Manual
For

Mechanical Weeding Robot

ROBOVATOR

Version 09
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F Poulsen ApS
ENGINEERING

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page

Contents

1 Preface

This is the user- and maintenance manual for the ROBOVATOR.

The ROBOVATOR is a robotic cultivator for automatic intra-row weed removal.

It is developed and manufactured by the Danish company F. Poulsen Engineering Aps.

The manual is organized into a few chapters that describes basic use and also has a reference section for how to do general configuration of the machine.
This is mostly for advanced users and dealers.
At the end Maintenance and troubleshooting is described together with a short visual glossary defining the name of different parts of the machine.

The ROBOVATOR is a very advanced computerized system at the very frontier of what is technological possible.

We, the manufacturer, has done our best to simplify the use of the machine – but single button operation is however not currently possible with this level of technology and manipulation of certain parameters in the system IS needed in order to optimize the way the machine works.

We therefore encourage the user to read through the manual. Chapter 5 can be skipped, but if the user want to know better how the machine works, this is the place to read.

There are a few notations used throughout the manual.

References to the four keys are like this:
[UP],[DN],[ESC],[ENT]

References to menu entries are done like this:

[CURIER] toplevel menu item.

[CURIER]->[*ITALIC*], parameter inside menu item

[CURIER]->[*ITALIC*]->"value" textvalue of parameter

[CURIER]->[*ITALIC*] = value , set/select (text)value of parameter

If the top menu part is clear from the context, then the first part [CURIER] is sometimes omitted.

Text in **boldface** denotes important text.

2 Before you start

2.1 Transport on 3-point hitch

**Be very careful when driving over bumps or dents in the road.
Shocks resulting from too careless driving, will cause damage to the
sideshift bearings, the parallelograms and the cams.
If transporting on 3-point linkage to field, please drive carefully.
We recommend using a trailer for transport.**

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

2.2 Transport on trailer or truck

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

2.3 Protection against rain and water

The machine itself is not protected against rain. Please make sure that die display never stays in Rain. The machine itself can stand a short shower. But in general it should be protected from rain. If the machine got wet, please grease the bearings. The cam has small openings at the bottom. Please do not clean the machine with an high-pressure cleaner.

2.4 Correct length of PTO

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!

2.5 Check each day

- 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.

2.6   Connecting the machine to the tractor.

Connect the lower lift arms of the tractor to the machine.
Connect the PTO axle to the machine.
Start the PTO and make sure that the speed of the shaft is at least 420 rpm.
If the speed falls below 360rpm the lamps and the hydraulic pressure are switched off and a warning message is displayed in the control box.
(too slow speed will cause excessive wear on the driving belt and lack of cooling)

Start the machine by turning the red switch.

Now the system is starting up and will start displaying messages after about 20-30 seconds and during this process, machine will start generating hydraulic pressure. Caution: Tools might move when pressure is applied.

Press **[ENT]** 10 seconds after the display ask you to do so.

You can now use the [OTHER]->[*Commands*]->"*move toplink*" command to adjust the length of the top hydraulic cylinder to fit the length to the tractor.

Please stay clear of the PTO and observe normal safety procedures when working behind the tractor!

3   Starting and shutting down of the machine.

3.1   START and STOP:

Start and stop the machine by turning the red switch. After stopping the machine, you must always wait one minute before turning the machine on again

After turning-on the machine, the white display will be showing a static message for 20-30 seconds with information of the manufacturer. The screen will then change and show a number increasing from 0% to 100%.

Screen then displays the message "Internal Communication" while computers and electronic subsystems synchronizes.
The screen then changes to a message, asking user to start PTO.
PTO rotation speed and System voltage is shown.
At this point start the PTO, if you have not already done so.
There is a delay of up to 8 seconds before speed is detected correctly.
When the PTO rotation speed is higher than 405RPM the machine automatically continues startup (and you will hear the pressure control valve activate and pressure build up – this takes one second or less).
A screen showing the *software version* and a message asking you to press **[ENT]** is then displayed. If the version number is overwritten by a message, it can be recalled (if needed) by pressing the button labeled **[ESC]** – but ONLY in this screen.

Please press button labeled **[ENT]** to continue and reach the [Main Menu].

3.2   Navigating the Display.

Controlling the status and parameters of the machine is done via the white display box.
It has 4 keys. Two arrow keys **[UP]** and **[DN]**, a cancel/return button **[ESC]** and a select button **[ENT]**.
The Display contains a very simple menu system.
Line 1 of the Display show the currently opened menu entry.
Line 2 shows status/error messages
Line 3 shows the name of the currently selected menu OR parameter. (press **[ENT]** to open)
Line 4 shows the value of an opened parameter.

Use the arrow keys to navigate up and down in the menus.

Pressing **[ENT]** will open a sub-menu (in the [MAIN MENU] / toplevel menu - or a *parameter* in a submenu.

When a parameter has been opened/entered – its value its name is displayed at bottom line and can be changed by pressing the arrow keys.
When the desired value or text is shown, press **[ENT]** to accept and use this value.
To cancel changing the value, press **[ESC]** which resets the value and returns to the (sub)menu.

Pressing the **[ESC]** multiple times will eventually navigate back to the [MAIN MENU].

Some parameters cannot be changed with arrow keys – these just shows the value of an internal value. For example the rotation speed of the value or the current hydraulic pressure.

3.3   Initialize

After you have started the machine, you must initialize it, to be ready for weeding. Without initialization, the machine will work but sideshift (automatic sideways movement of the H-frame) will be limited and fail.

Procedure:
1. Lift the machine a little off the ground until the measuring wheel is free.
   Wheel must be hanging free.
2. Press and hold the left arrow key and the **[ENT]** key

The machine will now start a series of movements which will stop if you release the keys.
It is important that no persons are close to the machine while it is doing this initialization.

First the machine will move the parallelograms to the left. Then to the right and finally move to the center position.
When the machine has finished the movements, you can release the keys.
The machine is now ready for operation

3.4   Activate tools

In the main menu: choose [ACTIVATE TOOLS] and press **[ENT]**. After 10 seconds a message is displayed if any of the lamps are defective. (indicated by an "E")

Lower the machine onto the field and start weeding.

The machine has an automatic side shift with 40 cm range. After driving about one meter, the machine will "lock" onto the position of the row. Only if the machine is too much offset to one side when entering the rows, there is a risk of damaging the plants. In this case use the [Sideshift Override] function to adjust the position of the machine before lowering it down on the row.

You can stop driving at any time. The machine will automatically resume the work when you start driving again as long as you do not lift the machine. PLEASE MAKE SURE YOU NEVER GO BACKWARDS when the machine is on or in the ground. This can damage the tools.

3.5   Turning on headland

Lift the Robovator with your 3-point linkage of the tractor. A sensor at the measuring wheel detects after 4 seconds that the machine is lifted. The side shift mechanism will center the machine and the toplink piston will be shortened so you have more space to go round.

3.6   Shut down

At end of weeding, make sure tools are deactivated and machine is ready for transporting. Lift the machine and wait until the toplink has shortened completely and sideshift has centered. Then disable further automatic movement of any hydraulic parts including toplink and shut of lamps by pressing **[ESC]** to go back into the main menu.

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" and press **[ENT]**

Stop the PTO from turning. Wait one minute. Turn the red switch off.

4 Other parameters often used

There are many settings and parameters that can be manipulated in the system. This chapter describes the most commonly used and changed parameters that is not described elsewhere in the manual.

4.1 Sunfactor

The cameras and the software is to a high degree not affected by changing lighting conditions. But changes to the color of light that happens during the transition from night/morning to day and overcast to sunlight, *does* have some impact. It depends on the crop and camera height and machine layout whether this means that changes to the machine settings has to be made. Direct sunlight simultaneously with shadows is the worst condition.
A cover does exist as add-on that can help in extreme cases.

The parameter [*Sunfactor*] is a compensating value for conditions with a lot of sunshine OR complete darkness. Usually set it to 0 when overcast. If the sun starts to shine, the image will

usually start to be fragmented – in this case you can raise the [*Sunfactor*] to 2.0 (20 in the wifi interface). Operating at night or at very early spring, a value of -1.0..-2.0 (-10..-20 in the wifi) should be used.

If the machine fails to recognize the crop, because of strong sunlight (Tools stay closed most of the time), use a setting of +2.
In the evening or when overcast, use a setting of 0. Or -2 if Tools stay out of the row most of the time.

(If the tools NEVER move into the row – you have to try either settings as the tool stays out of the row until it has detected a plant.)

Images below shows some situations with hi and low settings of [*Sunfactor*].

The parameter is accessible from two menus for convinience.

[ACTIVATE TOOLS]->[*Sunfactor*]   and [SETUP]->[*Sunfactor*]

For information on how to access images, please consult chapter 7. on WIFI, and paragraph 11.2 in the chapter on trouble shooting.
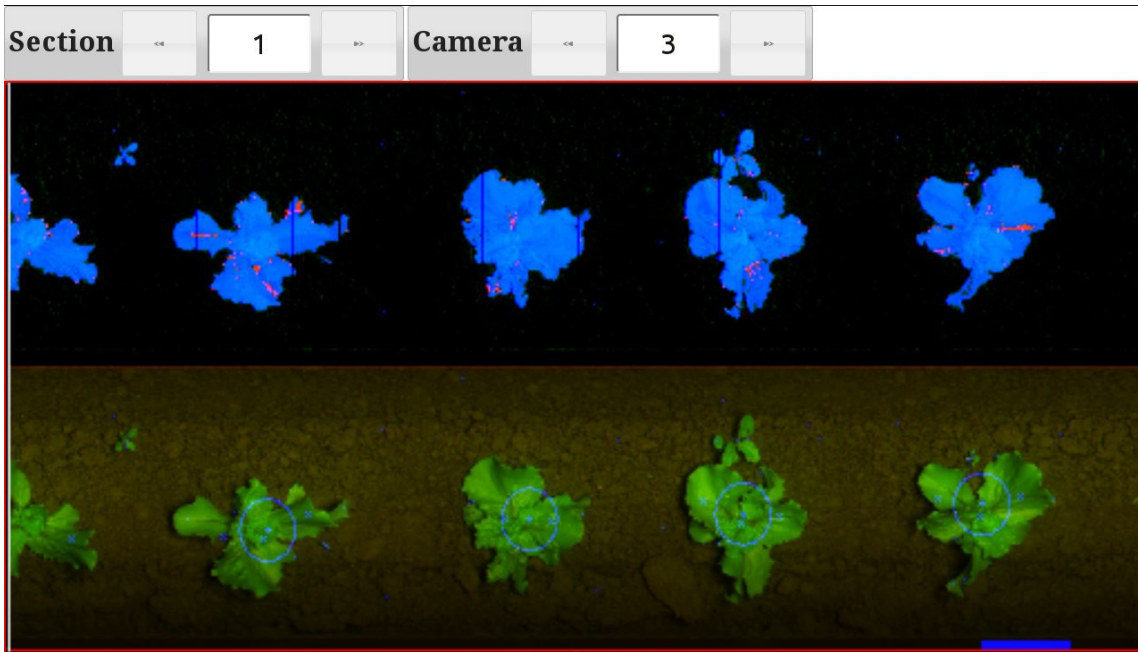
Figur 4.1: Nominal image with [Sunfactor]=0
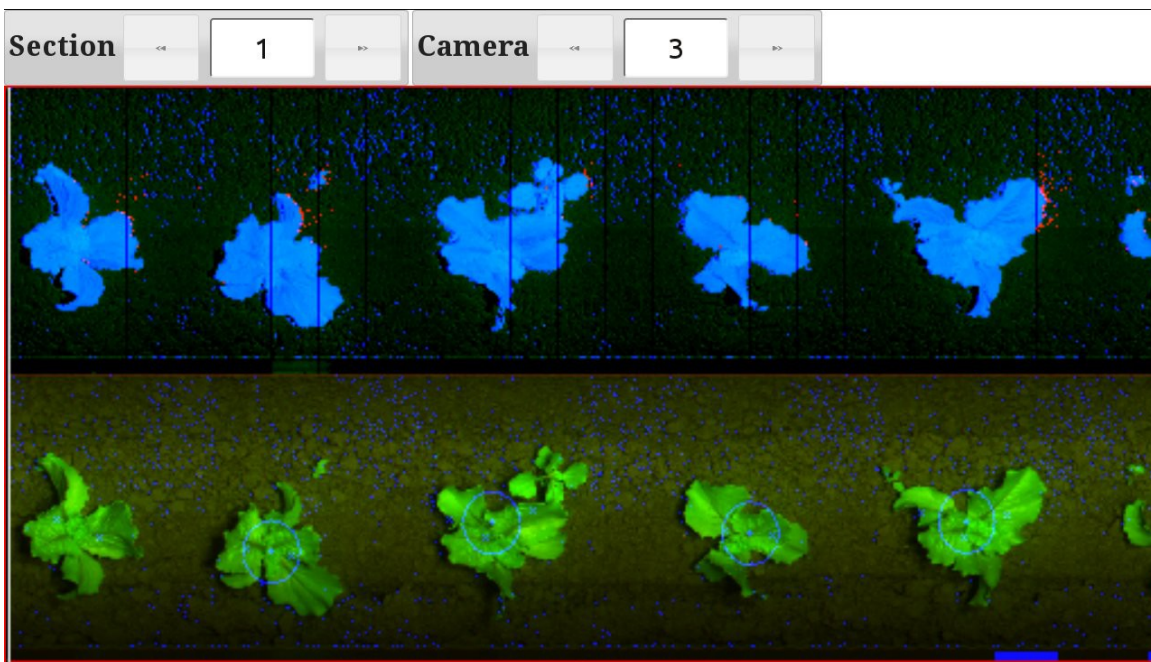
Figur 4.2: [Sunfactor] set at a (too) high value of +2.0 (20 in web interface). Background begins to have elevated values. Plants get more dense. Good if starting point is fragmented image.
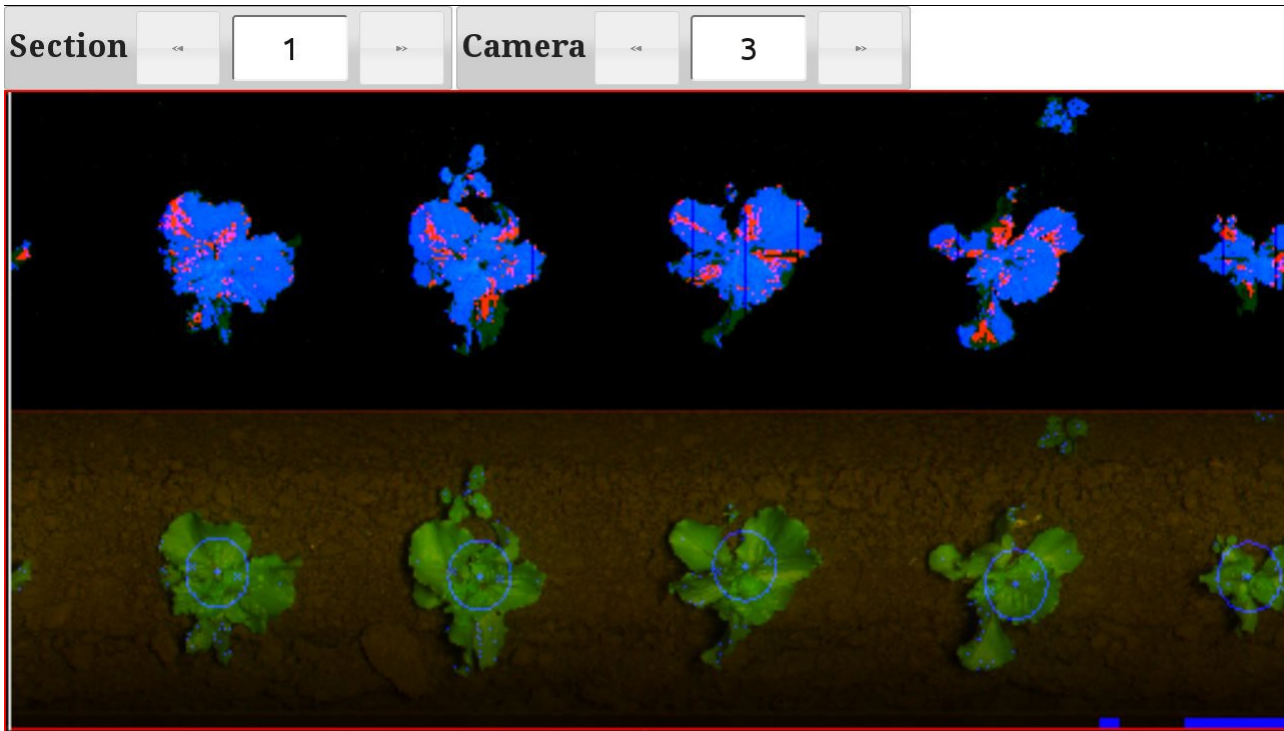
Figur 4.3: [Sunfactor] set at a very low value of -2.0 (-20) - Plants are beginning to fragment. Background is totally noise free. Small plants disappear. Good if starting point is noisy under segmented image.

4.2 PROFILES

The menu [PROFILES] provides a way for saving and loading a backup of certain parameter sets.

It contains the entries [*LOAD FROM*], [*SAVE TO*] and [*CURRENT PROFILE*].

When you select [*SAVE TO*], then you choose a slot to put a copy of the current values of some subset of parameters. However, values are NOT automatically loaded from this slot on the next

startup. I this is desired, you also have to use the [OTHER]->[*Commands*]->"Save values" command to store the values in the normal way.

When you select [*LOAD FROM*], then you choose a slot from where new values for some of the parameters are read. However, the new values are NOT stored over a restart UNLESS you go to

[OTHER]->[*Commands*]->"Save values" and use use that command.

Via the Wifi interface (See Chapter 8) you can change the slot names and give it a note.
Currently the following parameters are saved within the profiles:
Acceptsize
Plantdistance
Minimum Protect
sunfactor
safezone
centermode

Darksoil

Using profiles makes it easy to store and recall a setting for specific conditions or crops.

5   General Set up of the machine

This general configuration is normally done by the dealer. Please, follow these instructions only if you are an advanced operator, otherwise you can decrease work quality!

5.1   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.

5.2   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 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.

5.2.1   Setting of the camera height:

The normal position of the camera above the ground is always 45cm.
For plants larger than 10cm the camera should be positioned 50 cm above the ground.
This distance is measured from the bottom of the camera to the soil surface

Average plant diameter cm	5	10	15	20	25	30	35	40	50
Height from bottom of camera to ground	45	45	45	45	55	65	75	90	110

Table 1: Recommended camera height for different plant sizes

However, the camera must also be at least 35cm above the average top of the plants.

After positioning the camera, you must tell the system the distance to the plants. From the [Main Menu] Navigate to: [SETUP]->[*Camera Height*] and choose in the display, the distance from the bottom of the camera to the average top of the largest plants.
Make sure that the cameras are exactly vertical.

Do not select a significant higher value than the correct one as this can make the steering unstable. Selecting in a significantly lower value than the correct one, will make the steering sluggish and in extreme cases also unstable. However extreme precision is usually not needed – within 5-10% will

give reasonable steering and plant detection. For highest precision, measure to the widest part of the plant.

5.3   Sideshift factor

The "sideshift" is the lateral movement of the H-frame that the implements are attached to. The side shift system will continuously adjust the machine so the cameras are positioned exactly above the

plants. The side shift will compensate the deviation in small steps. You can use the [*Sideshift factor*]

to adjust how much the side shift will compensate a deviation in one step. [*SideShift Factor*] is

located in both the [ACTIVATE TOOLS] and [SETUP] menu..

A higher value will make the steering more prompt; a too high value however, will cause the machine to over steer and start oscillating

5.4   Optimizing the image

The camera combines its bi-color input to a single value that indicates whether the image point belongs to background (soil/stone/dead material) or foreground (living plant material – usually all the green stuff). Also see Figur 5.1.

A number of parameters controls how the computers interprets this value in the images from the cameras. Most adjustments are done automatically, but a few settings must be adjusted in order to help the computers to interpret what is plant material and what is not.

The 2 primary parameters are [*Soilline*] and [*Maxsoilline*] and a very important parameter is the

[*Darksoil*].

By design, the camera is virtually independent of light and shadow – but changes in the color of light (especially arising from changes in the amount of sunlight in contrast to the floodlight) can change image – a corrective parameter called *"Sunfactor"* is available and described in section 4.1. This can to some extent compensate for differences in lighting when going from night to day or from overcast mornings in the spring to sunlit summer days.

Changing these parameters can sometimes be necessary – but usually the values set from the factory will work just fine.

There is no rule of thumb for how to set these values as they complement each other and there can be more than one correct solution.

In the following the 3 primary parameters and one possible way of adjustment is described.
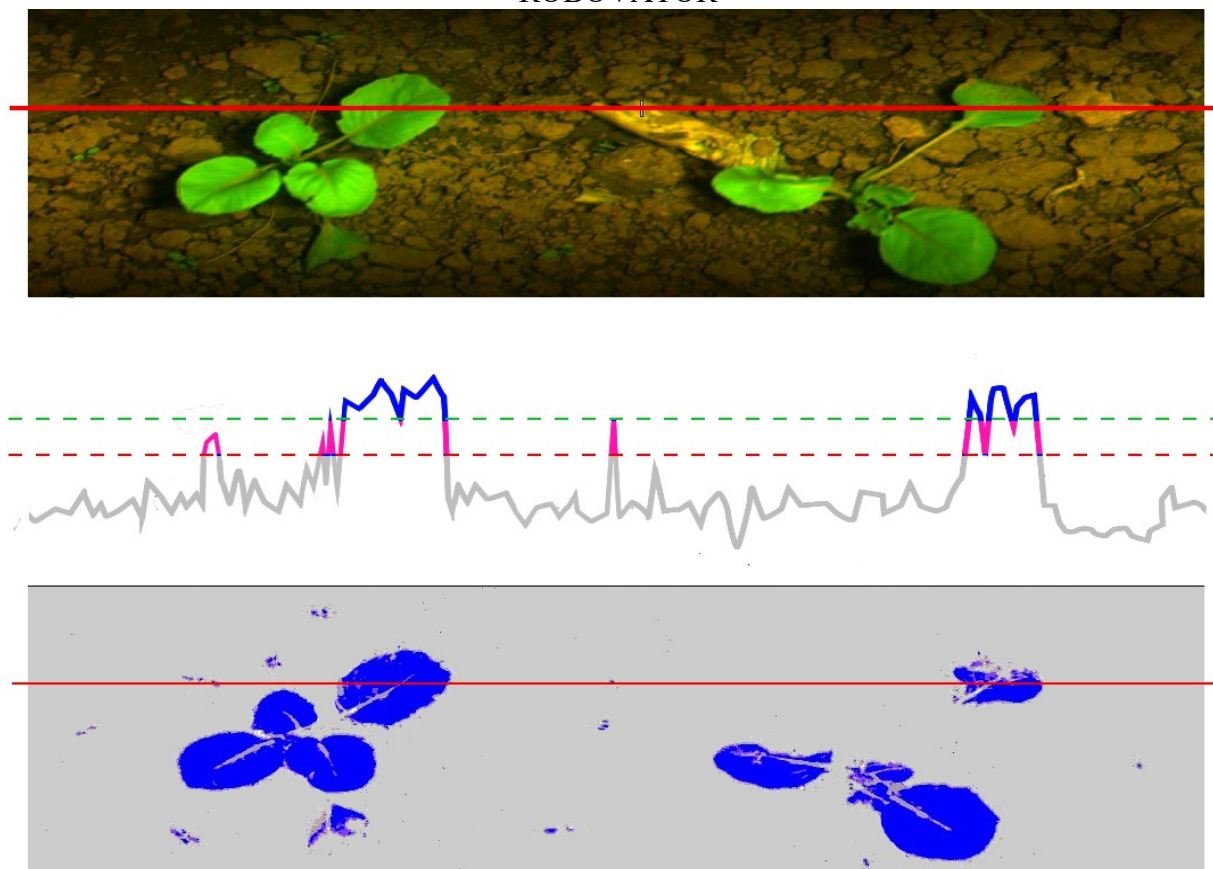
Figur 5.1: How camera analyzes the image. In the middle image, in grey, purple and blue, there is the data along the red line from the top image. Everything above the green dashed line (soilline) is plants/foreground. Everything below red dashed line (soilline) is soil/background. Inbetween values are interpreted based on context. The bottom image show the result of this analysis. Blue is what the computer accepts as plant material.

5.4.1 Soilline

[*Soilline*] can be thought of as controlling the level where background (soil) is seen as foreground (plants) and effectively controls the noise in between the bigger plants along the the row.

[*Soilline*] is a lower limit to what is perceived as plant material and prevents the system from seeing stones and other artifacts as plants. Anything below this is background/soil.
Typical values are 25-50. The lower the value, the more noise appears close to the plants and between the plants.
Soilline is best adjusted from the WIFI interface, but can also be found in the hidden menu

[LEVELS] (hold **[ESC]** while using arrow keys to access the extended menus). There is one parameter pr. Row.

5.4.2 Maxsoilline

[*MaxSoilline*] effectively controls the fragmentation of the plants – how noisy the plants look.

[*MaxSoilline*] is the maximumvalue the background can have. Anything above this value is by definition plant material.

[*Maxsoilline*] MUST ALWAYS be BIGGER than [*Soilline*]. Try to keep 5 to 15 units between those two.
Typical values are from 50-80, the higher the more fragmentation, but also more details in the shape.

[*MaxSoilline*] is best adjusted from the WIFI interface, but can also be found in the hidden menu

[LEVELS]. There is one parameter pr. Row. (hold **[ESC]** while using arrow keys to access the extended menus)

5.4.3 Darksoil

[*Darksoil*] controls the noise in the darkest parts of the image. That is, in deep shadows behind rocks or below leafs. Or if the soil is very black and/or wet. It has no impact in well lit parts of the image.
Normal value should be 0-3, but values up to 10-15 have a positive effect on noise. Beyond that, it will have a very negative effect on the rest of the image

[*Darksoil*] is found in the [SETUP] menu and there is only one for the entire machine.

5.4.4 Setting the soilline and maxsoilline, darksoil (only expert)

Prerequisite for tuning is that you have access to the images from the camera via the wifi web interface. See chapter 8.

There are two sections in the images. The lower half show what the camera records and found and accepted plants are marked by a blue ring.
The top half shows what the software *interprets* based on the parameters soilline, maxsoilline, darksoil and sunfactor. Blue colouring indicates plant material. Red colour indicates possible plant material. Isolated red is ignored by the software, but red parts that are attached to larger blue parts ARE taken into account as plant material. So generally a little bit red dots in the background is fine, but blue is not. A little bit red in the plants are also fine, but not too much. (Also see images later in this chapter)

Values [*soilline*] and [*maxsoilline*] can be found in Wifi SETTINGS menu button.
In the Display they can be found in a hidden menu accessible by holding down the **[ESC]** key and

navigating beyond the [OTHER] menu with the arrow keys. The hidden manu is called [LEVELS].

There is a seperate [*soilline*] and [*maxsoilline*] for each camera.

Normal procedure for setting soilline and maxsoilline:

Make sure that [*maxsoilline*] is only a few unit above [*soilline*]. Decrease those two values until noise begins to appear in the background. Plants will look fat and part of the background will touch.

Space between inner parts of leaves becomes foreground. Now increase [*soilline*] and [*maxsoilline*] a little bit – leave a bit of noise in the background.

Now raise only [*maxsoilline*] until plants are sharp and well defined.
It is fine to have a little bit of red in the plants. If there is still noise in the background – then raise

[*soilline*] a little bit. Only rule to obey is that [*soilline*] < [*maxsoilline*].

IF you cannot get into a situation where plants are well defined without fragmentation and at the

same time there is no or only little noise in the background – then increase [*darksoil*] a few steps until background noise disappears. The effect is very abrupt, so be careful. Max value of 10-15 should only be used in extreme cases. Fine tune soilline and maxsoilline.

5.5   Example images

In the following are shown images from the Wifi interface.
There are two sections in the images. The lower half show what the camera records and found and accepted plants are marked by a blue ring.

The top half shows what the software *interprets* based on the parameters [soilline], [maxsoilline],

[darksoil] and [sunfactor].
At the lower edge of the image – blue markings show where tool is commanded to go out of the row – ignore offset along the row, this is just a result of necessary time delays.

5.5.1 SOILLINE and MAXSOILLINE

Images below shows some situations with hi and low combinations:
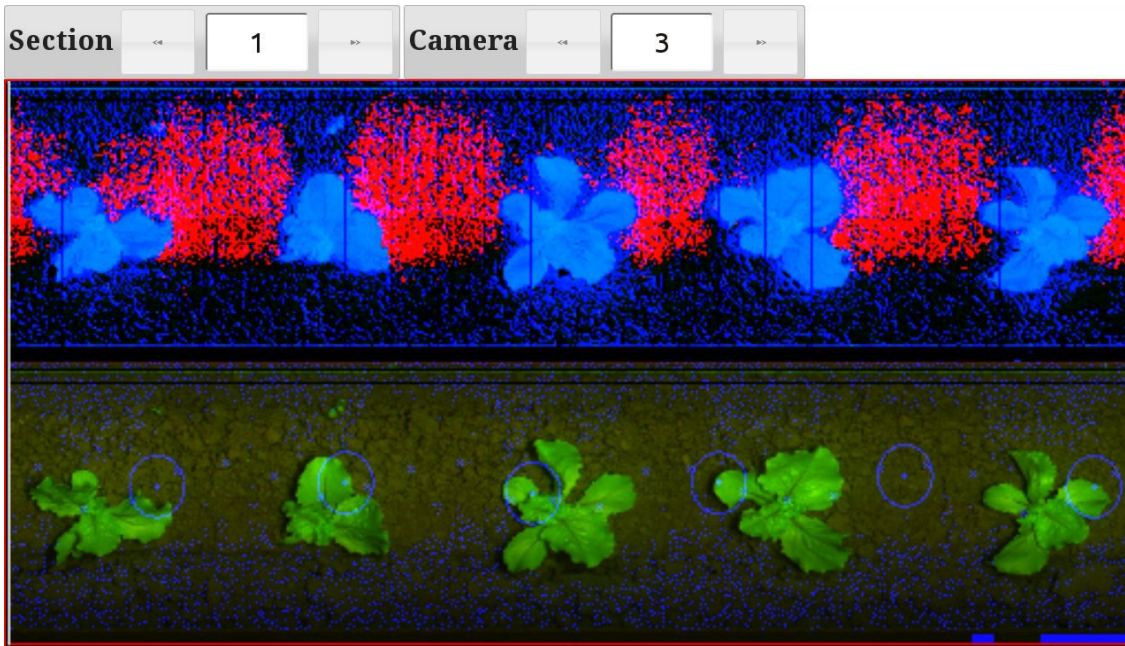
Figur 5.2: Both too low. Lots of background noise and plants are big and fat. Spills into background. Circle markings NOT on plant centers. [lowsoilandmax:15_25.jpg]
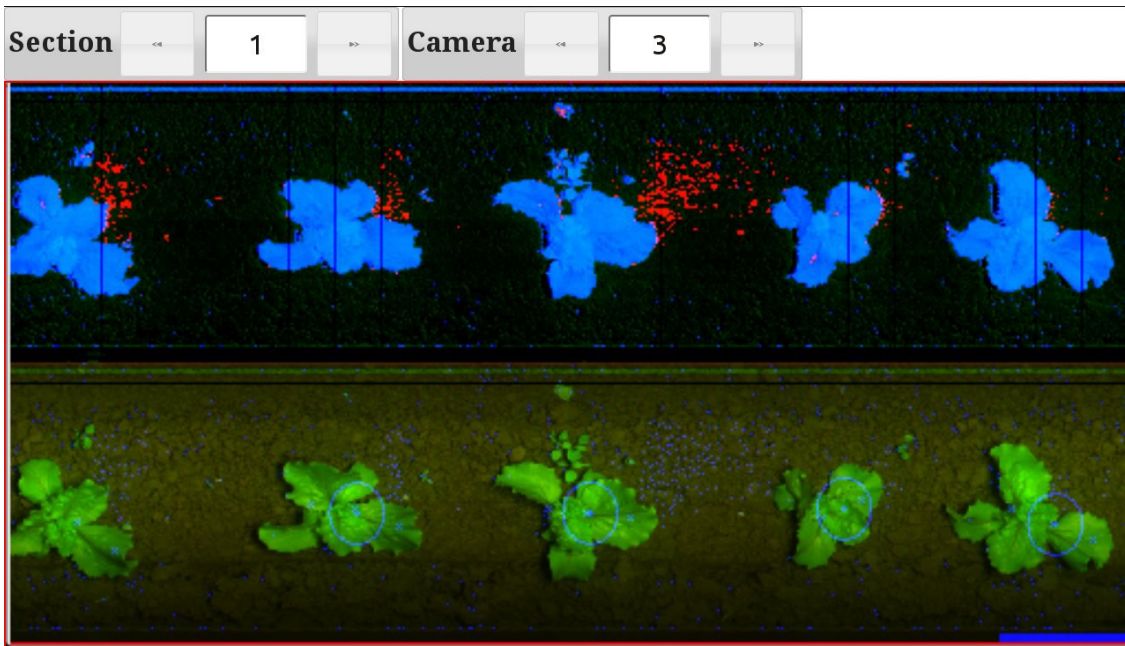
Figur 5.3: [Soilline] a little to low: Plants are cut fine, but there is elevated noise in-between plants. Typical is red patches between plants. [lowsoilline_15_70.jpg]
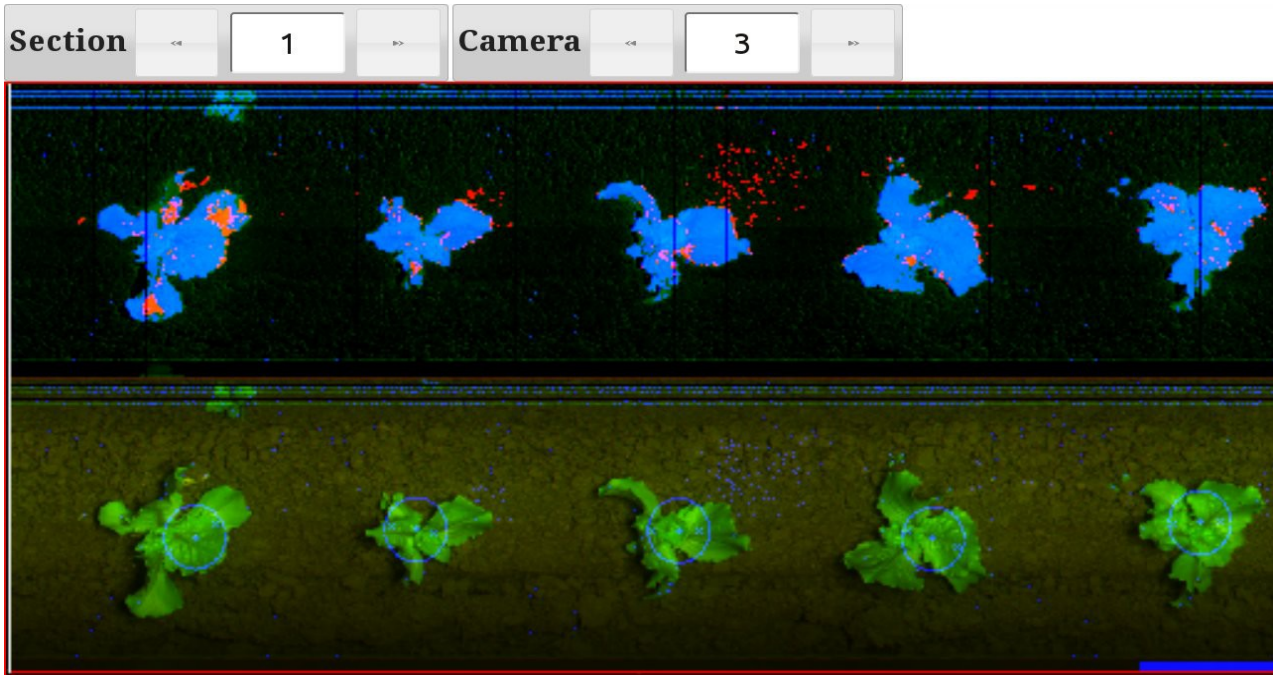
Figur 5.4: [soilline] too low, but **[maxsoilline]** too high: There is elevated noise in the background between plants, but at the same time plants are fragmented and show red and even green patches. [himaxlosoil_15_180.jpg]
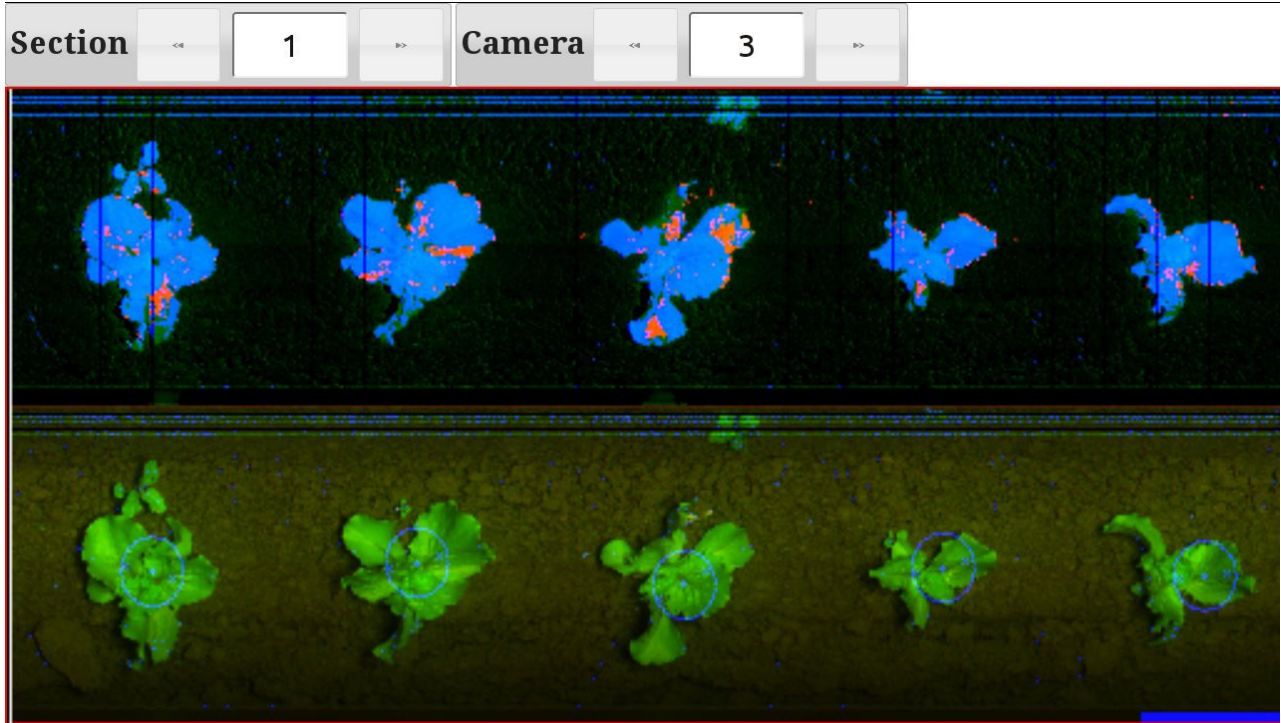
Figur 5.5: Little to high [maxsoilline]: Plants are beginning to fragment, but just a little. A good value for **[soilline]** prevents complete fragmentation despite **[maxsoilline]** being to hi – it is ok to have **[maxsoilline]** very high, but not **[Soilline]** .[himax_55_170.jpg]
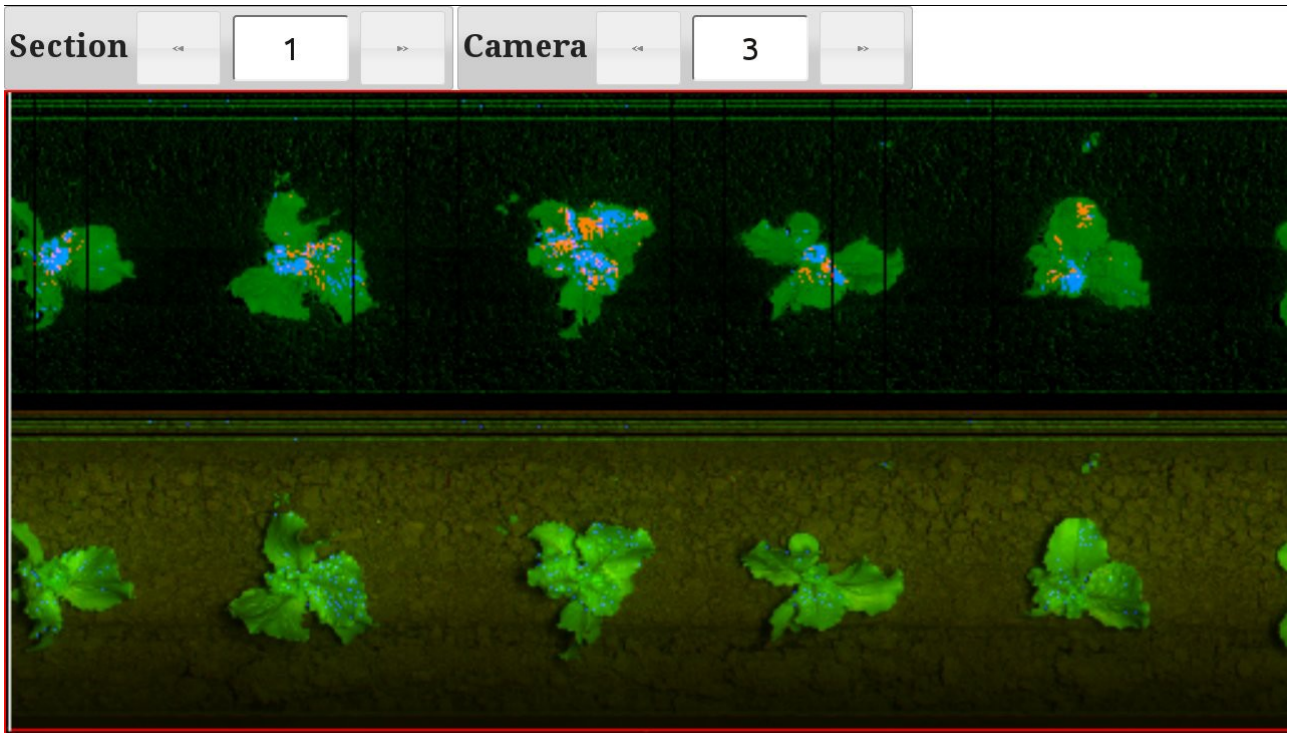
Figur 5.6: Both values to hi: When [soilline] begins to be too hi also – things get very bad quickly and foreground disappears completely or almost. - But be careful, this could also mean that [sunfactor] is set at a hi value and no sun or deep shade. [hisoilandmax_130_140.jpg]
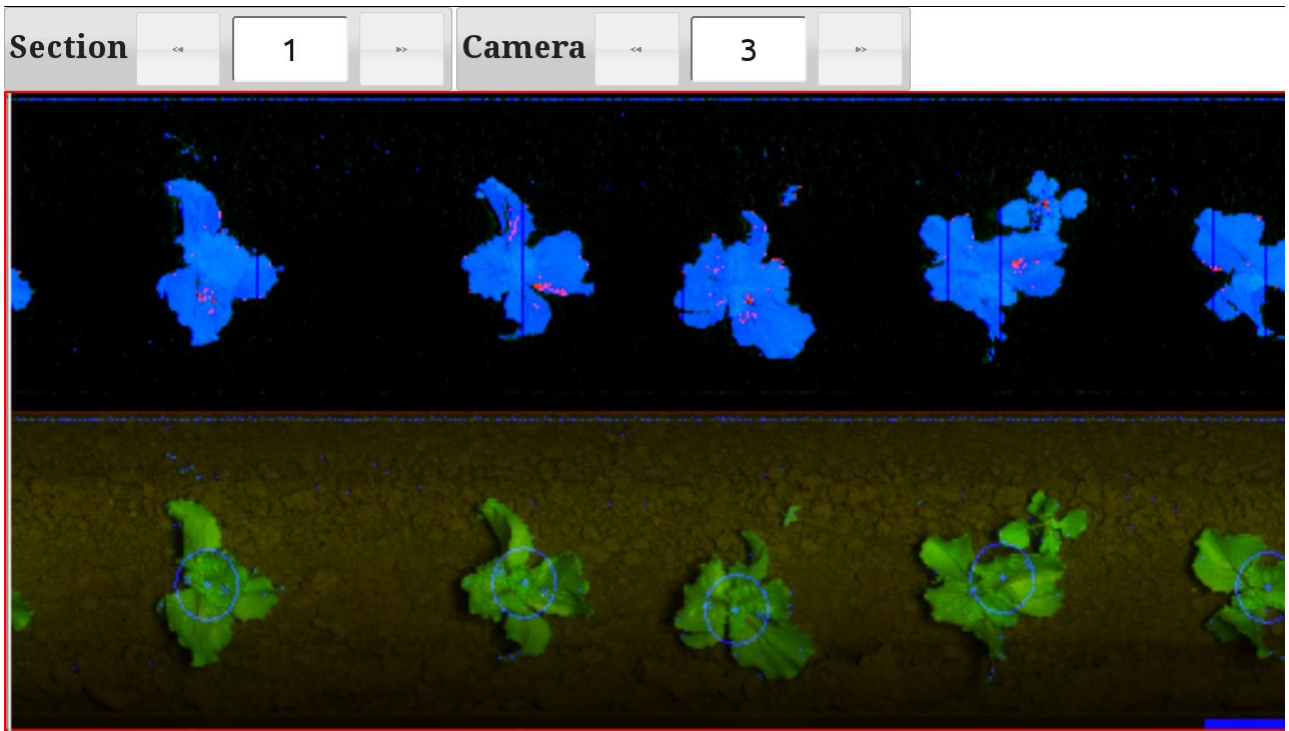
Figur 5.7: The PERFECT image: This can be VERY hard to achieve, be happy when it happens. [perfectvalues_55_65.jpg]

5.5.2 Darksoil Example images

The following images shows the effect of changing the [*Darksoil*] parameter.
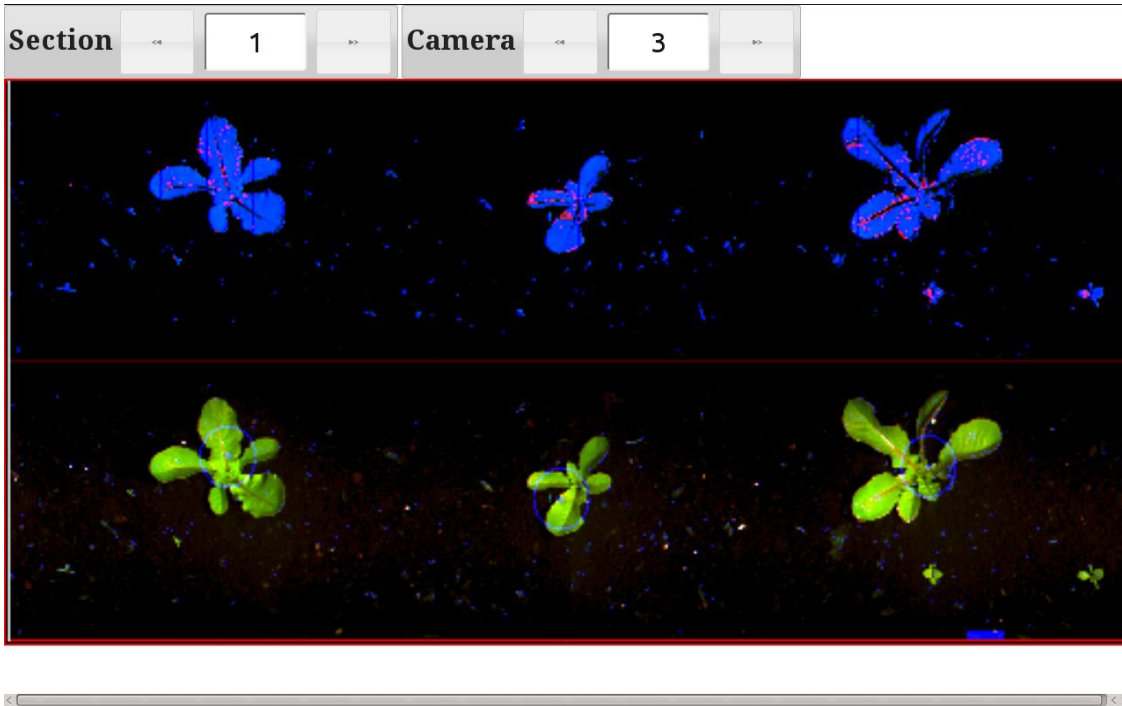
Figur 5.8: Normal value of [darksoil]
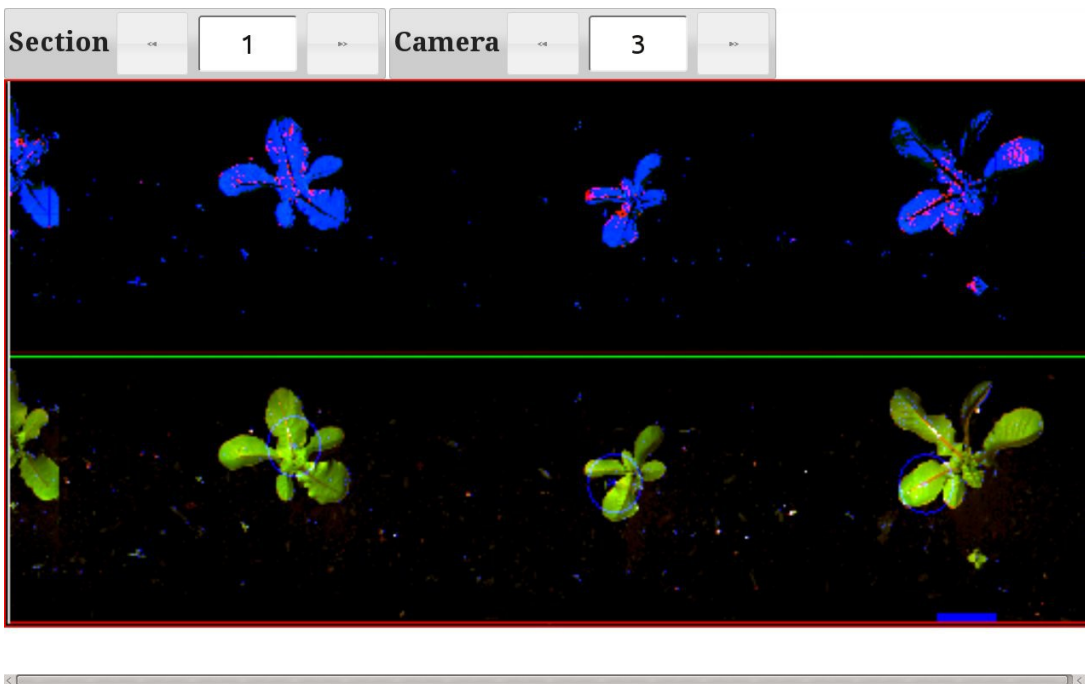
Figur 5.9: Too high value of [darksoil]
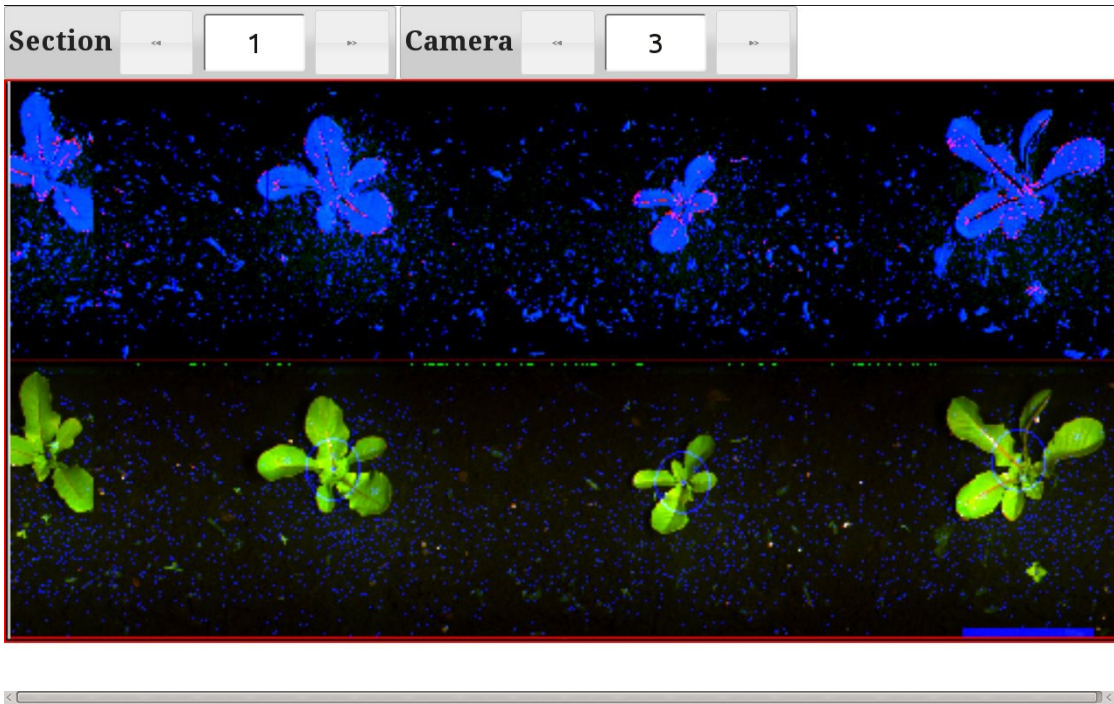
Figur 5.10: Too low value of [darksoil]

5.6   Detection type

After the images has been meassured, the computers tries to figure out where the plants are standing. This is done by analyzing the foreground and splitting and merging patches of green. To aid the computers, we have to select which algorithm to use.

This is done via the parameter: [SETUP]->[Detetction type].

Normally this parameter is set to "Standard" which will work for a majority of plants.

However in some cases, it can be an advantage to select another value for this parameter. This is most valid for systems that only should steer and not work with tools.

The following table gives a short (very technical) explanation for the different possibilities.

Detection Type	Description
"STANDARD"	For most transplanted or sown plants that can be described as "compact". By compact we mean that plantcenter is covered with leaves and that there is (overlapping) leaves in all directions. Algorithm considers and merges all foreground objects with centers within a circle 1.5x the [*acceptsize*]. Objects needs to be bigger than [*acceptsize*]. Examples are lettuces of most sorts.
"Long Leaves"	Like standard, except that algorithm only considers elongated objects. This can be tricky make work, as it depends heavily on the settings of [*soilline*] and [*maxsoilline*]. Good for "open/non compact" plants like sugarbeet that have long leafs and thin lef stems that disapear in the image.
"Every Leaf"	Simply considers every object that is bigger than acceptsize a seperate plant that can trigger the Tool.
"Non Compact"	Like standard, but optimized for plants that have the centers of the leafs fairly far from the root point. Red cabbage is a good example.
"Small Chive"	For tiny onions or chives seen sideways. Only uses half the image field so driving precision needs to to be extreme. Cameras needs to be set at an angle and in pairs of left/right. Also need configuring in a special manner in software.
"Chive"	For transplantet Onions or Chive seen sideways. Plants should be upright and fairly straight and generally not touching in the top. 10-25cm.
"Big Chive"	For big transplanted Chive and onions. Dense and upright. The top of the plants may touch, but the lower 10-20cm should be free of green material inbetween the plants – it should be possible to "look through the row". It should be possible to look through the plants.
"Onion (weed)"	Special case of Chive that is less affected by weed.
"SDU"	Special purpose.

Table 2: Detection types. Usually the Standard is the optimal value

6 Adjusting Hoeing

6.1 Plant related settings

A number of parameters related to the individual plant, controls how the hoeing works. One

parameter [*Acceptsize*] selects which plants should be protected.

6.1.1 Setting of "acceptsize"

To decide whether a plant is a weed or a crop plant the machine measures the size of the plant. There fore the crop plants must be bigger than the weed plants. The system uses the value

[*acceptsize*] to discriminate between crops and weed. This value can be seen as the smallest crop plant or the biggest weed plant. Plants smaller than this value will be categorized as weed and will be removed.

[*acceptsize*] can be found in both [ACTIVATE TOOL] and [SETUP] menus.

Set the right value so that the crop plants are not damaged but the weeds are killed.
If the weed is comparable to the crop size, you have to decide to whether to hoe both or to hoe none of them.

6.2 Protection zone

The protection zone is the area around the crop plant where the Tool has moved out of the row.

Four parameters: [*Centre mode*], [*Minimum* Protect], [*Safe Zone*] and [*ToolOffset*] controls the placement and size of the protection zone.

You have detected a crop plant by setting the right value of plant size. Now you can decide, how aggressive your tool will open.

6.2.1 Centre mode

The parameter [Setup]->[*Centre Mode*] specifies how the center of the protection zone for the plants are calculated.

You can choose between two calculation methods:

1. *"Area Center"*. When [*Centre Mode*] is set to *"Area Center"* then the protection zone is centered on the middle of the plant. The middle of the plant is defined as where the leaf area is the same on each side of the center of the plant. Tools will open symmetrically around this

    center. The size of the protection zone is solely controlled by the parameter [Setup]-

    >[*minimum protect*] and the protection area size is thus independent of the plant size.

    "Area Center" is an easy setup for circular and solitary (means single) plants. Also it is the best setting when plant sizes differ a lot.

The default factory setting is therefore [*Centre Mode*] = "*Area Center*".

Notice however, if the [*Centre Mode*] is set to "*Area Center*" and two or more plants are overlapping, only the *common center* will be protected from the knifes, and therefore both plants will most likely be taken away. See Figure 6.2

2. *"Edges"*. The [*Center Mode*] can also be set to "*Edges*". In this mode the program then detects the edges of the outermost leafs and centers the protection zone in a symmetrical way relative to these edges. Size of the protection area is thus dependent of the actual size of the plant.

In this mode another parameter [SETUP]->[*Safe Zone*] can be used to enlarge (positive values) or shrink (negative values) the protection area. Value of zero (0) means that the Tools are activated at the edges of the leafs. Negative values means the Tool will be hoeing under the leafs.

In this mode the [*Minimum protect*] is used for setting the minimum size allowed of the protected area and only comes into play if [*Safe Zone*] is set at a very negative value or/and the plant is very small (length along the row is less than the value of [*minimum protected*]).

Setting [*Centre Override*]="*Edges*" 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 while passing the overlapping plants.
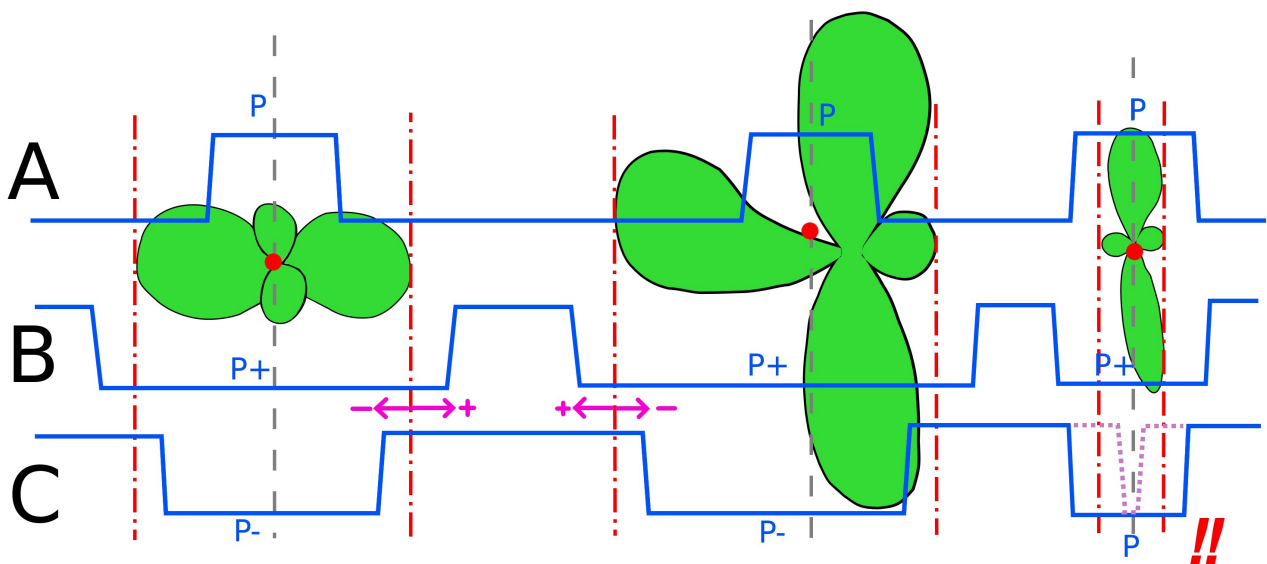
Figur 6.1 Movement of the Tool shown in blue. Plant centres and edges are marked in red.
Case A): [Centre Mode]="Area Center". The size of the protected zone is P=**[minimum protect]** and is centered on the plant *independent* of its size. Note that for asymmetric plants, there is risk of hitting root locus.
Case B)+C): [Centre Mode]="Edges". The size of the protection zone is dependant on the edges of the leafs. Parameter **[Safezone]** either enlarges the zone (case B) to P+, or reduces it (case C) to P-. However if the zone gets smaller than P=**[Minimum protect]** - then the actual protection zone will be P, as shown in the last example in case C, in order to protect the plant.

6.2.2 Settting of "Minimum Protected"

The [Setup]->[*minimum protect*] is a value which specifies what distance the knifes at least must

stay open around a center of an detected plant (see previous about "Centre Mode"). The size of the
Plant does not matter. That means they can also close under the leaves of a plant, if the minimum
protect is smaller than the radius of the plant.
If this value is set too high, the tool never closes. If it is too low, the root is damaged. You should
use a value that is slightly bigger than the transplanted block. Take care to use a larger value when
the plant is not circular and the root is not in the middle of the detected plant mass.
A good starting value is usually around 140mm (40mm block + 20mm root safety + 2x25mm knife
+ 30mm safety)

6.2.3 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 the same size at the front and rear edge of the plant . The [*safe zone*] controls
how close to the crop boarder 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 and the protected zone will
be calculated as Figure 6.2 shows.
If you want the knifes 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. In this case setting a suitable value for the [*Minimum protect*] will
save the plant because the computer will ensure that the size of the protection zone is bigger than

[*minimum protect*]. See figure 6.1 case C.

The safe zone is calculated from the edge of the first/last leave of the plant if the parameter [*Centre*

Override] is set to "*Edges"*.

When "*Area Center"* is selected, [*Safezone*] it is not taken into account and *[minimum protect]*
defines the protection area.

Figur 6.2: effect of nearby weed when [Center Mode]="Edges". Area between yellow lines is protected

6.3 Adjusting the opening width of the knifes

You can set the minimum and the maximum position of the knifes and thereby how close to the side of the plants the knifes will work. After a test drive, stop the machine and adjust the two screws on the front and back of the actuator to adjust the max and min movement of the tools. Remember to tighten the contra nut.

6.4 Adjustment of the working depth of machine

The working depth of the whole machine is controlled by the sensor at the measuring wheel at the 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 working depth is controlled by the hand wheel at the section carrying the measuring wheel.

6.5 Adjusting the wheels of the tool carriers.

You can use the handle on top of the tool carrier for minor adjustments of the working depth of the goosefoots. But please observe that you by doing this also adjust the height of the cameras and the angle of the parallelograms. The right setting is when the parallelograms are nearly horizontal and the cameras are at the specified height.

6.6 Adjusting the depth of knifes

The working depth of the actuators can be controlled by a handle on each actuator. The angle of attack can be adjusted at the actuators by a screw located on the front of each actuator.
You can also control the tension of the spring which holds the actuator in place. This spring should not be more tight than necessary because it will allow the actuator to move if hitting a large stone. However, it must be so tight that the movement of normal operation of the tools does not cause the actuator to move.

6.7 Adjusting the timing of the knifes:

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 Offset #*] to move. The changes take effect when the **[ENT]** key is pressed. To move the knife forward, increase the value; to move the tool backwards, decrease

the value. The [*Tool Offset*] parameter is only accessible when [Activate Tools] has been opened in the main menu.
If a tool is replaced, it would be advisable to adjust its position as described above because there can be small variations in the shape of spare knifes.

However, it can be difficult to asses 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 have been compacted, lover the parallelograms a little, lift the machine and drive backwards and try again.
6. Examining 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 knifes")

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.

Navigate to the [Other] menu and select [commands]->"*Save Values*" to do this.

6.8 Adjusting row offset

When making mechanical adjustments to the position of the tool carriers, the cameras and the tools – you should take care to do this as precise as possible.

However, despite being careful, the machine will sometimes not run exactly on top of the row. To make small adjustments (1-2cm), you can change the parameter

[ACTIVATE TOOL]->[*MOVE RIGHT*].

Positive values should move the entire H-frame a bit to the right of the position that the computers decides. Negative values move the Frame to the left.

If more adjustment that a few cm is needed, then set the value to 0 and then figure out what mechanical problem causes it.

Sometimes wind (or extreme sidehang) can cause plants to lean to one specific side – in that case this parameter can also be used to make sufficient offset. Be aware that the sign of the offset should be changed when turning the tractor around and going in the opposite direction.

Remember that **[ENT]** needs to be pressed to accept changes to the value.

6.9   Offsetting machine when lowering lift at start of hoeing

To make sure the cameras will correctly and fast lock on to the rows when lowering the machine at the start of the row – it will need to be set down very precisely so that the cameras are exactly (within 3-4cm) above the rows.

When machine is lifted in the Activated state, it will automatically move the H-frame to its centre.

Sometimes it can be difficult or time consuming to achieve correct positioning of the cameras by moving the tractor.

To solve this, the centre position of the H-frame can be overridden while machine is lifted.

Use the parameter [ACTIVATE TOOL]->[*Sideshift Override*] to position the H-frame such that the Tools are in the desired position and then set down the machine and go.

Machine will start hoeing from this position and the override is then reset to 0.

6.10 Dirt correction

For best results the machine must be used in dry conditions. However sometimes the soil is not dry enough and will built up a layer on the rim of the big white measuring wheel.

This will eventually result in the hoeing pattern moving a little backwards in the driving direction.

The symptom will be that ALL rows on a previously perfectly running machine needs to have its

[*TOOL OFFSET*] adjusted equal amounts in the same directions.

By making small changes to the [ACTIVATE TOOL]->[*DIRT CORRECTION*], a correction for the amount of dirt on the wheel can be made.

Usually the correction should be 1.0 for a clean tire.

Values 1.0-1.05 are possible. For a distance between camera and tool of 700mm, a correction of 1.05 will move the pattern approximately 35mm forward (5%).

[*DIRT CORRECTION*] is NOT saved together with the other parameters and thus NOT persistent across a restart of the machine.

7   Information in the display:

While working you can get the following information from the display:
- Distance Driven
- Speed
- No of cams online
- Error status of the lamps
- Battery voltage
- Hydraulic pressure
- Oil temperature (on some models)

- If there is a serious leak in the hydraulic system or if oil level is too low and air is being sucked into the pump, you will get an alarm and the system will not start.
- If the hydraulic pressure accumulator is defect or has too low pressure, there will be a message in the display.
- If the tractor is too much off course and the side shift is at its maximum, there will be a warning in the display
- If a bulb is defect, there will be a warning in the display 10seconds after activation.
- If the revolution of the PTO is too low, there will be a warning in the display and the lamps and all hydraulic valves will be turned off to save power.

7.1   Alarms and warnings

In line two of the display, the system will show Alarms and messages. The following table is a list of the most common messages and their cause.

Message text	Explanation
NO SERVO CONNECT	You tried to initialize the sideshift, but the system could not communicate with the controller. Verify that cables to the white box under the moving H-beam are intact.
PLEASE LIFT	You tried to initialize, but machine is standing on the ground OR the measuring wheel is in the transport position. Lower the wheel and lift the machine with the 3-point hitch.
CALIBRATION FAILED / CALIB ERROR	Initialization of sideshift could run to end either because user aborted or that sideshift ram did not move (fast enough). Inspect pressure+valves and for any blockage of the H-beam.
Use Master section	On a multisection machine you did not use the master display for starting the sideshift initialization. Use the correct Display.
Plantsize TOO low	You have seleted an acceptsize < 1cm. It will be autocorrected.
Plant dist. too low	You have selected a plant distance that is less than 1cm. It will be autocorrected,
BAT+RPM LOW!	Battery voltage is less than 12V and PTO speed is less than 405rpm.
GENERATOR ERROR	Generator is not charging battery
BATTERY LOW! (xx.xV)	Battery is less than 12V. xx.x shows current voltage.
LOW RPM!	PTO speed less than 405rpm
OIL LEAK???	Pressure does not rise above a certain minimum level fast enough. Hydraulic pressure system is now disabled for safety reasons. Cause is usually air trapped in the oil or low oil level in the oil tank. But it can also indicate broken hose or other malfunction so check for leaks. In case of air, then goto [OTHER]->[*Commands*]->"Failsafe PTO+HY". This will override the error and let the machine try to control the pressure. On older software you may need to restart system without PTO running and select this before starting PTO.
CHECK HY-AKKU!!	Pressure is rising TOO fast. Check the preload pressure of the Hydraulic Accumulator. It should be 50bar. It can also be a side effect of setting the pressure limits to low or too close. Finally too high PTO speed can in rare cases be the cause of this message.

Message text	Explanation
Connect Oil !	On systems without PTO input, this indicates that pressure sensor does not detect sufficient hydraulic pressure. (usually minimum 25 bars)
ELECTRONIC TO HOT!	Electronic compartment overheating (>50C). Can happen during summer in special warm conditions. Stop and let system cool. On systems with cooling system: check the fan and filter.
GENERATOR Temp.Hi!	On systems with temperature sensor on the generator (old systems) this indicates an overheating generator. Increase PTO speed OR stop the system. Clean generator with compressed air
WRITE ERROR	There was a problem writing settings to the internal USB media. Contact dealer.
OPEN ERROR	There was a problem loading settings from the internal USB media. Contact dealer.
Please Init. first	You have selected [ACTIVATE TOOL] without first going through the initialization process for the sideshift mechanism.
LAMPERR [-E-]	Shown 10 sconds after selecting [ACTIVATE TOOLS]. The "E" indicates which row does not light up. Camera 1 is at right of pattern. Check bulb and fuses.
LAMP OK	Shown 10 seconds after selecting [ACTIVATE TOOLS]. All lamps are lit. No action.
<<<<< GO LEFT!!	Sideshift is at the leftmost limit. Shift entire machine to the left to help the machine stay on track. (Or machine has lost track of the row)
GO RIGHT!! >>>>>	Sideshift is at the rightmost limit. Shift entire machine to the right to help the machine stay on track. (OR machine has lost track of the row)
CAMS LOST [-AA0AA-]	Comunication problem between computers. The 0 (zero) indicates which computer does not respond. See chapter with troubleshooting advice.

Table 3: Warnings, Errors and status messages

8 WIFI COMMUNICATION

PRELIMINARY
Information in this chapter is subject to changes and may not reflect actual system.

The ROBOVATORS has since summer 2015 been shipped with wifi and the possibility of controlling most functions via a tablet/Ipad, smartphone or computer. No special apps or programs are needed as everything is done via an internet browser supporting javascript and HTML5 (most modern browsers).

8.1 Connecting

Connect to the WIFI (Name of network =ROBOVATOR+ Seriel No of the machine)
Passw = ROBO2015 (capital letters)
Or (In case the wifi interface has been reset or not configured)
Network id= netis
Passw= password

Note: *If the network id is "netis" and there is a possibility of several ROBOVATORS working within 3-400meters of each other, then Wifi needs reconfiguring to avoid trouble connecting to the webinterface. See manual for the Wifi router – link to manual can be acquired by contacting develop@visionweeding.com.*

To connect with the ROBOVATOR open a browser (Firefox or Chrome, not Microsoft Internet Explorer) on your device.
In the address field type the address below and press enter. Save the address in your bookmarks for easy access.

http://192.168.1.199

A window should open like this:

'The main menu gives you several options:
- MACHINE USER INTERFACE
- Simple Image Viewer (Mobile)
- EXPERT menu
- LASTEST WEBIMAGE for cam3
- System LOGS and settings
- GET SOME HELP
- DATALOG256 FILES
- VERSION INFO

If you access the machine via a tablet or computer, please select "MACHINE USERINTERFACE".

If you use a smart phone, please select "SIMPLE IMAGE VIEWER"

DO NOT use the "EXPERT MENU" unless told to do so by the dealer.

The other options are described elsewhere in this manual. A few options are only there for fault finding and reference for the dealer and manufacturer.

8.2   *MACHINE USERINTERFACE*

The "MACHINE USERINTERFACE" looks like this: (in a one-section system)

Manual
ROBOVATOR
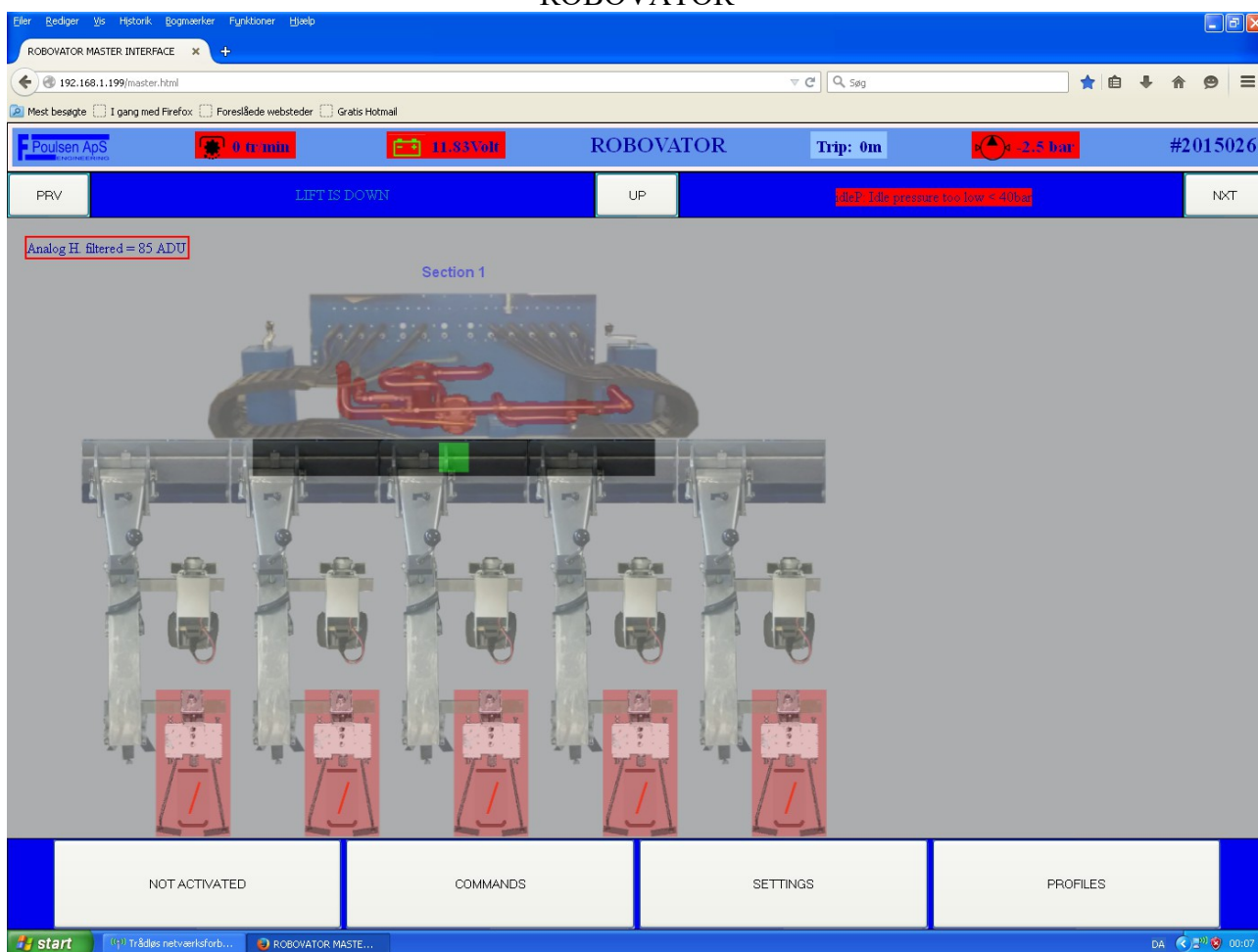
In the top line there is displayed some information like:
PTO speed, Battery voltage, Trip count, Hydraulic pressure, Serial No.
Note: if the field is colored red it indicates an error state.

In the next line you can press "PREV" or "NEXT" to go to another section (in a multisection system) The "UP" button takes you to the main section.
Some additional information like the status of the cultivator and the hydraulic system is also displayed.

A picture of the machine is displayed in the main section of the screen. If an error is present, the part related to the error is colored red.

Note the side shift bar; when the machine operates, the side shift position is displayed. If the side shift is close to the maximum movement, it will be indicated by a red color.

At the bottom of the screen 4 buttons are displayed.

The "ACTIVATED/NOT ACTIVATED" lets you control the status of the machine.

(Same function as selecting the [ACTIVATE TOOLS] menu on the display.)

The "COMMANDS" button opens the "COMMANDS WINDOW".

The functionality of the buttons in this window should be the same as the commands that can be

selected in the [SETUP]->[*Commands*] menu. Some functions will however not work. This window is preliminary.

The "SETTINGS" button opens the "SETTINGS WINDOW" The options in this menu are context dependent. When at the toplevel, settings related to the entire machine is available. When at the level with one section (toplevel for single section machines), settings related to one section and its

rows are editable. If at the level where one row (image) is shown, only [*soilline*], [*maxsoilline*] and

[*tooloffset*] is currently shown.

To see the image from a camera, simply click on the camera and the the *Camera* level opens and after a short delay, shows the latest image from the camera.
When you click on the image, it will reload after a few seconds, displaying a red cross until it updates.
To see the image from another camera, click "NEXT" or "PREVIOUS". In some cases this does not work. In that case select "Up" to go to the machine level and then select the desired row.

The image shown is the same as is shown in the "SIMPLE IMAGE VIEWER" that should normally be selected for use on small handheld units like smartphones.

Please note that the image will be black or show spurious image parts if system has not been activated or if the machine is lifted from the ground (so the sensor on the measuring wheel is activated).

8.2.1 Profiles

The "PROFILES" Button opens the "PROFILES WINDOW" where you can store and recall user settings. This feature is useful when you have a specific combination of parameters for a specific crop or field.
It is possible to save and recall 10 Profiles. Each profile can be labeled individually, f. ex. : "Large lettuce on dark soil" or "Small lettuce in sunshine" and it is possible to write a small note for the profile.

9 Maintenance

9.1 Cleaning air filter:

Depending on the amount of dust it is necessary to clean the air intake filter of the compressor (on some models). Other models do have an air filter at the computer box.
Remove the filter and clean it with a vacuum cleaner.

9.2 Cleaning of the Camera lens

If the lens of the camera is dirty, it can be cleaned with a <u>clean</u> rag with some window-cleaning detergent.

9.3 Belt tension:

The tension of the generator drive belt must be checked every 500 hours.
Replace if worn and retighten if too loose.

9.4 Battery:

Check the level of water in the battery every 500 hours and replenish with distilled water if necessary.

9.5 Hydraulic:

Check the level of hydraulic oil, replace with standard hydraulic oil. Eg AGIP OSO 46
For every 500 hours replace the hydraulic filter.

9.6 FUSES

Please choose fuse 15A size for Lamp in Lampswitch
Please choose fuse 5A size for Hydraulic valves at actuator on startswitch

9.7 Instructions to change the tools

To remove the retainer from the tool arm, heat the tool arm to 250 deg for 15 min in an oven.

You can also heat the nut with a torch, but then there is a high risk that the temperature gets over 300 deg in which case the steel looses its hardness and strength.

Remove the retainer, clean the thread and apply an anaerobic fastener like Three Bond 1373 or Loctice 603 to the thread. Take care that the thread is fully covered with the glue.

Mount the retainer, the blade and the nut and adjust the position of the blades so they are symmetrical.

Fit both the left and right tool arms in the actuator and adjust the blades before the glue settles.

The glue will reach maximum strength after 6 hours

When the tool is positioned in the actuator, make sure that the sharply bent end of the tool is correctly seated in the notch; see arrow in Figur 9.3

Figur 9.1: Retainer

Figur 9.2: Tool arm

Figur 9.3: Make sure the sharply bent end is seated in the notch

10 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 (lettuce software)

If there are too many small weed plants closely spaced they will be recognized 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 wit moss or algae, the machine may not work properly because the moss or algae can be detected as large plants.

If plant distance is larger than half the distance between camera and actuator there can be problems with tool movements when plants are very big and nearly touching in the row.

11 TROUBLESHOOTING

11.1 Boot problems

This Section only troubleshoots boot problems - it does not verify the correct function of the machine in the field.

In order to test the computers, it is *necessary* first to verify that the startswitch is working properly; therefore please follow this procedure:

1: How to test startswitch startup :

Turn on machine with a computer in slot 1.
The diode closest to the edge with 4 blue connectors on the startswitch should be blinking slowly (0.5Hz)
After 1-2 minutes it should start blinking faster (2Hz) indicating that computer 1 has established connection to the start switch.
If OK then start switch is OK and slot 1 can be used to verify other computers.

IF not, Make sure power-LED on computer 1 comes on! (if not - reinsert computer, check fuses, check voltage (12-14.8V), reinsert CFA card)
    THEN IF that does not help - change the cable to startswitch.
        THEN IF that does not help replace the computer number 1 with another one.
            IF that helps, the original computer has a fault. If it fails try yet another one
            Otherwise – start switch has a problem. - verify that jumper JP2 is present.

2: How to test if a computer is booting:
IF you think that one or more specific computer(s) does not work/boot:
THEN please insert the computer into slot 1 (nearest startswitch circuit board on the rightmost wall looking into the cabinet) and start up the machine.
The topmost diode on the start switch should be blinking slowly every 2 seconds (0.5Hz)
After 1-2 minutes it should start blinking 4x faster (2Hz)
If it does so, The computer in slot 1 is OK and can communicate on its serial bus (start-switch/display/servo).
(we assume that the connection to the start switch is ok and that start switch is working - ie. fast blinking with another computer inserted in slot 1)
If the start switch does not start blinking at 2 HZ, please proceed

IF the blinking does NOT go to the 2Hz level:
Verify that the diode labeled "POWER" on the computer (at the edge, topmost on circuit board with fan) is lit and stable (not blinking).
IF NOT - Voltage is not in range (11.7-14.8V) OR there is loose connection at either 12V or Ground at the backplane, preventing sufficient current for the startup of the computer.
IF diode is lit and you are unsure whether the start switch is working - then please turn off and put the computer at slot 3. Then startup and verify that Display is staying at the "Robovator...please wait" message. This confirms a faulty computer.
If display however works - then there is a problem with the connection to the start switch - hence this double check - proceed below "How to test the start switch"

Note: this test can also be done at slot 3

- if display continues to the **"Loading System...100% Done"** message, then the computer as such IS working. However if it does not, there can be problems with display and/or Servo and the cables to these units. Therefore testing in slot 1 is somewhat more likely to be trusted. Testing in both slots is the safest!

Few things to do with faulty computer (one thing at a time !!)
0. Verify basic hardware boot by removing ALL computers from the cabinet except the one under test.
    When powered up there should be a short beep from the computer board (not the display). If this beep does not come
    goto step 5 or replace the computer.
1. take out CFA card and reinsert
2. Replace CFA card with one from another computer that works - if this helps, get a new one from the manufacturer.
3. take off and reinsert jumper JP3 on the middle circuit board (only applies to versions 8 to 11). iokort version 12 does not have this jumper.
3. verify the insertion and orientation (stripe furthest away from backplane) of the wide grey ribbon cable connecting the motherboard with the middle circuit board.
4. Replace the ribbon cable with one from another computer that does work
5. reset cmos by moving jumper JP4 on motherboard (it might need to boot once without USB key before working correctly)

3: Testing slot 3
First verify that you have a working computer by placing it in slot 1 (assuming that startswitch is working).

Now, put a working computer (one which have passed the test No 2) in slot 3 and start up.

Because you have tested it to work with the start switch - it MUST also work with display and servo.
Therefore after 1 minute, the message in the display should change from "Robovator...Please wait" message, to "Loading System...xx%" message.
IF it does NOT do so - then there is a problem with either the display, the cable on the display, the plug on the cabinet, the internal cable from backplane to the cabinet plug OR a short circuit in the cable to the servo.

Then, after a few moments the xx in the display will reach 100% and display "Done" and then change to "Internal Communication".
It will stay there for 10-15 seconds, and then continue to a message either telling you to start the PTO or apply hydraulic pressure.
(NOTE: In this situation - the blinking diode on the start switch should go into its fastest blinking mode (10Hz) if everything else is working)

IF display is stuck at the "Loading System...100% Done" - then there is problems with the USB key or the files therein. Check that the USB cable is connected to the computer number 3 and that the USB stick is seated. If this does not help - then USB key or usb cable is faulty.
The start switch diode will NOT start blinking at 10Hz.
If machine has just been updated, then the new software might have a flaw.

IF display continues but stops at the "syncing power controller", then go to "Testing if communication from slot 3 to 1 is working"

4:   Testing communication from slot 3 to slot 1
1. Verify that you have a working computer in slot 1 (How to test if a computer is booting)
2. Verify that start switch is working (how to test start switch)

THEN IF display continues to stop at the "syncing power controller" then there must be problems with the LAN connection and/or the synchronization of the software:

1. Verify/check/replace the LAN cables to/from computer 1+3 and the power to the LAN switch. Try using another socket in the LAN switch. Please note any change in the number of lights on the LAN switch. There should be as many lights as there are computers connected + 1 for power.
2. Check/replace the narrow ribbon cable on first computer 3 - then on computer 1. Orientation is stripe furthest away from backplane on both connectors.

3. use a correctly configured computer with the SW_interface program running before startup to see numbers changing during boot in the "ROBOVATOR Segment STAUS" window. (1) means loading files. (2) means main program loading and running. a Filled/black/green dot means that user has pressed ESC and ENT and computer is at the main menu. a (3) means that main program has failed and ended. The SW_interface program can be found on the USB key in the SWINTERFACE catalog.

(Note: IF you recently have made changes to the USB key OR updated software and problems arose at first boot after change - then there is problems with missing or faulty files on the usb key. Recreate from backup. Always make backup before manual changes.)

--

After success with these steps - system should boot fully and ask to start PTO. - Please do NOT be Too fast on the buttons at this stage. When asked to press ENT to continue, it is advisable to wait at least one second before pressing ENT to get to the main menu.

Go into "Other"->Cams online to verify that all 1-8 cams show an "A". (this only applies to machines with up to 8 rows). Those with 0 has either not booted or cannot communicate via LAN. Please put them one after another in slot 1 to verify them. Computer 1 is the rightmost "A".

If this is ok - do tests in the field. If one computer fails - move it to another position and test again to verify if problem is related to computer or backplane.
Tools not moving can be either electric failure on computer, backplane, hydraulic, cables or camera.
Using sw_inspector software will help eliminating the camera.
Moving computer with error following identifies computer as problem.

(Remember to start at the top of this manual at each boot)

11.2 Camera image:

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 for analysis.

Also it is possible to record a datafile for use by the manufacturer to enhance the functionality of the machine and/or tune certain settings of the machine.

In order to download these data – either a computer (or a smartphone/tablet in case Wifi is enabled on the machine).

11.2.1   Procedure for setting up computer

[*The following is for cable connected computer. If connecting via Wi-Fi, this configuration is not necessary as the computer will get an IP number automatically*]
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: 192.168.1.221
In "subnet" type: 255.255.255.0

Click OK

Now the computer is set to a fixed address (192.168.1.221) Remember the old settings so you can undo the changes to your laptop

Connect he laptop with the machine with a patch cable. Either connect it to the external network outlet (only some machines) or open upper compartment and connect to the ethernet switch. (box with a lot of white cables going into it)

On machines with WIFI – just connect to it as described in chapter 8 with any device.

11.2.2   Procedure for simple image recording:

All newer machines with wifi or machines with updated software (version 2015.x or newer) have the web interface described in chapter 8.

However on older machines or in situations where we need a larger piece of what the machine has seen, the following description tells how to create an image from the last few meters of data.

Driving with [ACTIVATE TOOLS] selected, the computers will record an image of what is seen by the cameras. This image is continuously overwritten so that only the last 20 m at any time is being stored. (on older machines that has not been updated with recent software, it can be necessary to

first go to [OTHER]->[*commands*] and select "Enable Webimage")

When something has happened/passed that you want to look at then bring tractor to stop and press

[ESC] to go to the [MAIN MENU] . Now navigate to [OTHER]->[*commands*] and select "Update

WEB image". For best result, stop the machine 1 – 2 meters after an error.

Start an internet browser on the laptop/smartphone/tablet and write 192.168.1.11 in the address field
and press enter / goto
The addresses of the cameras are 192.168.1.11 to 192.168.1.1*x*, where *x* is the number of cameras.

You are presented with a menu – please select the bottom one called [Datalog 256 files].
This opens a new page showing a list of files. Each is a link.

Figur 11.1

There will be one file called "realdata.jpg". Click that file to view it OR right click the link and
select "save links as..". If you open the image you can also right-click the image and select "save
image as.."
The image data are the same as the examples in chapter 5.4 about optimizing the image.

11.2.3 Procedure for datafile recording

For better analysis at the Manufacturer, a datarecording can be made.

First go to [OTHER]->[*commands*] and select "*START LOG256*". Then go to the main menu and

select [ACTIVATE TOOLS]. Then drive for up to 100 seconds. Data will be recorded only when
wheel is turning.

Then go to [OTHER]->[*commands*] and select "*END LOG256*". This will end the datarecording.

Now use your internet browser to navigate to and follow the [Datalog 256 files] link as described
in the previous section. Start with ip number 192.168.1.11.

There will now also be one or more links called "rec_*YYMMDDhhmm.n.x*.raw".

The timestamp "YYMMDDhhmm" will be different – something similiar to "201510241044".
The recording number *n* and cameranumber *x*.

Rightclick the filename and select "Save link as..". You can give the file a new name that you can
remember and which is descriptive for error you are trying to document. Make sure that the

filename has an ending of ".raw" and that you do not delete the *n* and *x* numbers, as these record the recording number and the rownumber.

Proceed with the IP number 192.168.1.12 and so on until all cameras data has been saved.

The datafiles should be saved and sent to develop@visionweeding.com in an email explaining the problem and a description of the circumstances. Preferable in a zipfile with a copy of the files in base of the USB stick (NOT the subdirectories).

11.3 Computer/display

If the display says "waiting……" and nothing happens:
   Check cable to display (including connection from connector to backplane and wide grey flat cable on board)

If the display says "loading system….." and nothing happens:
   Check USB cable and stick.

If display says "internal communication….." and nothing happens:
   Check LAN, if startswitch flashes at speed 2
Check computer 1, if startswitch flashes at speed 1
If display says "oil leak" and the machine can not work:
Check that the oil level is visible in the window of the tank.
Check that there is no serious oil leak.
Tell the machine to ignore this error. Start the machine but not the PTO (on newer machines it is ok to start PTO).

Select [Other]->[*Commands*]->"*Safe HY/PTO*" and press enter.
Start the PTO.

11.4 Cams lost but the machine is still working:

The LAN switch is defect or the LAN cables/connectors have problems. Check/replace the narrow grey cable from mainboard to IO-board

11.5 Lamp not burning

If "lamp error" is indicated in display/tablet, check bulb, check fuse on lamp switch, check cables on lamp switch and lamp.
If "lamp error" is not indicated in display/tablet, check the computer (refer to chapter….)

11.6 Tool not working (one row)

Check if computer is on-line (use display/tablet)
Check the image on the tablet, verify that there is a blue line in the left side of the picture indicating the opening of the tool. If image/blue line is OK, check the cable from the backplane to the actuator.
If blue lines are missing change the settings to smaller plant size.
If the image is not ok, look for loose connections of the 3 cables between the camera and the backplane of the computer. Take out the cables and inspect the connectors for dirt and insert the

connectors again. Do this also on the camera end of the cables. Be careful not to put the cables in the wrong sockets. If problem persists switch the computers to see if problem stays on this row.
Check that the tools can operate:

In the menu [SETUP]->[*toolmode*] choose "Allways closed"

Go to the main menu and select [Activate Tools] to activate the machine: The tools should close. Deactivate the machine: The tools should open. If the tools fail to operate, check the glass fuses on the start switch.
Check the hydraulic valve by connecting 12 V to the solenoid to see if the tool moves.

11.7 Tool not working (more rows)

Check if computer is on-line (use display/tablet)
Check the image on the tablet, verify that the blue lines in the left side of the picture indicating the opening of the tool is OK. If there is a lot of black stripes in the images, check the speed cables/speed sensor wheel. Check that the wheel is allowed to run on the ground at all times and not lifted into the air. Check the cables from the wheel to the machine.
Remove the speed connectors from the backplane one at a time and put them back into their sockets.
Remove and replace the 2 black jumpers on the backplane with the jumpers installed.
To check if there is a problem with the speed signal do this:
In the display go to "trip menu" read the display. Mark the position of the wheel. Turn the wheel 10 revolutions forward. Turn the wheel 10 turns backward to the same position. Reed the display. The reading should be very close to the first reading.
If the error is more than 3% there is a problem with the wheel, cables or other hardware.

Note: The speed signal was reversed from PWR version 003C to 003D.

Check that there is not too much weed.

11.8 Steering not working

Verify that the pressure is ok. Verify that the machine can do the initialization.
If machine moves to the center, check the up/down sensor.
Check the images on all rows.
Check that there is not too much weed.

Un precise steering can be due to problems with camera or servo-controller.
Servo controller troubleshooting:

1. does the display give a message like "no servo connect) at startup? If yes, check all cables to servo-controller. If this does not solve the problem, replace servo-controller
2. Does display give a message like "pls. lift machine" if yes, check that the sensor sensing the that the machine is lifted functions properly, check that the signal is present at the startswitch. (see that the diode comes on and off when the machine is lifted and lowered)
3. Does the display give a message like "error at initialization? When the machine is initialized? If yes, check the ball bearings allow free movement of the frame.
4. Read the system pressure on the display, is it between 60 and 100 bar? If not, check the cables to the hydraulic valve controlling the pressure. (bottom of machine close to electric battery) If no pressure, hydraulic valve maybe defect)

5. If still problem with servo-controller, remove the connectors (mark the positions) and connect a wire from battery to the valves (right valve at bottom of tank looking into the machine). If you connect the outer spool to the battery, the frame should move in the one direction, when you connect the other spool to the battery, the frame should move in the other direction. If the frame does not move, and the pressure is ok, the frame is stuck or the valve is clogged.

11.9 When lowering the machine, measuring wheel does not touch surface

Depending on the geometry of 3-point hitch and toplink and field conditions (tracks) the robovator might be tilted very much. As a result of this, it might occur that meassuring wheel does not come in contact with surface when the machine is standing on its support wheels.

In this case, just disable the Tools by pressing **[ESC]** and then activate the Tools again by pressing **[ENT]** (assuming Tools was activated). The toplink will now press outward and lower the machine until it detects contact with the surface.
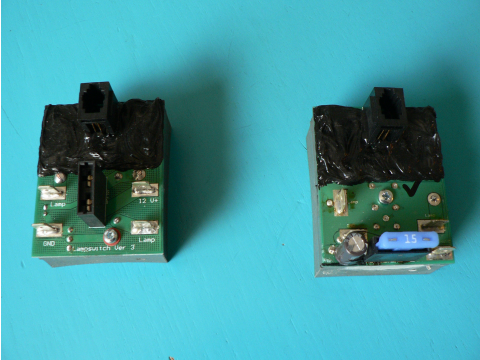
(repeating will pull it in again)

For a more permanent solution – use another hole at the toplink to move machine further back. Just keep in mind that when machine is vertical, the toplink piston should be able to move 3-5cm in each direction.
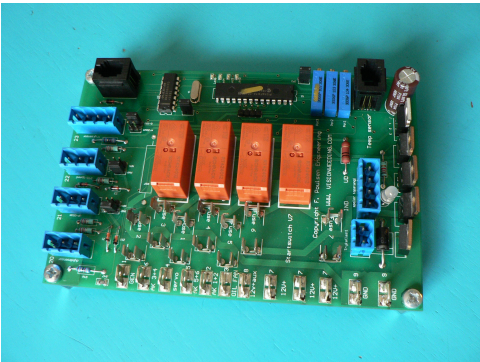
12 Glossary:

The Lamp switch is used for turning the lamps on and off and for monitoring the status of the lamps. It is connected to the backplane with a flat 4-wire telephone cable.

The start switch is used for controlling power to the tools, for controlling the hydraulic pressure, the generator, the depth control and for other functions.
It is connected to backplane 1 with a flat 4-wire telephone cable
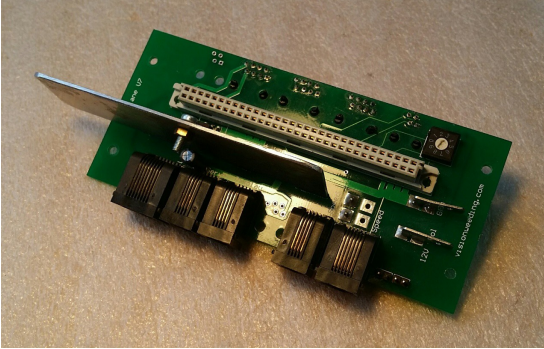

The LAN (Local Area Network) switch is used for connecting the computers and the router with each other.
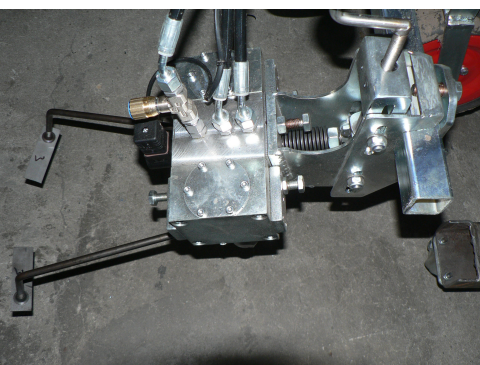
The Actuator operates the tools.
The tools consists of the tool arms and the knifes

The Backplane that connects the computers with the rest of the machine.

The Computer that does all the processing of the data from the cameras. There is one computer pr. Row.