GPSit
PRECISION LAND MAPPING

ORCHARD SURVEYING INFORMATION

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Introduction

Matt Flowerday developed the map-based Cultivar Licensing Audit Programme for Zespri® in 1998 and his company, GPSit, have carried out the programme since 2001.

This document provides an overview of the auditing process and defines orchard areas, terminology and technology involved in a Zespri® audit. It covers the evolution of surveying technology and explains the effect improved techniques may have on audit results.

Matt Flowerday.

GPSit's first office in the early 2000's.

Zespri® Audits

As a part of the Cultivar Licensing Audit Programme, GPSit undertakes a survey on every orchard to establish the size of production (block) areas for Zespri®. A change in orchard structure including end assemblies and Ag-Beam, can change the size of a block and impact Zespri® Licenced areas.

In accordance with Zespri® audit guidelines, all blocks on the orchard are surveyed at the time of the audit, regardless of when they were last surveyed.

Licence Area Definition

A block including any Zespri Licenced Variety (including Males), regardless if producing or not, is included in the licenced area.

Season

The GPSit audit season runs from the **1st of September through to the 31st of August every year.**

If a grower has purchased a new or an additional Zespri® Variety licence(s), they will have an audit scheduled for the next season. Any grower with a Zespri® Variety licence that has not purchased any additional Zespri® Variety Licence in recent years, will undergo an audit every three years under the Zespri® Random Auditing programme.

Unfinished Structure or Estimated Areas

A block with kiwifruit plants that are not yet "producing" at the time of an official Zespri® audit will still be included to reflect the actual block size at the time of the audit. If the supporting structure (such as an Ag-Beam) has not been finalised at audit, then the block will still be measured at the current size and recorded as “Post Only”. This indicates that the block size is based on an incomplete measurement that is likely to change in the future once the supporting structure has been completed. A grower must know these details when considering how far out to develop their canopy or when bidding for licence.

GPSit can provide maps to growers who would like an estimation of the block size(s) once the structure has been completed. Please note that this may incur additional charges.

Block Area Calculations

GPSit uses the GPS measurements collected during the audit to calculate the area of each block for Zespri® Audits. All areas are calculated in two dimensions and reported as hectares rounded to two decimal places e.g. 1.45 ha.

Note: Three-dimensional calculations have been considered and rejected because of multiple reasons. Please see the appendix for further details.

Site Visit

A site visit is required for GPSit to undertake a Zespri® Audit survey. This will be organised with a grower prior to a surveyor arriving on site. While it's not a requirement, **we strongly recommend** that an individual who is familiar with the orchard be on-site during the survey to discuss any structural changes, block split(s) and/or block name changes.

Audit Results

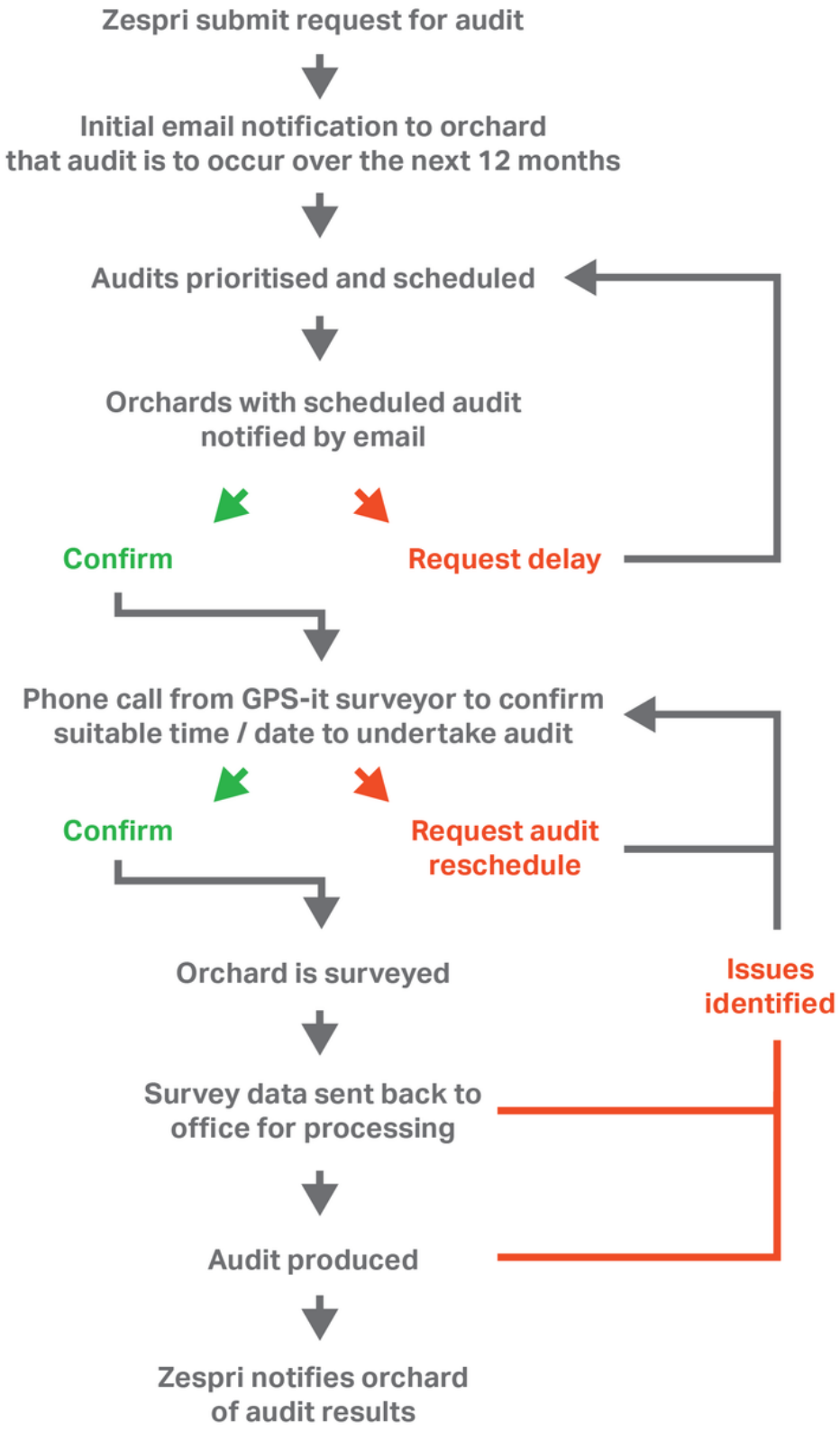
GPSit is contracted by Zespri® to undertake the audits and provide audit results directly to Zespri within 20 working days of completing a survey.

Growers should contact the Zespri® Licence Team on 07 572 6440 or new.cultivars@zespri.com for further information as to when they will receive their audit results.

If a grower does not agree with the results of their latest Zespri® Audit they should contact the Zespri® Licence Team directly.

The Zespri® Auditing Process

Below is an overview of the auditing process. GPSit endeavours to contact the person listed as the primary contact in Zespri®'s records to inform them of their audit.



Orchard Definitions

A typical kiwifruit block is constructed of various structures including (but not limited) to end assemblies, internal structures and wires/cables. These structures form rows, end assemblies and overhang that make up a block.

The following section includes the definitions GPSit and Zespri® use to undergo a survey.

End Assembly Structure:

Strainer Posts - posts are placed at the ends of a block and are a part of the end assembly.

Deadman Posts - long posts pushed deep into the ground to anchor the strainer posts in place and are part of the end assembly.

Internal Structure:

Supporting Structure - beams that run perpendicular to the row to support the canopy wires. These are typically timber or Ag-Beam.

Support Posts - are placed between each plant down a row to hold up the supporting beams and leader wire.

Wires:

Leader Wires - a heavy gauge wire that runs from strainer post to strainer post down the length of the row along the top of the support posts, to support the main leader of the kiwifruit plant.

Canopy Wires - smaller gauge wires that run parallel to the rows and are held up by the support structure. These wires are designed to support the kiwifruit canes which grow across and form the canopy.

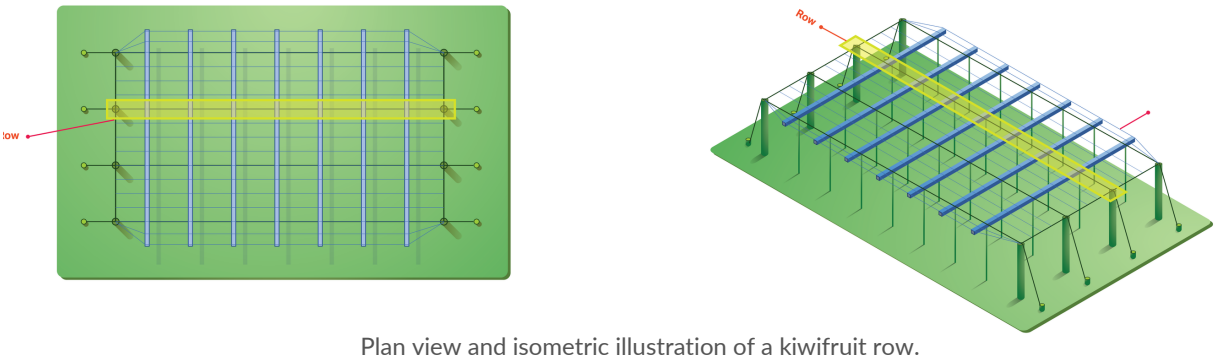
Wire Support Cable (Supporting Cable Wire) - a thick cable that runs perpendicular along the end of the row attaching each end of the strainer posts to each other. The canopy wires are tied off at each end to the support cable.

Rows

Row refers to a row of kiwifruit plants following the leader wire from one end assembly to the opposing end assembly. Kiwifruit blocks are generally described by how many ‘rows’ of plants are in a block. Rows can be planted in various ways.

Male on Outer Row

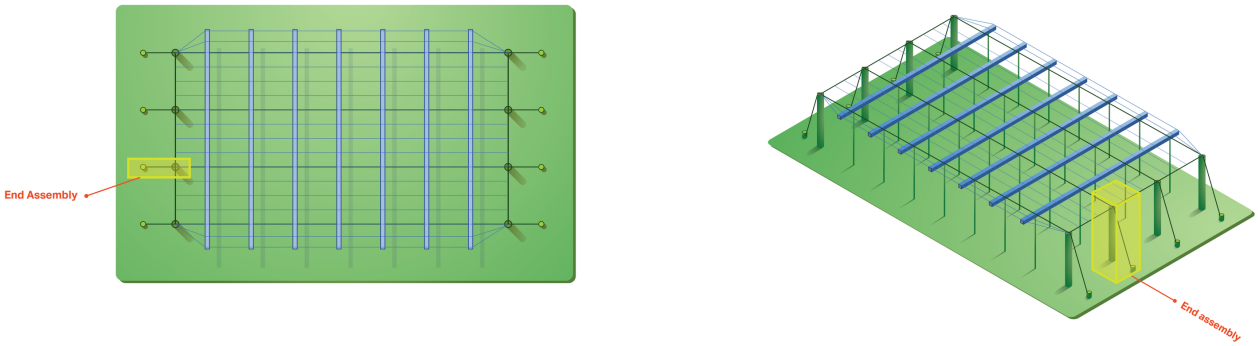
This is where the outer row of a block is a strip of male plants. If a male is used to pollinate the Zespri® PVR'd variety adjoining it then we will include the area in the canopy area calculation.



Plan view and isometric illustration of a kiwifruit row.

End Assembly

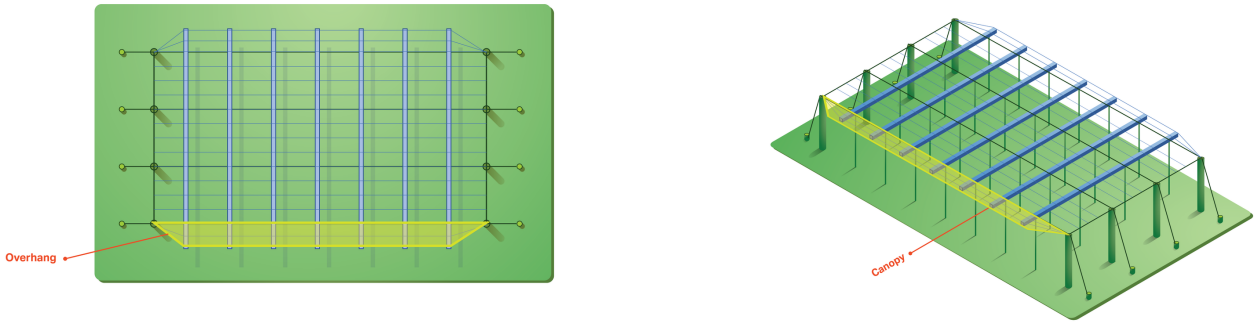
These are at the end of each row and comprise of a strainer post and a deadman post. There are various end assembly setups, such as box end assembly and larger strainer posts with no deadman.



Plan view and isometric illustration of a kiwifruit end assembly at the end of a row.

Overhang

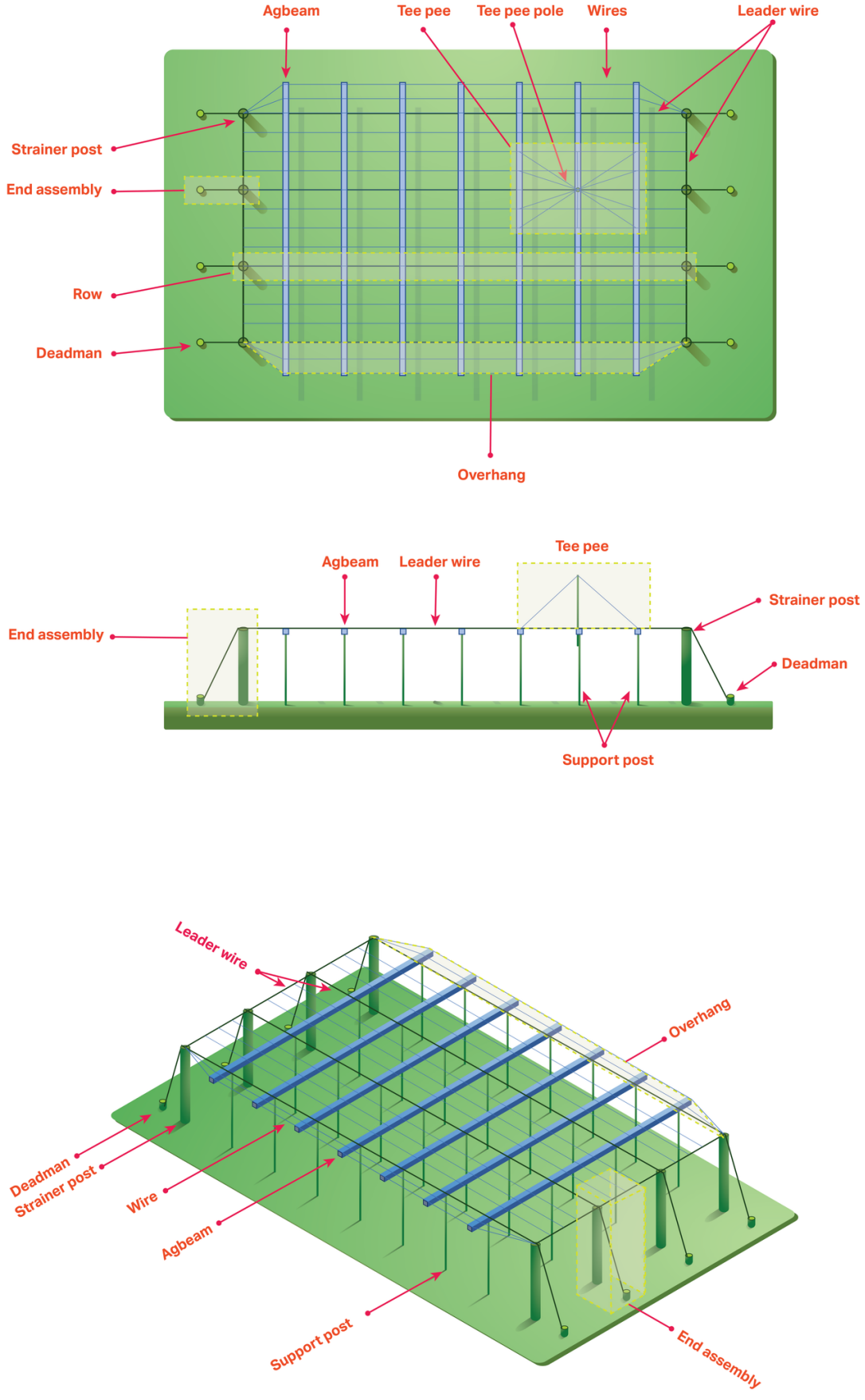
Overhang is defined as structure that extends beyond the outside leader wire and is considered as supporting structure therefore is part of the kiwifruit block productive area. Overhang measured from the end of the pergola (typically Ag-Beam) and **is included in the licenced area calculation**.



Plan view and isometric illustration of a kiwifruit overhang.

Row Layouts

Rows in a kiwifruit block can be planted in various ways depending on the growing strategy used in the orchard.

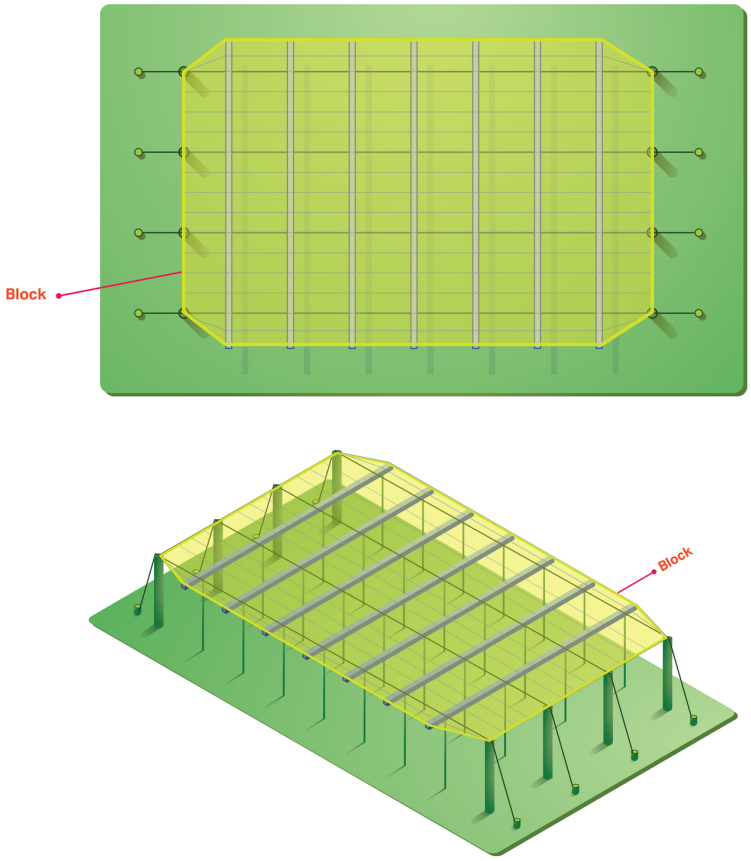


Illustrations of typical kiwifruit block structure with parts labelled.

Blocks

A block is a physically and visually identifiable area of an orchard typically separated from other areas by label, shelter or other physical attributes.

To establish the size of a kiwifruit block GPSit measure from the outer edge of the strainer posts and supporting structures. Block areas are calculated in two dimensions, measured in hectares, and rounded to two decimal points.



Plan view and isometric illustration of a kiwifruit block (not to scale).

Aerial imagery of a typical kiwifruit block with the structure visible.

Aerial imagery of a kiwifruit block with established kiwifruit growing over the structure.

Why a Block Size May Change

Below are some common orchard changes that are likely to affect a block's productive size. Some changes may be obvious and others less so.

Change in Structure

Changing from a T-Bar structure to a pergola structure type will likely increase canopy area due to the addition of support structure such as Ag-Beam and therefore increase productive area.

Replacing End Assemblies

Replacing an end assembly may impact the block size if it is a different length to the original end assembly or placed in a different location.

Tightening Strainer Posts

Pulling a strainer post outwards to increase tension and reduce slack in the leader wires will increase the overall productive area.

Survey Equipment & Technique

Survey methods have changed over time as per the industry and Zespri® (see the following section titled "Survey technology" for further details).

Merging blocks together

Sometimes when contiguous blocks are merged, the area can vary slightly from the sum of the two separate blocks. This is due to rounding applied at the individual block levels.

Note: All blocks are rounded to 2 decimal places.

Examples	Block A	Block B	A + B Total	Block Total (Rounded)
Rounded Up	1.1111	1.444	2.555	2.56
Rounded Down	1.155	1.159	2.314	2.31

*Areas measured in hectares.

Optional Extra Structures

Teepee

Teepees (also known as stringing poles) consist of a pole extended vertically above a support post, with wires strung downwards to the surrounding wires below that forms a ‘teepee’ shape. Teepees allow other kiwifruit vines to grow upwards.

The use of teepees does not affect the surveyed area.

Aerial imagery of a kiwifruit block with teepee structure.

Cantilevered Canopy Structure

Cantilevered canopy structures can extend the area of a block out over the end assembly or to the side of a block.

Cantilevered canopy structures are included in the surveyed area.

Common Block Variations

While most blocks follow a similar structure there are some variations. Below are the most common variations found in a kiwifruit block.

Overhead Cable

Some kiwifruit orchards consist of supporting cable wires instead of Ag-Beam or timber to support the vines. Here, strainer posts surround the perimeter of the block.
In this case, GPSit will measure a block from the outer edge of the strainer posts.

Stepped Edges

These appear where the strainer posts do not line up straight and have support structures between them.
The overhang from a stepped edge will be surveyed and included as productive area calculation.

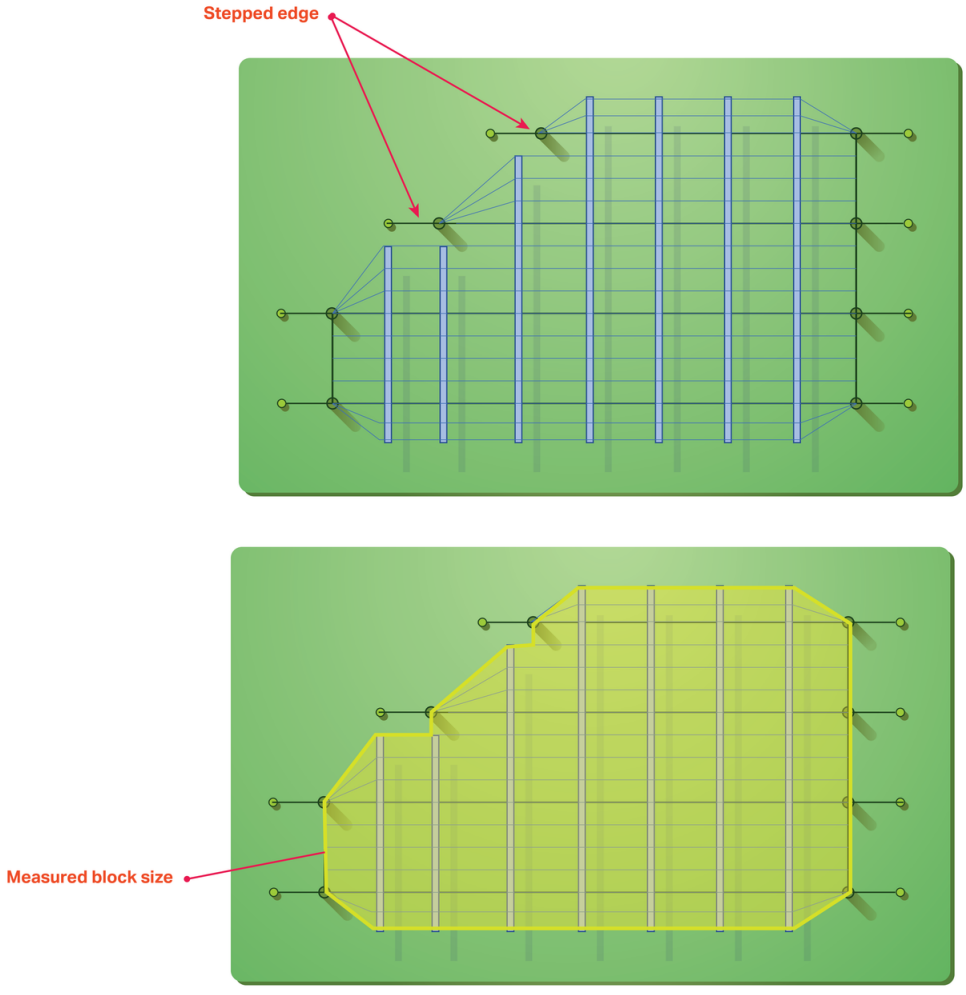


Illustration highlighting the productive area of a stepped edge block.

Multiple Blocks in a Contiguous Structural Area

Where multiple blocks exist in a single contiguous structural area (with no gaps such as shelter rows, roads or paths between them) the outer edge of a block is defined by the strainer post or supporting structure while the inner (connected) edge is defined based on the block split. See the section below for block splits.

Example of seven blocks contained in a single contiguous area.

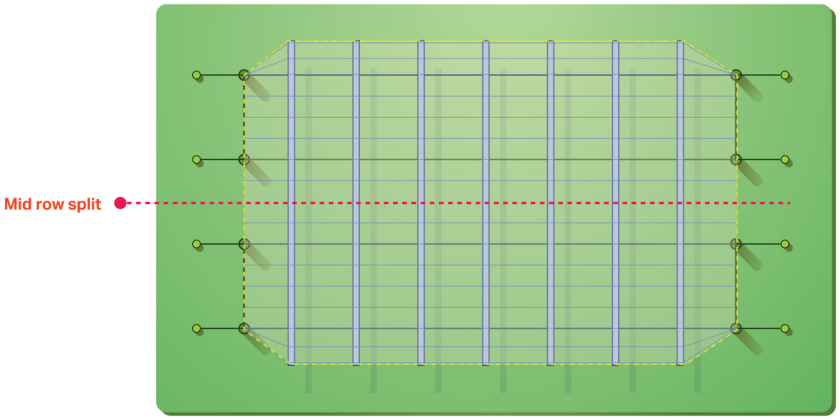
Block Splits

Block splits are usually determined by the male planting layout. The two most common splits are **mid-row splits** and **male-row splits.**

A grower may choose to vary this demarcation of the block split, but the location of the split must be clearly, permanently and physically marked on the block. Ongoing canopy management is expected to adhere to this split permanently. Failing to comply with a custom split location in a subsequent audit or inspection may result in a grower being in breach of their Zespri® license terms.

Mid Row Split

Where the blocks are planted in rows with opposing female plants the split is typically drawn 'mid-row'. This is the midway point between the two adjacent leader wires where the canes from each side would meet.

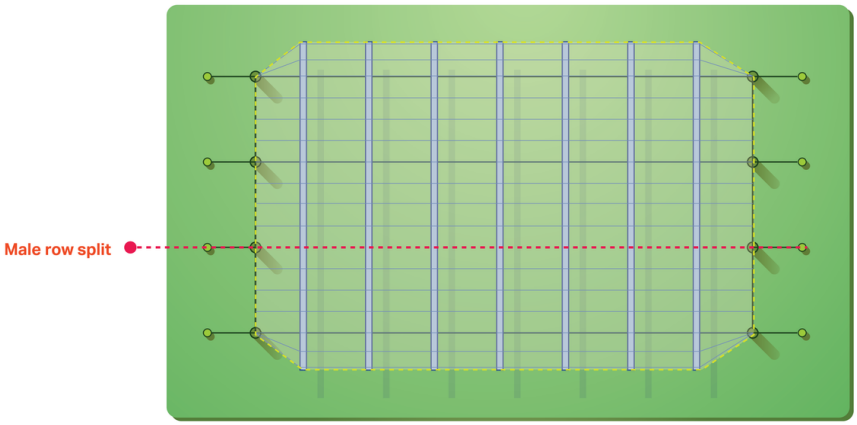


The mid row split meets halfway between the two leader wires.

Aerial imagery with a mid row split drawn over for illustrative purposes.

Male Row Split

Where the block is planted in a strip male layout the split is typically drawn on the leader wire line of the male row between the two varieties. If a male row (male on outer row) is used to pollinate the Zespri® Licence variety adjoining it, then the male area will be included in the canopy area calculation.



The male row split occurs along the leader wire.

Kiwifruit block containing both SunGold (left) and Hayward (right) split on the male row (red and white line).

Outer row on Strip Male blocks

The outside male row on a block that has a Zespri Licenced Variety is included in the overall block measurement. The measurement is taken at the outer edge of the strainer post parallel to the row. If the row has an Ag-Beam and/or supporting structure extending past the row then this is measured and included in the licenced area.

Block joins (Infill)

For non-contiguous blocks that have been joined, for example after shelter removal. The new canopy area is based on the infill area from the extension of the previous structure. However, if the in-fill area is unlicensed and the canes are extending into the new infill area, a measurement will be taken at the extent of the canopy and used in the licence area calculation.

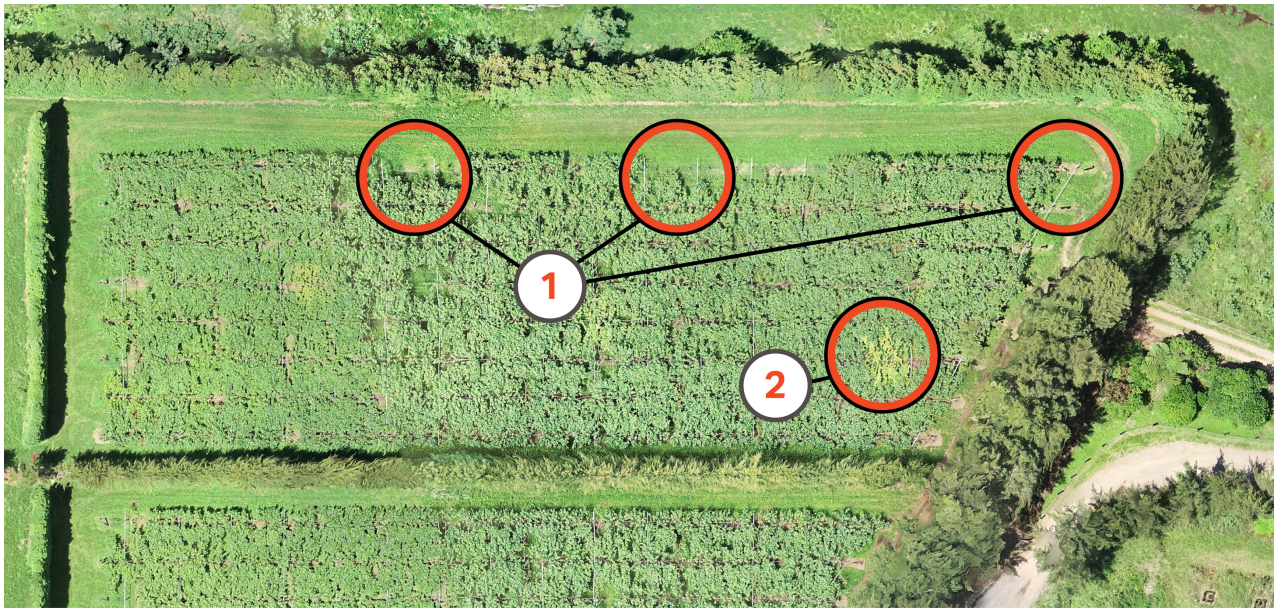
Utility Areas

Areas within a block that have supporting structures (that are intentionally unplanted and used as an accessway for example) will be recorded as a utility area and excluded from the licenced area calculation. These utility areas must be clearly specified by the grower, otherwise, they will be recorded as a plantable area.

Example of an Utility area in an orchard.

Blocks with Missing or Poor Health Vines

Blocks including areas of missing vines or poor health vines **are included** in the total area calculations. However, a block cannot consist of only missing or poor-health vines. If a grower wishes to exclude certain areas of the block due to poor health or missing vines, they need to contact the Zespri® Licence Team directly on 07 572 6440 or email them at new.cultivars@zespri.com.



(1) Example of missing vine (2) Example of vine with poor health. These are still included in the total area.

Aerial image of a kiwifruit with dead vines, note this block still has kiwifruit structure and would still be considered part of the canopy area.

Survey Technology

GPSit has continued to develop and refine data capture methods in line with technological advances and customer requirements.

Data Capture Evolution

Data collection from 1998 to 2010 involved mounting GPS antennas on vehicles and quad bikes where the driver would position the corner of the vehicle as close to the required point to record data. This strategy was both low-cost and most efficient during this period.

Around 2010 kiwifruit industry events (including the introduction of PSA) meant orchardists and industry bodies (such as Zespri® and KVH) became very cautious about using vehicles on orchards. Also, quad bikes are no longer used as they are a health and safety hazard risk due to their use in unfamiliar territory (orchards).

As a result of these changes our surveyors now walk around the orchard with survey equipment.

GPSit Survey Technology

GPSit survey with commercial grade GNSS (Global Navigation Satellite System) RTK (Real Time Kinematic) equipment.

The equipment determines latitude, longitude, and height coordinates from a specific position within centimetres of known accuracy. It also recalculates and confirms its position every eight to ten seconds against a network of known reference points. This network of known reference points is maintained and calibrated by providers such as LINZ and Trimble.

During a survey, multiple GPS (Global Control Points) points will be taken to measure a block's productive size.
Additionally, several GCP control points will be taken around an orchard to geometrically correct the aerial imagery taken during a survey. Please see the section "Aerial Imagery" below for further details.

The accuracy of GNSS has significantly increased over the last 20 years. Therefore, it is possible for small adjustments between the most recent surveys and previous surveys that were impacted by less accurate GPS points (especially in more remote areas), high shelter belts and other interference and methods of collecting these points. If you have an issue with the variance in your orchard please contact the Zespri Audit team.

GPSit continually monitors the evolution of this equipment to assess how it can be applied to the New Zealand agricultural industry.

GNSS (Global Navigation Satellite System) RTK (Real Time Kinematic) equipment.

Aerial Imagery

Since 2016 GPSit has been collecting aerial imagery for every Zespri® Audit survey that has been conducted.

Why Capture Aerial Imagery?

GPSit combine aerial imagery with survey data (captured at the time of auditing) to geometrically correct the image into an Orthophoto so that the scale is uniform. This allows the image to be used for accurate measurement.

How Aerial Imagery is Captured

GPSit's surveyors use UAV drone technology to capture aerial imagery typically at 120m (400ft). All of our surveyors are certified by the Civil Aviation Authority (CAA) to fly the drones we use.

How Aerial Imagery is Utilised

- As a reference to confirm the accuracy of GNSS data collected in the field
- To better understand changes in orchards between audits.
- To provide a backdrop to the block data in tools such as Landkind.

Aerial imagery used to highlight the structural changes to this kiwifruit block which was extended on the southern end.

Appendix

Why were three-dimensional areas rejected?

Three-dimensional areas were considered and rejected due to:

- Calculation impracticalities
- Increased costs
- Alignment with generally accepted surveying practices
- The general insignificance of any area difference between 2D and 3D for kiwifruit blocks.

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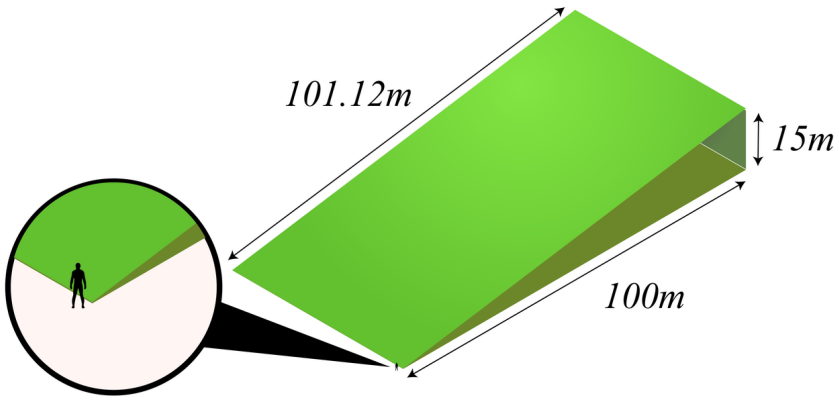
Example

If a kiwifruit block is 100m long by 50m wide with a rise of 15m over the block, the increase in area would be just 1.12% (using the Pythagorean theorem calculation).



A kiwifruit block with a 15% gradient only increase its area by 1.12%.

$$c = \sqrt{a^2 + b^2}$$

Formula to calculate the length of a slope (c) for a given height (a) over distance (b).

Disclaimer

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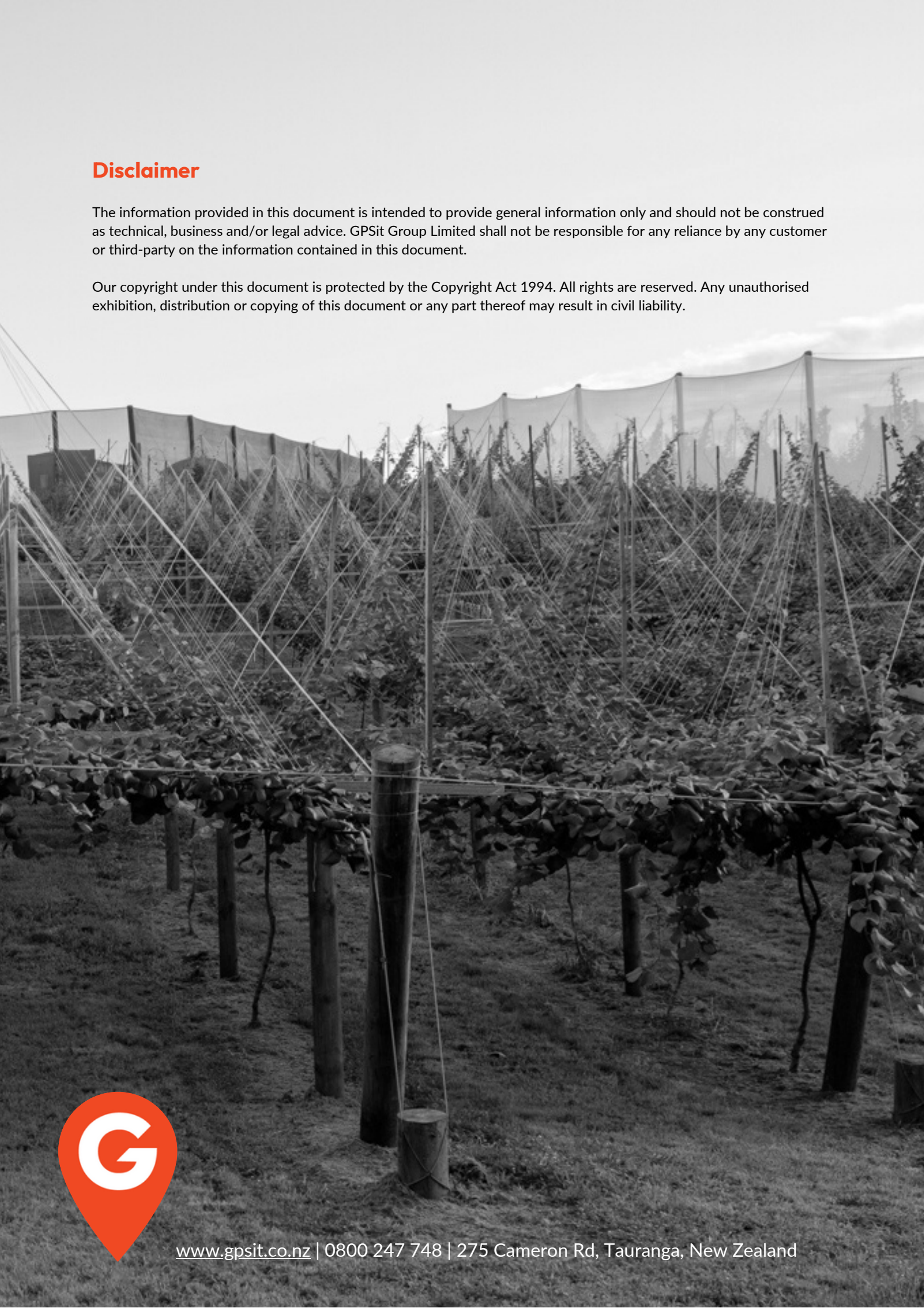

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