stop driving and start again without loosing track of the plants. Just stop driving. When you resume driving the machine will continue working.

However, the plant under the camera may be lost.

If you want to make a short pause, stop the PTO from turning. When the lamps have gone out, you can lift the machine and press the ESC button.

The reason for this is that when you pres the esc button, the machine will go to the centre position. This should only be done when the machine is lifted from the ground.

You must take care that nothing is in the way when pressing the esc button since this movement of 10 cm is executed automatically and cannot be stopped.

If the pause is longer than a few minutes, turn off the red switch because otherwise the battery will be quickly drained.

## Adjusting the machine before you start

### Adjusting the No of rows:

If a 5-row machine is used in a 4-row crop, block the camera No1 or 5 with tape and remove the implements.

### Adjusting the row spacing:

It is important that the cameras are positioned above the middle of the row. It must be ensured that the line of sight (painted on the camera) points to the middle of the row. Move the cameras if necessary. Be sure that all cameras are positioned correctly; otherwise the steering will be impaired, especially at large plants.

Move the hydraulic actuators so they are positioned exactly above the middle of the rows.

After a test drive, stop the machine and adjust the outer and inner stops of the knives to suit your needs.

### Setting of MINIMUM PLANT SIZE:

The minimum plant size must be typed in the display. This value can be seen as the smallest crop plant or the biggest weed plant. The system uses this value to discriminate between crops and weed. Plants smaller than this value will be categorised as weed and will be removed.

**If the weed is comparable to the crop size, the machine can not work.**

### Setting of the camera height:

The normal position of the camera above the ground is always 42cm.

For plants larger than 15cm the camera should be positioned 50 cm above the ground.

This distance is measured from the bottom of the camera to the soil.

After positioning the camera, you must tell the system the distance to the plants. Navigate to: *Main menu/Cam Setup/Camera Height* and type in the display the distance from the bottom of the camera to the average top of the largest plants.

### Setting of the “Centre Override”:

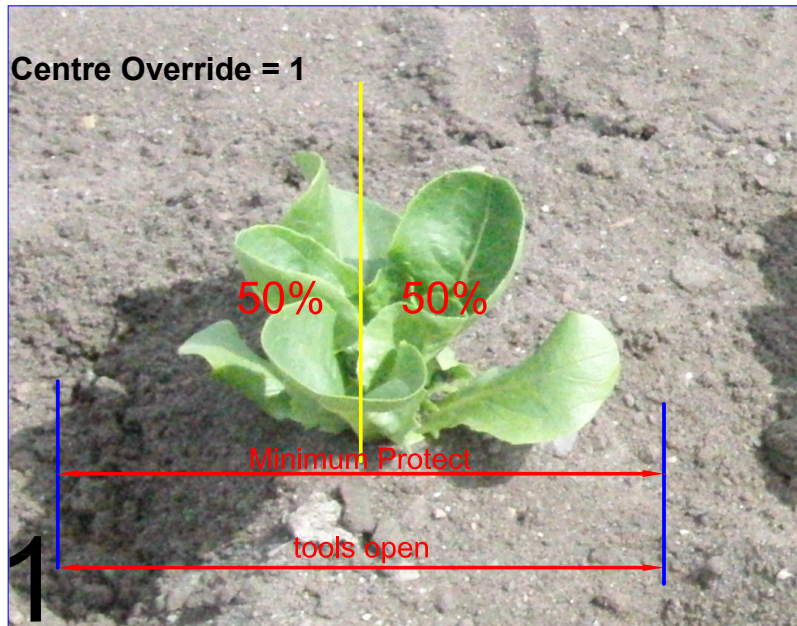
This parameter specifies how the plants are detected and how the knives operate.

When this parameter is set to 1, the the knives open and closes according to photo No1.

The middle of the plans is defined where the leaf area is the same on each side of the plant.

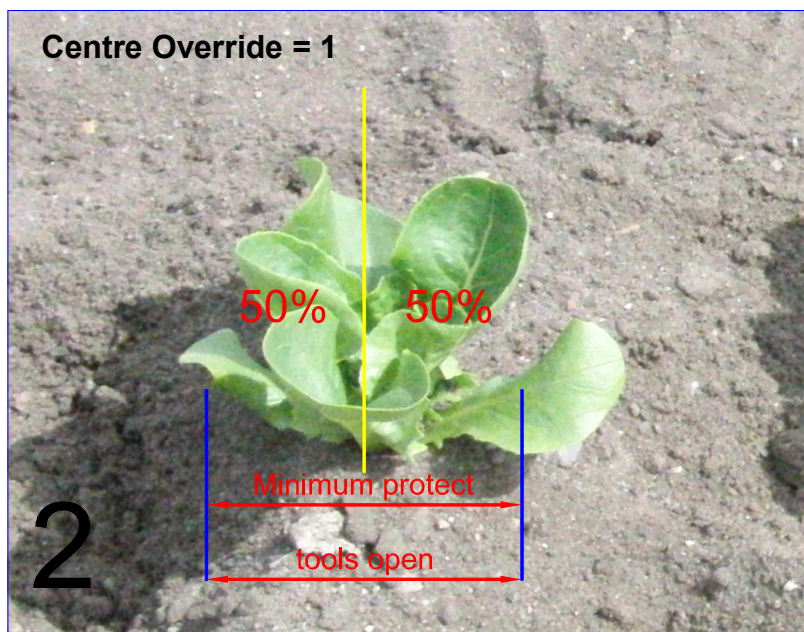
The *centre override* can be found in this way: Navigate to: the *other* menu hold the “ESC” key pressed and go to the *algorithm setup* with the arrow keys. Then choose to the *centre override* menu with the arrow key. When working with *centre override* set to 1, the parameter *safe zone* should always be 0.

The default factory setting is *centre override* = 1



The root of the plant is often close to the position of the yellow line, but not always.

The parameter *Minimum protect* controls how close to the plant the knives will work. On photo No 1 the *minimum protect* is large.



On photo No 2 the *minimum protect* is small.

### **Setting of MINIMUM PROTECTED**

The *minimum protect* is a value which specifies that the knives must stay out of the row at least this distance when they move out because of a crop plant. If this value is set too high, the tool never moves in. You can use this parameter to adjust how close to the plants the tools should operate..

The photo No 1 – 2 shows how the *minimum protect* operates.

If you want the knives to operate under the leaves, you can set a smaller value for *the minimum protect*.

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The *centre override* can also be set to 0. To do this: Navigate to: the *other* menu hold the “ESC” key pressed and go to the *algorithm setup* with the arrow keys.

Go to the *centre override* menu with the arrow key. Press enter and change the value to 0.

The program then uses the first-last method to detect the plants, see photo No 3-5.

When the *Centre Override* parameter is set to 0, you can work with both *safezone* and *minimum protect* to control how close to the plants the knives should work. See photo 3 – 6.

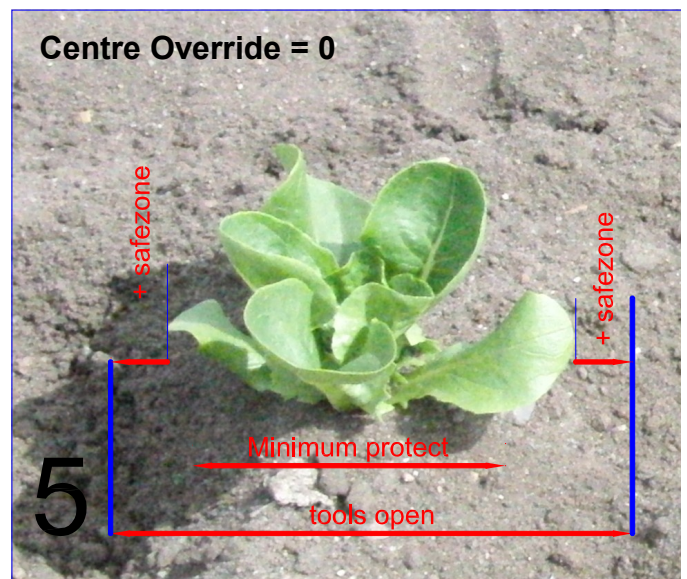
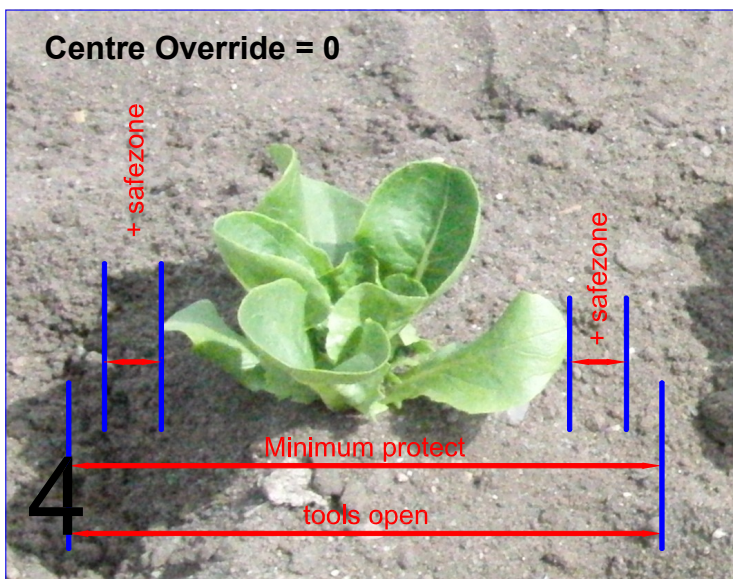
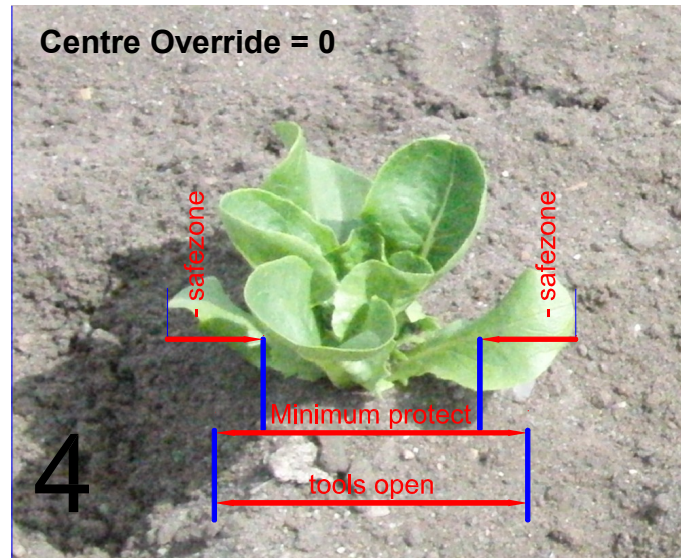
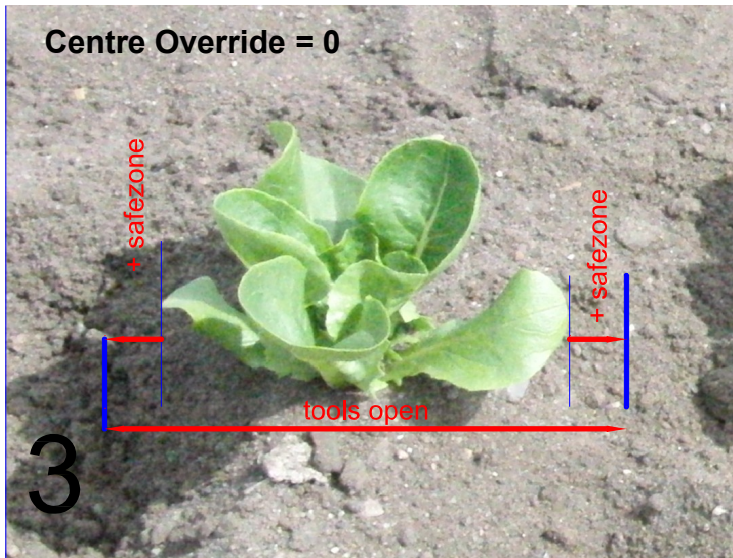


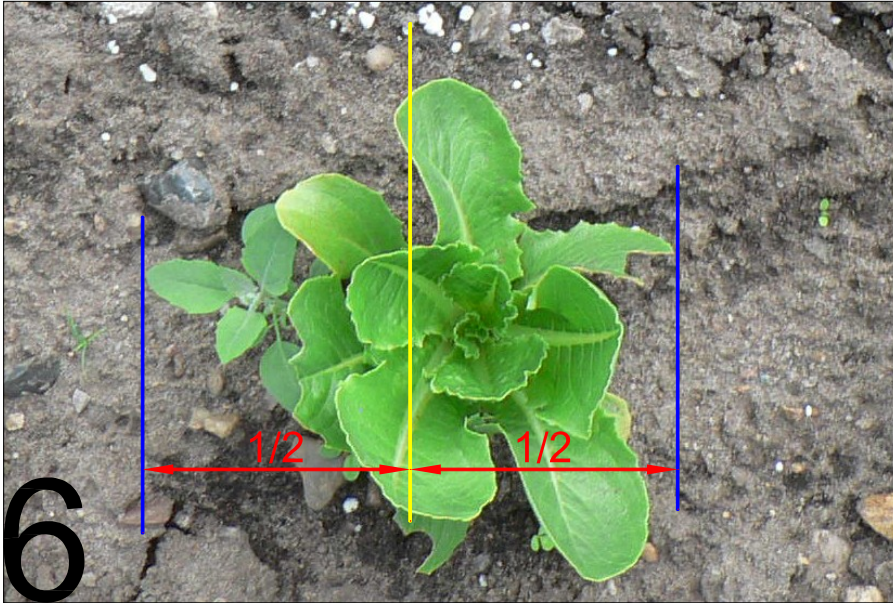
Photo No 3 – 5 shows how the knives operate as a result of different combinations of *Minimum protect* and *safe zone*

The setting with the parameter *centre override* set to 0 should be used when the plants starts to overlap. The overlapping plants will be detected as one big plant and the tools will stay open. However, if the *centre override* is set to 0 and the plants are overlapping, only the common centre will not be cut by the knives, but both plants will be taken away.

### Setting of SAFE ZONE:

The *safe zone* is the distance between the outermost parts of the plant and the middle of the knife. There is a safe zone of same size before and after the plant. The *safe zone* controls how close to the crop the machine will work.

Please notice that the cameras cannot see the block, but only the green leaves. If there is a weed plant close to the plant and the leaves overlap, the position of the plant will be calculated as photo No 6 shows.



If you want the knives to operate under the leaves of the crop, you can set a negative value for the *safe zone*.

However, if the plant is small or asymmetrical there is a risk that the knife will hit the block by choosing a too negative value, see photo No 6. In this case setting a suitable value for the *Minimum protect* will save the plant.

The safe zone is calculated from the first/last leaf of the plant if the parameter *center\_override* is set to 0.

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## **Initialise:**

Before you start to drive into the row, the machine must be initialized.

Procedure:

1. Lift the machine a little off the ground until the wheel is free
2. Press and hold the left arrow key while shortly pressing the “Enter” key
3. Stop pressing the keys

**The machine will now start a series of movements which cannot be stopped.**

It is therefore important that no persons are close to the machine while it is doing this Initialisation.

First the machine will move the parallelograms 200mm to the left. Then 200 mm to the right and finally move to the centre position.

The machine is now ready.

## **Driving in the crop rows**

### **Start weeding:**

In the main menu: choose ”activate tools” and press ”ENTER”. After 10 seconds a message is displayed informing if any of the lamps a defective. (indicated by an “E”

Drive carefully and as accurate as possible into the rows while lowering the machine 1 – 2 meters before the first plant.

If the machine is too much offset by entering the rows, there is a risk for damaging the plants.

After driving about one meter, the machine will “lock” onto the position of the row.

You can stop and start the work at any time. The machine will automatically resume the work when you start driving.

If you press “ESC” during the stop, then after pressing “activate tools” the first meter will not be weeded correctly. This is because the memory is cleared by pressing “ESC”

Only press “ESC” when the machine is lifted off the ground otherwise there is a risk of damaging the implements by the automatic sideways movement of the machine.

### **At the end of the row:**

When you arrive at the end of the row, stop the PTO and lift the machine after the last plant has been weeded. Then press the “ESC” key.

When driving into the next rows, lower the machine, start the PTO and activate the tools

## Optimizing the machine while driving

In order to ensure that the quality of the weeding is as high as possible, it is important that the machine is carefully adjusted.

### Displacement to the side:

You can adjust the position of the machine to the left and to the right during operation: Use the arrow keys and choose *sideforskydning*. The displacement takes effect when you press “Ent”.

“Left” is as seen from the tractor looking back.

Be careful not to press “ESC” because then the machine will stop weeding.

Do not use a value for *sideforskydning* greater than 10 because this will impair the steering.

### Adjusting the working position of the knives:

While driving it is possible to adjust the precise point at which the knife moves in and out of the row. This gap, in which the crop plant must be in the middle, can be moved forward and backwards. Use the arrow keys and choose “Tool No” to move. The changes take effect when the “Ent” key is pressed. This new position will become the position from which the next adjustment will be made. This is why you start at 0 next time you enter this menu.

If a knife is replaced, it would be advisable to adjust its position as described above because there can be small variations in the shape of spare knives.

However, it can be difficult to assess whether the knife works symmetrically around the crop only by looking at the crops passing. If soil is being thrown at the leaves, it can look as if the plant is being moved by the knife.

To determine exactly where the knife has been, you should do this:

1. Stop the machine.
2. Reposition the implements operating between the rows so they will not touch the soil.
3. Compact the soil a little around 3 – 4 plants ahead of the machine. Clear all plants and remove all green leaves one meter before and after this spot.
4. Drive past this site and brush the loose soil carefully away with a soft brush (better than using your fingers)
5. If the knife operated above the ground because it has been compacted, lower the parallelograms a little, lift the machine and drive backwards and try again.
6. Examine the track of the knife, to see if the knife operated symmetrically around the middle of the plants.
7. Measure any deviation and adjust accordingly in the display and on the screws on the actuators. (see section “Adjusting the movement of the knives”)

It can seem a little tedious to do this calibration, but the result will be effective for many millions of plants!

Please remember that all changes will be cleared next time the machine is switched off unless the changes are saved.

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### **Adjustment of the working depth:**

The working depth of the whole machine is controlled by the sensor at the measuring wheel at rear of the machine. The length of the hydraulic rod at the top of the machine controls the tilt of the machine and thereby the working depth of the implements. The valve at the hydraulic cylinder should be adjusted so that the cylinder moves very slowly in and out while driving in the field. The working depth is controlled by the hand wheel at the section carrying the measuring wheel.

The working depth and angel of attack can also be adjusted at the actuators by a screw located on the front of each actuator.

### **Other settings:**

You can try to increase the “*minimum plant size*” until the machine begins to take away the smallest crop plants and then decrease the value somewhat. In this way it is possible to adjust the machine to weed relatively large weed. However, the changing of plant size should be done at the end of the rows because you will have to press “ESC” to go to the “plant setup” menu. When the work in the row is resumed, the first meter will not be weeded correctly.

### **Information:**

While working you can get the following information from the display:

- Distance Driven
- Speed
- Plant count
- No of cams online
- Error status of the lamps

## Maintenance

Depending on the amount of dust it is necessary to clean the filters in the cameras.

### **Cleaning of cam-filter (not on all models):**

Remove the top of the camera by unscrewing the nut and lifting the top part off.

Unscrew the 4 M4 nuts securing the top bracket. Remove the bracket and the filter.

Place the filter element between two pieces of suitable mesh.

Tap the sandwiched filter with a stick or clean it with a vacuum cleaner. Do not use compressed air as this will damage the filter.

When you assemble the camera, do not over tighten the 4 M4 screws.

If the lens of the camera is dirty, it can be cleaned with a clean rag.

### **Cleaning of machine air filter (not on all models):**

The filter is located on the right side of the machine. (Only on model with serial No 1, 2 and 3)

Remove the cover by unscrewing the 4 plastic screws and remove the filter from the inside the cover. Clean the filter as described above.

### **Belt tension:**

The tension of the generator drive belt must be checked.

Replace if worn and retighten if too loose.

### **Battery:**

Check the level of water in the battery and replenish with distilled water if necessary.

### **Hydraulic:**

Check the level of hydraulic oil, replace with standard hydraulic oil. Eg AGIP OSO 46

For every 500 hours replace the hydraulic filter.

## Troubleshooting

To verify that the cameras are working correctly, it is possible to download a recording of what the cameras have seen. This image can be saved on a laptop and subsequently sent to: [develop@visionweeding.com](mailto:develop@visionweeding.com) for analysis.

### Procedure:

In the main menu choose: "other", "commands", "enable web interface"

Driving with "tools activated" the computers will now record an image of what is seen by the cameras. This image is constantly overwritten so that only the last 20 m at any time is being saved. Stop the machine, lift it and press "ESC" and choose "update web image" in the *other/commands* menu. For best result, stop the machine 1 – 2 meters after an error.

If your laptop has not got a fixed IP address do the following (windows computer):

In the control panel choose network connections, settings, settings for TCP/IP protocol.

Check "use this IP-address"

Type in: 192.168.1.10

In "subnet" type: 255.255.255.0

Click OK

Now is the computer set to a fixed address (10) Remember the old settings so you can undo the changes to your laptop

Connect the laptop with the machine with a patch cable. The internet connector is located inside to the right at the bottom of the gray box. Or you can use the Ethernet switch in the upper compartment (on machines from serie No 04)

Start the browser on the laptop and write 192.168.1.41 in the address field and press enter.

Follow the instructions on the screen.

The addresses of the cameras are 192.168.1.41 to 192.168.1.45

The images should be saved and sent to [develop@visionweeding.com](mailto:develop@visionweeding.com) in an email explaining the problem and a description of the circumstances.

## Adjusting the soilline:

The **Soilline** is a parameter which controls the sensitivity of the camera. By raising this value the sensitivity of the camera is decreased.

If the camera fails to detect the crop plants even if the **plantsize** is set correct, the value of the **soilline** must be lower.

If the tools do not go in between the crop plants, even if the parameters **plantsize** and **minimum protected** and **safezone** is set correct, the value of **soilline** must be raised. To adjust the soilline parameter, do the following:

In the “other” menu hold the “ESC” key pressed and go to the “Image Setup” with the arrow keys. Go to the “Soilline” menu with the arrow key.

Adjust the “Soilline” for the appropriate camera.

For each camera there are two values; the “MaxSoilline” and the “Soilline”. The “MaxSoilline” should be 20 – 30% higher than the “Soilline”.

Save the new value if the problem is solved.

Normally it is not necessary to adjust this parameter. Always check that the “MINIMUM PLANTSIZE” parameter and the “MINIMUM PROTECTED” parameter are set correctly. Remember, if plants are almost overlapping, set the *Centre override* to 0.

## Transport on trailer or truck

Remove the measuring wheel and the display and put them inside the car.

Protect the cameras from water by covering with a plastic bag which must be secured with tape.

Fit the struts for transportation on the parallelograms of the machine.

Adjust the supporting wheels so that the weight of the machine is distributed on both the wheels and the supporters.

Adjust the wheels of the parallelograms so the weight is distributed evenly on both the wheels and the implements.

Secure the machine on the truck.

## Limitations

What the machine can **not** do:

The machine can not distinguish between weed and crop. It can only distinguish between small and large plants.

If there are too many small weed plants closely spaced they will be recognised by the camera as large plants and the machine will treat them as crop plants and not take them away.

This is why the machine will only work on transplanted crops and only when the weed plants are still small.

If the soil is covered with moss or algae, the machine may not work properly because the moss or algae can be detected as large plants.