

User Manual of Agricultural Machinery Autopilot System



Instruction for Use (IFU)

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Technology and service

If the content you required cannot be obtained from the IFU, please contact the installation technicians of relevant project.

The current interface function is displayed as a test version, and the actual interface function shall be subject to the actual version.

Table of Contents

| | |
|--|----|
| I. Instructions for Using Products | 1 |
| II. Product Introduction | 2 |
| 1. Product Introduction | 2 |
| 2. Product composition | 2 |
| 3. Software interface | 4 |
| III. Product Use | 5 |
| 3.1 Power-on | 5 |
| 3.2 Confirm RTK and Peripheral states | 5 |
| 3.3 Settings of farm tools | 6 |
| 3.3.1 Set the width of farm tools | 6 |
| 3.3.2 Width of next row | 7 |
| 3.3.3 Set the distance from the working point of farm tools to the hanging point | 7 |
| 3.3.4 Set the deviation of farm tools | 7 |
| 3.4 Set the navigation route | 8 |
| 3.4.1 Set AB straight line | 8 |
| 3.4.2 Set parallel curves | 9 |
| 3.4.3 Set diagonal harrowing | 10 |
| 3.4.4 Set up a circular job | 11 |
| 3.4.5 Set the loop operation mode | 12 |
| 3.5 Autopilot | 13 |
| 3.6 Power-off | 13 |
| IV. Common functions | 14 |
| 4.1 Next row calculation | 14 |
| 4.2 Drag | 15 |
| 4.3 Plot sharing | 16 |
| 4.3.1 Single machine sharing | 16 |
| 4.3.2 Nearby plot | 17 |
| 4.4 Mark | 18 |
| 4.5 Simple mode | 18 |
| 4.6 Camera | 19 |
| 4.7 WiFi hotspot | 19 |
| 4.8 Clear interface, reset data, reset point B | 20 |
| 4.9 Parameters | 21 |
| V. Common Problems | 22 |
| 5.1 Failure analysis of equipment information | 22 |
| 5.2 Common failure analysis | 23 |

I. Instructions for Using Products

| | |
|---|--|
|  | When the equipment is not in use for a long time, please disconnect the power cord to prevent the vehicle battery from feeding. |
|  | When supplying power to the product (system), you must note the equipment power supply requirements (the power supply voltage range is 12~24V). |
|  | When the equipment is turned on for autopilot, the driver should not leave the cockpit. |
|  | Autopilot system is strictly prohibited during non-working hours and non-working areas. |
|  | The autopilot system cannot control the speed of the vehicle. The operator must manually adjust the speed of the vehicle to ensure that the operation is at a safe speed and will not cause the vehicle to overturn or lose control. |
|  | Do not disassemble and assemble the equipment without permission, otherwise it will not be warranted. |
|  | Voice prompt is affected by the surrounding environment, so only prompt function is performed, and the driver should keep driving safely. Heilongjiang Huida Tech Development Co., Ltd. will not bear the losses caused by not hearing the voice prompt. |

II. Product Introduction

1. Product Introduction

Agricultural Machinery Autopilot Navigation System is an autopilot system, a large torque motor is used to control steering wheel. It is suitable for tractors, transplanters, pesticide spraying machines, crawler tractors and other agricultural machinery. Through practical application & verification, all supporting components are readily available, which is completely suitable for all agricultural machinery with steering wheels in China. In terms of design, the particularity of agricultural production and operation environment is fully considered, and the practical problems in the process of agricultural production and operation are perfectly solved.

- Improve the operation accuracy effectively, meet the requirements of standardized agriculture, and improve the quality of agricultural products;
- Change less crossing and no-omission under manual operation to no-crossing and no-omission under automatic operation, which improves the operation efficiency;
- Extend the operation time of agricultural machinery, operator stops but machine does not stop, and can work in the field at night;
- With simple operation, the intensity of driver is reduced, and the requirements for the operation level of driver are reduced;

2. Product composition

(1) Onboard navigation terminal



- 10-inch high-brightness touch screen, which is clearly visible in the sun
- Built-in radio and other modules
- Wide temperature range of -40 ~ 70°C, which is suitable for working in special areas and extreme working environment

(2) Satellite antenna



- Has the functions such as planning driving route and saving operation data
- Support Beidou/GPS/GLONASS/Galileo/SBAS
- High receiving sensitivity improves vehicle positioning and navigation accuracy

(3) EM-100 motor



- DC motor with high torque, which is suitable for various vehicles
- Low operating noise, low calorific value and high accuracy

(4) Attitude sensor



- Terrain compensation technology ensures navigation accuracy without fear of longitudinal slope and transverse slope
- IP67 protection level, compact size, easy to be installed

(5) Hydraulic valve (optional)



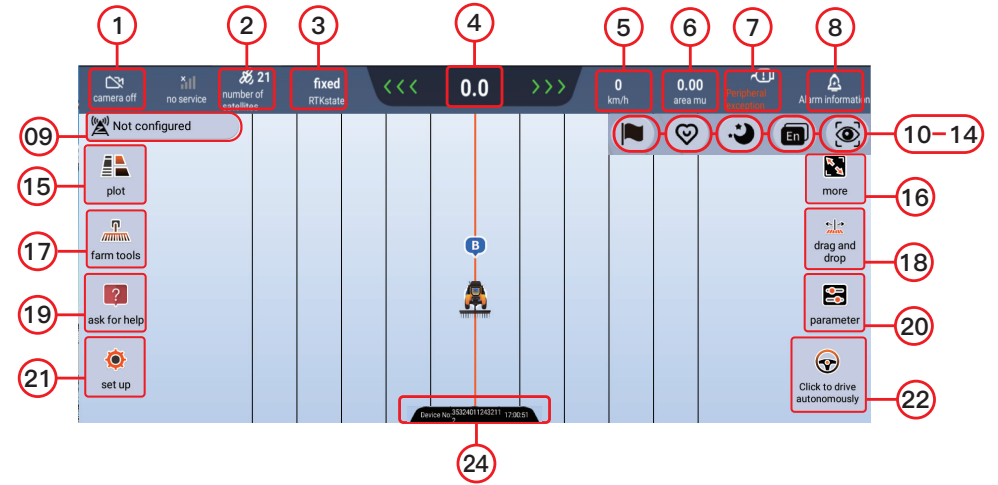
- Electronically controlled proportional hydraulic valve
- Maximum system pressure: 210Bar
- Minimum system pressure: 120Bar

(6) Gyroscope angle sensor (optional)



- The left and right steering angles of the front wheels are detected and fed back to the controller
- It is used for correcting and improving the straight-line driving accuracy of vehicle
- Leading the application of gyroscope angle recognition scheme
- Support self-estimation of antenna error, easy to be disassembled and assembled, and calibration is not required

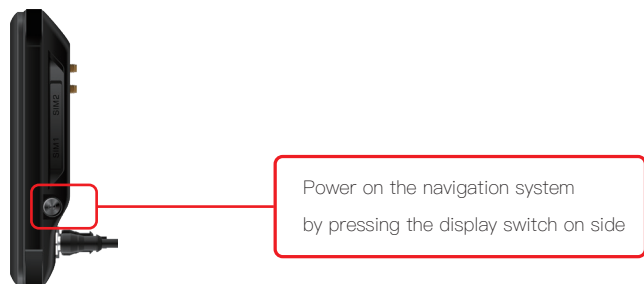
3、 Software interface



| | |
|---|---|
| 1. Camera switch | 2. Number of satellites: Number of satellites searched |
| 3. RTK differential state: fixed/floating/pseudo-range/single point | 4. Lateral deviation: It is negative when the vehicle is on the left side of the navigation route and is positive when the vehicle is on the right side of the navigation route |
| 5. Real-time speed | 6. Operating area: in mu |
| 7. Connection state of equipment peripherals | 8. Alarm information: Prompt for the cause of equipment failure |
| 9. Base station information: It indicates the current base station form (temporary station, mobile cors, large base station and small base station) | 10. Mark: Mark position |
| 11. Care mode: Simple operation, interface with large font | 12. Brightness display: Day/night mode switching; |
| 13. Language switching: Chinese/Uighur; | 14. Best scale |
| 15. Plot information: Including local plots and nearby plots (downloadable) | 16. AB line setting: Including setting the field, clearing the interface, resetting the data and resetting the point B |
| 17. Setting of farm tools; Including the width setting of farm tools and the quick setting of handover lines | 18. Drag: Including left and right drag, restore AB line, and drag to here |
| 19. Help: Including one-click help, instructions for use, SIM card renewal | 20. Quick adjust of parameters |
| 21. Interface settings | 22. Manual/automatic driving status switching |
| 23. Equipment number | |

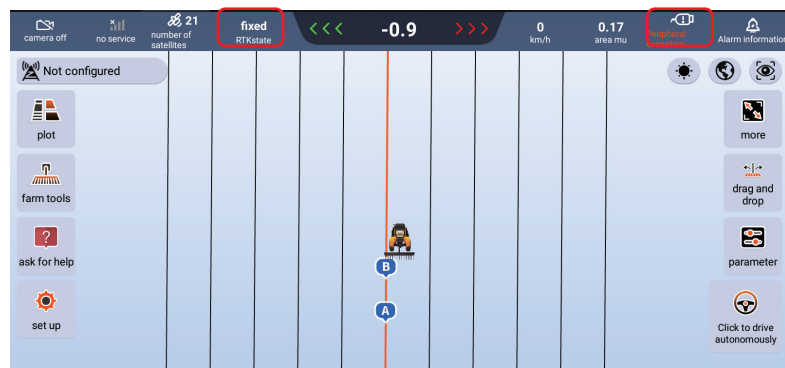
III. Product Use

3.1 Power-on



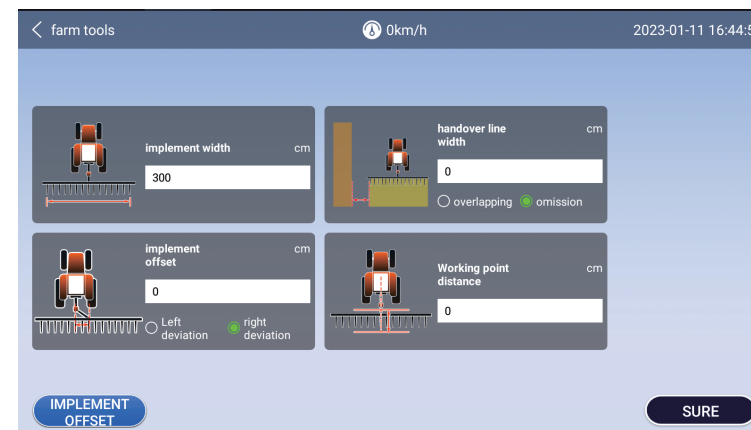
3.2 Confirm RTK and Peripheral states

Before autopilot, check whether RTK and peripherals are normal. Go to the next step after they are normal



3.3 Settings of farm tools

Click the "Farm Tools" button on the left side of the screen to enter the setting interface of farm tools, which can set the width of farm tools, the distance from the operating point of farm tools to the hanging point, the width of connecting rows, the deviation of farm tools and other information.



3.3.1 Set the width of farm tools

As shown in the figure below, you should measure the operation width of the actual farm tools before operation, and measure the actual distance from the middle point of the track to the middle point of the track after dragging the farm tools.

Please ensure that the measured width of farm tools is correct, otherwise it will affect the combination ridge !! Enter the width of farm tools after measurement



Width is the effective working width of farm tools

3.3.2 Width of next row

Overlap: The current operation width is overlapped when there is a duplicate area between the previous operation width and the current operation width

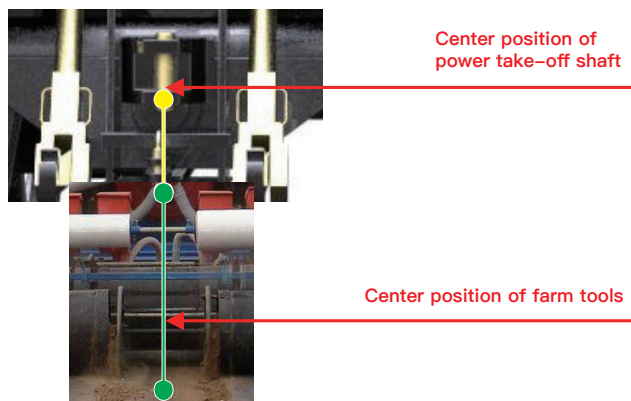
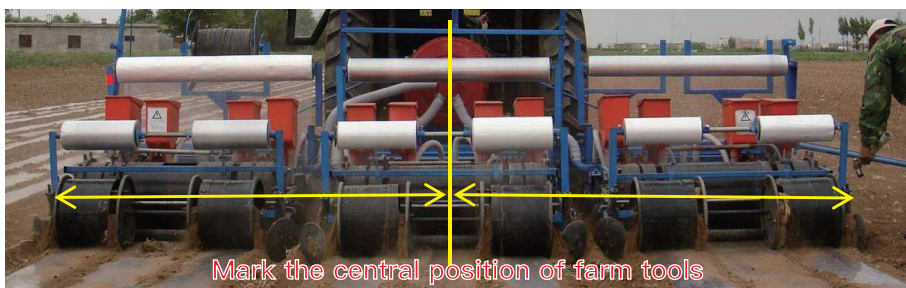
Omission: The area where there is a gap between the current operation width and the previous operation width is omitted

3.3.3 Set the distance from the working point of farm tools to the hanging point

Fill in the actually measured value

3.3.4 Set the deviation of farm tools

Deviation of farm tools: The value is measured from the center of agricultural machinery to the center of farm tools, and it is more accurate to measure farm tools on the ground



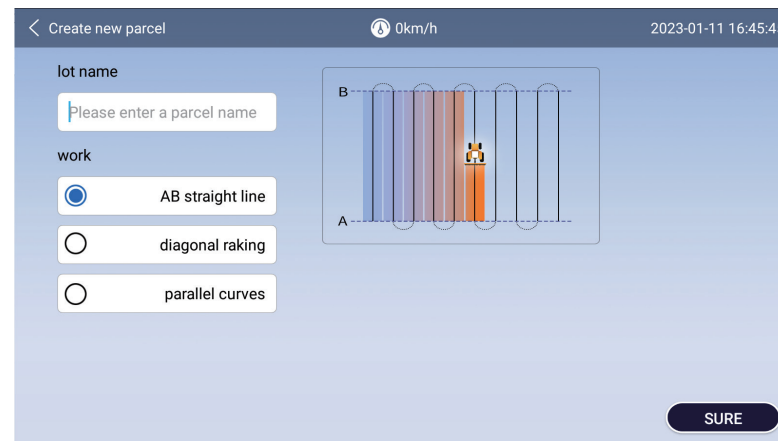
Attention: Mark the center of farm tools, adjust the lower pull rod of farm tools, and ensure that the center of farm tools and tractor are in the same line

3.4 Set the navigation route

3.4.1 Set AB straight line

When the vehicle is driven to the field edge, turn the front of the vehicle towards the direction of operation, click the "A" button on the screen, and set point A.

Drive the vehicle to the field end manually, click the "B" button on the screen, and set the point B. Complete the drawing of AB line.



Select AB line for type of operation mode

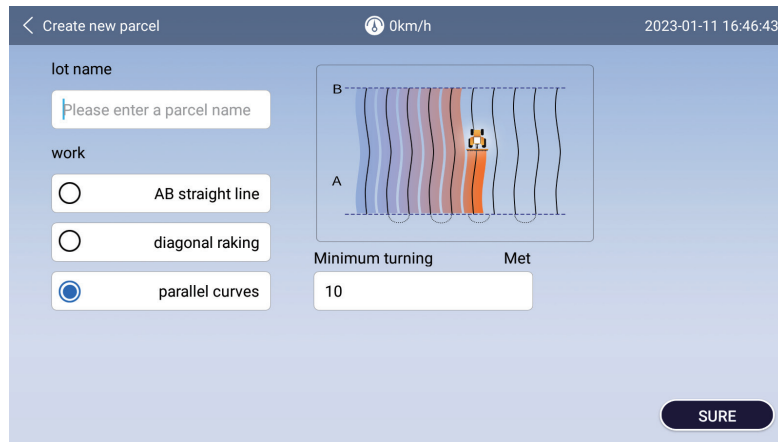
Notes:

- ①When setting up AB line, vehicle should not work as far as possible, and be driven without load.
- ②Whenever the vehicle changes the plot, it is necessary to reset the AB line once. If the operation is not finished on the same day, the same AB line can be called to continue the operation the next day.

3.4.2 Set parallel curves

Select parallel curves for type of operation mode.

Click point A on the field edge, drive the tractor to the other end along the ground boundary, and click point B, and the generated AB line is a parallel curve.



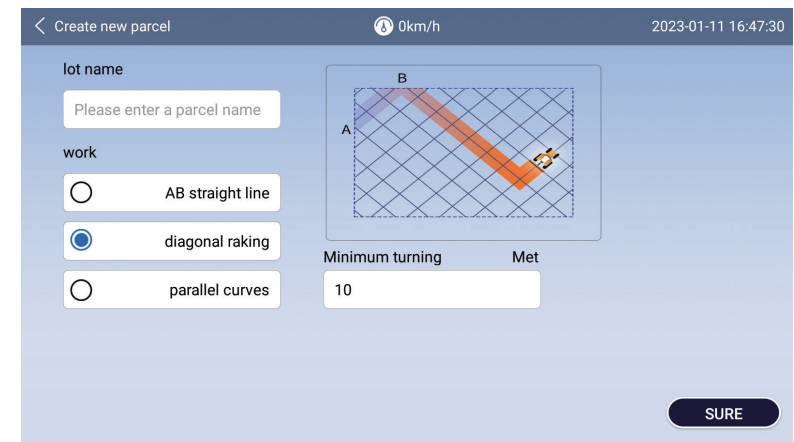
Select parallel curves for type of operation mode

Notes:

- ① When setting up AB line, vehicle should not work as far as possible, and be driven without load.
- ② Whenever the vehicle changes the plot, it is necessary to reset the AB line once. If the operation is not finished on the same day, the same AB line can be called to continue the operation the next day.

3.4.3 Set diagonal harrowing

Click the Record Boundary button at the field edge, click point A, drive the tractor to the other end of the field, click point B, return the tractor from point B to point A along the other three sides, and click the "Stop Recording" button, and the generated trajectory is the diagonal harrowing trajectory.



Select diagonal harrowing for type of operation mode

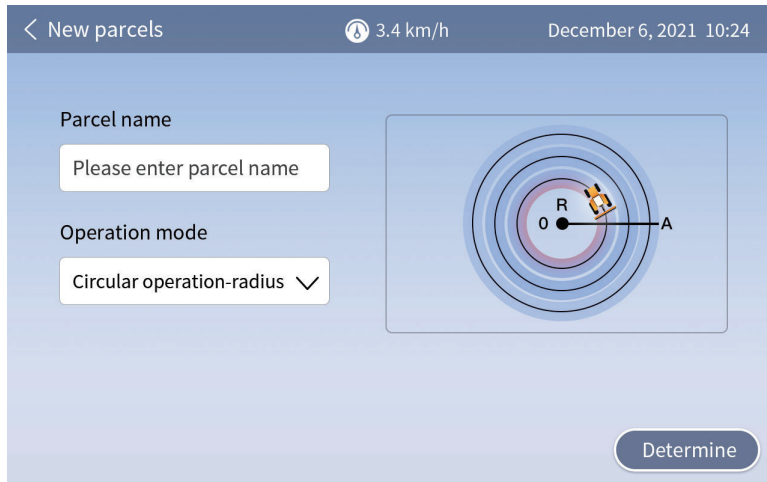
Notes:

- ① When setting up AB line, vehicle should not work as far as possible, and be driven without load.
- ② Whenever the vehicle changes the plot, it is necessary to reset the AB line once. If the operation is not finished on the same day, the same AB line can be called to continue the operation the next day.
- ③ It can turn automatically according to the planned path during diagonal harrowing operation.

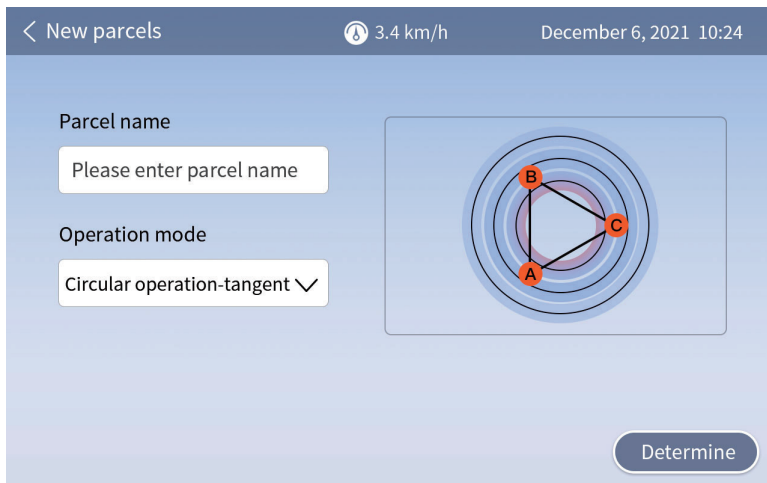
3.4.4 Set up a circular job

Select the routing mode according to the actual situation

Mode 1: For the radius method, it is at the center of the circle, the center of the tail of the farm tool is close to the center of the circle, click point O, drive to the boundary manually, tangent the left/right outer boundary of the farm tool to the outer boundary of the circular block, and click point A to generate the operation trajectory.



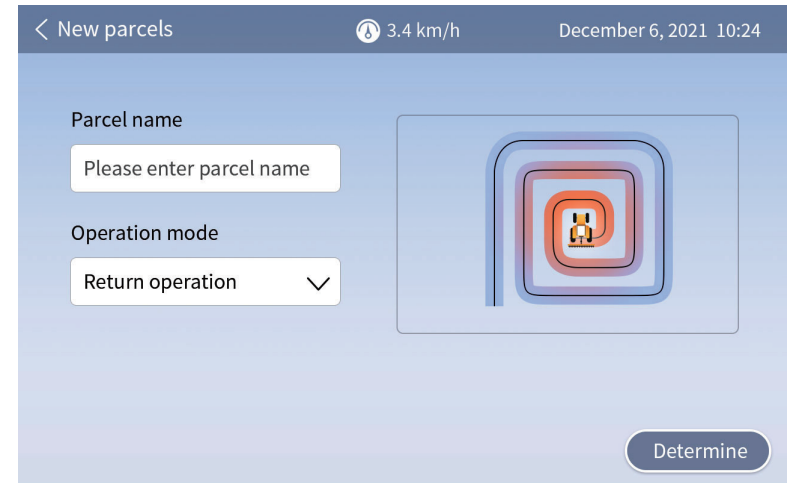
Mode 2: For the tangent method, it marks the boundary of circular working plot with the outer edge of farm tools on the same side. Click point A, in the same way, mark point B and point C, and the operation trajectory can be generated after point C is marked



Note: The positions of three points of ABC should be at the trisection of the circle. That is, the schematic diagram of operation mode.

3.4.5 Set the loop operation mode




Click point A at the field edge to mark, drive the vehicle to the other end of the field edge manually and click point B, then drive around the field edge for a circle manually, and mark point C and point D at the corner in turn to generate the operation trajectory



Select loop mode for type of operation mode

Note: The loop operation mode can only be applied to regular square and rectangular terrain

3.5 Autopilot

| Icon | Indicates state | Function |
|--|-----------------------------------|--|
|  Orange | System autopilot is ready | Click to start autopilot |
|  Green | The system is under autopilot | Click to stop autopilot |
|  Red | The system cannot start autopilot | Autopilot cannot be started, check the failure |

3.6 Power-off



Power off the navigation system by pressing the display switch on side

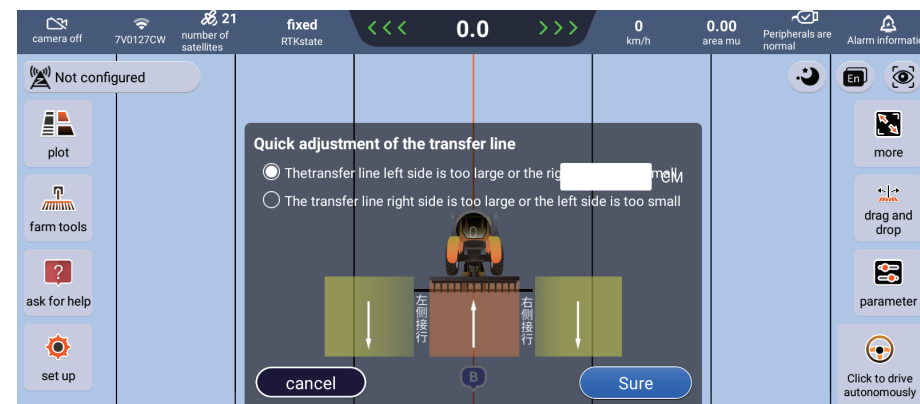
IV. Common functions

4.1 Next row calculation

Basic conditions: The accuracy of navigation straight line is normal, the width and missing value of farm tools are set correctly, and the farm tools are fixed firmly without shaking.

Commissioning steps

- Conduct autopilot operation, drive twice at a constant speed, and measure the width of the current bonding ridges. (Note: The operation width is the width of the outermost two seeding ports)
- Data acquisition: For the current combined ridges, find the position with straight line accuracy of 0 ~ 1cm, measure the width of the combined ridge three times at a distance, calculate the average value, and calculate the difference between the actual value and the ideal value.
- Input data: Select the actual deviation direction of the connecting row, input the difference value, and click OK to complete the quick adjustment of the connecting row.



4.2 Drag

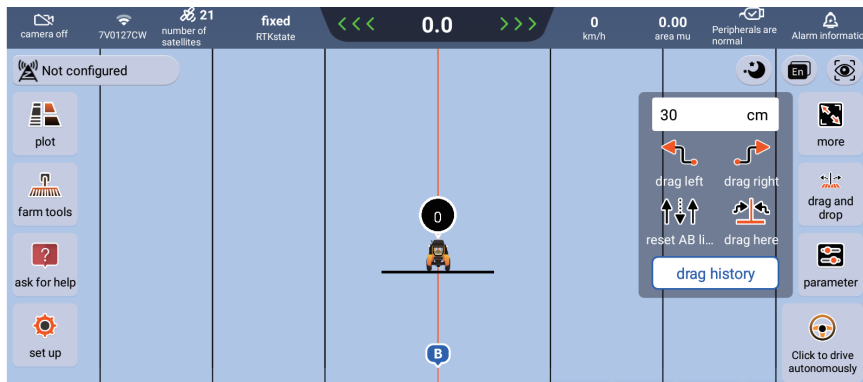
You can drag the navigation route, and drag to left and right to make the navigation route reach the ideal position

Drag to left: Click Drag, the navigation route moves to left

Drag to right: Click Drag, the navigation route moves to right

Restore AB line: All dragging records will be cleared and the first AB line of the current plot will be restored

Drag to here: Drag navigation route to the specified location

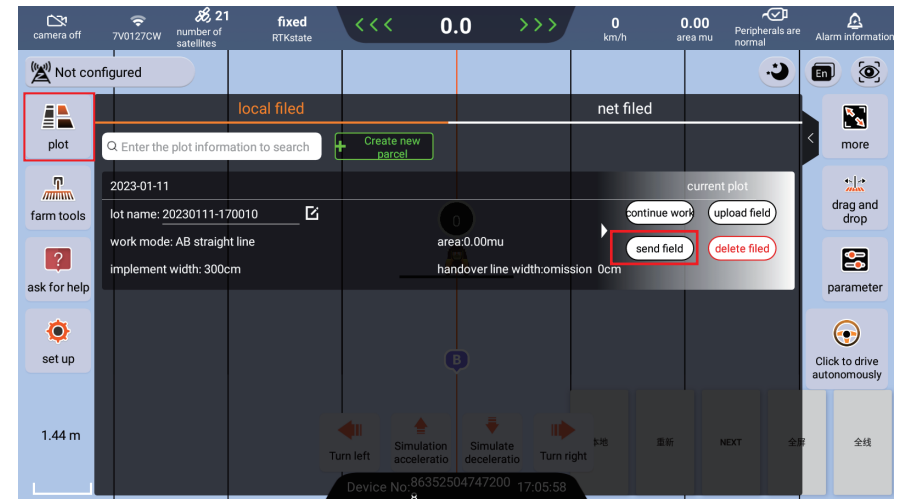


4.3 Plot sharing

4.3.1 Single machine sharing

User 1 creates a new plot. After finishing the routing of AB line, click "Send Plot" in the "Operation" button to share the AB line with User 2.

You can also click "Upload Plot" to upload AB line to the cloud.



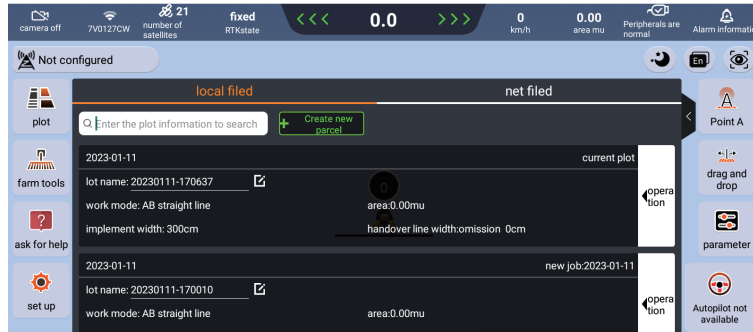
Notes:

- ① User 1 should enter the device ID of User 2
- ② User 2 should wait for sharing information in the main interface, and click Accept to share AB line with User 1.

4.3.2 Nearby plot

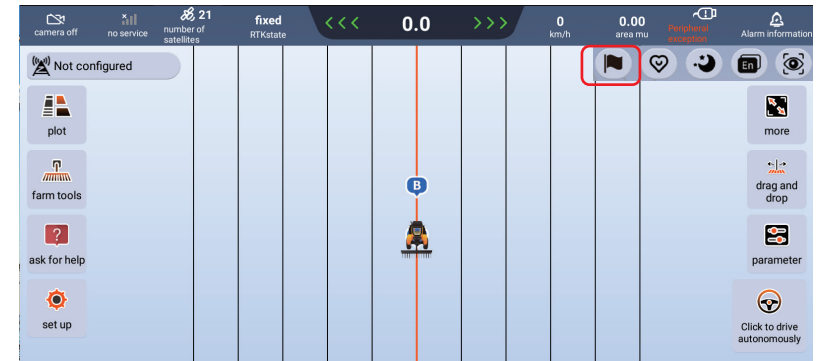
Nearby plots contain list and map modes (the mode could be achieved with network available)

The user can import the required AB line through the list and map mode in nearby plots for operation.



4.4 Mark

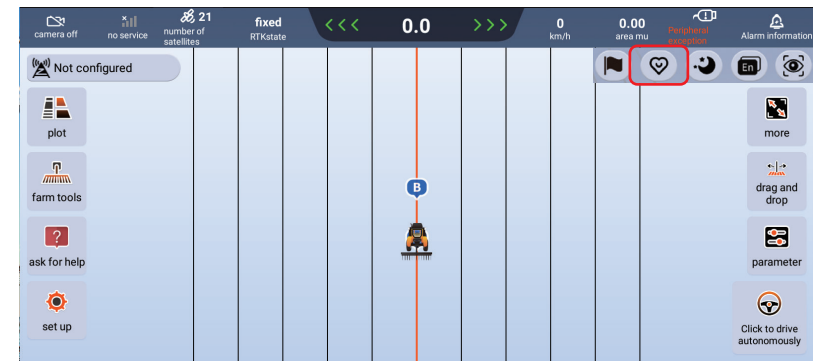
The location information of the current plot can be marked by the positioning of the vehicle, and then when the vehicle drives near the marked position in autopilot operation, it will be prompted



Note: ①: Prompted distance could be modified in Settings.

4.5 Simple mode

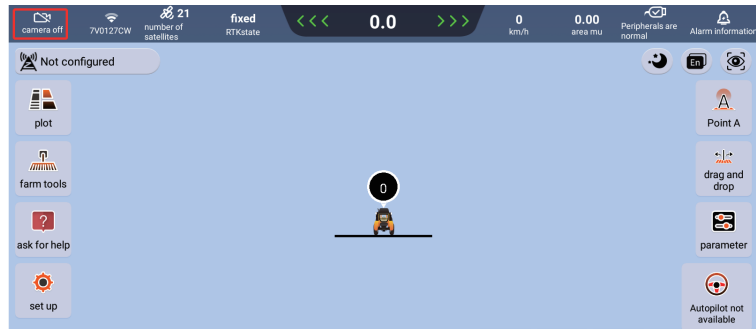
Under the normal interface, click "Simple Mode" icon to enter. The mode icon has larger text and simpler functions. The functions required are at hands, and the contents required are just around the corner. Click the icon under "Simple Mode" to quickly return to "Normal Mode"



Note: If you want to debug the vehicle, please debug it in normal mode, and debugging is not supported in simple mode.

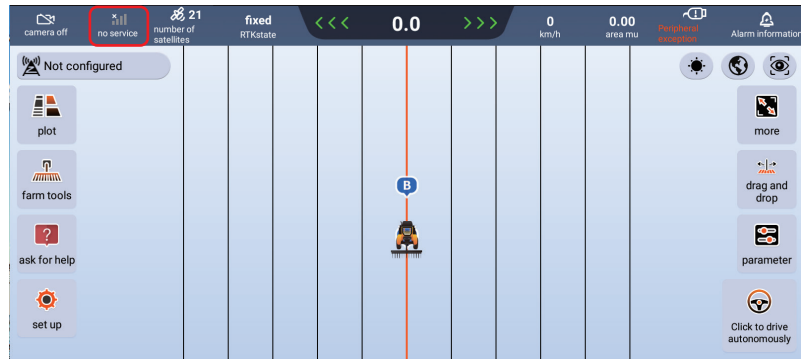
4.6 Camera

The camera provided by the system can monitor the operation of farm tools in real time. You can click the camera button in the upper left corner to open or close it



4.7 WiFi hotspot

The user can connect to the mobile phone WiFi hotspot to connect to the network

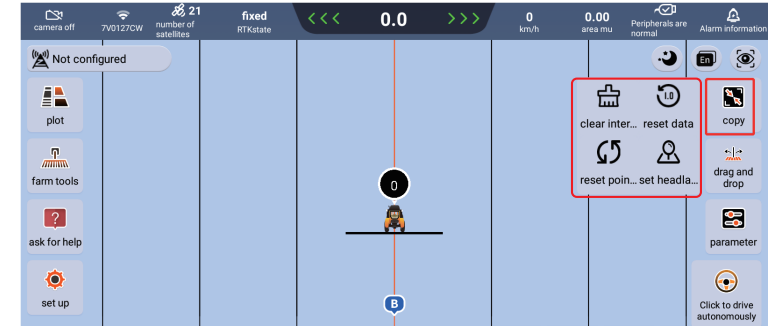


4.8 Clear interface, reset data, reset point B

Clear interface: Click the "Clear Interface" button to clear the driving trajectory of the current plot (yellow operation trajectory)

Reset data: Click the "Reset Data" button to reset the AB line of the current plot and its driving trajectory information.

Reset point B: If point B is routed incorrectly, click the "Reset Point B" button on the screen to reset point B.



4.9 Parameters

Lateral refers to lateral error deviation, and heading refers to heading angle deviation. Theoretically, the sensitivity is increased when the vehicle steering response to the deviation is not positive, and decreased when the vehicle steering response to the deviation is excessive.

Recommended value

Terrain compensation: 50 turning gain: 4

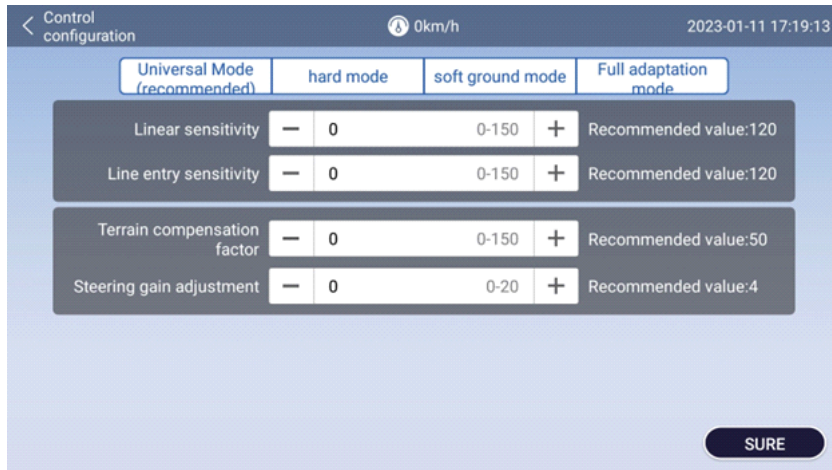
Universal mode (inlet 120–lateral 70–heading 30)

Hard ground mode (inlet 120–straight line 120)

Soft ground mode (inlet 120–lateral 70–heading 30)

Full adaptation mode (inlet 120–lateral 70–heading 30)

Generally, universal mode is used, and the soft ground mode should be used for soft ground condition



V. Common Problems

5.1 Failure analysis of equipment information

| Status bar | State information | State analysis |
|-------------------|-------------------|---|
| Positioning state | Fixation | Normal |
| | Float | The number of satellites received by the equipment is less or the satellite signal is poor |
| | Pseudo range | Base station signal is not received |
| | Single point | Only one position point is resolved (the signal is not received) |
| | NGPS | No satellite signal |
| Data source | Not Configured | Base station is not configured |
| | Normal | Normal |
| Control box | Not connected | Check the connection main wire harness |
| | Connected already | Normal |
| Angle sensor | Not connected | Check wire harness connection of gyroscope |
| | Connected already | Normal |
| Front wheel angle | Uninitialized | Initialization will occur when the vehicle is stationary for a long time, and the vehicle will be started to travel forward for a certain distance (the speed is > 1.6km/h) |

5.2 Common failure analysis

| No. | Fault phenomenon | Cause analysis | Solution |
|-----|------------------------------|---|---|
| 1 | Terminal is not started | Fuse is burnt | Change fuse |
| 2 | Motor is not rotating | Motor fault | Replace the motor |
| 3 | Blank screen flash screen | a. Display the terminal reason; b. Main harness of navigation dimension is damaged; c. Power supply of the main wire harness of the receiver is blocked; d. Battery feed/power harness loose | a. Replace the display terminal; b. Replace the main harness of navigation terminal; c. Replace the main wiring harness of the receiver; d. Charge the battery/tighten the power cord |
| 4 | Autopilot stop | Abnormal cable connection | Check cable connection |