LandWISE INCORPORATED

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Protocols for GPS Guidance

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HAWKE'S BAY REGIONAL COUNCIL

Horticulture

Farmlands

Sustainable Farming Fund

GISBORNE DISTRICT COUNCIL

Ballance

nzfc new zealand fresh cuts

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The LandWISE website will always contain the latest version of these protocols.

Refer to www.landwise.org.nz/resources LandWISE Protocols for Successful Precision Agriculture

Table of Contents

About This Document

Purpose

This document is intended to guide the design and implementation of Precision Agriculture (PA) systems. It establishes standard protocols and processes for use within and between farms. Wide adoption of these protocols will reduce downtime and waste and make skills transferable between employers.

Farmers and contractors may follow the general processes outlined here, but may develop their own specific procedures. This document should be used primarily to ensure that all of the main aspects are considered.

Audience

This document is intended for farmers and contractors, equipment suppliers and consultants implementing Precision Agriculture systems.

Diverse skills are necessary to successfully develop a Precision Agriculture system. It is expected that farmers will consult with others for specialist advice.

Background

Rapid development has taken place with Precision Agriculture in New Zealand. Gaps exist because there are few good resources written specifically for New Zealand. This document aims to fill these gaps.

The LandWISE Protocols guide farmers from the initial purchase of equipment through implementing Precision Agriculture on their farm. It provides simple approaches to many disciplines involved in Precision Agriculture, the relevant tools, and things that need to be taken into consideration.

The LandWISE Protocols were prepared as ‘generic documents’ that identify and codify procedures independent of brand or model. This is not always achievable. Brand or model specific recommendations are identified where possible.

NOTE: This document is intended to be used in conjunction with resources and updates on the LandWISE website and in User Manuals

for Precision Agriculture equipment and software. See www.landwise.org.nz.

Acknowledgements

This document has been developed with support from farmers, Precision Agriculture industry representatives and LandWISE members who are already finding success with Precision Agriculture. Thanks to all who have assisted. Also thank you, in advance, all those who will contribute to its ongoing improvement.

In putting together the GPS protocols, special thanks go to Scott Lawson and Donovan Keen (True Earth Organics), Hugh Ritchie (Drumpeel Farm Partnership), John Ahearn and Wade Riley (GPS Control Systems), Chris Butler (New Zealand Fresh Cuts) and Patrick Nicolle (Nicolle Contracting).

1. Introduction

These protocols were created after LandWISE farmers' comments about the learning required to adopt Precision Agriculture (PA) and the use of GPS, whether for machine control or data capture.

These will aid those starting with Precision Agriculture, or a new aspect of Precision Agriculture, or for training. They can also be an aid to remembering how to do things at the start of each season. The intention is for the accumulated learning of LandWISE farmers to be included here. It will form a record of best practices developed over time.

Trimble users and local representatives have supported this work, so there is a Trimble flavour to some content. Where known, this is marked 'T' at the start of any relevant phrases. We welcome comment from other users and dealers about inclusion of other brand specific comments.

The intention is for this material to be mostly generic. Also this is intended to be a living document. We welcome its use by anyone, conditional on your sharing with LandWISE any improved ways of doing things for future updates.

This is intended as a guide to learning and successful adoption of Precision Agriculture. LandWISE accepts no liability for any outcome arising from its use.

Is Precision Agriculture for me?

Precision Agriculture offers farmers the chance to be more efficient with inputs and lift their profitability while making their farming more sustainable. But it does require some changes, so here are some points to ponder about whether Precision Agriculture might suit your system.

1. **Do I want to improve the profitability and/or sustainability of my farming operation?**
2. **Can I learn to cope with technology?**
3. **Do I have access to the right people to change my farming system?**
4. **Will saving 10% on my costs, cover the likely cost of changing my system?**

2. Farm Setup for Precision Agriculture

Farm layout

1 **Lay out paddocks to suit Precision Agriculture**

Note: Parallel sides and square paddock shapes whose width is a multiple of your implements will allow for efficient operations. Some farmers have redesigned paddocks accordingly.

Note: Consider irrigation system configuration and location of permanent laneways, drains or ponds.

2 **Identify existing Base Stations that can provide appropriate coverage**

3 **Identify sites for new Base Stations that provide line of sight to desired fields if required**

Note: If a new base station is being sited, consider potential future users in choice of position as this may allow you to share costs.

4 **Install permanent installation site for portable base stations if these are to be used**

Note: Repeated return trips to the area justify up front costs in many cases.

Example: Some farmers mount a steel post in a concrete base

Data Management

1 Create a Farm Map Book with correct Field names listed

Note: this can be used to avoid errors by entering Field names exactly as spelled in the Map Book.

2 Establish file directory structure

Recommendation: use a directory structure as in diagram below:

Note: This allows operations to be stored and recovered logically.

3 Establish file naming convention

Recommendation: File naming should follow the convention: OperationCropYYYY-MM-DD.ext

Example: YieldMaize2009-02-21.shp

4 Establish procedures for the backup of data

Recommendation: Back up tractor data onto the card in the on-board computer after each operation is completed.

Note: Follow agreed file naming convention, with correct spelling, no spaces, CapitalsToStartEachWord.

Note: Back up regularly and in a number of ways, to ensure safety of data

Note: Save tractor data needs to the office computer regularly

Reason: This safe-guards against theft of GPS or corruption of the onboard computer.

Note: Establish office backup procedures for all farm and personal data.

Note: Consider what would happen if you lost your GPS or computer. Create a system to prevent data being lost.

5 Determine the need to archive field data

Note: Some practitioners prefer to keep all data "live".

Note: The need for archiving will depend on available data-storage capacity

Recommendation: Replicate the standard structure for archive file directories, as described in 1 – 4 above.

3. Tractor setup

Tractor roll calibration 'T'

To be conducted every time a GPS unit is shifted into a tractor

Note: Follow manufacturer's instructions for roll calibration

Note: Before you begin:

1 **Ensure the vehicle is correctly prepared**

Note: Hydraulic oil should be at operating temperature

Note: Refer to the vehicle documentation

Note: Check tyre pressure is correct and the same on each side

2 **Choose the smoothest possible surface**

Note: Calibrate on a flat area, away from buildings (otherwise deflection can occur). Ensure RTK is fixed.

3 **Perform initial calibration without an implement**

Note: Perform calibration with the booms folded in on a high clearance sprayer.

4 **Use a pin through the drawbar to mark the ground**

Note: ensure drawbar is carefully centred

OR: Use tyre tracks if pin not available.

5 **Create or follow established AB line**

Recommendation: Minimum distance 100m - ideally 150m +

Note: Ensure tractor is on-line and has no heading error

6 **Turn tractor and return along same AB Line at 2-3km/hr**

7 **Assess the variation between the out and back lines**

Note: For RTK error <2cm error is satisfactory

8 **Enter roll calibration**

9 **Repeat calibration exercise on a different AB Line**

Note: Fine-tune settings with the implement attached or booms folded out

Equipment measurement and installation

Pre-operation setup is required for precision. (It is a form of process control; treat it like setting up a lathe in a workshop)

Note: Sideways movement is possible with side wall movement in tires, especially without water and at lower pressure

Implement calibration

1. **Centre and level the implement**
2. **Check sway blocks for tightness if this desirable**
3. **Check sway chains for desired tightness (to contain sway but allow some catchup)**
4. **Level implement on known flat surface**
5. **Ensure implement exactly follows tractor centre**
6. **Measure distance between units for every row and**

   Note: inconsistencies will affect following operations and should be corrected where possible.

   Note: outside units are often bent in use and may need adjusting periodically.

Swath width settings

1. **Calculate the swath width, multiply the number of rows by the row spacing**
2. **Enter swath width and number of rows**
3. **Set sprayer swath width based on number of rows covered. Multiply rows covered by row width and enter as swath width**
4. **Measure your implement, to each coulter from centre**
5. **Swath width and application width should generally be set the same**

Implement setup on FMD/FMX (Trimble)

Note: Make changes to setup pre-season to avoid mid season misalignment with existing work

Note: Ensure that no existing operations will be affected before making in-season changes

1 **Enter Implement width in metres to 4 decimal places e.g. 3.0480 m**

Recommendation: Work in metrics only using attached table of conversions in Appendix 1.

Note: Conversions are based on 1 inch= 0.0254 metres.

Example: Converting inches to decimals: 30 inches x 0.0254 = 0.7620 m

Reason: Avoid metric to imperial conversion errors

Recommendation: Never convert from imperial to metric using the Trimble system

Reason: It has hidden decimal places

Note: To see and check entered implement widths to 10 decimal places print the "implements_FMD.xml" file

Reason: This is the only method that allows you to see this detail

2 **Select Hitch type: 3 point or drawbar**

3 **Set row number**

4 **Set application width**

Note: Usually same as swath width

5 **Set F/B (forward/back) offset.**

Note: Measure from GPS antenna to seed placement or ground engaging tools for FMD. For FMX use centre of rear axle.

6 **Set L/R offset to be zero**

Note: Current Implement description cannot be edited later.

Note: Possible fix is to delete and reload the implement

GPS unit exchange between machines

1. **Check antenna placement**
2. **Ensure correct controller orientation**
3. **Reload tractor configuration file**

   Note: individual tractors should be numbered and labelled eg. JD6420 #1,#2 etc, as should antennae and controllers.
4. **Check that radio is on correct station**
5. **Complete roll calibration**

4. Establishing AB Lines

1 Identify optimum AB Line

Recommendation: Follow an existing AB line if suitable

Consider: your longest runs, least turns

Consider: harvester fill distances and unload point

Example: grass seed – longer runs, maize – shorter runs

Consider: drainage and up and down slope, row impact on water runoff

Consider: fit of AB lines with Irrigation equipment

Consider: width options for future controlled traffic conversion

2 Set AB Line

Recommendation: Use full length run to set AB Lines

Reason: Setting the AB line on a long run takes little extra time, and decreases any chance of error

Note: If using headland complete function, point A should be fixed with the tractor heading across the end of first leg, prior to turning down it, so that antenna is positioned at row centre

3 Record AB Lines

Recommendation: Plot AB Lines on laminated farm plan map or map book

Reason: Drivers can see where to go

Recommendation: Consider password protection to prevent tampering with AB lines.

Recommendation: Label Master AB lines to include channel used

Example: Label as MasterABCH1 if there are options.

Recommendation: Label infill headland as MasterInfillAB

Recommendation: Label headland as: MasterHeadlandAB

Note: Always work off same base station the AB line was created on.

Note: If screen is not reacting correctly. Recalibration of the touch screen may be required, see the manual.

Note: Unless there is a very good reason, use these Master AB lines

4 Establishing Special AB lines (eg. For AB lines for tillage only)

Recommendation: Label special AB Lines with descriptor of purpose or use

Example: Drainage AB, Temporary AB (delete on completion)

Recommendation: Label Crosswork AB Lines to include angle in degrees

Example: Label as Crosswork45^{o}NE or Crosswork45^{o}NW etc,

5. Setting up the field

Before You Begin

Before you start setting up your new field:

- Select correct GPS radio station
- Ensure roll calibration is completed

Determining Working Patterns

1 **Determine up-rows and down-rows**

Reason: To minimize chance of error in coulter spacing, width or roll calibration.

Note: This is particularly important where cross slope can cause implements to swing offline behind tractor.

Example: Some farmers always work down the first row from the gateway, to ensure consistency.

2 **Record determined up and down rows or pattern**

Reason: To allow up and down rows to be followed for other operations.

3 **Establish AB line for field**

Note: Headland AB line is created with first outer pass

4 **Create Infill AB line on same pass according to entered number of headland passes.**

Example: 3x10m headlands will create AB line 5m inside headland.

5 **Rename Infill AB line**

Recommendation: Label infill headland as [BaselineName]InfillAB

Example: If Infill AB is off MasterAB Line, name as MasterInfillAB

6. Performing Guided Operations in a Set up Field 'T'

Fitting implement to tractor

1 **Check implement is in working order.**

2 **Connect to 3 point linkage (Left arm, right arm, toplink).**

3 **Raise implement on hydraulics.**

4 **Centre implement on tractor using sway chains.**

5 **Level implement using right arm adjustment.**

6 **Check the correct row spacing (in mm) for this job.**

Setting up GPS Control Unit for Operations (FMD display)

1 **Turn on GPS system after tractor is running**

Note: Press the "CONFIG" button (spanner icon on FMD)(Tractor button on FMX)

2 **Select the implement. Check its settings and press "OK"**

Note: Press the "RUN" button.

3 **Select the field**

4 **Create the new event**

Note: Name with description and date (US system M D Y) - Press "OK"

5 **Go to swaths**

Note: Check that you are using the correct AB line - Press "LOAD"

6 **Choose appropriate steering sensitivity**

Note: Flat smooth ground = high sensitivity. Rough ground = low sensitivity.

Setting up GPS Control Unit for Operations (FMX display)

1 Turn on GPS system after tractor is running

Note: Press the "Tractor "button on top right hand of screen

2 Check current implement settings - press "Edit" to make adjustments

Note: Press "Switch" to change the implement "If screen displays a lock beside the "Switch" button you will need to enter the display Password"

3 Verify the "Client, Farm, Field" data is correct and spelled correctly

Note: Remember the AB lines follow the "Client, Farm & Field" it is very important to get this right!

Note: If the field has been worked before and "Logging" was turned on you will need to enter a "New Event" to remove the logging from the Run Screen! You can then Name the "Event" to correspond to the operation currently being performed.

4 Press the "Swaths" button

Note: If the field has been worked previously choose the correct "Headland or AB Line" for the current operation.

Note: If the field has not been worked previously choose the swath you need to perform "headland, Curve, or AB" if choosing headland enter the number of headland runs you require "Follow the directions at the bottom of the screen to complete the Headland Swaths" If AB swath is required choose "New Straight" at the bottom of the screen.

5 Press "Set A – drive 50 meters and Press the Set B button"

Now you have an AB line

Note: It is recommended that you use the longest run in the field to set the AB line.

Note: When bedding or planting for best accuracy. Line-up Planter/Bedder "Press A" drive to other end of the field line up again and "Press B"

6 Choose appropriate steering sensitivity.

Note: this is located under the "NAV II icon" looks like the silver box mounted somewhere in the tractor.

Note: Flat Smooth Ground = high sensitivity, Rough Ground = low sensitivity.

Performing Operations

1 **Determine correct travel path pattern for field.**

Note: Travel in same direction as originally planted. i.e, 'up-rows' and 'down-rows'

2 **Start operation**

3 **Once implement settled in operation, stop and check for correct alignment**

4 **On return row, stop and check swaths meet correctly**

Shut down procedure 'T'

Important: when finished, - Press "HOME" and then press "SAVE" on FMD. On FMX press close field which autosaves a summary file.

1 **Complete backup procedure to card**

Important: when finished, - Press "HOME" and then press "SAVE" on FMD. On FMX press close field which autosaves a summary file.

2 **Turn off FMD (screen) before turning off the tractor. On FMX press shutdown on the screen.**

Note: Wait for ping sound and for screen to go black, then - Turn off master power switch

3 **Perform tractor to office backup**

4 **Using cards for backup and file transfer.**

Note: If using FMD, CF cards are required for storage. On the FMX a USB stick is used. (Lexar firefly suggested). If using both FMD and FMX with shared data, a CF to USB adaptor can be used to transfer files. See Appendix 2 for more detail.

Using Skip function

Recommendation: Avoid using skip function if possible as it does not stay in system for following operations, it is deleted at shutdown.

1 **Shift is a recommended alternative, as it *is* recorded.**

Note: This is done in the swath screen. The shifted AB line needs to be renamed. E.g, DrainABLine1

2 **If skip function is used, note location and details of skip for following operators.**

3 **If using trim, then reset to zero.**

7. Transferring Data 'T'

Transferring data from Tractor 1 to Tractor 2 (FMD)

1 **Take card from tractor 1**

2 **Remove tractor 2 card**

3 **Insert tractor 1 card into tractor 2**

4 **Transfer folder of field data onto Hard Drive of tractor 2, highlight field name and press transfer**

5 **Replace tractor 2 card in tractor 2**

6 **Transfer from tractor 2 Hard Drive back to tractor 2 card**

7 **Replace tractor 1 card in tractor 1**

8

Transferring data between Office and Tractor

1 **Take card from office**

2 **Remove tractor card**

3 **Insert office card into tractor**

4 **Transfer folder of field data onto Hard Drive on tractor, highlight field name and press transfer**

5 **Transfer Tractor Hard Drive data to office card**

6 **Remove office card from tractor**

7 **Replace tractor card in tractor**

8 **Transfer data from tractor Hard Drive back to tractor card**

9 **Transfer office card data to Office computer Hard Drive**

Note: Deletion is permanent and non-reversible.

8. Selecting a farm software package

Below are some things to consider before buying field record keeping and GIS mapping software for use in crop production.

Note: Most companies have demo versions available or provide the software for evaluation on a limited basis

Ease of Use

Is it easy to understand and do specific tasks?

Are online or face to face training opportunities provided by the software company?

Hardware Requirements

The more elaborate GIS software that works with large data sets and imagery needs additional memory displaying the information.

In some cases it may require you to think about updating or replacing your computer and operating system.

Keep in mind that software will generate its own data so sufficient data storage and back up plans are needed to keep your data safe.

Support and Training

Check to see what training is offered that best fit your needs. These can consist of online courses or self-guided tours and training modules included on CD or DVD.

You can save time and frustration by taking time to learn the basics of using your new software.

Also check to see what level of help and support is provided by means of manuals, help section built into the software, and online help through the company web site, knowledge base, or user groups.

Features

1 **Consider Expandability, functionality, and appropriateness for your situation**

Note: While you are not likely to need all of the features below, look ahead to where Precision Ag might take you

2 **Check which data formats it accepts**

3 **Check it can import and export files of the type you will require**

4 **Check it works with your hardware and controllers**

5 **Determine whether you will be able to use to display imagery**

6 **Determine whether it can create application maps to communicate with other programs and VRT controller equipment**

7 **Determine whether you can digitise field boundaries, buffers, or areas**

8 **Check that you can generate the reports you need**

9 **Determine whether it can process economic data or farm accounts, or easily export to another package**

10 **Check that you can analyse several years or layers of data together**

11 **Determine whether it can make calculations for variable rate applications, profit maps, or other management maps**

12 **Determine whether it has the capability to change data projections, coordinates, and units**

Note: If not, other services or software may be needed if you intend to work with several spatial layers of different projections, this can mean more cost

13 **Does it provide online help?**

Price

Software prices can range from free to several thousands of dollars. You should also take into consideration annual subscription fees.

Also check to see if there is a money-back guarantee or time frame where you can return the software if you are not satisfied with the software.

Maintenance

For software companies to make their income and update your software they require subscription fees.

If you plan to use your software long term it is advisable to keep up with the maintenance, especially if support is included.

To find out more

Talk with other farmers who have invested in software.

Ask other farmers online: www.landwise.org.nz, www.agriculture.com and http://talk.newagtalk.com/ are websites that have online message boards.

9. Appendix 1: Conversion Table

Inches to Metres

Note: enter the metric figuresin metres to four decimal places, do not convert to metrics from imperial in Trimble GPS.

Inches (1”=0.0254 metres)	Metres (enter in FMD to 4 decimal places)
24”	0.6096
30”	0.7620
36”	0.9144
48”	1.2192
60”	1.5240
72”	1.8288

NB For other dimensions multiply inches by .0254 to get metres

10. Appendix 2: Replacement of Data Media 'T'

It is advisable to replace media, i.e, cards for FMD, or USB for FMX yearly. File structures are the same for both.

Data files are Linux based so the formatting of storage in the relevant console is essential so that file structures are made compatible.

Note: It can be helpful to label with date and tractor number.

Note: For Trimble FMD. When replacing cards, put new card in tractor and switch FMD on. This creates correct directory structure. The card can then be used in a PC and have relevant files copied into root directory structure.

Note: For FMX, the files are held in 2GB internal memory. USB is used to transfer files. USB has to be formatted in FMX in same way as the card for FMD.

Recommendation: Lexar firefly is recommended USB type for FMX.


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