LandWISE INCORPORATED

YieldEst
LandWISE Yield Variability Estimator

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Sustainable Farming Fund

Horticulture New Zealand

LandWISE INCORPORATED

YieldEst was prepared with Funding from the Ministry for Primary Industries Sustainable Farming Fund, LandWISE Inc., and Horticulture New Zealand Vegetables Research and Innovation Board under MAF SFF Project L11-150.

It is available from LandWISE via www.landwise.org.nz

The Project Team included representation from LandWISE, Horticulture NZ Vegetables Research and Innovation Board, Onions NZ, Hawke's Bay Regional Council and Plant and Food Research.

YieldEst was developed in partnership with ASL Agricultural Software Ltd.

Liability

Read the End User Licence Agreement. We make the calculator available at no cost and accept no liability for any errors it contains.

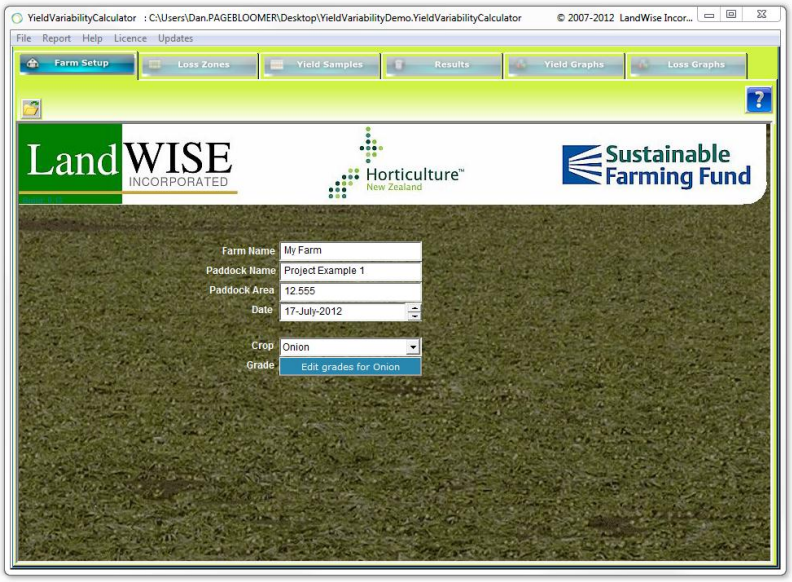
Contents

Introduction

Purpose

YieldEst is designed to help growers assess yield and variation within crops, and to determine the potential value and benefits of remediation where yields are suppressed.

Growers and agronomists readily identify significant differences in growth or yield by simple observation. They recognise areas of suppression, damage and loss within crops. The Estimator gives them a simple way to systematically and fairly measure and assess the value of related financial losses.



Process

The process for assessing the financial implications of crop damage has four stages:

- Identifying zones of variable (poorer) performance
- Determining the area of each zone
- Measuring the yield in each zone
- Calculating the cost of poor performance

A further stage is to confirm causes of loss, and develop strategies to avoid future losses.

How the Estimator works

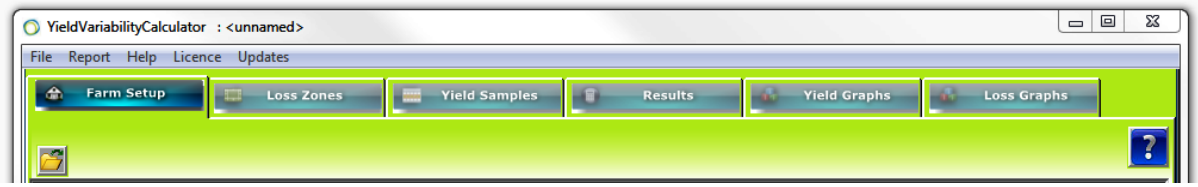
Menu

Five menu bar items sit at the top left of the screen:

- ***File*** – open and save new or existing files, and exit the program
- ***Report*** – opens a printable and exportable summary report
- ***Help*** – explains how to use different aspects of the estimator
- ***License*** – at present the program is free licence to New Zealand farmers
- ***Updates*** –check you have the most recent version of the program

Tabs

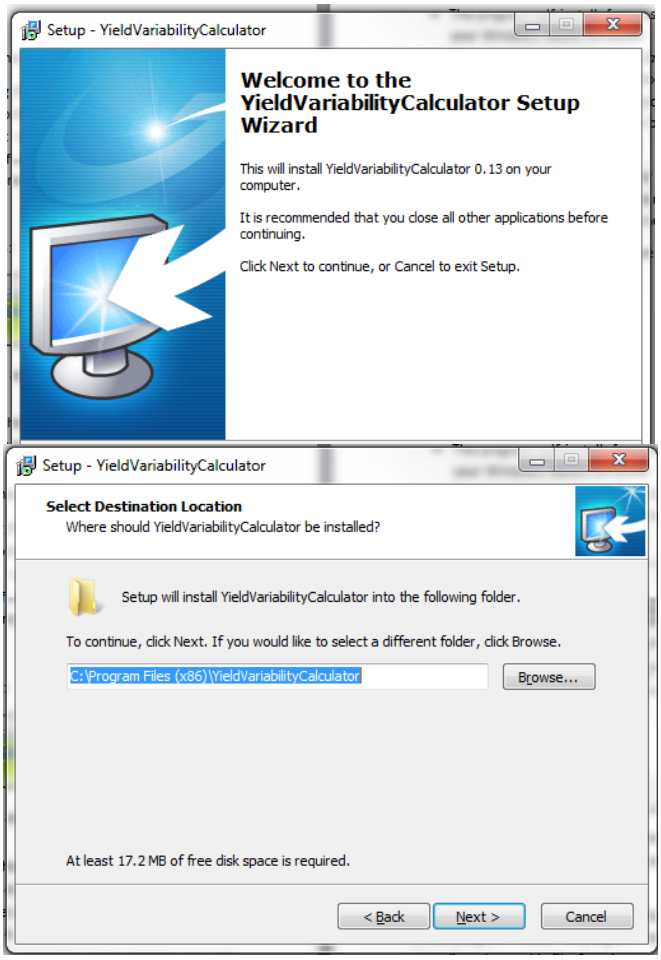
YieldEst has six tabs:



Farm Setup	where you enter data about the farm, paddock, crop and yield and price expectations
Loss Zones	where you enter the shape and size of areas where yield is compromised, and cause of any losses
Yield Samples	where you enter the size of sampling areas and the weights of each grade in each sample
Results	a summary table showing gross yields, values and the value of lost yield in each loss zone presented
Yield Graphs	graphs of gross value, yield and financial return by zone
Loss Graphs	graphs of the lost value, causes and relative importance

Setting up the program

The program self-installs from a setup file *SetupYVC.exe* downloaded to your Windows based computer



- Download *YieldEst* setup file from the LandWISE website www.landwise.org.nz/tools
- Launch the setup program
- Read and Accept the Licence terms
- The program will seek to load into a default directory. You can change this if necessary

Once setup, launch *YieldEst* from either the desktop icon or the program menu. The program starts with the most recent file open. You can edit and save this file. Save it as a new file if required.

Or start a new file by selecting “New” in the “File” menu.

Instructions for using the Calculator are found in the ***Help*** Menu, or by clicking the blue Help icon.

Entering Data

Farm Setup

YieldEst creates a new file for each paddock. If more than one paddock, or more than one crop in a paddock, is to be assessed, a separate file must be saved for each one.

Click the Farm Setup Tab to select the Farm Setup screen.

Enter details of the:

- Farm
- Paddock
- Paddock area
- Assessment date, and
- Crop.

Paddock area

Enter the paddock are in hectares, if possible to three decimal places.

This area value is critical. It is used to determine potential yield and value, and also the area of the Main Zone.

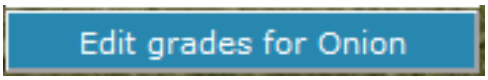
The Main Zone is all that part of the paddock that is not part of a Loss Zone (see below). The Main Zone will have the highest average yield of the paddock, but it may not reach the “Potential Yield” for the crop.

Crop

A number of crop type options can be selected from a dropdown list. You can add any other crop by selecting <NEW CROP> from the list.

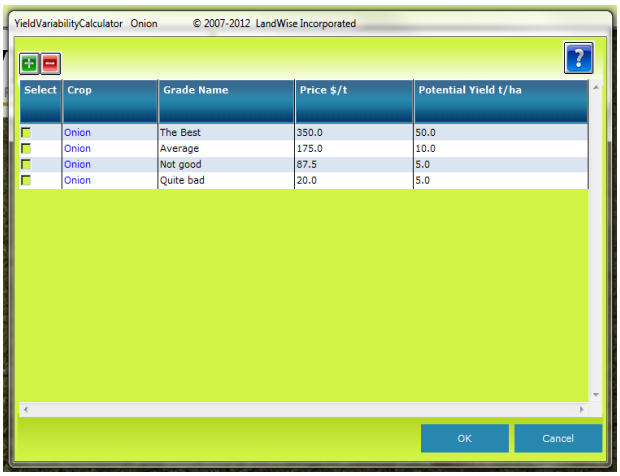
Crop Grades

Any number of grades, each with different potential yields and prices, can be used.



Click the Edit grades for Crop button below the Crop name.

A new window will pop-up for the crop with a table listing each grade name, price ($/t) and the potential yield (t/ha) for each grade.



If you edit the grades, the new information will be kept when you save the file. Grade data saved in previous files WILL NOT be altered.

Click the green + button to add grades, or red – button or remove them.

Potential Yield

Potential yield is the maximum achievable for the variety, planting date, water and nutrition etc available to the cop. The potential yield to enter could be known from literature or prior experience. Or yield in the highest yielding part of the field.

The anticipated possible yield and price of all product grades must be entered in the *Yield Variability Calculator*. *YieldEst* assumes that the overall potential yield includes all grades across the full field area.

Potential Value

Potential value is calculated from potential yields and prices entered. The product prices may be gross return for each grade or nett of known charges such as harvesting and transport if these are levied on a per tonne basis.

Loss Zones

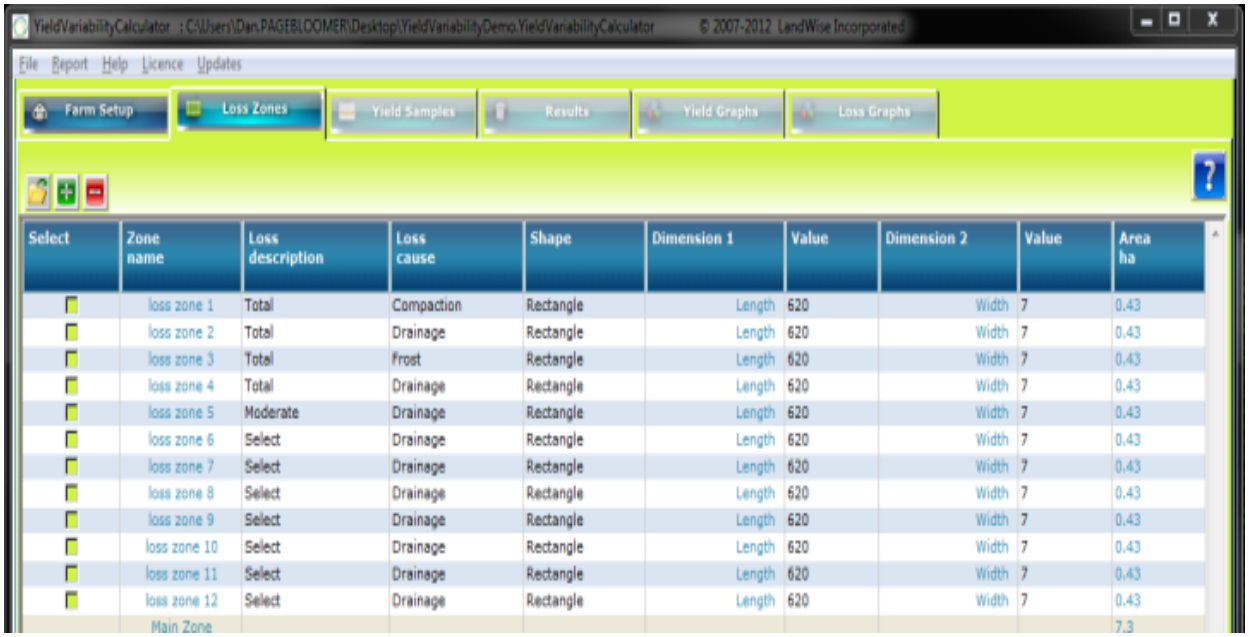
A Loss Zone is an area within the paddock where yield or quality is reduced. You can have as many "Loss Zones" as you need for each paddock.

Click the Loss Zones tab to enter the Loss Zones screen

Click the green + button to add Loss Zones. Select a Loss Zone and click the red – button to remove it. You cannot undo a remove!

For each loss zone, enter:

- A description of the amount of loss - selected from a dropdown list
- The cause of the loss - also selected from a dropdown list
- The area's shape – also selected from a dropdown list
- The area's dimensions – in metres (dimensions required depend on shape selected).



Select	Zone name	Loss description	Loss cause	Shape	Dimension 1	Value	Dimension 2	Value	Area ha
	loss zone 1	Total	Compaction	Rectangle	Length	620	Width	7	0.43
	loss zone 2	Total	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 3	Total	Frost	Rectangle	Length	620	Width	7	0.43
	loss zone 4	Total	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 5	Moderate	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 6	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 7	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 8	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 9	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 10	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 11	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	loss zone 12	Select	Drainage	Rectangle	Length	620	Width	7	0.43
	Main Zone								7.3

YieldEst calculates the area of each Loss Zone, and the area of the Main Zone, which is displayed at the bottom of the table.

Yield Samples

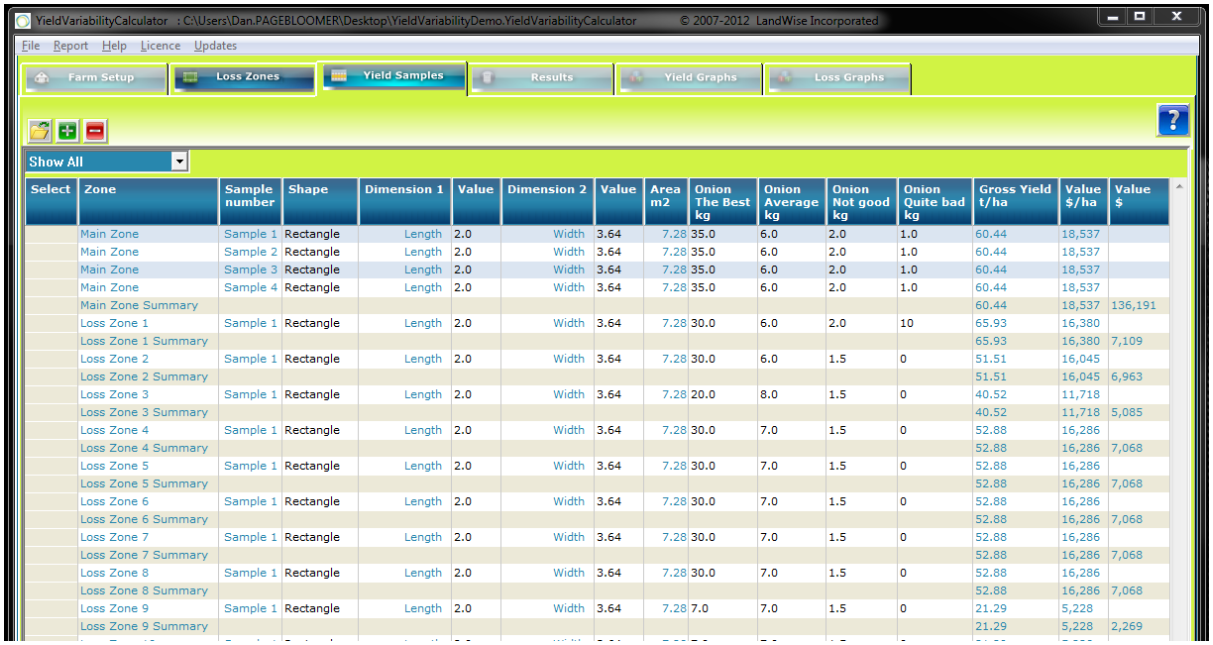
You can have any number of samples in the Main Zone and each Loss Zone. The more samples you have in each area, the better the reliability of your results. You must have at least one sample in each Zone!

Click the Loss Zones tab to enter the Loss Zones screen

Click the green + button to add a Sample Plot. Select a Sample and click the red – button to remove it. You cannot undo a remove!

For each Sample, enter:

- The shape
- Dimensions
- Weight of crop harvested for each grade.



Select	Zone	Sample number	Shape	Dimension 1	Value	Dimension 2	Value	Area m2	Onion The Best kg	Onion Average kg	Onion Not good kg	Onion Quite bad kg	Gross Yield t/ha	Value $/ha	Value $
	Main Zone	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	35.0	6.0	2.0	1.0	60.44	18,537	
	Main Zone	Sample 2	Rectangle	Length	2.0	Width	3.64	7.28	35.0	6.0	2.0	1.0	60.44	18,537	
	Main Zone	Sample 3	Rectangle	Length	2.0	Width	3.64	7.28	35.0	6.0	2.0	1.0	60.44	18,537	
	Main Zone	Sample 4	Rectangle	Length	2.0	Width	3.64	7.28	35.0	6.0	2.0	1.0	60.44	18,537	
	Main Zone Summary												60.44	18,537	136,191
	Loss Zone 1	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	6.0	2.0	10	65.93	16,380	
	Loss Zone 1 Summary												65.93	16,380	7,109
	Loss Zone 2	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	6.0	1.5	0	51.51	16,045	
	Loss Zone 2 Summary												51.51	16,045	6,963
	Loss Zone 3	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	20.0	8.0	1.5	0	40.52	11,718	
	Loss Zone 3 Summary												40.52	11,718	5,085
	Loss Zone 4	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	7.0	1.5	0	52.88	16,286	
	Loss Zone 4 Summary												52.88	16,286	7,068
	Loss Zone 5	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	7.0	1.5	0	52.88	16,286	
	Loss Zone 5 Summary												52.88	16,286	7,068
	Loss Zone 6	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	7.0	1.5	0	52.88	16,286	
	Loss Zone 6 Summary												52.88	16,286	7,068
	Loss Zone 7	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	7.0	1.5	0	52.88	16,286	
	Loss Zone 7 Summary												52.88	16,286	7,068
	Loss Zone 8	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	30.0	7.0	1.5	0	52.88	16,286	
	Loss Zone 8 Summary												52.88	16,286	7,068
	Loss Zone 9	Sample 1	Rectangle	Length	2.0	Width	3.64	7.28	7.0	7.0	1.5	0	21.29	5,228	
	Loss Zone 9 Summary												21.29	5,228	2,269

YieldEst will calculate

- Gross yield (t/ha) of each sample
- Financial value ($/ha) of each sample,
- Weighted average yield (t/ha) for each zone
- Weighted financial value ($/ha) for each zone.

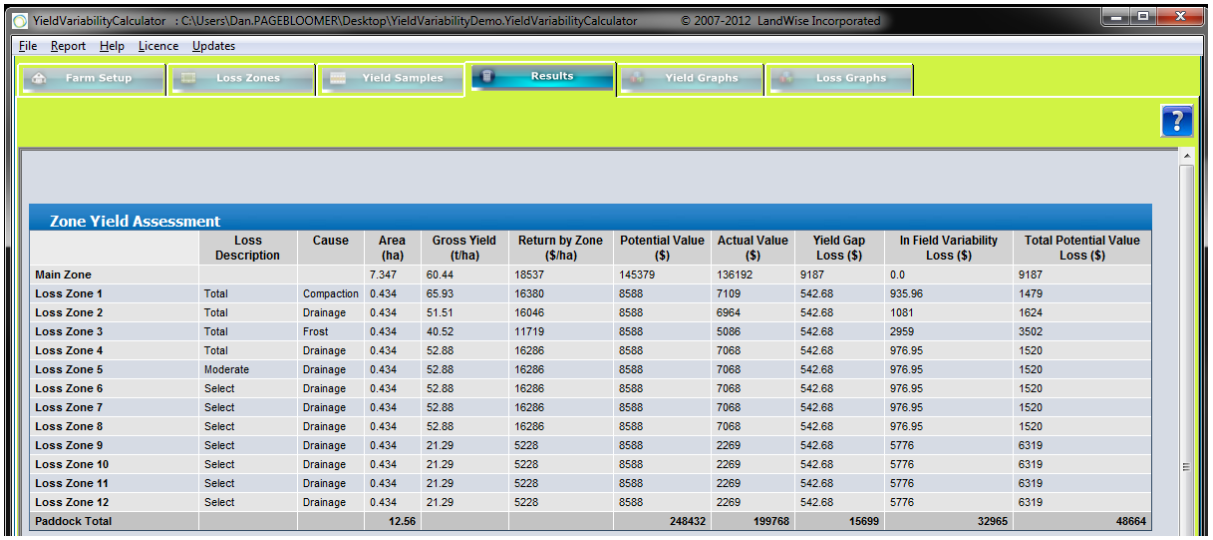
Calculating Cost of Losses

This section describes how *YieldEst* automatically determines the financial cost of losses by comparing *achieved yields* in the zones with the *potential yield* for the crop and accounting for crop value.

Results

Click the Results tab to select the Results screen.

YieldEst presents results as a table in the Results screen.



Zone Yield Assessment

	Loss Description	Cause	Area (ha)	Gross Yield (t/ha)	Return by Zone ($/ha)	Potential Value ($)	Actual Value ($)	Yield Gap Loss ($)	In Field Variability Loss ($)	Total Potential Value Loss ($)
Main Zone			7.347	60.44	18537	145379	136192	9187	0.0	9187
Loss Zone 1	Total	Compaction	0.434	65.93	16380	8588	7109	542.68	935.96	1479
Loss Zone 2	Total	Drainage	0.434	51.51	16046	8588	6964	542.68	1081	1624
Loss Zone 3	Total	Frost	0.434	40.52	11719	8588	5086	542.68	2959	3502
Loss Zone 4	Total	Drainage	0.434	52.88	16286	8588	7068	542.68	976.95	1520
Loss Zone 5	Moderate	Drainage	0.434	52.88	16286	8588	7068	542.68	976.95	1520
Loss Zone 6	Select	Drainage	0.434	52.88	16286	8588	7068	542.68	976.95	1520
Loss Zone 7	Select	Drainage	0.434	52.88	16286	8588	7068	542.68	976.95	1520
Loss Zone 8	Select	Drainage	0.434	52.88	16286	8588	7068	542.68	976.95	1520
Loss Zone 9	Select	Drainage	0.434	21.29	5228	8588	2269	542.68	5776	6319
Loss Zone 10	Select	Drainage	0.434	21.29	5228	8588	2269	542.68	5776	6319
Loss Zone 11	Select	Drainage	0.434	21.29	5228	8588	2269	542.68	5776	6319
Loss Zone 12	Select	Drainage	0.434	21.29	5228	8588	2269	542.68	5776	6319
Paddock Total			12.56			248432	199768	15699	32965	48664

The results presented are:

Gross Yield — sum of measured yields from all grades (t/ha)

Return by Zone — financial value of all yields and grade ($/ha)

Potential Value — the maximum value of crop in the zone, based on potential yields entered in Crop Setup ($)

Actual Value — the actual value of crop measured in the zone ($)

Yield Gap Loss — difference between Main Zone yield and Potential Yield, applied across the Zone area ($)

Infield Variability Loss — difference between Main Zone and Loss Zone yield value ($)

Total Potential Loss — sum of Yield Gap Loss and In-field Variability Loss for the Zone ($)

Gross Yield

Gross yield sums all weights recorded for all grades and applies this across the area of the Zone. If sample plots are different sizes, a weighted yield is given.

Return by Zone

Return by zone shows the relative returns of each zone as dollars per hectare. The zone returns are calculated from the zone yields and the product grade prices entered in the Crop Grades table.

Potential Value

Potential value determines the total dollar value of crop in the zone, if the full potential yield was realised. It assumes any factor reducing Main Zone yield applies across the entire paddock.

Actual Value

Actual Value is the actual income (return) based on measured yields by grade and price, adjusted for the area of each zone. If sample plots are different sizes, a weighted yield is given.

Yield Gap

The Yield Gap refers to the difference between the Potential Yield and the Main Area yield. It reflects an overall penalty, and may relate to compaction, drought or other subtle factors.

Yield Gap is very important; often it costs more than the obvious losses but because it affects the whole paddock it is not easily noticed.

In-field Variability Loss

Value lost from Variability compares the Zone returns with the Main Area actual returns to identify the relative loss caused by variability within the paddock. The graphs show the proportion of loss caused by identified problems such as drainage, compaction or frost.

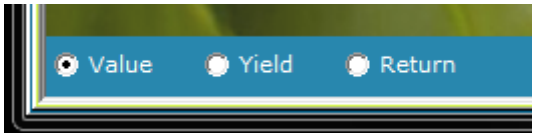
Potential Value of Loss

Losses are calculated by comparing the achieved zone returns with the potential returns. If the achieved yield is higher than the potential yield that was entered, a negative loss will be shown.

Yield Graphs

Click the Yield Graph tab to view results as bar graphs

Select the graphs by clicking the radio buttons at the bottom left of the screen



Results are presented as:

- Gross Value per zone ($)
- Gross Yield by zone ($)
- Return by zone ($/ha)

Value

The Gross Value graph also shows Potential Value and Actual Value for the paddock as a whole. The Main Zone and Loss Zones are also shown with the actual value of crop produced in each. This shows the relative importance of each area in straight dollar terms.

Yield

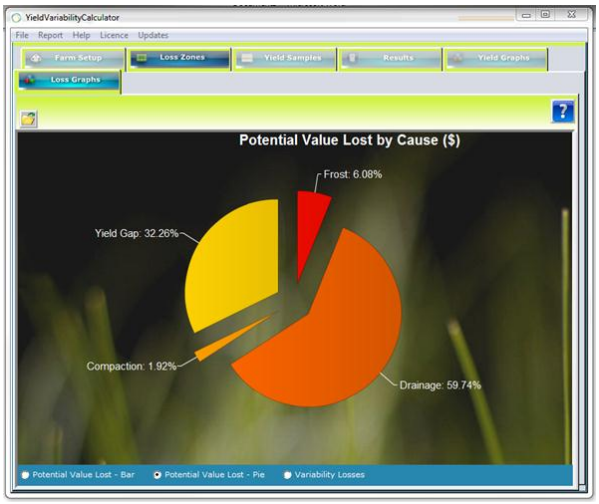
The Gross yield graph presents the information as tonnes per hectare (t/ha). This highlights the productivity differences in each of the Zones, and relative to potential productivity.

Return

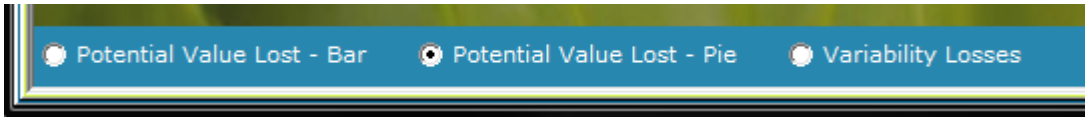
The Return by Zone graph combines yield and price to present the return for each zone as dollars per hectare ($/ha). This highlights the financial variability between zones.

Loss Graphs

Click the Loss Graphs tab to view results as bar and pie graphs



Select different graphs by clicking the radio buttons (bottom left of screen)



Results focus on the causes of poor productivity, and are presented as:

- Potential Value Lost by zone ($) Bar graph
- Potential Value Lost by zone ($) Pie graph
- Variability Losses by zone ($/ha) Pie graph

Holding the cursor over the pie graph segments will show the dollar value of loss caused by the factors identified during yield assessments.

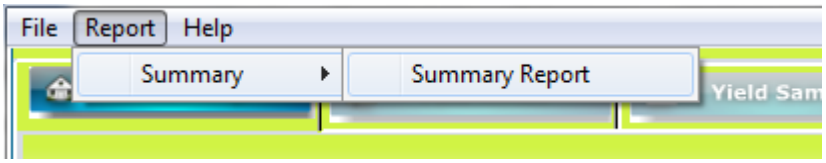
Potential Value Lost

The Potential Value Lost is the difference between the actual yield measured in any zone and the yield the zone would have achieved if the potential yield was reached.

In the Main Zone, this is the Yield Gap. In the Loss Zones, it is the Yield Gap plus Infield Variability Losses in that specific zone.

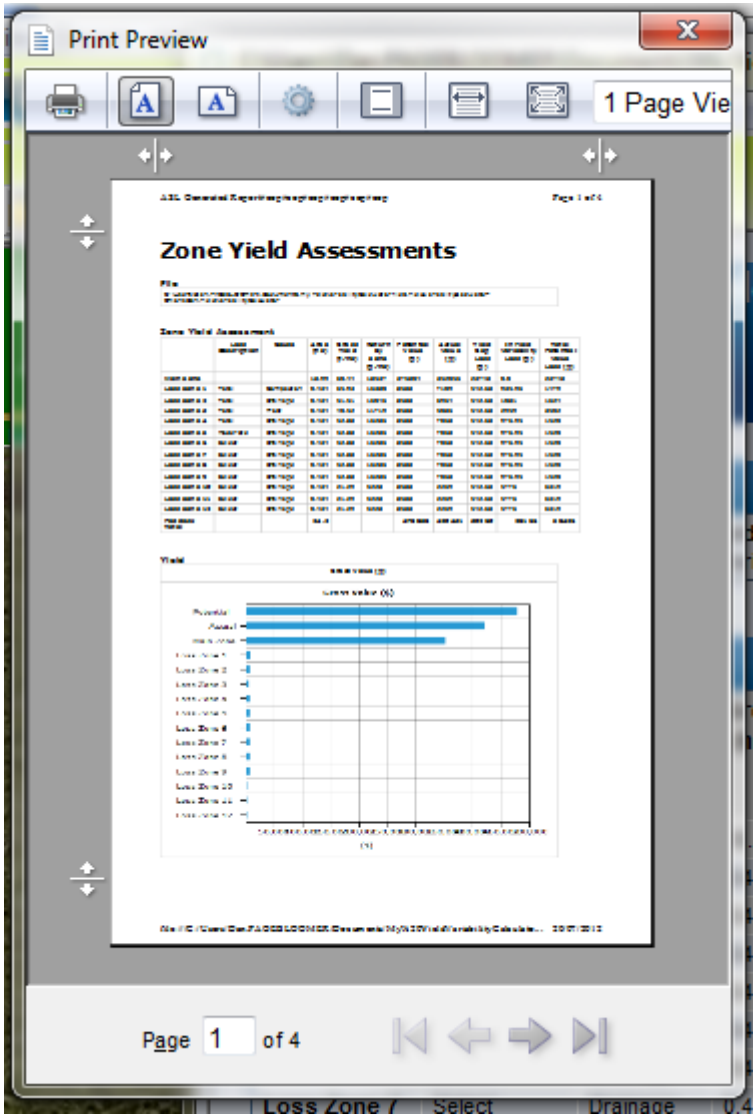
The bar graph option shows the actual dollar value lost by cause (e.g. compaction, drainage).

Printing Reports



Click the “Report” Tab, then Summary/Summary Report to generate a printable report.

Select Print Preview to check the page layout.



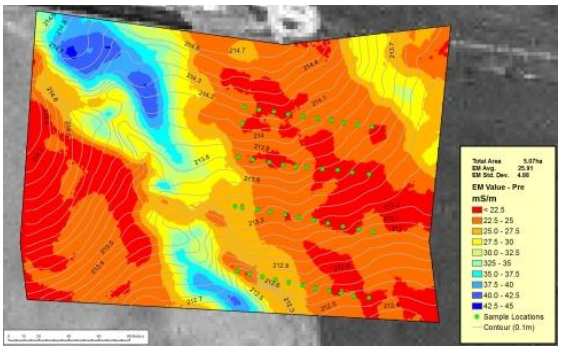
Use the margin sliders to adjust settings and have the Report Table and Graphs lined up.

Identifying Zones in the Field

This section outlines ways to identify different yield zones within a field using basic observations.

The main method of identifying zones is detailed crop scouting. Places of interest include those with:

- Poor germination
- Retarded development
- Drying out or drowning
- Obvious crop damage
- Apparent yield reduction



Soil maps may suggest areas for yield comparison

You might also target areas you know have different soils, weeds, irrigation or other factors that can affect yield.

YieldEst allows for one main zone and any number of different yield zones or areas to be identified. Each area can be a different shape.

YieldEst suggests a series of Crop Loss or Penalty severity descriptions:

- None
- Minor
- Moderate
- Major
- Severe
- Total

Penalty descriptions are subjective

These are clearly subjective descriptions. Their purpose is to label and contrast zones that growers identify in their fields. Affected areas (zones) can be marked with flags and a note taken of suspected problems.

Calculating Areas

This section explains the use of basic geometry to calculate the area of zones within a field. *YieldEst* does the mathematical calculations, using different formulae depending on the zone's shape.

The main errors will be from field measurements: the shapes will not be quite true, and the boundaries will be rather blurred. Remember, this is a way to get a quick approximation of the cost of variability on crops. Perfection is impossible. But best effort will give best rewards.

Whole Paddock Area

There is no calculation for the whole paddock area – just enter the number of hectares in the Farm Setup screen.

Loss Zone Areas

YieldEst recognises five shapes, selected from drop down menus in the table cells:

- Rectangle
- Triangle
- Oval
- Ring
- Odd

In each case, dimensions in metres must be entered.

It can be tricky to see actual shapes in a crop. Move about and make a best guess. Then measure the critical dimensions. Be as accurate as practical!

Entering Known Areas

Even if the area of a zone is known, it must be entered into *YieldEst* as a shape with dimensions in metres.

Select **Rectangle** shape, enter the area in hectares as the length dimension, and the number 10,000 as the width dimension. The calculated area will equal the hectares you entered.

Rectangle

Use the **Rectangle** option for squares and rectangles (a), parallelograms (b) and trapeziums (c). We can use it to estimate other four sided figures (d) too.

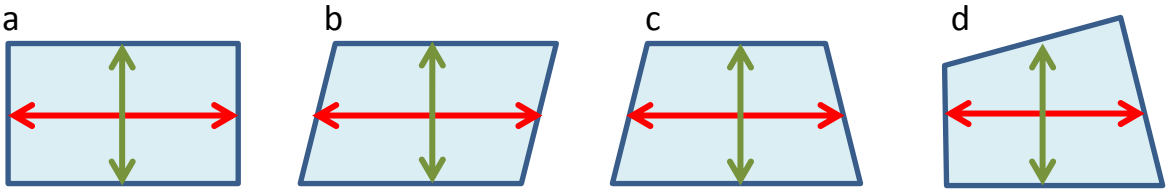


Figure 1: Rectangle shape options and dimensions

The formula is width times the length. The width is the average width and length the average length (measure at right angles through the middle of the shape rather than the edges).

Triangle

Use the **Triangle** option for any three sided figure.

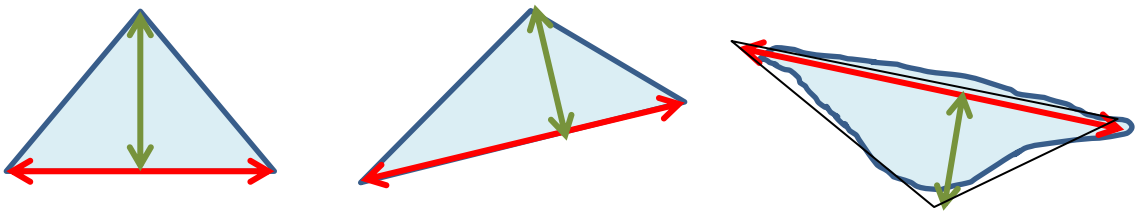


Figure 2: Triangle shape options and dimensions

The formula for any triangle is half the width times the height. Use the longest side as the width. The height must be measured to the opposite corner (at right angles to the long side).

Circle and Oval

If **Circle** is selected only one dimension (its diameter) is required. For the **Oval** option a long and a short "diameter" are needed.

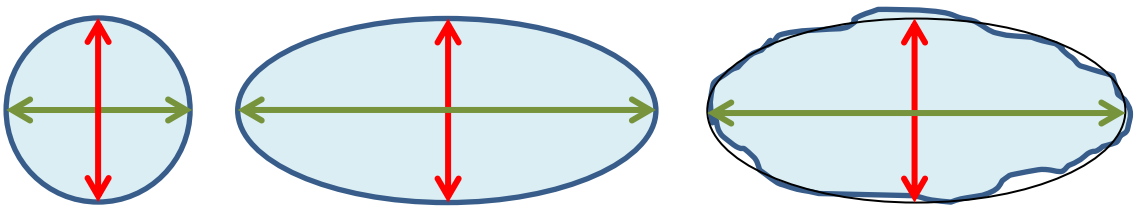


Figure 3: Oval shape options and dimensions

The formula is *Pi* times half the long diameter (length) times half the short diameter (width). For true circles, width and length are the same.

Ring

Use the **Ring** option for round areas with a missing centre – for rings. For oval rings, use average diameters.

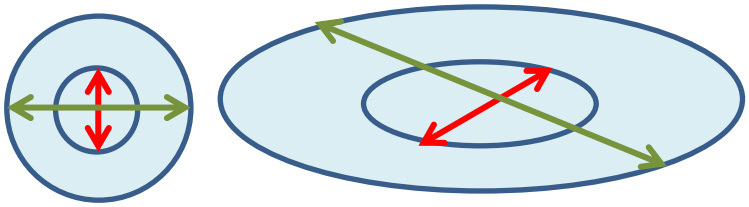


Figure 4: Ring shape options and dimensions

To make *YieldEst* work correctly, ensure the outer circle and inner circle diameters are correctly entered.

Odd

Use the **Odd** option for irregular shaped areas (see Fig 5 below).

Divide the odd shape into equal sections along its longest length. The area can be calculated using the *trapezoidal rule* which assumes each section is made of straight lines (the thin black lines in figure below).

Accuracy will be better if the shape is divided into a greater number of sections.

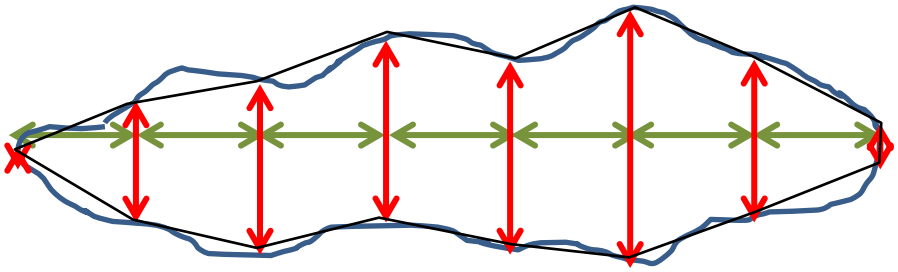


Figure 5: Odd shape dimensions

Enter the length of *each section* (green arrows) as the Section length in the *Yield Variability Calculator*. Do not use the full length.

Add together half the first and last widths and all the intermediate widths (red arrows). Enter the total of these as the Summed width in the *Yield Variability Calculator*.

Calculating Yields in Fields

This section outlines ways to determine the yield within zones of a field. *YieldEst* does the mathematical calculations, using inputs from sample measurements.

The main errors will be from field measurements: the places you take your samples may not be truly representative of the whole zone, and in-field grading can be tricky. Some crops require sampled crop to be processed away from the field.

Remember: this is a way to get a quick approximation of the cost of variability. Perfection is impossible. But best effort will give best rewards.

Sample Plots

How many samples?

To have good confidence in your results you should use four sample plots in the Main Area zone. *YieldEst* will work with only one sample plot per zone, but you can have much less confidence in the results.

At least one yield sample is taken in each Loss Zone. More samples in a zone will increase confidence in results. Two is far better than one, three better still. You would seldom justify using more than four samples.

YieldEst calculates weighted average yield and value in each zone. (If one sample area is larger than the others, it receives a higher weighting.)

Choosing the Sample Plot Location

Deciding where to sample has a big effect on your results.

Make sure the places chosen are within the defined zones, and that the sample areas are representative of that zone.

Within that, try to select at random. You might toss a bucket over your head and centre the plot on that, or decide to start rows five metres from where you are standing.

Sample Plot Area

YieldEst requires you to set a shape and size for the sample plots. Generally the sample plot will be a rectangle or square. Select from the drop down list in the Area Shape cells.

All plots should usually be the same size for all samples. *YieldEst* will adjust averages if sample plot sizes vary, but equal size plots are preferred.

Crop Types

In bed crops (e.g. potatoes or onions), the sample plot will be the full bed-width and at least two metres along the bed. The width to enter in *YieldEst* will be the bed spacing (centre to centre of adjacent beds) in metres. The length will be the length of bed sampled. Consider taking your sample from each of two adjacent beds to get better representation.

In most row crops (e.g. sweetcorn or maize) use at least two adjacent rows, and measure at least two metres along each row. The width to enter in *YieldEst* will be the number of rows times the row spacing in metres. The length will be the length of row sampled.

For broad-acre crops (e.g. peas or squash) and for pasture or feed crops, select squares or rectangles and enter the width and length accordingly.

Orchard crops might be based on single or multiple trees. Determine the area of the sample plot from tree number, in-row spacing and row spacing.

Measuring Yield

Harvest the entire crop within the sample plot and weigh the total sample to the nearest 10 grams.

Grade the crop as required, maybe into Grade1 and Grade 2, and remove rejects. Weigh each grade separately.

YieldEst allows any number of different grades, each with different prices.

Problems with measuring yield

If the crop is sold fresh (e.g. onions, squash or fruit), then fresh weight is a valid measurement.

Crops that are sold at set moisture content (e.g. maize) or after further processing (e.g. peas or sweetcorn) are more difficult.

The Loss Zones have plants with different growth and stress patterns, and unprocessed fresh weights may be misleading. Ideally, these crops will be hand processed and/or dried to consistent levels so valid comparisons of each zone are possible.

Crops sold by units

Some crops (e.g. some leafy vegetables) are sold by number rather than weight.

In that case you might just enter the number of units in the *Potential Yield* cell in the *Crop Grade Setup* table, and in the *Sample weight* cells in the *Yield Sample* table. The summary data and graphs will label yield as tonnes per hectare, even though it is actually numbers you are dealing with.

Do consider using weight measurements too as they may give better indication of actual growth differences in the zones.

Future Strategies

The dollar cost of losses indicates the scale of the problem or problems experienced and the value of mitigating these in the future.

Determining a course of action requires knowledge of causes and likelihood of recurrence. Some problems such as poor planting practice are avoidable through better staff management. The cost to fix is minimal. Some such as hail damage cannot be managed away. Others lie between.

A risk management approach helps decision making. Questions to resolve include:

- What is the cause of the problem?
- How severe are its consequences?
- How likely is it to recur?
- What will it cost to remedy?
- Is that worth doing?

Who is LandWISE?

LandWISE is a farmer dominated collective focused on economic and environmental sustainability.

Formed in 1999 to co-ordinate on-farm R&D and extension in vegetable and arable cropping, it was incorporated in 2003 as a society with charitable status.

The LandWISE Board has leading farmers, regional government, science, marketing and processing representatives and one co-opted representative from each of the Foundation for Arable Research and Horticulture New Zealand Vegetables Research and Innovation.

Providing leadership and support to develop and promote sustainable crop production, its membership is open. See www.landwise.org.nz/join

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