

# Tillett and Hague Technology Guidance and Control System

## Brief operator's guide

### Inter-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.

V 6.5 February 2020



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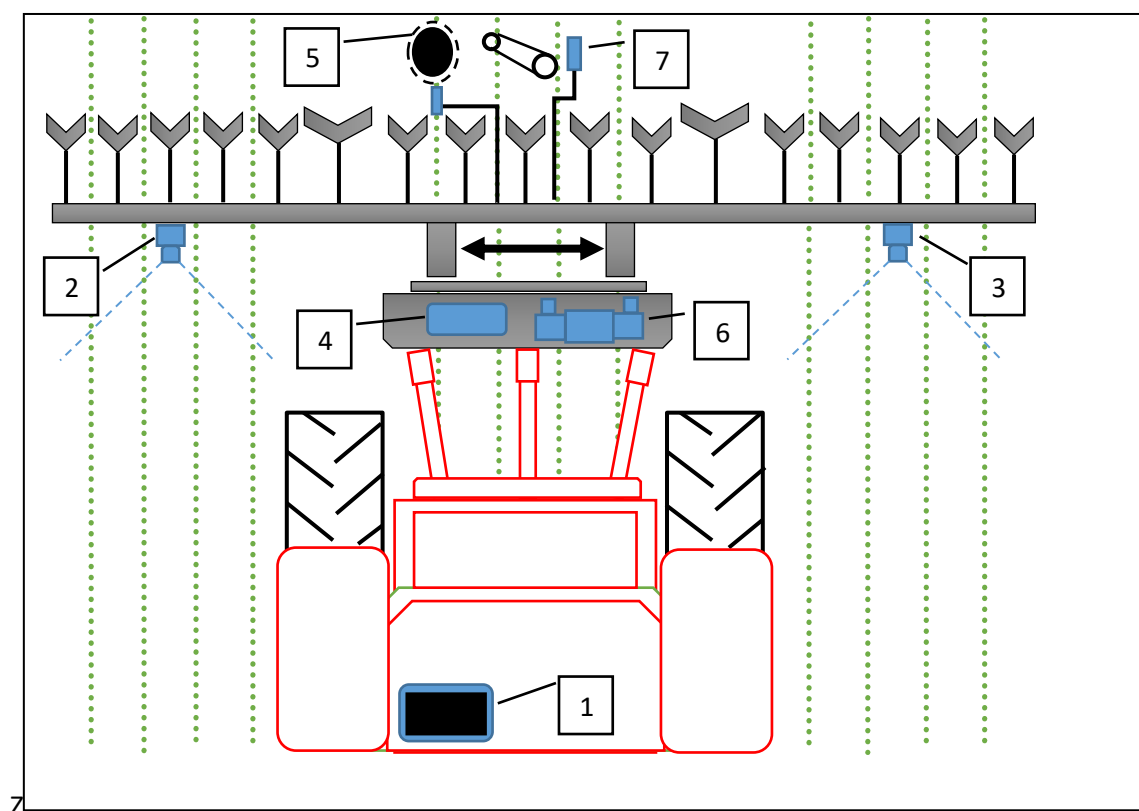
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## 1. System description

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 relative to those crop rows.

There are 3 main components to the system.

- A digital camera **(2)** or cameras **(2/3)** mounted on the implement looking ahead at a wide area of crop normally taking in several rows each.
- A cab mounted console **(1)** containing a computer to analyse camera images and find exact row centres.
- An implement mounted control box **(4)** housing the 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)**.



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

The system uses a colour to pick out green crop and weed from backgrounds containing soil, stones and trash. (Settings to work in red crops are also available.) Crop rows are located within a scene by matching a template corresponding to the known planting pattern with crop rows as they appear in the camera image. That image is displayed live on the console with the template overlaid as green lines.

A live video display allows user to check for a good match between template and crop rows, which is important for accurate row following.

## 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 the hydraulic supply is off, and any residual pressure is released.
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. Ensure that the 12V supply is fused appropriately (20Amp max).
10. When routing the loom and power supply cables ensure that they do not cause a restriction or trip point in the cab.

### 3. Machine set up

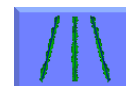
Connect the implement to the tractor ensuring that the camera pole is vertical and that there is no lateral movement in the 3-point linkage. Mount the console in the tractor cab and connect to the implement so that the cable does not restrict cab access. Connect to a fused 12V supply. Also connect the hydraulic hoses.

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 menu should appear.



From this screen you have the option to enter the working screen, the service tools menu or the configuration file editor (pen and paper symbol). This abbreviated version of the manual only covers the working screen. For more information consult the full reference manual.

Use the touch screen button with a crop row symbol to enter the working screen incorporating a live video image as described in the next section.



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 that 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.

The machine is now ready to be taken to the field.

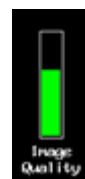
Before proceeding it is worth familiarising yourself with the working screens.

## 4. Working screen

The working screen has the following features:

- Live video over which are superimposed two sets of markings. The first are green lines representing the template to which crop rows are matched. The second are a series of eight crosses arranged from the top to the bottom 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.
- Briefly touching on the main video images switches to a full screen mode. Guidance continues in this mode, but information symbols are obscured. Touching again reverts to a normal size.
- Systems operating with multiple cameras will display live thumbnail video along the top of the display.
  - Briefly touching on a thumbnail selects that image for main display. Alternatively, the button labelled with a multiple camera graphic toggles between thumbnails for full size display.
  - Touching and holding on an image, or its thumbnail, stops images from that camera being used for guidance, making guidance reliant on remaining cameras. When a camera is disabled in this way a red cross is superimposed over the image. Touching and holding again restores normal function.

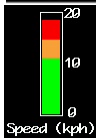
- An image quality gauge to the left of the screen giving relative indication of likely tracking performance. A low bar indicates either a poor template match or poorly defined crop rows. Guidance will, under most circumstances, operate down to an indication of approximately 20%.
- If custom colour is selected a plant symbol is shown at the top and to the right of the image quality gauge. Its colour reflects the custom colour choice selected.
- If lights are connected 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.

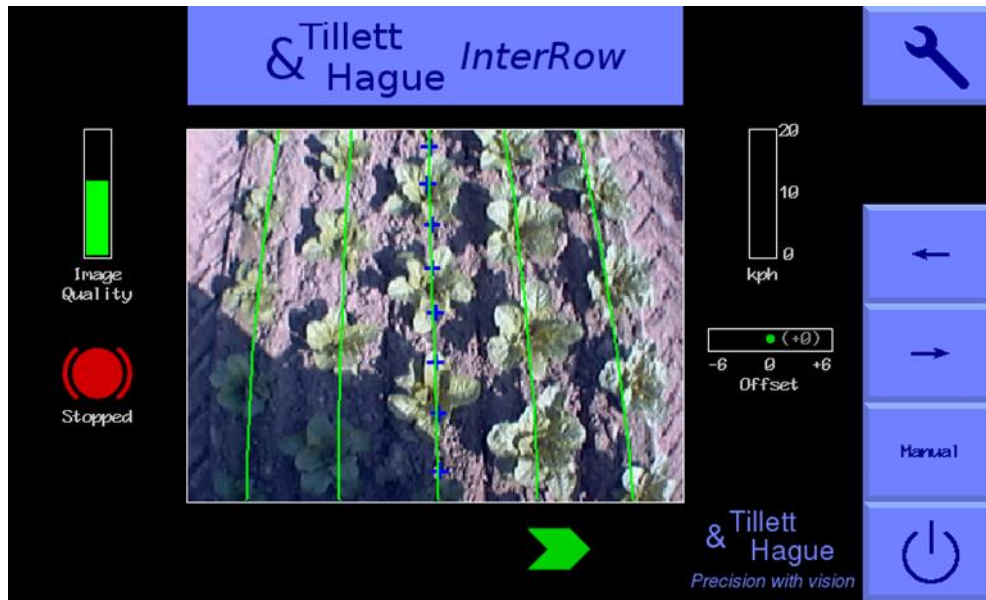


- Information symbols at the bottom left of the display:
  - A warning triangle indicating poor tracking is displayed if estimated lateral position error exceeds 25mm. If enabled the warning triangle will be accompanied by an audible warning.
  - An implement lift symbol is displayed if the lift sensor 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 which should match tractor speed.
- A green dot or red/green chevrons below the image indicate side shift position. A red chevron with a vertical bar indicates the limit of travel has been reached.
- The fine offset gauge shows the amount of left or right bias set by the user. This is used to compensate for minor lateral camera misalignment but can also be useful on side slopes. It has six 1cm steps in either direction by default.





The function of touch screen buttons located along the right of the screen are:

- Spanner symbol, this button accesses the setup screen. (see below)
- Double camera symbol on multi camera systems and blank for single camera systems. This button toggles between cameras affecting the main image displayed.
- “Left arrow” moves fine offset left 1cm, or when in manual mode, side shifts/steers 7% to the left.
- “Right arrow” moves fine offset right 1cm, or when in manual mode, side shifts/steers 7% to the right
- Touch screen button labelled “Manual” disables vision steering and allows the user to move left or right manually in steps of 7% of full stroke for each press of the arrow buttons. For disk steered machines this is achieved by automatically steering the discs to maintain the desired slide position. To avoid mechanical damage these functions only operate when lifted or moving.

In manual mode, green lines representing the template and purple cross hairs are locked on the screen whilst retaining a live video image.

Return to vision guidance by pressing same button, now labelled “Camera”, again.

By default manual control is retained when moving forward with a normal tracking screen displayed so the operator can see if vision guidance is likely to be successful.

For machines with mechanical guidance feelers the “Manual” button cycles between manual mode, feeler and vision guidance. In manual or feeler guidance mode the fine offset slide bar is replaced by Text in red capitals indicating the mode in use. For machines with a remote override manual control box the text would say “REMOTE MANUAL” when the box was switched on.

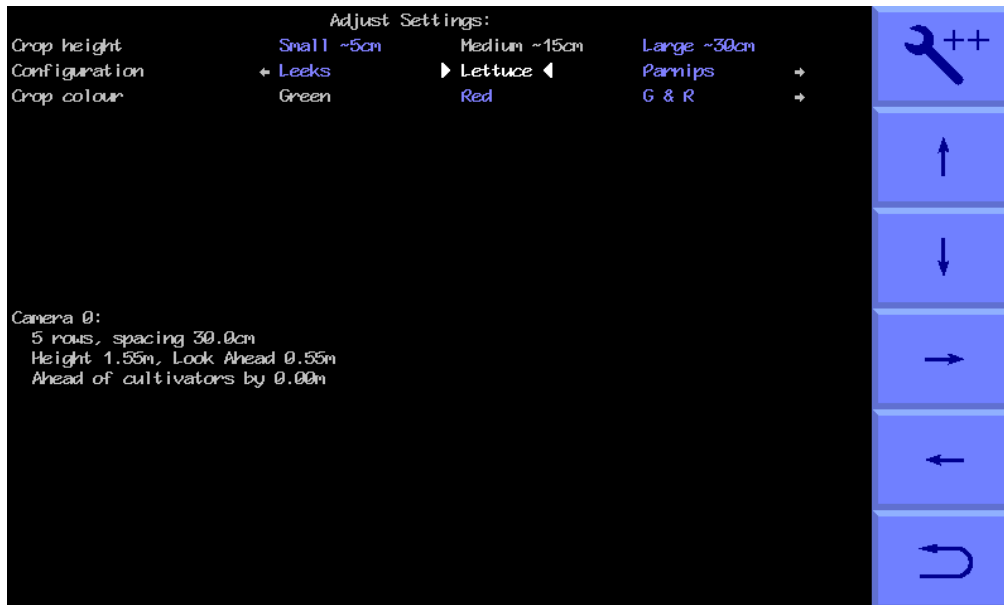
- Pressing the touch screen button with the power switch logo enters a shutdown screen from which you can confirm shutdown.



## 5. Setup Screen

The setup screen allows operators to select which of the pre-loaded configurations they wish to run and to make other choices such as selecting an appropriate crop size.

Navigation within the set-up screen is achieved by moving the cursor over options using touch screen buttons labelled with arrows. When the cursor is over a setting its text changes from blue to white, indicating it is selected.



“**Crop size**” increases template size to compensate for the crop canopy getting closer to the camera as it grows avoiding the need to physically adjust camera height. As a guide, crops up to approximately 5cm (2”) high are regarded as small, 5cm (2”) to 15cm (6”), medium and greater than 15cm (6”) high, large. Ensure that an appropriate crop size is selected before starting work.

“**Configuration**” allows users to select between alternative pre-programmed configuration files for different crop planting geometries requiring different templates. The main parameters of the chosen configuration file are displayed at the bottom of the setup screen, they are:

Camera number (Note - camera numbers start at zero)

Viewing - Number of rows being used for tracking.

Spacing - The row spacing between the rows being viewed.

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).

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.

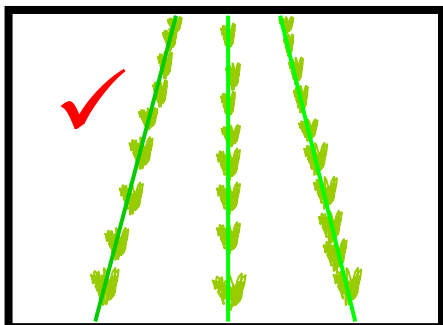
“**Crop colour**” (optional facility) – For green crops select “Green”. Select “Red” for salad crops that are fully red. It is also possible to select “Custom” colour which can bias the colour used by the system to search for foliage. This can be advantageous on crops such as brassicas or alliums with a blue/green colour (a value of about 50 has often be found to be satisfactory).

For plants with a combination of red and green foliage there is a red/green option labelled as R&G.

## 6. Getting to work in the field

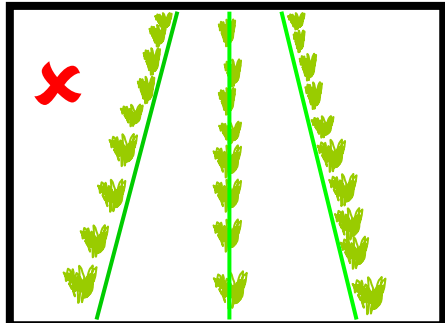
To ensure good guidance it is vitally important to match the template, as illustrated by the green lines, to crop rows as they appear in the live video image.

Draw into the crop and set the cultivator down. The cultivator should be level and set onto the rows as accurately, and as straight as possible with the camera at its normal operating height (as displayed in the “set up” screen).

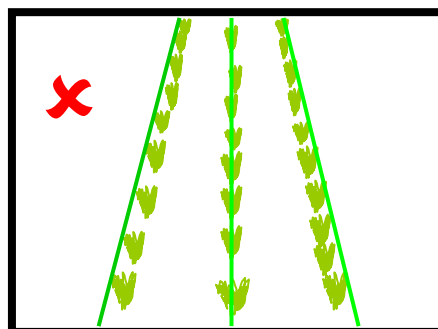


Green lines superimposed over the live image should align with crop rows.

If the green lines appear narrower or wider than the real crop rows check the “crop size” selected in the “set up” screen and change if appropriate. If this does not resolve the problem, it may be that the camera height (measured from centre of lens to ground level) does not match the figure displayed in the “set up” screen. Either measure the correct position and move the camera accordingly or adjust camera height until the “picture” looks correct as illustrated above.

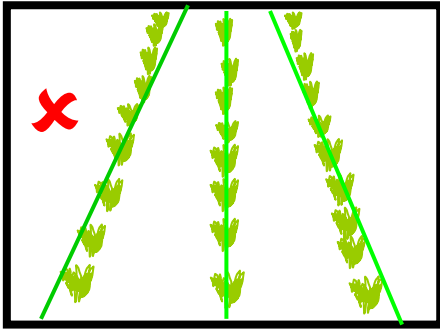


If the camera is too low, then the template will appear narrower than crop rows. In this case raise the camera.



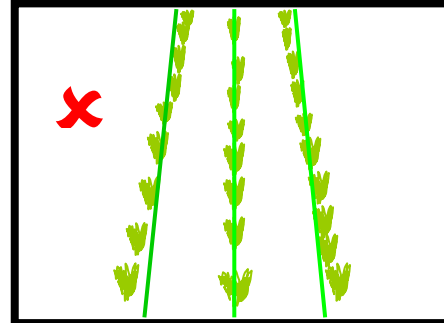
If the camera is too high, then the template will appear wider than crop rows. In this case lower the camera.

If the template matches mid screen, but not at the top or bottom, check that the implement is level. If it is already level, then camera inclination angle may need adjusting.



If template lines appear narrower than crop rows at the top of the image but wider at the bottom, rotate the camera up so it views further ahead.

If template lines appear wider than crop rows at the top of the image but narrower at the bottom, rotate the camera down so it views less far ahead.



Good tracking will only be achieved if template lines are centred on all the rows being tracked.

It is also possible to align the camera by measurement, though this is not covered in this abbreviated manual. Please ask your dealer or consult the full reference manual.

Set off slowly into the crop. The implement should quickly align with crop rows. It is possible that it will have settled at a small lateral offset which can be corrected using the fine offset facility available from the working screen.

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 loses track of crop rows the operator should carefully guide the implement through to the next good reference.**

Once you are confident tracking is accurate and reliable, forward speed can be increased. Mechanical interaction between blades and soil would normally limit speed to below 15 kph though guidance will continue to operate at higher speeds. The speed bar goes red at speeds above 15 kph.

Each time the implement is lifted at headlands it will centralise ready for the next run.

Vision guidance works in low light levels, but for full night operation lights are required.

Fine offset settings are saved from previous sessions.

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.