Tillett and Hague Technology Guidance and Control System Brief Operators Guide

In-row

Disclaimer:
Considerable effort has gone into making Tillett and Hague guidance and control systems reliable under normal commercial conditions. However, it is possible that under some adverse circumstances the guidance system will be unable to operate reliably. It is the operator's responsibility to ensure that the machine is operating in a satisfactory manner. Should a fault develop, or excessive crop damage occur, operation should cease and if necessary, advice sought from your dealer or implement manufacturer.

V10.18 Inrow March 2026

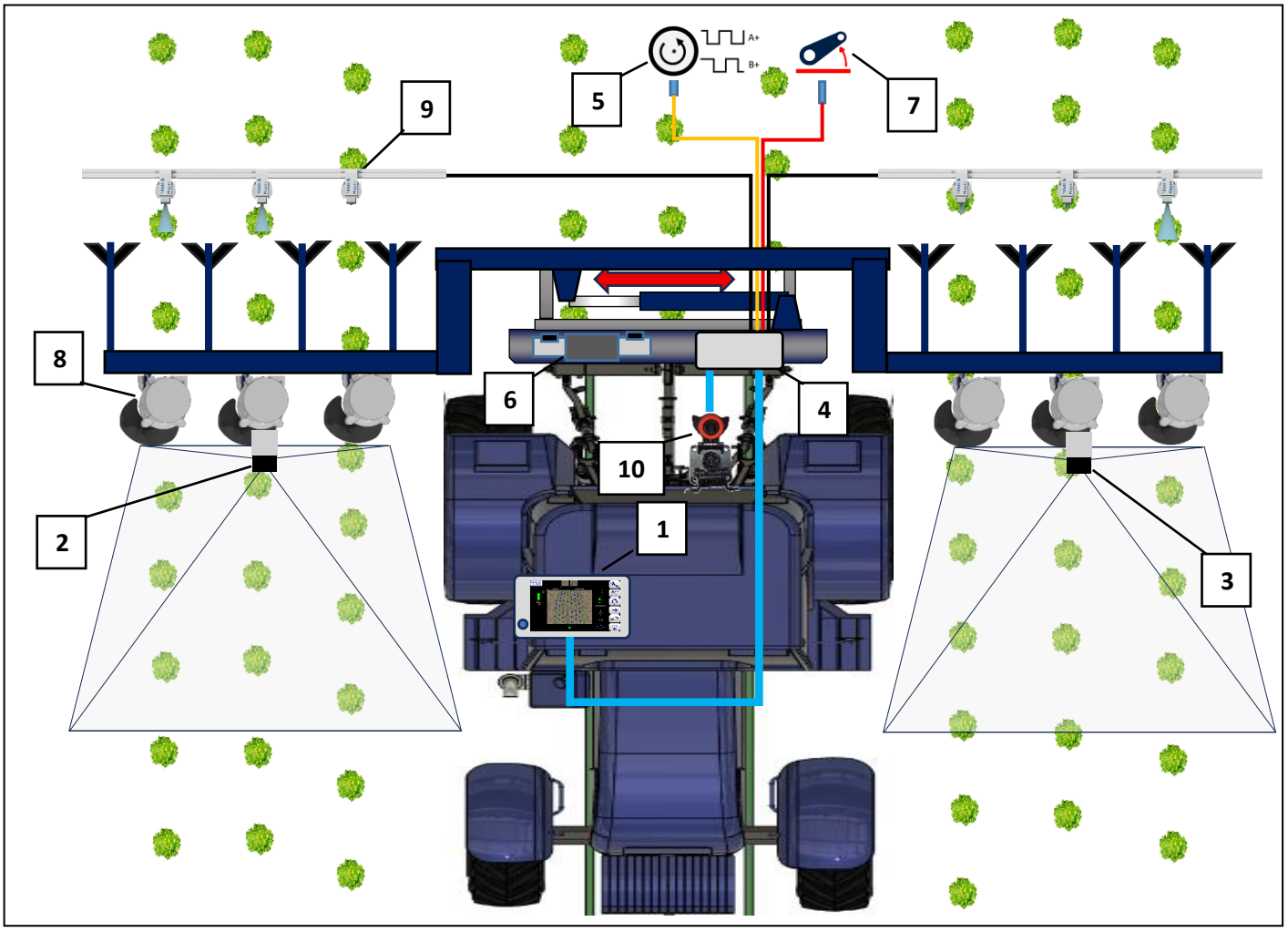
Contents:

1. Product description

This vision guidance system analyses data from digital cameras to identify crop rows. Rows are tracked over successive images and their position be used to steer an implement laterally relative to those crop rows. When running in in-row mode individual crop plants are also tracked so that in-row cultivators or spray nozzles can be synchronised with plants as they pass under the implement.

The main components to the system are:

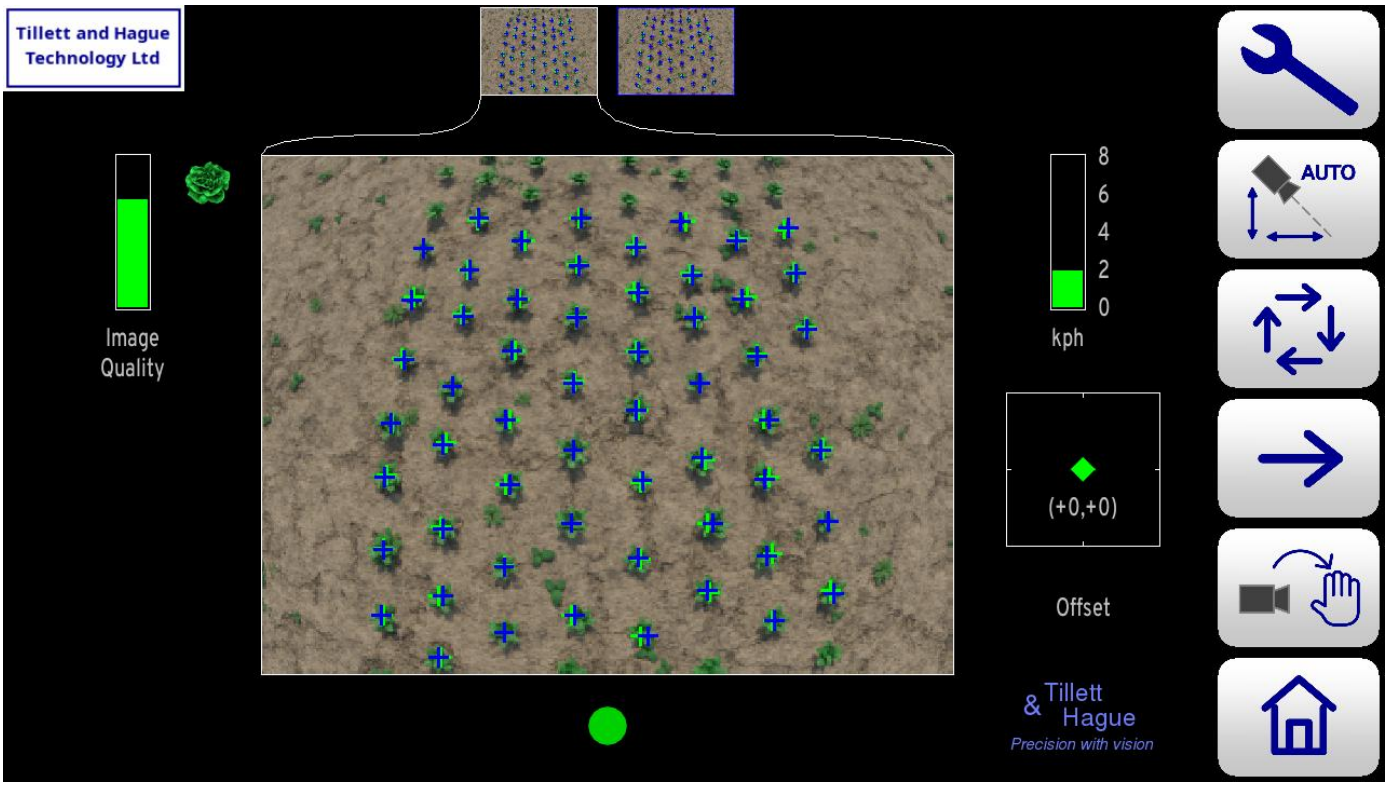
- A digital camera **(2)** or cameras **(2/3)** mounted on the implement looking ahead at a wide area of crop viewing all rows to be tracked.
- A cab mounted console **(1)** containing a computer to analyse camera images and find crop row/plant centres.
- An implement mounted control box **(4)** housing an electronic board that controls hydraulic valves **(6)** for side shift or disc steering. That board also accepts input from position and proximity sensors **(5/7)** necessary for closed loop control.
- In-row cultivators **(8)** and/or nozzles **(9)** are connected to the implement module **(4)** via CAN.
- ISOBUS connection (**10**) for lift and odometer input is an option.



Schematic of a rear mounted in-row guidance system with side shift

The system uses a colour camera to pick out green crop and weed from backgrounds containing soil, stones and trash. (Systems can also be configured to work in crops of other colours.) Crop plants are located within a scene by matching a template corresponding to the known planting pattern with crop plants as they appear in the camera image. That image is displayed live on the console with individual crop plants overlaid with blue and green crosses for in-row and crop rows overlaid with green lines for inter-row.

Live video display allows users to check for a good match between template and actual crop geometry, which is important for accurate plant tracking.



Console working screen showing a typical live video image for a 2-camera in-row machine with the template superimposed as blue and green crosses over individual crop plants.

2. Safety

1. Machines should be operated under general safety and accident prevention regulations.

2. The operator is responsible for safe operation of the machine even when automatic steering is operating.

3. The guidance system is only intended to guide agricultural implements within agricultural fields.

4. When carrying out repairs or adjustments to an implement, ensure that that the hydraulic supply is **OFF**, and pressure is **ZERO.** If electric rotors are fitted ensure the 42V supply is turned **OFF.**

5. Never conduct maintenance work on a side shift mechanism while it is supporting the implement.

6. Side shift and steered disc mechanisms form pinch, trap and shear points. Be aware of these when carrying out maintenance.

7. Regularly check the condition of electrical cables, hydraulic hoses and fittings.

8. Do not allow other persons to ride on or work near an implement when it is in operation.

9. The optional tractor power supply cable has a 20Amp fuse fitted near to the battery terminals. This is for short circuit protection and must not be omitted. If connecting to an existing 12V power outlet ensure that it is appropriately fused.

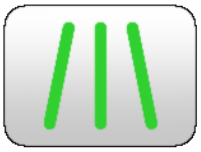
10. When routing the loom and power supply cables ensure that they do not cause a restriction or trip point in the cab.

3. Information screens

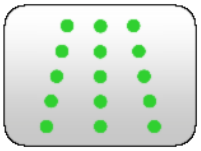
Home Screen

Switch the console on by pressing the button for a second or two until the button is illuminated. Wait for the system to “boot up”. After a few screens of PC boot up text the start up screen should appear.

From this screen you have the option to enter the Inter-row working screen (Three green crop rows symbol), In-row working screen (9 discrete plants symbol), Service Tools Menu (Spanner and screwdriver symbol) or the Configuration File Editor (Pen and paper symbol). This abbreviated version of the manual only covers the in-row and inter-row working screens. For more information consult the full reference manual.



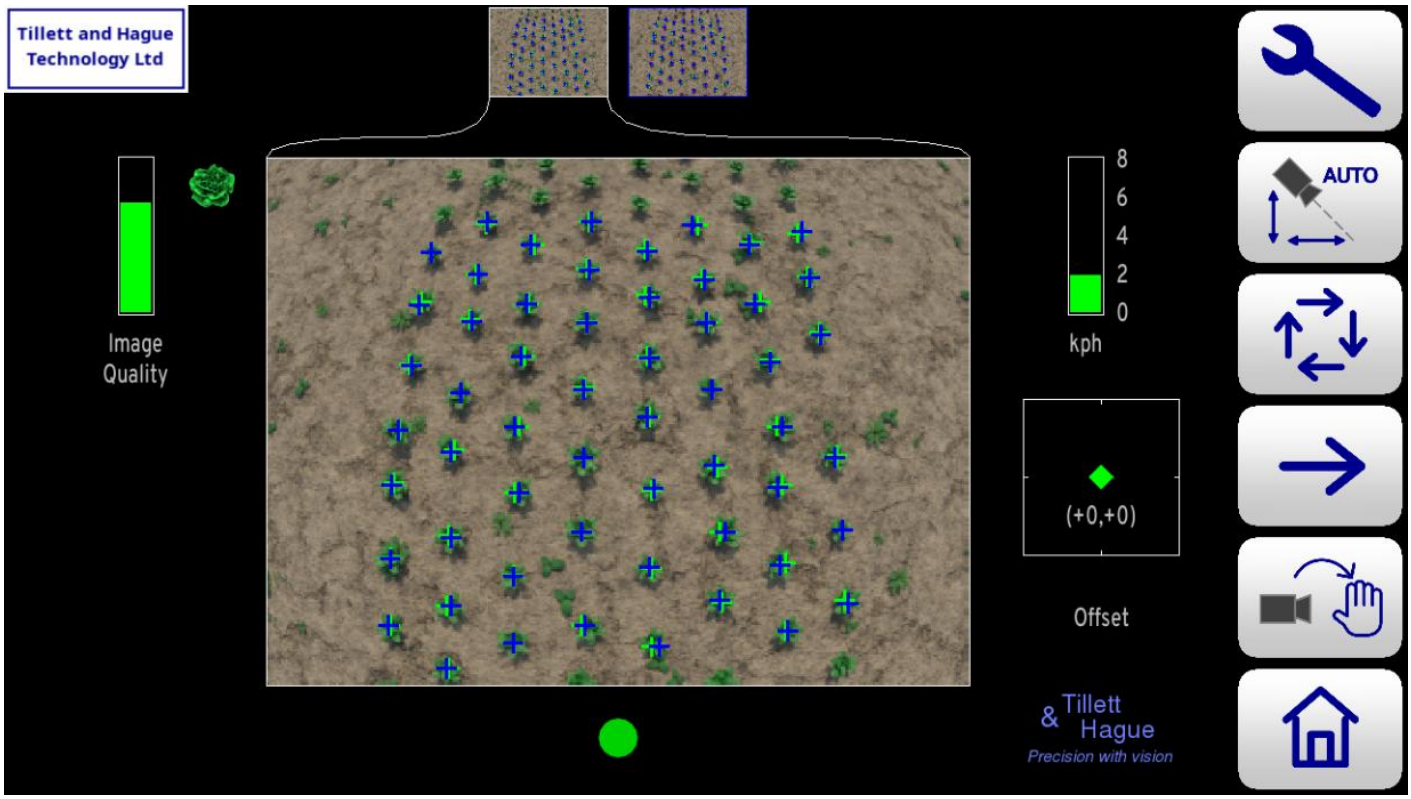
Use the touch screen button with a 3 crop rows symbol to enter the inter-row working screen for purely inter-row operation.



Use the touch screen button with a 9 crop plants symbol to enter the in-row working screen for in-row operation.

Working Screens

The working screens have the following features:



- A live camera video image in the centre of the screen over which are superimposed lines or crosses representing the templates being matched to the real crop plants.

- **For inter-row the row tracking** templates are represented by green lines that should match up with real crop rows. There are also a series of eight crosses arranged in the centre of the image. These represent how well the template lines up at different levels up the image.

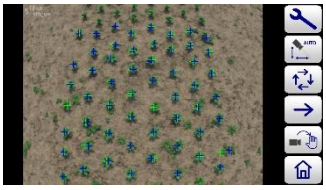
- **Blue** crosses indicate a good match. 

- **Yellow** and **red** crosses indicate a poor match. 

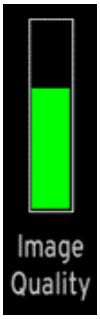
- **For In-row individual plant tracking** there are two arrays of crosses, **Green** and **Blue**.

- **Green** crosses represent the estimated position of individual crop plants. They are initially placed near the top of the image according to nominal plant spacing and estimated position of previous plants in that row. They should therefore be close to, but not necessarily exactly aligned with actual plants in the video image.
- As they progress down the image, observations of individual plant position from each successive image, depicted by **blue** crosses, are used to refine this initial estimate so that by the time they reach the bottom of the image green crosses should accurately reflect plant position. It is the last estimate of plant position as they leave the bottom of the image that is used synchronise in-row cultivator units or nozzles.
- **Yellow** and **Red** crosses indicate poor template. An image with a high proportion of red or yellow crosses is likely to lead to poor tracking. Steps should be taken to improve the situation and cultivation should only proceed with caution.

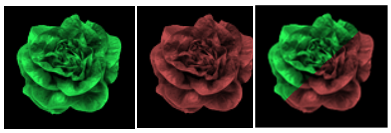
- Systems operating multiple cameras display live thumbnail videos along the top of the display.
  - Touching thumbnails selects them for full size display.
  - Briefly touching on the main video images switches to a full screen video mode. Guidance continues in this mode, but the information symbols, speed, position indicator etc are obscured. Touching again reverts to the normal size image.



- An image quality gauge to the left of the screen giving relative indication of likely tracking performance. The higher the green bar the better. A low bar indicates either a poor template match or poorly defined crop plants. Guidance will, under most circumstances, operate down to an indication of approximately 20% albeit at reduced accuracy.



- If a crop colour option is activated a plant symbol is shown at the top and to the right of the image quality gauge. The colour of the plant symbol indicates the current colour choice. Touching on the symbol pops up a screen that allows you to change that choice.



- If custom colour is activated an adjustment tool is offered in the pop-up tool, Touching the colour band itself selects a colour bias. For fine adjustment use the +/- buttons.

  Note
  - It is recommended to contact your dealer before using custom colour settings. In general, use of custom colour is likely to degrade rather than improve tracking performance. It should only be used with expert advice if absolutely necessary.

- If lights are configured a light bulb symbol is shown at the bottom right of the image quality bar. Touching the symbol turns lights on and the bulb yellow.

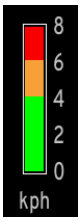
- Information symbols at the lower left of the display:
  - A warning triangle indicates poor tracking. If it is displayed with a horizontal double headed arrow lateral implement position error is estimated to exceeds 25mm.

  - If the arrow is vertical, a phase angle error of at least one of the rotor units exceeds 15°. Displayed as a vertical arrow and warning triangle along with the affected rotor number. On seeing this warning users should check performance on the ground. A vertical direction warning triangle may also be displayed if an odometry discrepancy between measured speed and visual odometry occurs.

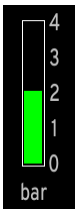
  - If enabled the warning triangles will be accompanied by an audible warning.
  - An implement lift symbol is displayed if the lift sensor detects the implement is lifted.

  - A circular red braked symbol is displayed if the implement is down but not moving.

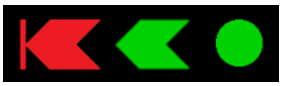
- A speed gauge on the right shows forward speed and should match tractor speed. The speed bar is normally green, an amber section indicates 75% of maximum speed and a red section indicates over speeding. For in-row machines maximum speed dictated by the in-row device type. The speed gauge will scale to suit the application. In the case of rotors, disc size will dictate maximum speed.



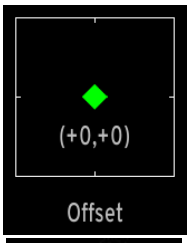
- A spray pressure gauge displays system pressure if spray nozzles and spray pressure monitoring are configured.



- A green dot and red/green chevrons below the image indicate side shift or slide position. A red chevron with a vertical bar indicates the limit of travel has been reached. This should not be allowed to occur for extended periods.

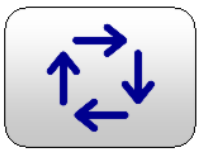


- The fine offset gauge shows the amount of left, right, forward or backward bias set by the user. This is used to compensate for minor lateral camera misalignment, but the lateral fine offset can also be useful on side slopes.



- The fine offset flip symbol, activated in the advanced setup screen, allows quick reversal of fine offset. Useful when changing direction of travel on slopes or in crops blown by a cross wind for example.

- The up and down offset alters the phase relationship between the in-row cultivators/nozzles and the crop plants. It applies equally to all in-row units (and nozzles) in that camera view.
  - Up/positive applied offset advances in-row devices forward
  - Down/negative applied offset retards in-row devices rearward.
  - For multiple camera machines, changing timing of one camera forward and backward will not affect the timing of devices controlled by other cameras.



- A button with four arrows arranged in a square, cycles the fine offset direction button below
- A button with a single arrow can be pressed to apply a 1cm fine offset adjustment to the selected camera in the direction shown by the button.

- **Briefly** touching the button with a Camera ↷ Hand symbol enables manual mode and disables vision guidance. The fine offset adjustment arrow buttons are replaced by thicker left and right arrow buttons. The user can manually steer the side-shift or steering discs to test their function. To avoid mechanical damage these functions only operate when lifted or moving.

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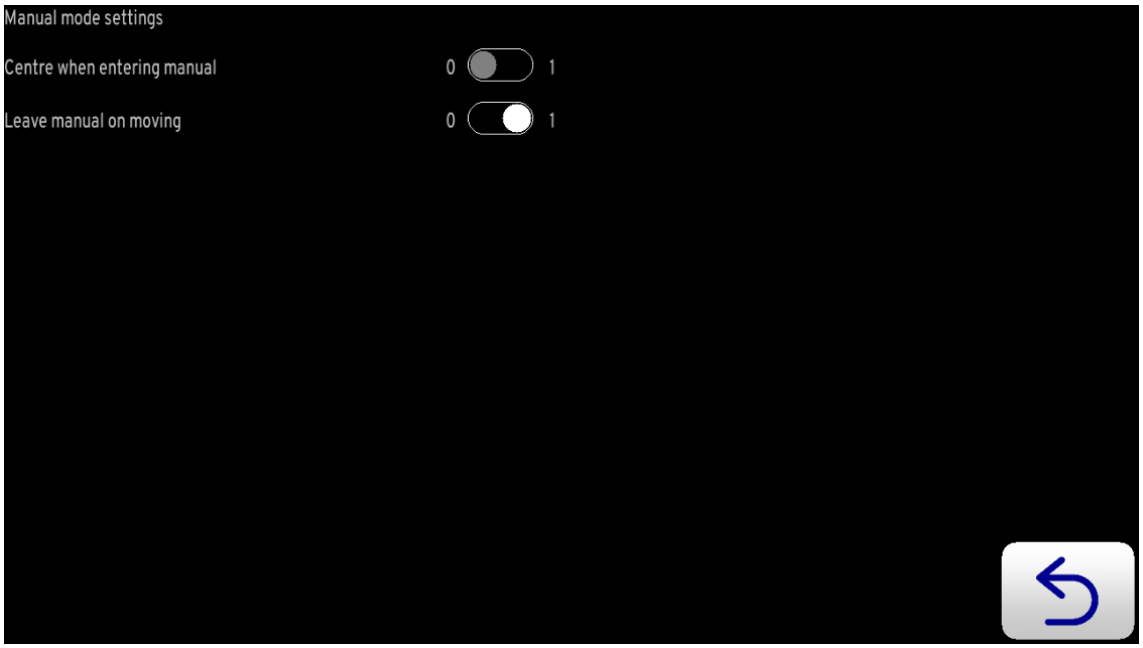
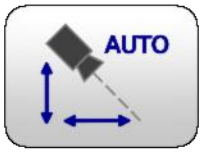
- Manual mode can also be used to set help set camera geometry. In manual mode the green template lines are displayed as a fixed grid along with a blue centre crosshair.
- Return to vision guidance by **briefly** pressing the same button which is now labelled with a Hand ↷ Camera symbol.

- **Touching and holding** that button pops up a manual mode settings screen enabling you to change default behaviours as described above. Options are turned on and off by touching on switch icons.
- See the reference manual for a full explanation of these options activated by touching on their toggle switches, The first two are the most likely to be required and are:
  - "Centre when entering manual" when **ON** ensures side shifts centre when entering manual mode. When **OFF** the side shift stays at its current position on entering manual mode.
  - "Leave manual mode on moving" in the default **ON** position guidance automatically drops into vision guidance mode when you start to move. If the switch is in the **ON** position guidance stays in manual mode, which for in-row applications is used to help setup camera geometry.



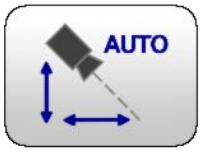
- **Briefly touching** the auto-learn button introduces a small amount of flexibility to camera height and angle/look ahead parameters for the camera currently displaying the main image. The system automatically adjusts those parameters to give a better template fit for that camera only. This machine learning can be performed whenever the machine is in work, either when stationary or moving.



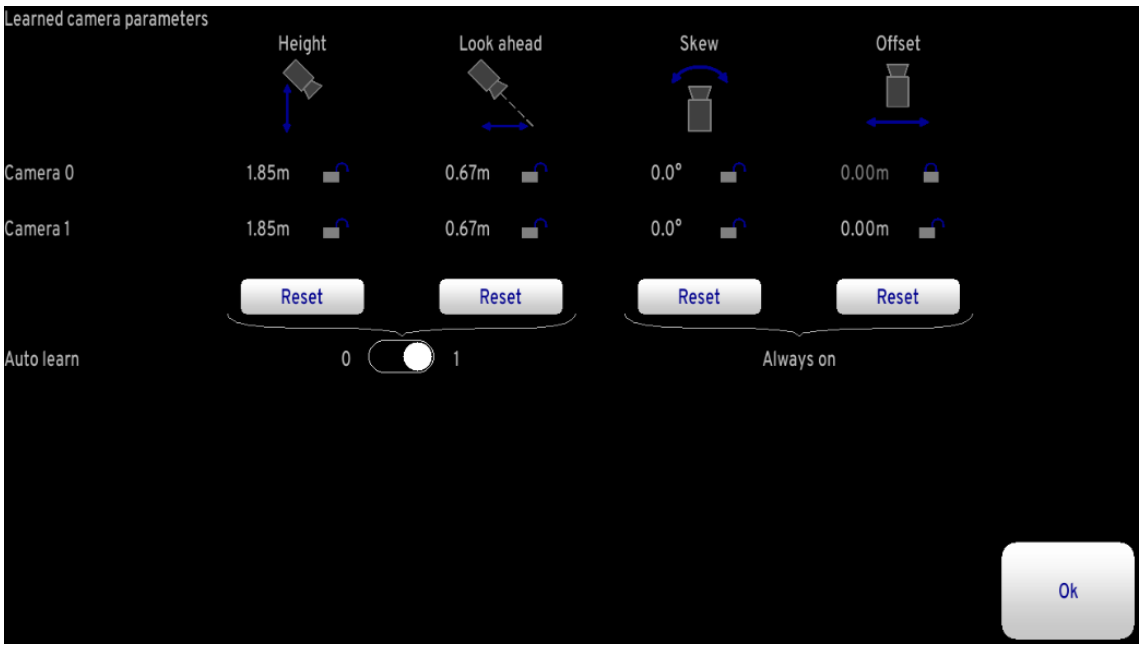
For best results, only trigger auto camera pose estimation on flat ground when crop rows are straight and clearly defined.

Be aware changes to automatically learned camera parameters may change device timing requiring fore and aft fine offset adjustment.

- **Touching and holding** the auto-learn button when moving has no effect, but when stationary opens a popup box displaying all four machine learned parameters. Those parameters are:



  - ***Camera height***, the height of the camera (measured from the camera lens) to ground level.
  - ***Camera lookahead***, a measure relating to camera angle to the vertical
  - ***Camera skew***, a measure of camera angular misalignment in the horizontal plane.
  - ***Camera offset***, the lateral error between two or more cameras fitted to the same section.



For a full explanation of this page you are referred to the reference manual. It should not be required for normal operation.

Auto machine learning of camera skew and offset is compulsory for all systems, but auto-learning for camera height and lookahead estimation can be turned off using the touch toggle switch on the bottom line. Turning auto-learn off freezes parameters at their current learned values. Turning auto-learn back on resets to configuration values.

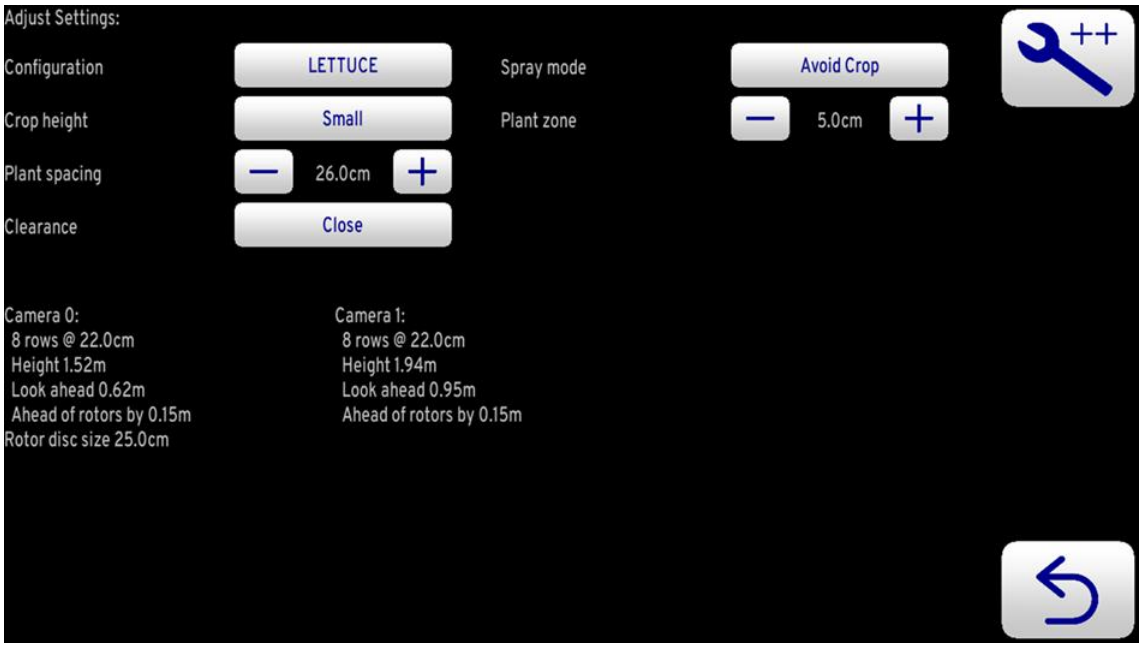
Changes to automatically learned camera height and lookahead may also influence in-row device timing. To avoid accidental changes to device timing it may be desirable for routine running to turn auto-learn OFF after camera position correction parameters have been learnt and stabilised.

- The button with the house symbol returns you to the start-up screen.

- The button with the spanner symbol will take you to the setup screen.

Setup Screen

The setup screen allows operators to select which of the pre-loaded configurations they wish to run and adjust parameters to suit the crop conditions in the field. Settings are remembered between sessions.



Touching on ***"Crop Height"*** alters template size to compensate for the crop canopy getting closer to the camera as it grows. This avoids the need to physically adjust camera height when moving between crops of different heights. There are settings for small, medium and large crops. The definition of small, medium and large is scaled according to camera height in accordance with this table.

Touching on ***"Configuration"*** allows users to select between alternative pre-programmed configurations for different crop planting geometries that require different templates. The main parameters of the chosen configuration are displayed at the bottom of the setup screen. They are:

Camera number (Note - camera numbers start at zero)

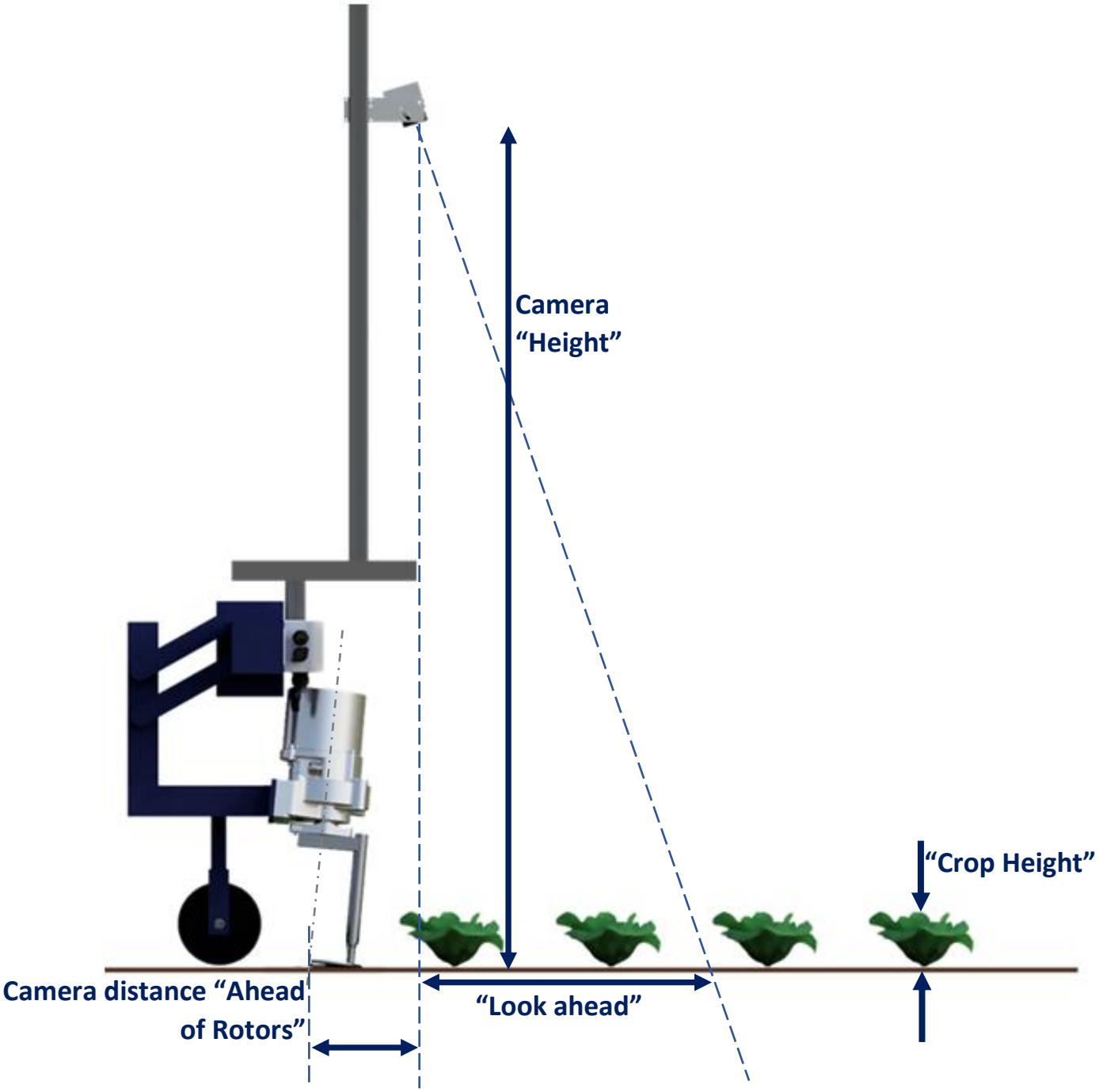
Number of rows being used for tracking and their spacing

Camera "Height" - Distance vertically from lens to ground when in work

Camera "Look ahead" – Horizontal distance along the ground from a point vertically below the lens to the centreline of sight (marked by cross hairs in "Manual" mode).

Camera distance "Ahead of Rotors" - Horizontal distance along the ground from a point vertically below the lens back to the centre of rotation of rotors at ground level.

Rotor disc size – the disc size fitted to rotary cultivator units (Ensure that selected configuration matches fitted disc size. Not used with reciprocating cultivators/nozzles.)

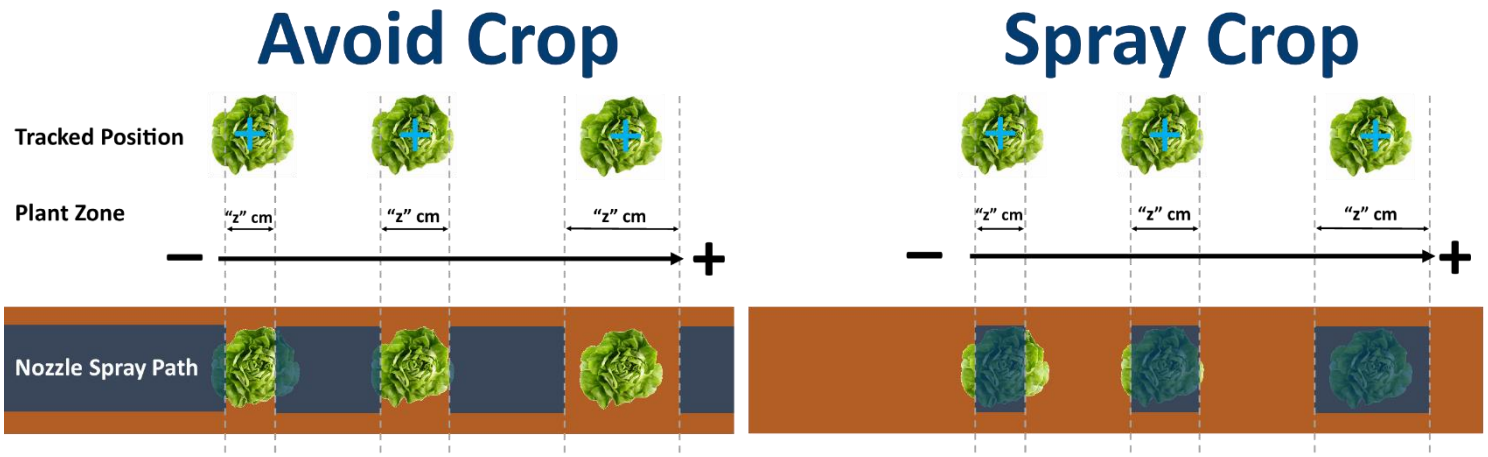


Ensure that an appropriate configuration file is selected before starting work. If such a configuration is not available, please ask your dealer to create one for you.

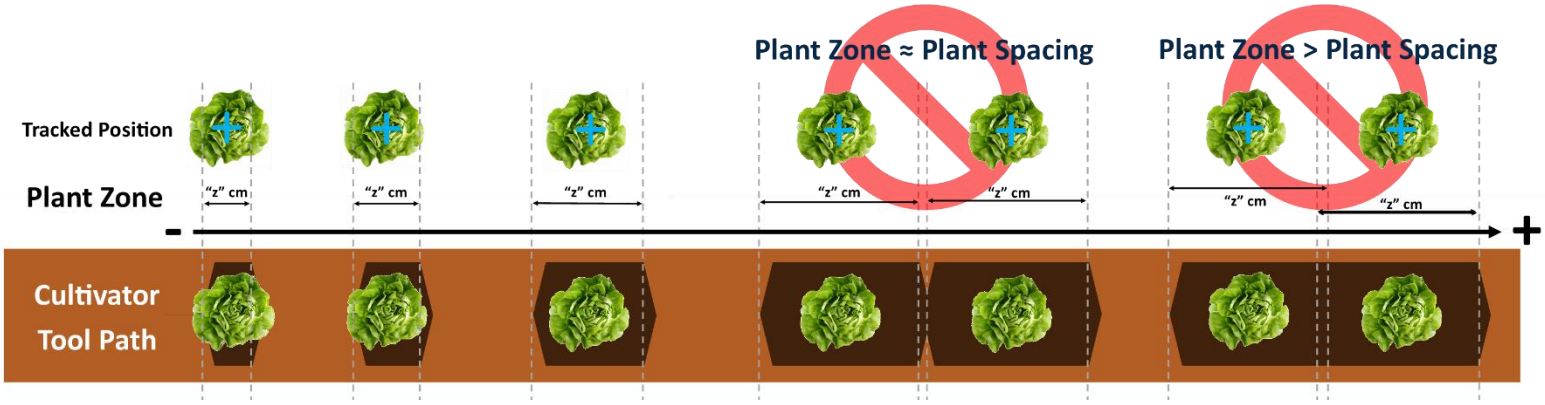
"Plant Spacing" Average spacing between plants within-the-row. The spacing can be increased (+) or decreased (-) in steps of 2.5cm (1") using +/- buttons.

"Clearance" An optional rotor facility - Enables rotor discs to cut slightly closer or further from the plant than normal, through changing the entry and departure points of the disc when rotating around a plant. Touching on the button will provide a drop-down list of the options, close, normal and wide. It is also possible to change physical clearance around crop plants by changing to a disc selection for one designed for a different uncultivated zone around the crop plant.

"Spray mode" Used for nozzle operation only – Selecting from the drop down list the operator can configure the nozzles to either **spray on** the crop or **avoid**ing the crop.

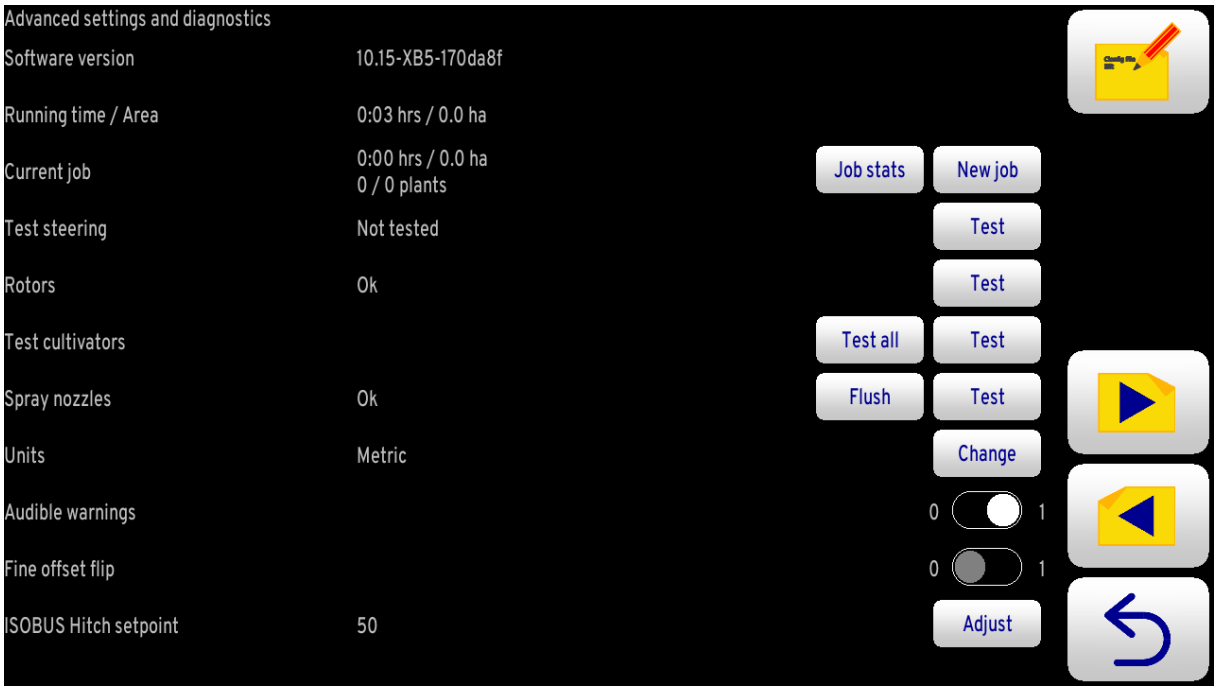


"Plant Zone" This setting is applicable to both nozzles and reciprocating blade cultivator implements. It adjusts the start and end point of nozzles or reciprocating blades symmetrically around the located plant. The value can be incremented or decremented in steps of 2.5cm (1") using the + and – buttons.

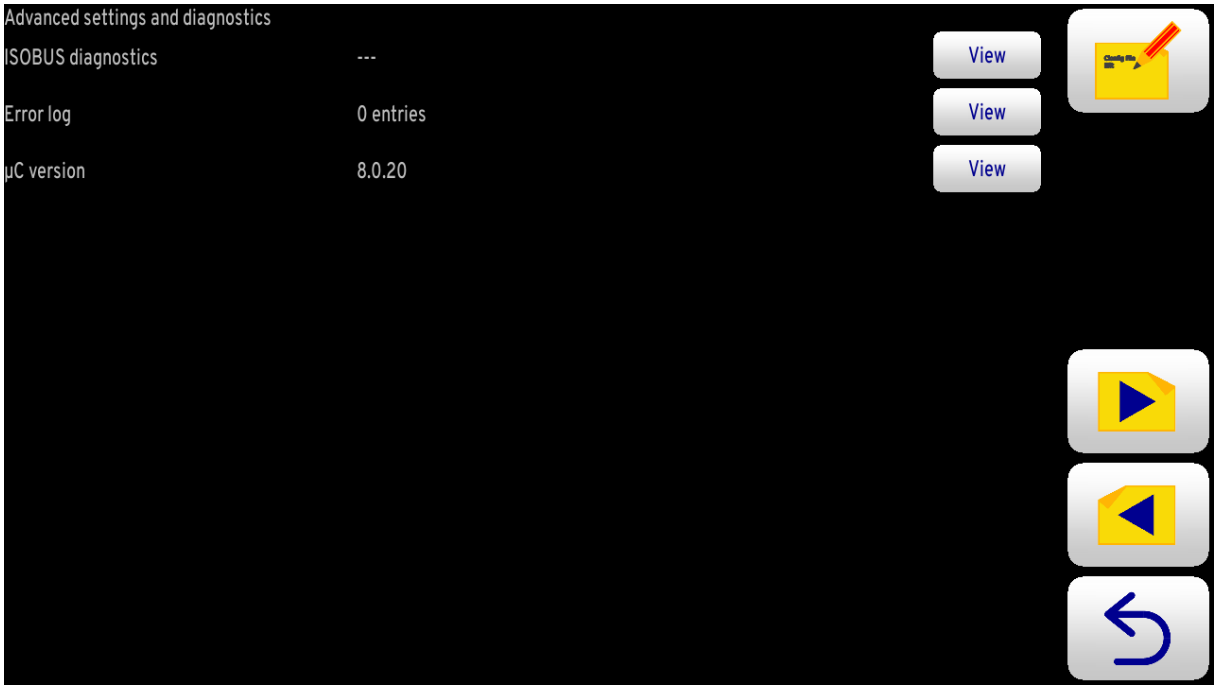


Advanced Settings and Diagnostics Screen

The advanced setup & diagnostics screen is accessible from the setup screen by pressing the button with the spanner ++ symbol. This screen provides test functions and displays some diagnostic information.



Additional settings and diagnostics can be accessed using the buttons labelled with a page icon and direction arrow if applicable.



The top of the screen lists the implement software version, total running time and total area covered.

Current job

Displays elapsed time, area covered, plants located/plants treated. Pressing on ***"New Job"*** resets these counters.

"Job Stats" produces further job details including:

- *"Plant Population"* expressed as the number of plants per unit area (plants/ha or plants/acre)
- *"Plant Spacing"* is the average plant spacing and variability expressed as a standard deviation e.g. 37.8 +/- 3.4 cm
- *"Plant Size"* is the average linear distance across the crop foliage and size variability expressed as a standard deviation e.g. 18.6 +/- 3.1 cm

"Test Steering" this utility tests position sensor output, steering rate and calibrates steering direction. In the case of a successful steering test an "OK" message will be returned. If "too slow" or "too fast" messages are returned this could be due to insufficient or excessive oil flow. If a proportional steer valve is fitted, the steering test also calibrates the proportional valve flow characteristics.

Caution
Ensure steering mechanism is clear of obstructions and people before running.

Rotors

"Test Rotors" this utility test the function of individual or multiple in-row rotary cultivator units. It plots live graphics of demanded speed vs measured speed. If successful, an "ok" message is returned. If the test is unsuccessful advice will be offered. For assistance interpreting rotor output tests contact your dealer.

Note
When performing rotor tests check personnel are clear and ensure electric rotor power supply is ON and charging.

Cultivators

"Test" energises reciprocating in-row cultivators in mapped order for one second each in a continuous cycle.

"Test all" Activates alternate reciprocating in-row cultivators for one second then switches to the other half for one second in a continuous cycle.

Note
Reduced cultivator insertion and retraction speeds could indicate insufficient hydraulic flow.

Nozzles

"Test" presents three options from a pop up menu. (Leakage and blockage tests require condition monitoring to be installed):

Visual Test – Turns all nozzles ON individually in mapped order for one second each in a continuous cycle.

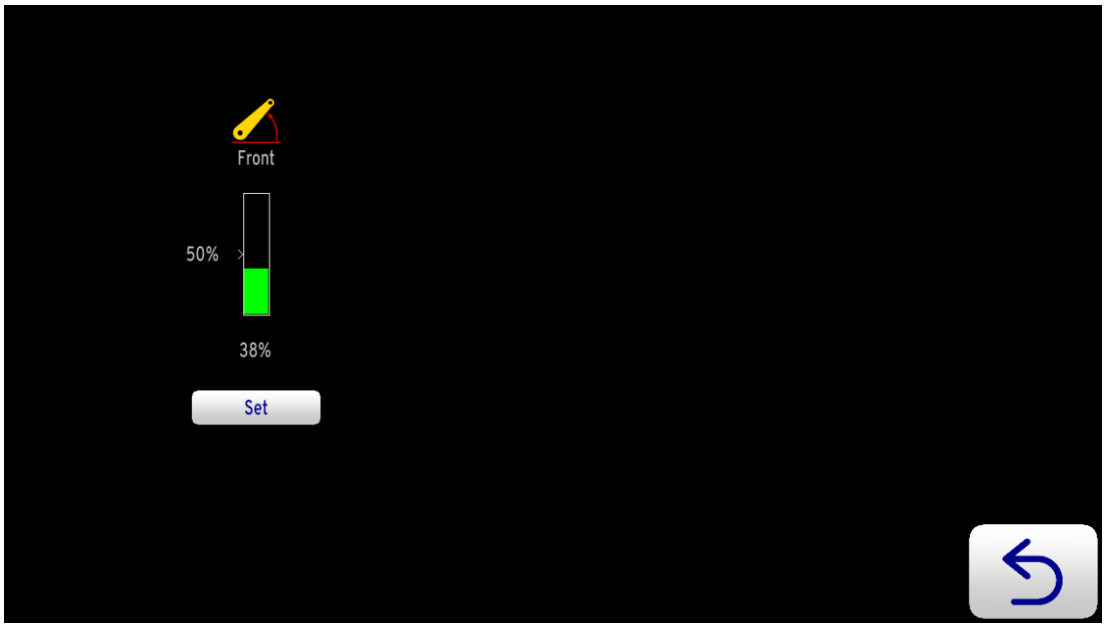
Leakage Test –Spray lines are pressurised and pressures monitored to identify drops in pressure that could indicate leaks or nozzles stuck in the open position. If leakages are detected, spray bar address information on the detected leak will be displayed.

Blockage Test –Spray lines are pressurised, and nozzles individually opened. Pressure decay monitored is to check for blockage or incomplete opening. If blockages are identified, affected nozzle channels will be displayed.

"Flush" Activates alternate nozzle channels for one second then switches to the other half for one second in a continuous cycle.

Note
A weak spray occurs during a flush nozzles test could indicate insufficient pump flow capacity.

"ISOBUS Hitch Setpoint" (For ISOBUS connected systems only) this utility provides a means of adjusting the hitch transition point between in-work and out of work. The green vertical bar is a live representation of tractor hitch position read from the ISOBUS. Pressing the "Set" button changes the transition point to the current hitch position which is then displayed as a percentage of full stroke at the base of the bar.



"ISOBUS Diagnostics" this utility allows for observation of live ISOBUS data. Useful in ensuring that connection between tractor and implement has been achieved and sensor data is available for implement operation.

The other settings listed on this screen relate to operating preferences and fault diagnostic information. Refer to your dealer or the full reference manual for explanation of these features.

4. Start-up Checks

Connect the implement to the tractor ensuring that the camera pole is vertical and that there is no lateral movement in the 3 point linkage. Mount the console in the tractor cab and connect to the implement so that the cable does not restrict cab access. Connect to a suitable fused 12V supply. Also connect the hydraulic hoses along with the electric rotor power supply and spray supply if applicable to your implement setup.

If either electric or hydraulic rotors are present and the implement is lifted you will be presented with a message to perform an initial start-up test of the rotors to check their function. Ensure that either 42V supply is ON and charging and/or hydraulic flow is set to operating levels for the rotor start up check. Following a successful rotor start up test you will be brought to the working screen.

If the implement is lowered to its normal working position the “stopped” (red brake) symbol should be displayed on the working screen and the speed bar should read zero.

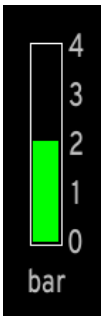
Set the tractors hydraulic control to provide a constant flow to the implement with the facility to disengage the supply immediately should a fault occur.

Lift the implement clear of the ground. The side-shift or steered discs should centralise and the “stopped” symbol replaced by the “Lifted” (yellow lift arms) symbol.

Note

- Side-shift/disc travel all the way to one side on lifting the implement may indicate the hydraulic supply is connected the wrong way.
- Rapid side-shift/disc oscillations back and forth about the central position indicates that the hydraulic flow rate is too high

If nozzles and pressure monitoring is present on your implement fill spray tank with water and engage pump, spray pressure is indicated on the working screen with a pressure gauge bar. Check circuit for leaks and ensure pressure is set to an appropriate level.



Note

- Too high spray pressure can result in spray nozzles being unable to open.

Step 1 – Checking Hydraulic Steering Operation

To ensure accurate camera guidance, set hydraulic spool valve to working position and raise tractor revs to working levels. Perform a steering test accessed via the Advanced Setup and Diagnostics screen.

ON/OFF Steering Valve Implements – Observe steering speed while test is in motion and answer on screen prompts for left and right orientation as sat in the tractor looking in the direction of travel. If steering test fails, hydraulic flow may require adjustment. Hydraulic flow should be adjusted so that a suitable steering speed is achieved, between 6cm/second and 10cm/second is generally a good starting point. Flow restriction for steering speed may be performed with an adjustable flow restrictor(s) connected to the steer valve. Also ensure that supply flow from tractor does not form a limitation.

Proportional Steering Valve Implements – Run steering test utility and answer left and right orientations as per the ON/OFF valve steer test. Following this, a test of peak steer speed is performed by the utility to ensure that maximum set speed can be achieved. If maximum steering speed cannot be achieved and reports a “Too slow” message, supply flow from the tractor may need to be increased.

Step 2 – Checking Hydraulic Levelling Operation

If hydraulic levelling function is fitted it is good practice to check that it operates and that the implement can level itself correctly in relation to the ground. If you implement does not have an automatic levelling function feel free to skip this test.

The integrated levelling system will only operate when the implement is in work position. It operates by a pair of sensors (UP and DOWN sensors) and a hydraulic actuator on each side of the implement responsible for the height control of each side of the machine.

- If both UP and DOWN sensors are activated the hydraulic actuator for that side will retract as the implement it to high.

- If no sensor is activated the hydraulic actuator will extend as the implement is too low.

- If only the DOWN sensor is activated the hydraulic actuator will not move as the implement is in its working/OK position.

Adjustment of levelling operation is achieved by increasing distance between UP and DOWN sensors which will increase deadband/reduce levelling sensitivity.

Hydraulic flow adjustment of actuators can increase or decrease reactivity of levelling system, but care should be taken to not increase levelling speed to a level that is excessively fast, as it can cause the levelling system to overshoot and become unsteady.

Check with your dealer for if and how you can adjust implement levelling operation.

Step 3 – Rotor Start-up Test

If rotors are present in the selected configuration an initial short rotor test is performed upon entering the working screen. If this initial rotor test and synchronization passes, the rotors are ready for operation. For more comprehensive rotor tests and/or calibration see the advanced settings and diagnostics screen (Spanner ++)

Caution
Ensure electric rotor power supply is ON and charging/hydraulic flow is ON and tractor engine revs at working levels before performing initial rotor start-up test.

Step 4 – Nozzle Start-up Test

Before setting the nozzles into work it is good practice to ensure that all nozzles are operating and forming a correct spray pattern. A visual test accessible from the advanced settings and diagnostics screen (Spanner ++) is good to check that all nozzles are operating individually and that they are spraying correctly.

Note
When first setting nozzles up, it is advised to test using clean water only to check that target plants/plant spacings are sprayed accurately.

Step 5 – Reciprocating In-row Blade Start-up Test

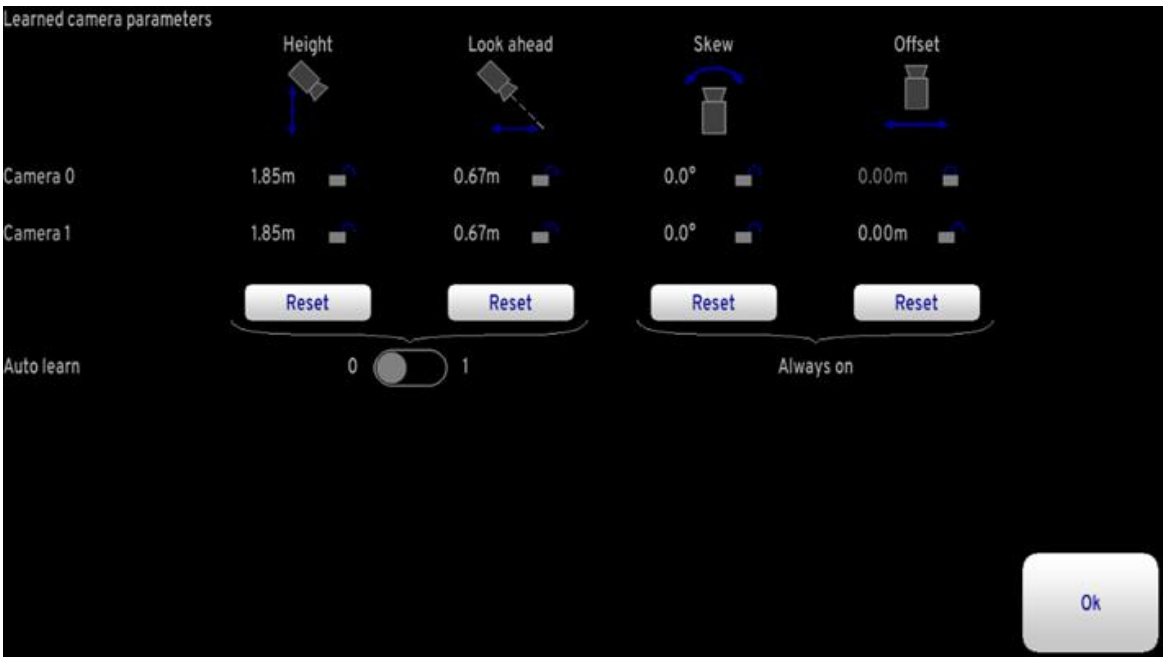
Before setting off using reciprocating in-row cultivator units it is best practice to perform a cultivator test via the advanced settings and diagnostics screen (Spanner ++) to ensure that all cultivators work correctly prior to operation in the field with tractor hydraulic supply flow at normal working levels.

Step 6 – Camera Setup by Measurement

Camera setup is critical to ensure an accurate template match. Camera setup parameters are measured in relation to the ground level, in the case of raised beds, this is the level where the crop is planted.

Initial camera setup by measurement can be performed either in the field with-in crop rows or in the farmyard without rows. Camera setup will only need to be done on first setup of an implement but regularly checking that camera geometry has not changed is prudent.

Start by resetting all the learned parameters by pressing and holding the auto-learn button on the working screen to pop up a learned parameters setting page. Turn off the “Auto-learn” function using the toggle switch on the bottom line and “Reset” buttons to reset camera height and look ahead to configuration values. Camera skew and offsets should also be reset to zero by touching on the appropriate “Reset” button. “Auto-learn” should remain off through the setup process and only turned on when setting off in the field.



Learned camera parameters pop up page with “Auto learn” switched off, and Skew and Offset reset to zero

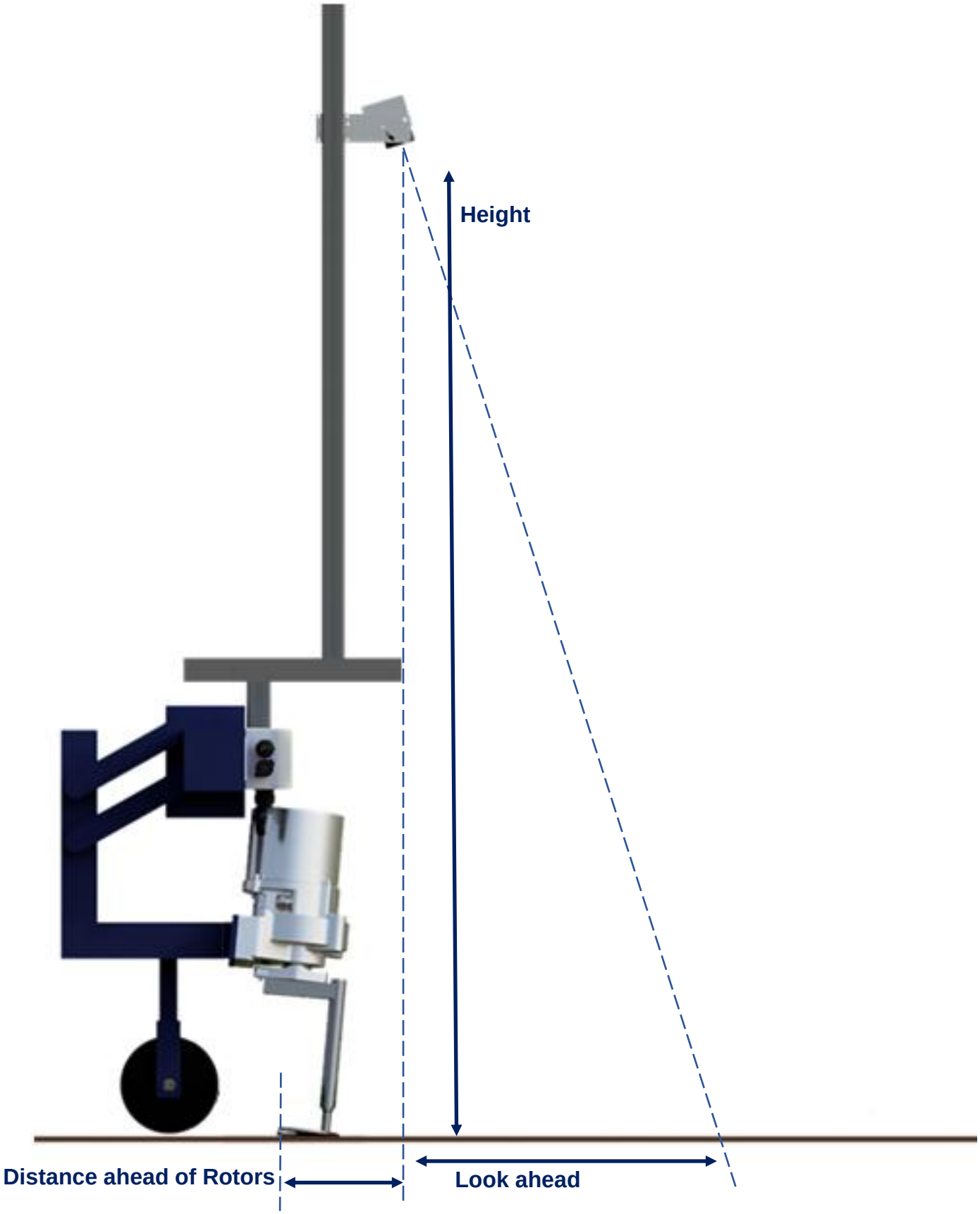
From the working screen enter the Setup screen by pressing the spanner button. Select the configuration you wish to set up the cameras for. Make a note of the Height and Look ahead values for each camera. Note that each camera may have different height and lookahead values entered.

Having checked the implement is fully lowered to working position and that top link has been set so that the implement is level. Adjust the camera so that it matches the height in the selected configuration. Now mark a point directly below the camera.

And from that point measure forwards and place an object at the “Look ahead” point. As shown in the image. Return to the working screen and enter manual using the Camera ↷ Hand button and two blue cross hairs will appear on screen. Adjust camera inclination to align the object placed at the look ahead point with the horizontal blue cross hair.

Now measure back from the camera to the centre of rotation of the in-row rotors. This should match the “Distance ahead of Rotors” figure shown in the configuration.

Your camera is now aligned. This same process can be repeated for each camera in turn.


Height
Distance ahead of Rotors
Look ahead

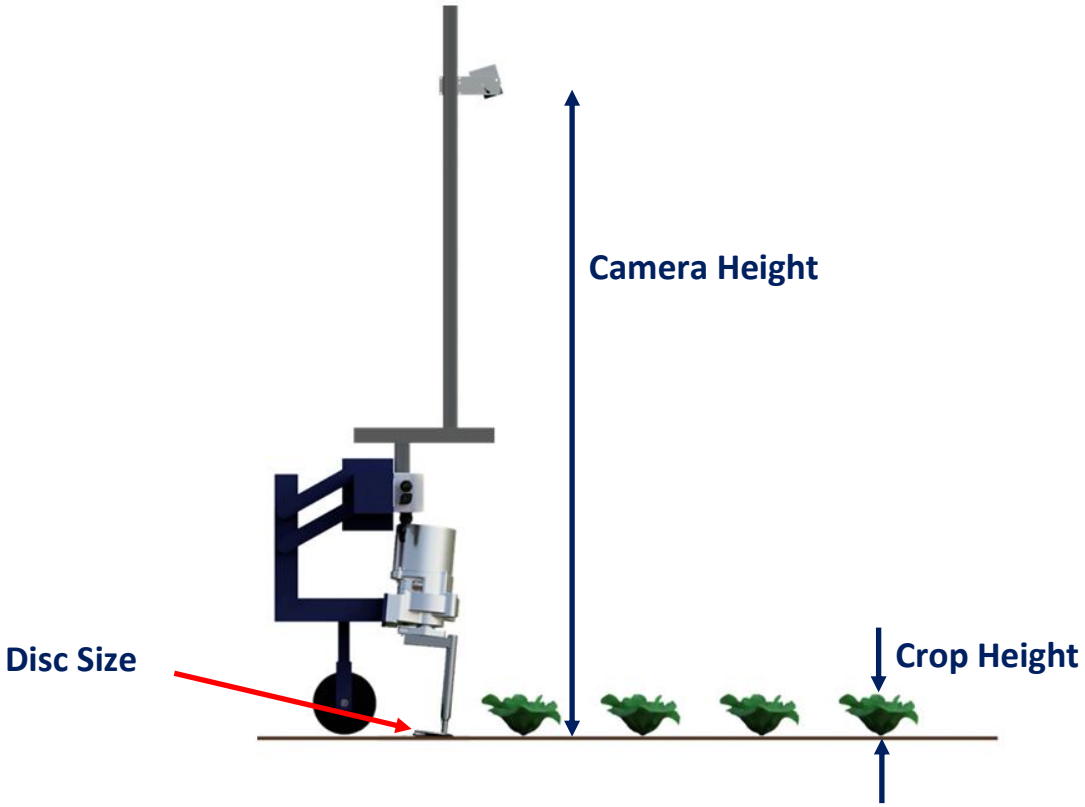
5. Getting to work in the field

Step 1 – Selecting a configuration and crop height

From the working screen press the button labelled with a spanner symbol. This switches the display to the setup screen.

Adjust the crop height setting to suit the height of the crop in the field. It is best to set the height setting to suit the majority of the field. The crop height setting must be set appropriately so that the crop rows template matches the actual crop rows.

Select the correct configuration to suit the implement setup, disc size fitted and crop geometry selected especially if multiple configurations are loaded onto a single console.



Step 2 – Checking camera height and inclination in the field

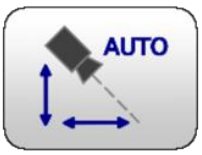
Return to the working screen and go into manual mode by touching on the Camera ↷ Hand symbol button. Set the implement down onto a typical section of crop aligned with the rows. Draw forward a few cm to ensure it has settled at its normal operating depth. If necessary, adjust the top link to level the implement keeping the camera pole vertical.

Step 3 – Check template match with crop rows

The green template lines should be parallel with and at the same spacing as the real crop rows, though they may not be exactly aligned.

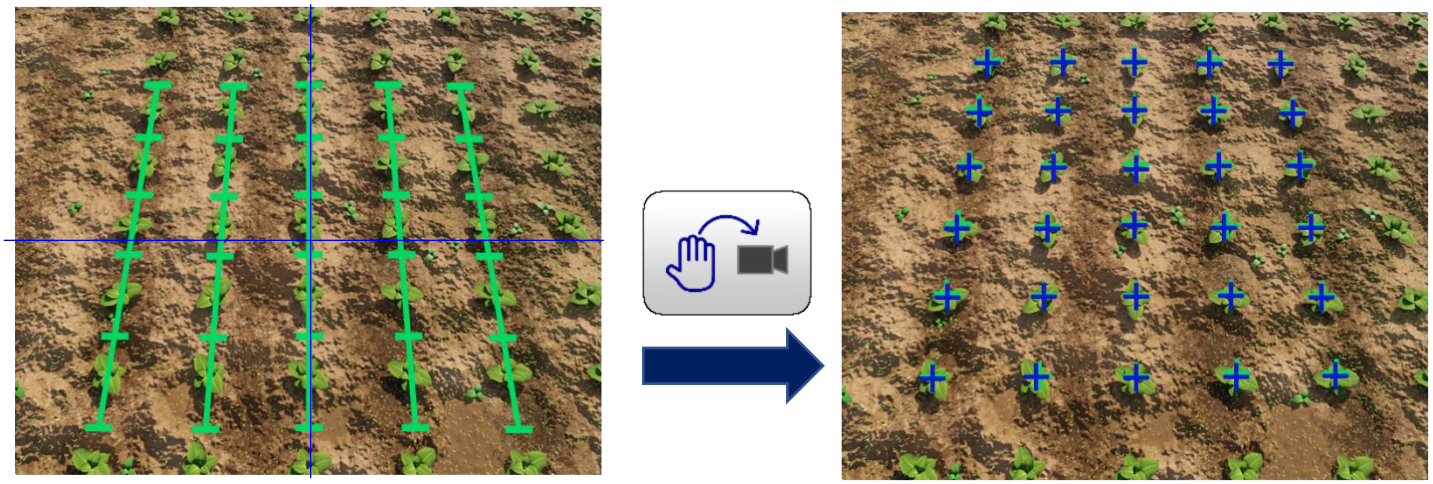
Touch the same button again to start vision guidance. You can be sure that the machine is ready for tracking in in-row mode if an array of blue and green crosses has appeared over plants as they appear on the display. For inter-row mode you should see a relatively straight line of blue crosses up the centre of the row pattern.

If the template lines/crosses are close to but not exactly aligned with the real crop rows you can briefly touch the Auto learn button. This should bring the template into a more accurate alignment with crop rows.



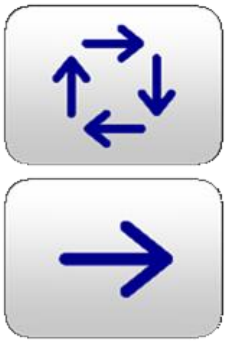
Step 4 – Initial running and adjusting lateral position

When you are happy you have a good template match. With the working screen in vision guidance mode and an array of blue crosses on each crop plant or a set of blue crosses up the centre of the row pattern or a cross in interrow mode, set off slowly.



You may wish to consider taking most cultivators out of work for the initial pass to minimise crop damage.

If tracking appears good set off slowly. The implement should quickly align with crop rows. It is likely that after a short distance it will have settled at a small lateral offset. Small offsets can be corrected using the fine offset facility.



Toggle the fine offset direction button and apply the required fine offset in the desired direction. Each press of an arrow key biases the steering in steps of 1cm (3/8”). Continue down the field stopping occasionally to check lateral position.

If the required fine offset exceeds the available number of steps the camera should be physically moved laterally. If fine offset is set to the left, then the camera should be moved right as viewed from behind looking forward.

It is the operator's responsibility to decide at which point the vision guidance system becomes 'lost'. If the system losses track of crop rows the operator should carefully guide the implement through to the next good reference.

Tip

Once you are confident tracking is accurate and reliable, forward speed can be increased and all inter-row cultivation blades engaged.

Tip

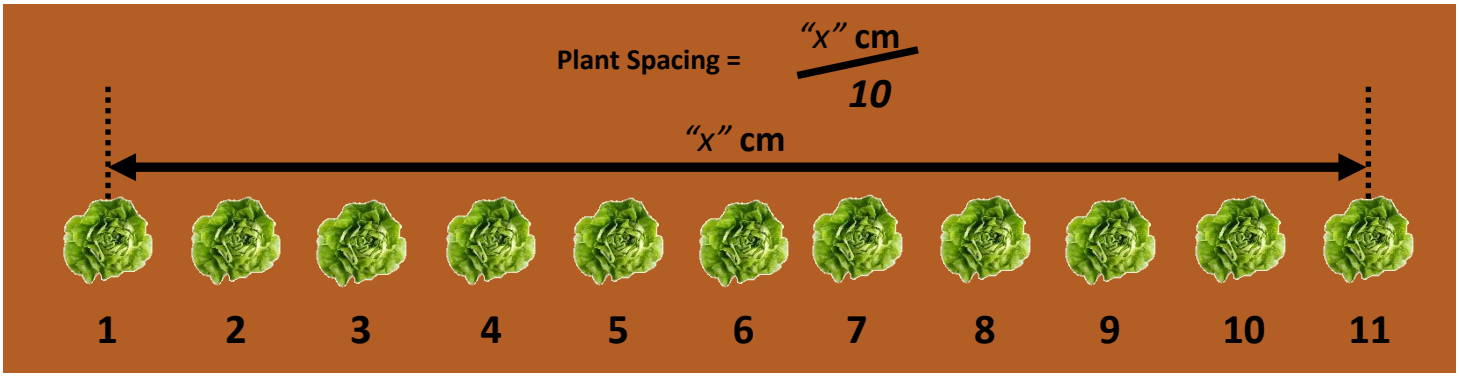
When setting up a multi-section machine it is advised to treat each section and its associated cameras as a separate machine and perform individual setup of each section in turn.

Once lateral fine offset has settled and relevant adjustments to lateral camera position have been carried out, we can now focus on in-row operation and fore and aft offset adjustment.

Step 5 – Adjusting Plant spacing

The plant spacing figure shown on the setup screen should be adjusted to be at or just below the measured average spacing in field.

Average plant spacing in field can be calculated using a typical stretch of crop by measuring the distance of 10 plant spacings or 11 plants and dividing by 10, as per the diagram below:

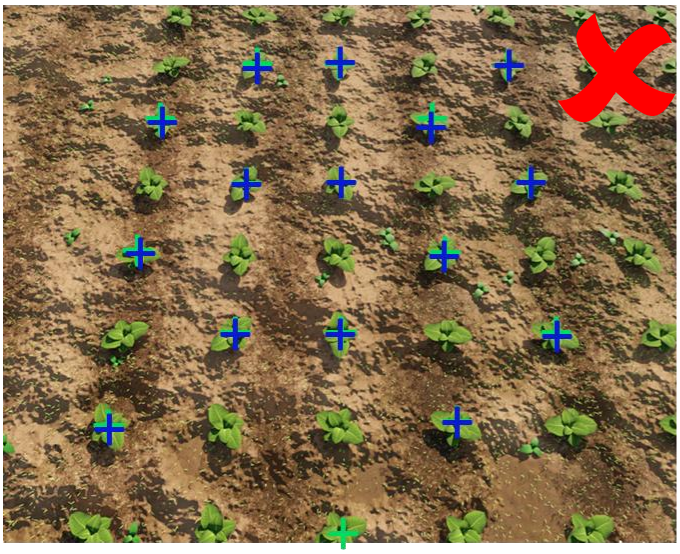


Observation of the live camera image tracking crosses can also provide feedback on if plant spacing has been incorrectly set by a large amount as shown below.

More plants than crosses

=

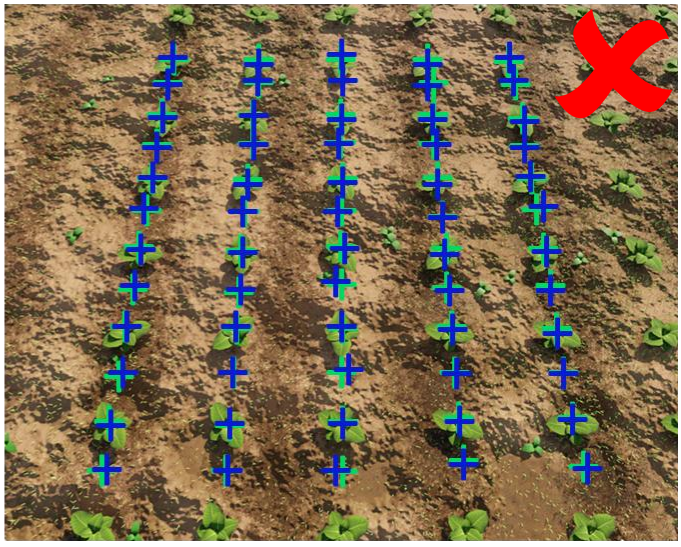
Plant Spacing too large



More crosses than plants

=

Plant Spacing too small



Step 6 – Running with rotary blades

Set off at low speed. After the first few plants have been passed the accuracy of cultivation around plants should be examined and judged on a per camera basis initially.

If rotors controlled by the selected camera view are consistently cultivating around a point that is ahead of crop plants the fine offset should be moved down using the DOWN arrow. Similarly, if rotary cultivators are cultivating about a point behind the plants the UP arrow should be used.

Each button press corresponds to 1cm (3/8”) of shift forward or rearward.

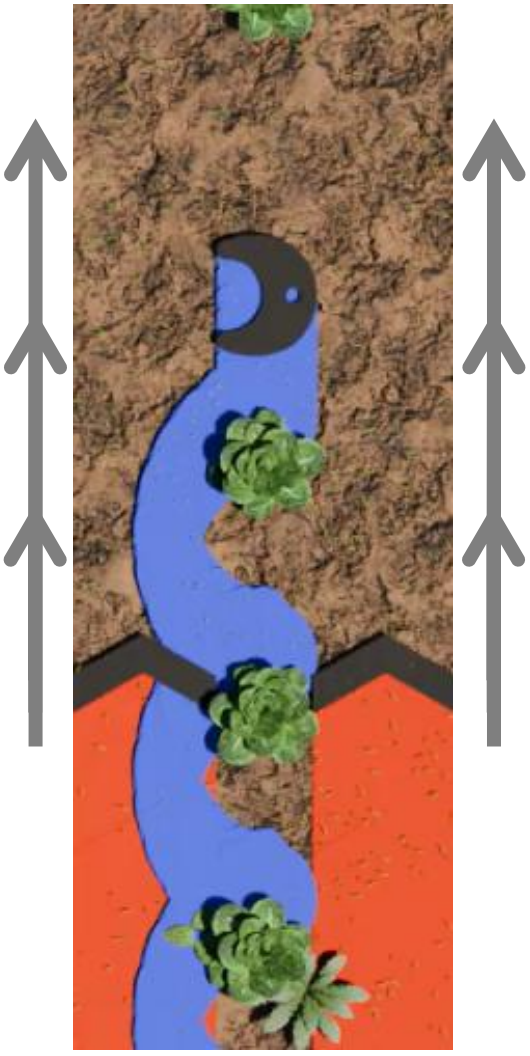
Note: If you use auto-learn to refine camera height and look ahead it may also affect rotor timing

Tip

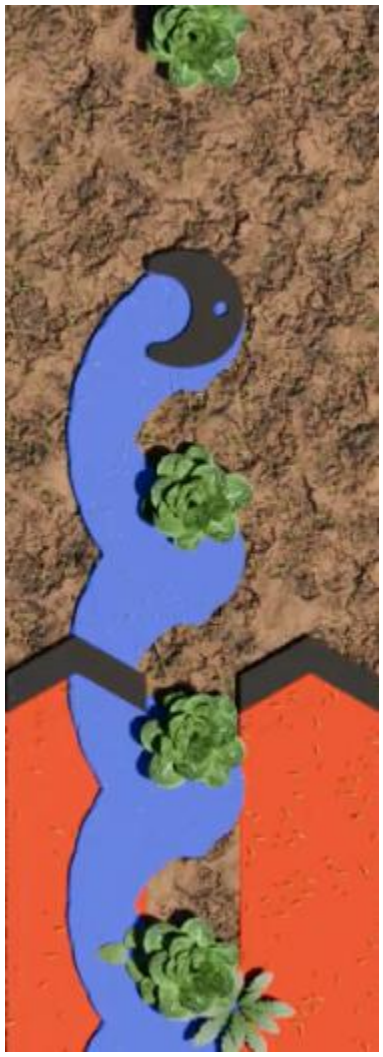
When setting up a multi-camera or multi-section machine treat each camera view separately and perform individual fore aft fine offset setup of each camera in turn.

Tip

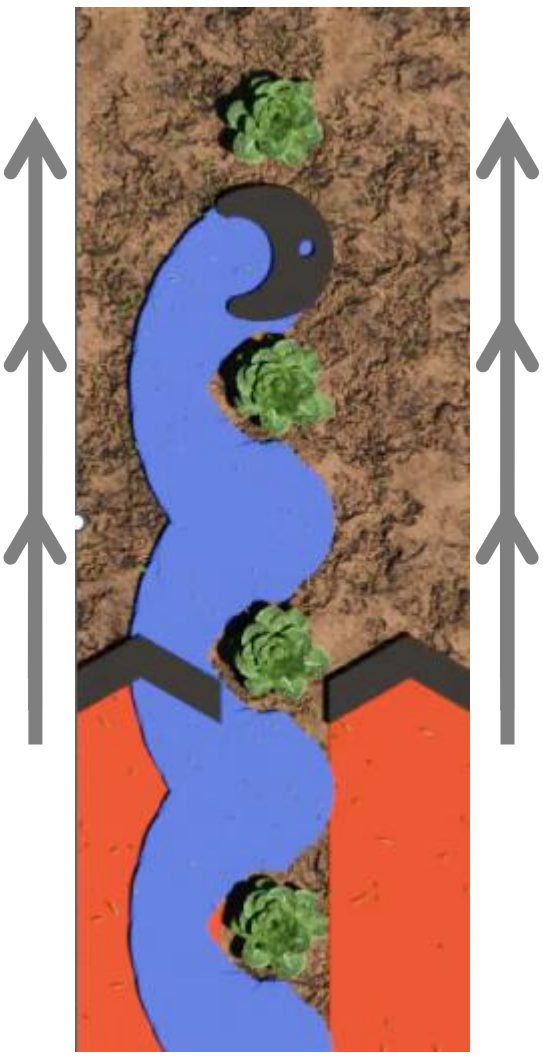
Once a group of rotors have had fore aft fine offset adjustment performed, individual rotors can be adjusted mechanically forward and back, to fine tune cultivation of each rotor if required.



Problem: Cultivation after plant
Solution: Press fine offset up arrow key



Problem: Cultivation before plant
Solution: Press fine offset down arrow key



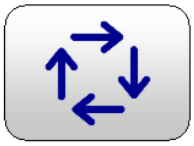
Correct set up with cultivation symmetrically around plant

Step 7 – Running with Reciprocating Blades

Set off at low speed. After the first few plants have been passed the accuracy of cultivation between plants should be examined and judged on a per camera basis initially.

It is best practice to initially start setup of reciprocating blade cultivators with a larger plant zone setting entered. Accessible from the working screen by pressing the setup button (spanner symbol). Once you are happy with forward fine offset adjustment and cultivation is central around the crop plant zone can be reduced to increase cultivation area.

If reciprocating cultivators controlled by the selected camera are consistently cultivating ahead of crop plants the fine offset should be moved DOWN using the down arrow. Similarly, if cultivators are cultivating behind the plants the UP arrow should be used.



Note: If you use auto-learn to refine camera height and look ahead it may also affect cultivator timing

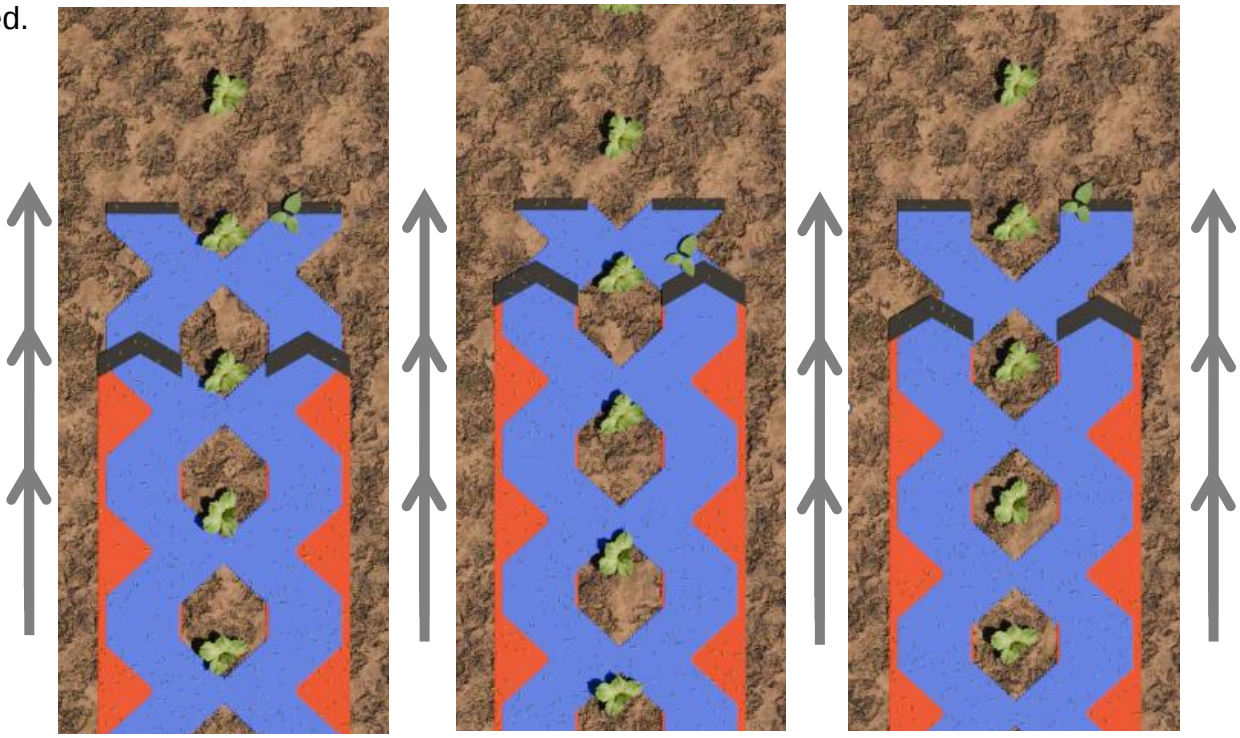
Each button press corresponds to 1cm (3/8”) of shift forward or rearward.

Tip

When setting up a multi-camera or multi-section machine treat each camera view separately and perform individual fore aft fine offset setup of each camera in turn.

Tip

Once a group of cultivators have had fore aft fine offset adjustment performed, individual cultivators can be adjusted mechanically forward and back, to fine tune cultivation of each cultivator unit if required.



Problem: Cultivation after plant

Solution: Press fine offset down arrow key

Problem: Cultivation before plant

Solution: Press fine offset up arrow key

Correct set up with cultivation symmetrically around plant.

Step 8 – Running with Nozzles

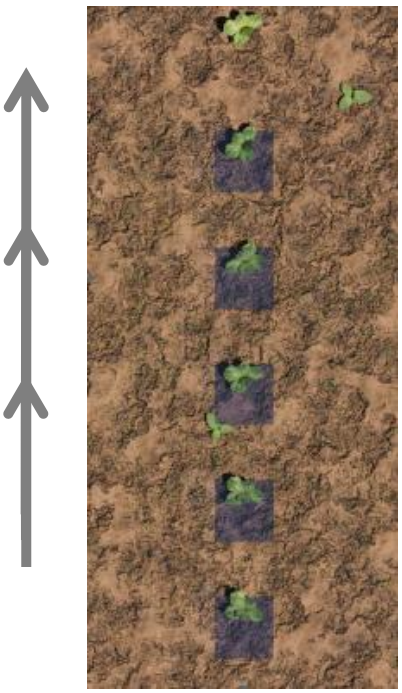
Set off at low speed. After the first few plants have been passed the accuracy of spray nozzles on plants should be examined and judged on a per camera basis initially.

It is best practice to initially start setup of nozzles using clean water. And spray targeting can be best judged using the setting “Spray plants” with a smaller plant zone distance entered.
Once you are happy with nozzle spray positioning, chemical can be primed if necessary, appropriate spray mode selected and plant zone can be set to desired level.

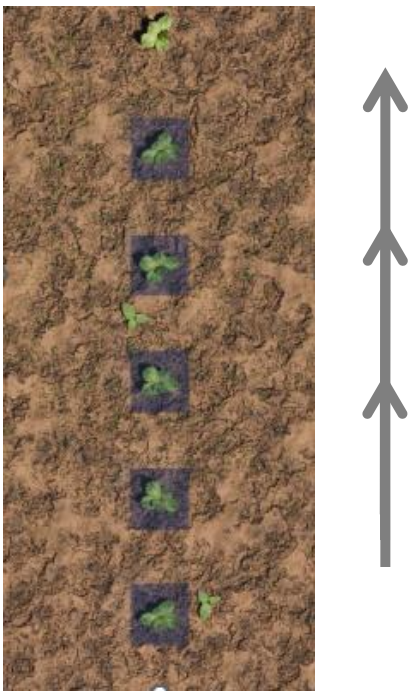
If nozzles controlled by the selected camera are consistently spraying ahead of crop plants the fine offset should be moved DOWN using the down arrow. Similarly, if nozzles are spraying behind the plants the UP arrow should be used.

Each button press corresponds to 1cm (3/8”) of shift forward or rearward.
Tip
When setting up a multi-camera or multi-section machine treat each camera view separately and perform individual fore aft fine offset setup of each camera in turn.
Tip
Once a group of nozzles have had fore aft fine offset adjustment performed, individual nozzles can be adjusted mechanically forward and back, to fine tune spray timing of individual nozzles if required.

Problem: Nozzles spraying after plant
Solution: Press fine offset down arrow key



Problem: Nozzles spraying before plant
Solution: Press fine offset up arrow key



Correct set up with nozzle spraying symmetrically around plant.

Step 9 – Running with both nozzles and cultivators

Set the machine up so that the cultivators (reciprocating or rotary) are timed correctly as described in Steps 6 or 7 above.

Nozzle offsets from cultivators in the direction of travel are pre-configured on a per nozzle basis to match the physical layout of your machine. If cultivator timing is correct, the timing of nozzles should also be aligned with passing plants.

Fine offset acts equally on both cultivator and nozzle timing.

If you wish to make changes to nozzle timing relative to cultivators, you can either physically move the nozzles, or get your dealer to alter the pre-programmed nozzle offsets in the configuration you are using.

6. Notes on daily operation with a correctly set up machine

- Before operation check that electrical and hydraulic connections are secure and that there are no obstructions to side shift/disc movement. Check also that any hydraulic filter indicators fitted do not show that the filter is blocked.
- On first setting the implement down in the field check for each camera that the green and blue crosses line up with crop plants and form relatively straight lines corresponding to crop rows. There should be few yellow or red crosses.
- Proceed with caution for first few meters checking that the speed gauge matches the tractor's and that implement alignment is good. If performance is satisfactory speed can be increased.
    - Within-row tracking should be very good at linear speeds of up to 3 (rev/s) times disc size (e.g. 3 rev/s x 0.3m = 0.9 m/s =3.2 kph) for hydraulic rotors and 5 rev/s for electric rotors.
    - Reciprocating blades are generally only effective at lower speeds. Higher speeds are possible, but blades may not have time to reach fully into the row, thus reducing efficacy.
    - Soil and crop conditions may dictate maximum speeds.
- Vision guidance works in low light levels, but for full night operation lights are required.
- Fine offset is remembered from previous sessions and so there should not be any need to adjust this unless changes have been made to camera position.
- Setup parameters such as crop height, plant spacing, clearance etc are remembered from last operation of selected configuration file.
- If there are changes effecting template match such as minor crop height differences, a brief touch on the auto-learn button when moving or stationary should bring template lines back into alignment.
- Use of auto-learn to refine camera height and look ahead may also affect rotor timing, it is possible to "freeze" camera height and lookahead learnt corrections by turning OFF Auto learn after the initial learning session for more predictable operation. If you think it would be beneficial to turn ON Auto Learn to re-evaluate camera learnt parameters this acceptable but remember to check in-row device timing.
- Side slopes may result in some lateral error due to the tractor "crabbing" across the slope. Normally this is not significant, but in extreme cases it may be necessary to use the fine offset function to compensate. If operating in this way remember to reverse the bias when heading in the opposite direction and to return to a neutral setting when stopping work or moving to a flat area. A similar technique can be used to compensate for crop bent laterally by a cross wind. The offset flip tool can be useful in these circumstances. NB do not touch the auto-learn button on side slopes.
- When the implement is lifted at row ends it will centralise ready for the next run.
- At the end of the day shut down the system by pressing the touch screen button with the power button logo and the system will shut down automatically. The power button led go out but will continue to briefly illuminate every 5 sec indicating that power is still applied via the implement. In this state the current draw is negligible.
- It is also advisable to discharge any hydraulic accumulators by reversing the tractor's hydraulic spool briefly or setting the hydraulic spool into "float" position. The implements pressure gauge indicates if this has been achieved.

7. Maintenance and Storage

Please follow the maintenance and storage instructions below in order to ensure your precision guided implement stays in first class working order

1. Regularly check the routing of hoses and cables and protect against chaffing.

2. Check both coarse and fine spray system filters for clogging

3. Although all components are designed to be shower proof, we recommend that the console is housed in a dry environment and that the implement is not exposed to wet weather for extended periods when not in use.

4. Never pressure wash any part of the guidance system.

5. Always ensure power is supplied from a supply that is appropriately fused (10 - 20 amp).

6. Always ensure the correct supply polarity is adhered to.
   BLUE = - negative, BROWN (fused side) = + positive.

For further reference materials including the full reference manuals see the QR link below or go to www.thtechnology.co.uk

Tillett and Hague Technology Ltd

Delivering precision with vision