RIM

Ryegrass Integrated Management

A tool to evaluate the profitability of ryegrass (*Lolium rigidum* Gaud.) control methods in the no-till broadacre cropping systems of the Southern Australian grainbelt, short and long-term and at the paddock scale

User guide

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This 2013 version of RIM results from the revision, redesign and restructuring of RIM 2004 which was originally described in:

Pannell, D., Stewart, V., Bennett, A., Monjardino, M., Schmidt, C. and Powles, S. (2004). RIM: a bioeconomic model for integrated weed management of Lolium rigidum *in Western Australia. Agricultural Systems 79:305-325.*

Contact AHRI for the original reference, user and workshop manuals of RIM 2004.

The core of RIM, including baseline data, results from the collective effort through various institutions of many scientists. We thank them for their contributions to RIM. Please refer to RIM's credits and modelling references for more information.

Citing this document	Lacoste, M. (2013) RIM, Ryegrass Integrated Management – User guide. *Perth, Australia: Australian Herbicide Resistance Initiative, The University of Western Australia.*

RIM

or **'Ryegrass Integrated Management'** is an Excel®-based software developed by the University of Western Australia.

Intended as a **learning and extension tool** for agronomists, farmers and students, RIM allows users to experiment with a number of **crop rotations** and **weed management** options, to build strategies and test their performance. RIM's main outputs are **financial gross margins** and **ryegrass plants and seeds numbers** per hectare.

The modelling underlying RIM includes hundreds of **parameters** built around **data and assumptions**. **This guide clarifies a number of questions, including the main assumptions behind the options and where parameters can be customised.**

The last section offers an introduction to the **background calculations** for the advanced user wishing to further investigate the mechanisms of the RIM model.

RIM's interface

Unlock RIM here to access the background calculations.

Welcome!

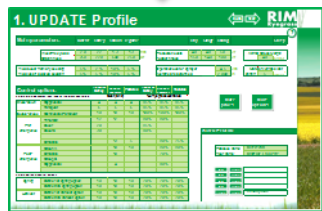Check the tutorial box if needed, then click Start.

Credits & Info
Where RIM comes from and what kind of questions can be answered using the model.
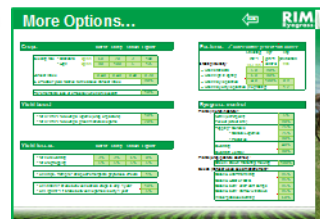
1. DEFINE your Paddock

This page allows you to set your paddock's parameters. You can save several paddocks and reload them later.

More Prices
These two pages allow you to further customise your current paddock, with parameters such as levels of ryegrass control, inputs and machinery prices, yield benefits and penalties, etc.
More Options

2. SELECT your Strategy

The core of RIM. Choose options, build your strategy, and see the effects in real time in the graphs underneath.
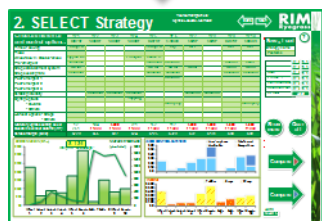
*The graph on the left shows the changes in your annual **gross margin** (green bars) and in the **mature ryegrass plants** survivors (green line). On the right, the blue bars reveal the **costs dedicated to weed control**, whilst the bottom graph details where your **income** is derived.*

3. COMPARE your Results

Summary &
The 'Compare' **Economics** arrows in the strategy page freeze your results into the **top** or **bottom** part of those pages, allowing you to easily compare alternative strategies and paddock profiles. **Yields & Competition**
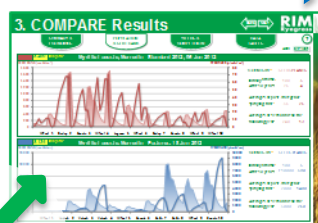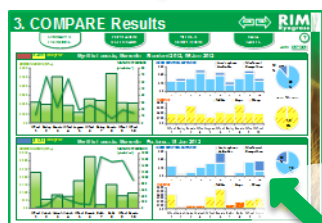
*Check the **help** ? for how to interpret these graphs.*

Ryegrass Population & Seed bank
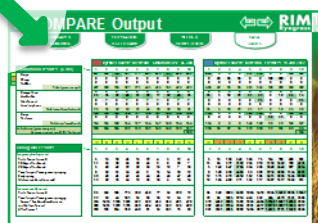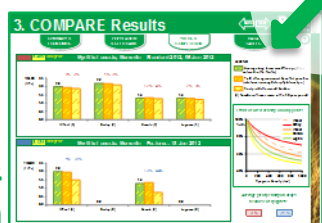
*The **actual data** behind RIM's graphs.*

Data tables

*Compare **yield penalties** from agronomic decisions (such as rotations) and from the **ryegrass burden.***

Export

Export selected pages to a PDF file for printing or for your records, and save the data tables to Excel.

*If your system does not allow exporting to the **PDF** format, RIM will save automatically to **XPS** or show a printing **preview**.*

*From here, **exit RIM** or **start again**.*

How RIM works

RIM represents a **paddock of your choice** (properties can be customised), in an **average farm** (representative of the Southern Australian grainbelt), in an **average year** (no climatic variation). Results are **per hectare** or **per m²**.

4. Ryegrass plants

The population of each period is comprised of newly germinated plants and the survivors from the previous period.

Ultimately, the population of ryegrass in early spring will determine the effect of the weed burden on crop yields (competition). The age of the weeds and the crop density will impact the number of seeds produced by surviving ryegrass.

5. Agronomic factors

Rotations, seeding technique and timing, grazing intensity, crop sacrifice, spraying or swathing all have positive or negative impacts on both yields and finances.

The effects of some management choices last up to 3 years.

6. The following years

The seed bank is carried over as well as the financial balance and some agronomic effects.

Tickle / Plough
Knock-down
Double-knock

Pre-Em. (on germination＊)
No-till or full-cut seeding

Agronomic factors

Benefits ⊕ **YIELDS** ⊖ **Penalties**

⊖ **WEED BURDEN**

Dry	Wet	Delayed 1-2 weeks	Delayed 2-3 weeks	Post-Em.	Spring options	Harvest options
%	%	%	%	%	%	%

control

RYEGRASS PLANTS — **MATURE SURVIVORS**

Last spring (start)

Break

SEED BANK

germination
dormant

natural → mortality

% * % * % * %

Harv.

Next year

Prior to break	0-10 days after break	10-20 days after break	Before post-em. spray	Early spring	Before harvest	Summer

$$$

3. The Seed bank

A proportion of seeds remains dormant in the soil seed bank, another cohort dies (natural mortality), while the rest germinates in cohorts at different times of the year following a specific pattern.

Germination progressively depletes the seed bank which is replenished in spring, when new seeds are produced by mature ryegrass plants that survived the growing season.

2. The Finances

At the end of the year, gross margins are calculated from the receipts (yield x prices) and from the cost of seeding, harvesting and weed control.

A long term average (or "nominal annuity") accounts for tax, inflation and interest.

1. Seven time periods in a year

Management options occur at specific times. Each period tracks the resulting changes in ryegrass seeds and plant numbers over the year.

Establishment options

Seeding

	Timing related to the break of season	Ryegrass control	Yield impact	Other impacts
Dry	Before	None	Benefit **P** (better competition from early seeding)	↘ Pre-emergent efficiency ○ ↗ Erosion risk ●
Wet	Shortly after	Only the few plants that germinated before the break	-	-
Delayed	1-2 weeks later	Only the first important emergence flush	½ Penalty	Only options allowing for tickle, mouldboard plough, knock-down and double-knock
+Delayed	3 weeks later	Most of the ryegrass that will germinate that year	Penalty **P** (late finish)	

Techniques

|		
	Tickle	Early shallow cultivation: does not control ryegrass but stimulates its germination (more occurs earlier, see patterns below).
P	**Mouldboard plough**	Completely inverts the soil, killing all emerged weeds and decimating 98% of the weed seed bank in the process.
P	**Knock-down & Double-knock**	One or two applications of non-selective herbicide(s).
P	**Pre-emergent herbicides**	Control ryegrass as it germinates. Effective until post-emergence spraying.
○	**Full-cut seeding (wide points)**	Slightly increases ryegrass germination, much higher control than no-till, but with increased erosion risk.
●	**High seeding rate**	Leads to higher crop density and better competition against ryegrass.

Seedbank kill is only 30% if a second mouldboard is done less than 3 years before the first (seeds brought back to surface). If structural constraints are removed, a permanent yield benefit can be specified. ○

The later the seeding, the more ryegrass will have germinated and be controlled by various options. For instance, combining +delayed seeding with a tickle and a double-knock will maximise ryegrass control, whilst dry seeding with full-cut will result in low control for the highest environmental cost.

Costs

Comprise machinery R&M and fuel requirements

●

```
  = no-till seeding    (+extra cost of full-cut)
                       (+extra cost of tickle)
  + seed               (+extra cost of high rate)
  + fertilisers        (- nutrient savings)
  + other inputs       Depends on rotation
  + crop insurance     (none if crop sacrifice planned)
```


No tickle   + tickle
80%   85%   Sown crops and pastures
70%   75%   Regenerated pastures
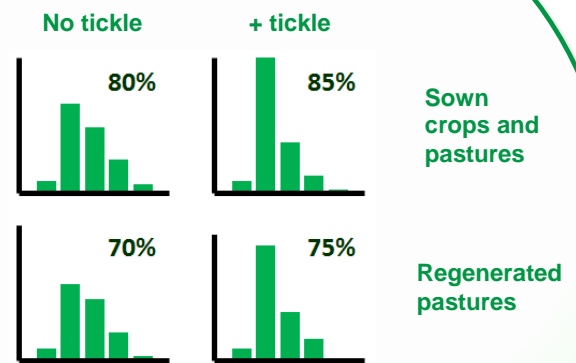
Ryegrass emergence patterns (no-till)

(with the total % of the seed bank that germinated at the end of the season)

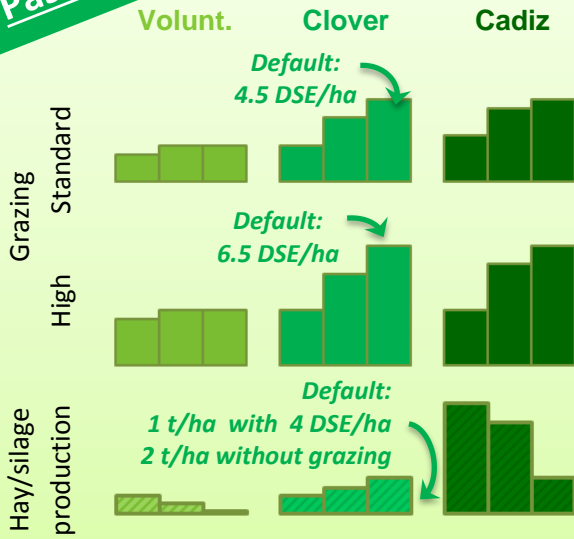Customisable in: **P** Paddock ● Prices ○ Options

Pastures

○ **3-year production trends**

Volunt.   **Clover**   **Cadiz**

Grazing

Standard — *Default: 4.5 DSE/ha*

High — *Default: 6.5 DSE/ha*

Hay/silage production — *Default: 1 t/ha with 4 DSE/ha, 2 t/ha without grazing*

When planned, stocking rates are decreased accordingly

If the pasture is let to grow, results will be 20% higher the following year from better establishment

"VOLUNTEER"

= standard pasture, non-improved (no seeding)

A **sprayed volunteer** (knock-down in autumn, brown manuring in spring) is equivalent to a **Fallow**.

"SUB-CLOVER"

= hard to semi-hard seeded legume: high regeneration ability, need to re-sow only if not grown for a few years (3 as default)

similar in use to Medic

"CADIZ" (French serradella)

= soft-seeded legume pasture: needs re-seeding every run. Produces more than clover more fragile and lower ryegrass control.

similar in use to Lucerne

The longer the pasture phase, the higher the ryegrass control. Default for clover: 50% the first year, 80% if 3-year phase minimum (85% and 95% with high intensity grazing).

Spring options

	Green manuring	Brown manuring	Mowing	Hay & Silage	Topping	Swathing
Specific cost	Same as full-cut	-	Yes ●	Yes **P**	-	Yes ●
Followed by spray *	-	1.2	1.2	1.2	0.5 for cereals & canola, 0.25 for legumes & pastures	
Nutrient removal	-	-	-	Yes ● (less for silage)	-	-
Harvest savings	Yes	Yes	Yes	Yes	-	-
Ryegrass control	○ Default: 100% (spray controlling the survivors)				Variable ○ higher in pastures	Variable ○ higher in cereals
Impact on yield	↗ ○ next year	↗ ○ next year	↗ ○ next year	-	↘ ○	↘ if not done ○

see details p.7

* With a non-selective herbicide. Numbers indicate relative rates compared to the knock-down options **P** . Includes the sprayer operation costs (see next page).
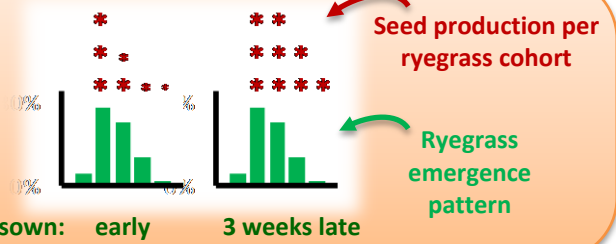
Harvest options

In spring, surviving ryegrass plants that reach maturity start producing seeds.

Higher ryegrass seed production occurs:

→ **from earlier emerging ryegrass cohorts**
→ **in crops sown late**, due to reduced crop competition

Seed production per ryegrass cohort

Ryegrass emergence pattern

Crop sown: early   3 weeks late

Harvest weed seed control (HWSC) targets seeds that enter the harvester

	Whole paddock burning	Narrow windrow burning	Chaff-tramlining **	Chaff cart, burning dumps	Harrington Seed Destructor	Bale Direct System
Targeted fraction of residues	Chaff, straw, stubbles	Chaff, straw	Chaff	Chaff	Chaff	Chaff, straw
Residue removal*	Burn	Burn & re-distribution	Re-distribution	Burn	-	Export
Ryegrass control	10% to 90% ○ highly variable	Default: 85% (largely dependent on the proportion of ryegrass seeds that ○ enters the header, 95% of which is destroyed in good conditions)				

 * Residue removal impacts moisture and nutrient retention. When **exporting** residues, both the nitrogen (N) and the potassium (K) are lost to the system. Conversely, when **burning** residues, most of the N is lost to the atmosphere however the K remains in the ash. In potassium-limited environments, the subsequent **re-distribution** in concentrated areas can affect following yields. Moving windrows compensates for this effect, otherwise higher inputs may be required. ●

** Requires localised herbicide application to compensate for different machinery wheel widths.

Includes a cost of fire risk for occasionally burning more than planned area (based on environmental cost) ●

Relative machinery costs
● **P**

+ bales income

Reference: total 17 $/ha

One pass for all options

burning

herbicide spray

extra labour

Machinery repayments

RIM considers **an average farm** that is already equipped with essential machinery such as a harvester, seeding equipment and sprayer. Hence, their capital cost is not considered. HWSC tools are **specialist** machinery and their repayment costs need to be accounted for in order to **compare** them with other weed management options.

cost every time a herbicide is sprayed

Burn paddock · Narr. windrows · Chaff-tramlining · Chaff cart · HSD · BDS · Harvest · Full-cut seeding · No-till seeding · Tickle · Sprayer

■ Nutrient removal (nominal costs) ■ Extra operating costs ■ Fuel ■ Repairs & Maintenance ■ Repayments (for ≈ 8 years)
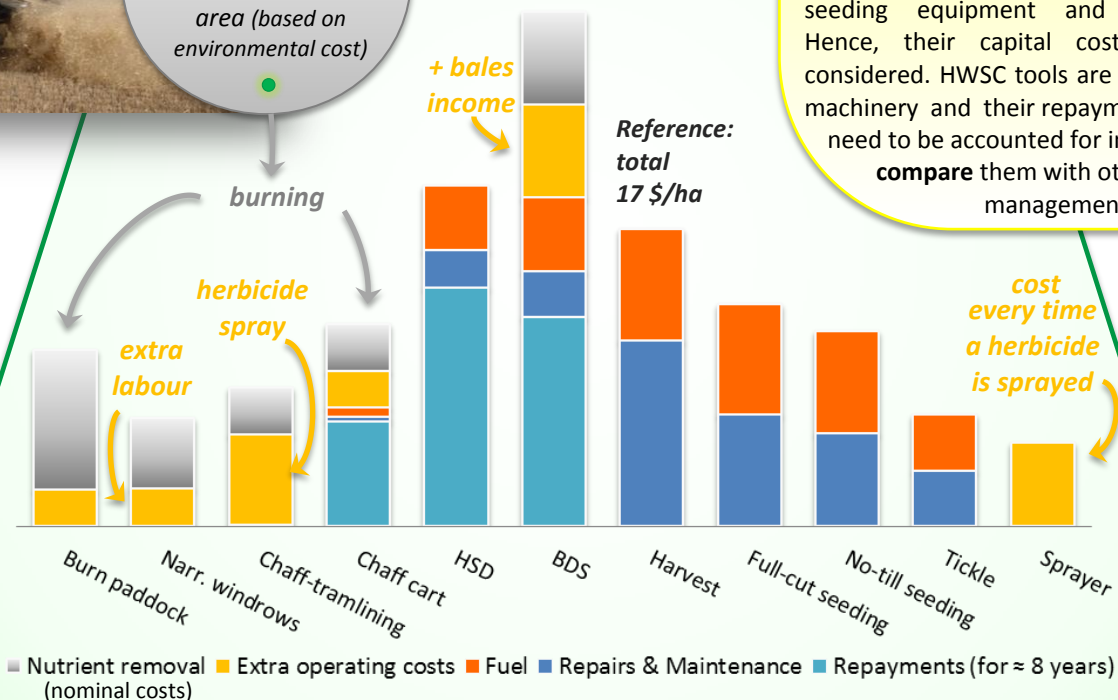
Impacts on yields

Customisable in: **P** Paddock ● Prices ○ Options

Maximum yield proportion lost from ryegrass burden (>300 plants/m²)

2 t/ha

- Wheat — 60%
- Barley — 45%
- Canola — 60%
- Legumes — 60%

PENALTIES | BENEFITS   P ○ *

Management

Reflects the competitive advantage of seeding early

late / early — cereals	3 - 1.5 weeks
late / **early** — canola	+10%

after green manuring

after brown manuring or mowing — *cereals*   *legumes*

Legumes maximise the benefits of crop sacrifice

These default yield penalties can be adjusted as well

phytotoxicity of pre- & post-emergents

if not swathing cereals

if not swathing canola

-5% crop-topping (all)

mouldboarding, permanent (all)

Rotations

cereal following:
- a volunteer pasture phase
- a 1 year legume pasture phase
- a ≥2 years legume pasture phase
- a legume crop
- a canola crop

canola following a legume crop

nutrient savings as well ●

+10%

residual effect for the 2nd consecutive crop

if 2-year break

-10% canola
legume

if only 1-year break between crops

The benefits of a healthy rotation are accounted for via:

- *positive impacts of pastures and break crops on yields, with corresponding penalties for sensitive crops*

- *nutrient savings following legumes*
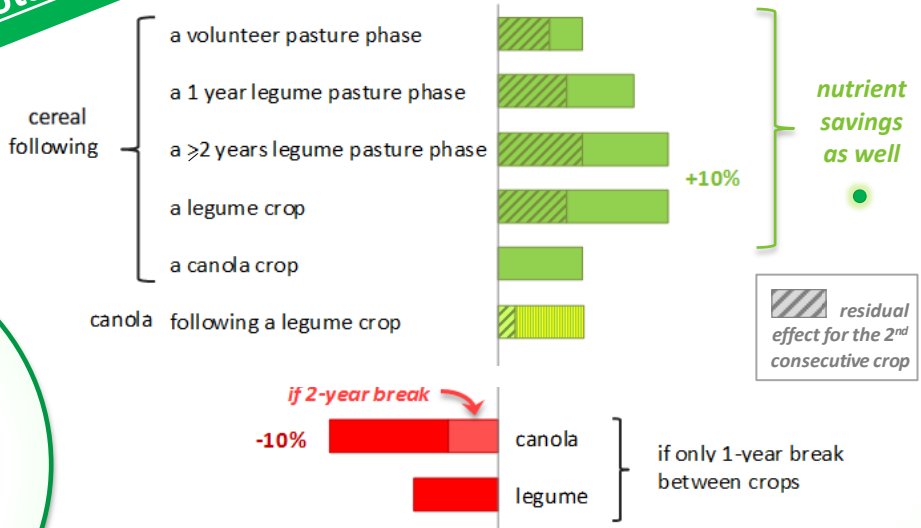
* Crops and pastures in RIM are meant to cover a wide range of situations: a **sprayed volunteer = fallow**; a **hayed barley = oat**; a **legume crop** = lupins, lentils, peas, chickpeas, faba beans, etc.

Adjustments can be made in the Options and Prices pages. Some of these parameters are located behind the interface: see next page.

Background calculations

The interface allows the user to customise major parameters, to update prices, and to select management options before displaying results. To access what happens behind the scene, **unlock RIM** from the Info page.

Organisation

■ Interface	▦ Calculations	▨ Macro-related
→ Navigation	⇒ Connections	●●●● Parameters
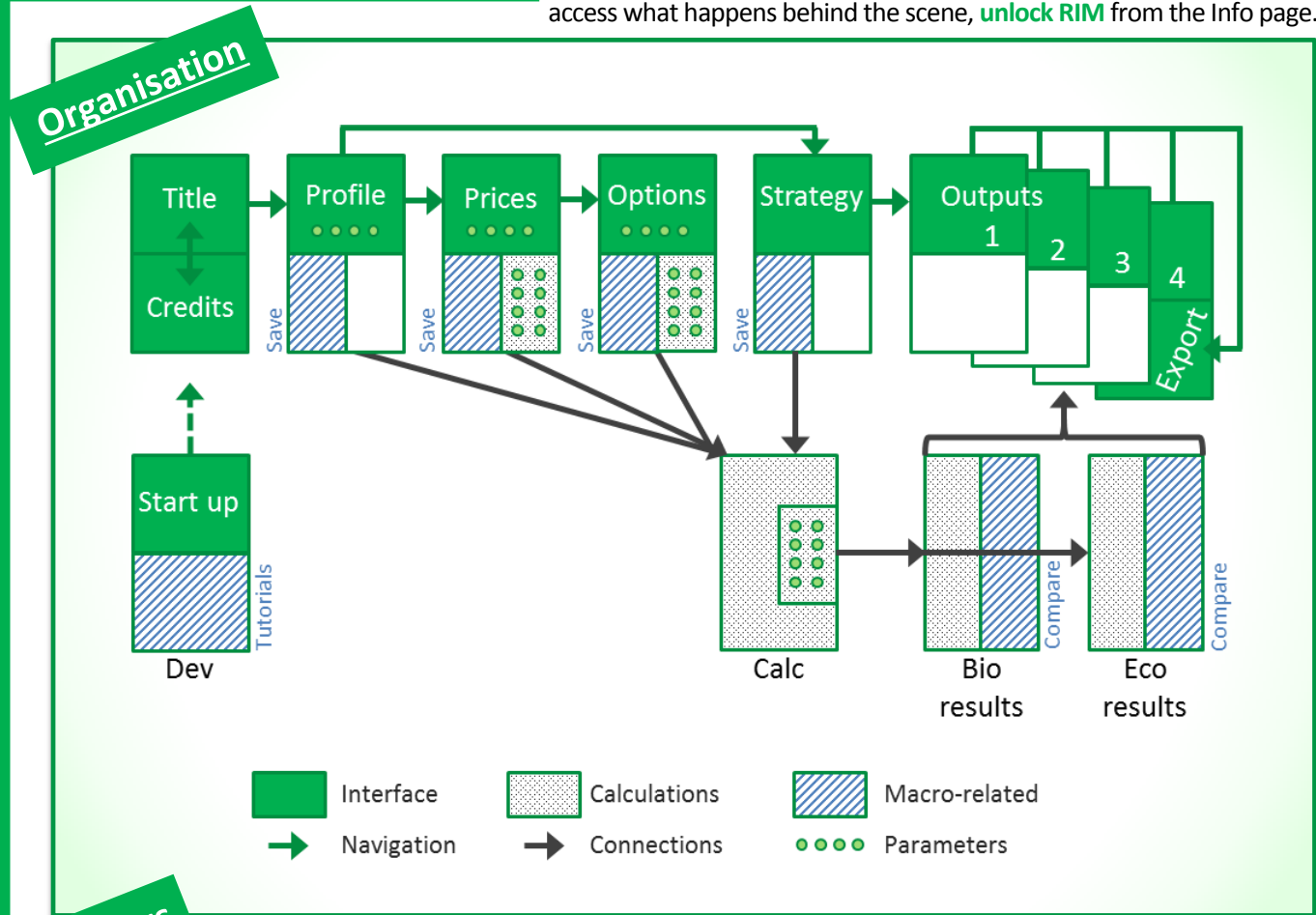
Parameters locations

'Prices'

Establishment costs

- **Machinery:** R&M, fuel, residue removal, operational & repayment costs

- **Crops:** seed costs, fertilisers (incl. savings), other inputs, insurance

- **Pastures:** seed, fertilisers & other input costs

Financial values

(inflation rates, tax, etc)

Note: the parameters in 'Paddock' (='Profile') are linked to these three pages

'Options'

Crops

- **Variables:** plant densities, kernel weight, harvest index, establishment, max. losses, competition factors, etc.

- **Yield benefits & penalties:** from rotations and practices

Ryegrass

- **Germination patterns**

- **Variables:** mortality rates, seed production, competition factors, etc.

Pastures

- **Stocking rates & fodder**

- **Ryegrass control**

- **Crops after pastures:** fertiliser savings & yield benefits

'Calc'

Ryegrass control

With some parameters from 'Profile' and 'Options'

Options prices

With some parameters from 'Profile' and 'Prices'

There are 3 types of parameters (identified with colour key):

→ Linked to the interface: direct input from the user.

→ Not linked: critical parameters not accessible from the interface.

→ Linked via ratio tables: the user usually inputs only one value, whilst the others are calculated from ratio tables that provide reference proportions between similar parameters.

Some parameters are directly used in the two 'Results' pages but most undergo various calculations beforehand.

'Calc'

This is RIM's engine room, where the model performs a number of **calculations** based on the **user's choices**.

1 Strategy choices are translated into **codes** that the model can work with. The first steps of the process are:

Strategy interface → Table 1: Codes ⟷ Table 2: Ryegrass control / Table 3: Control costs / Table 7: Rotation codes etc. → Further calculations

Examples of codes:
'0' = wheat,   '2' = canola,
'53'= barley is the 2nd cereals after a 3-year phase of clover.
A code appears when an option is selected in 'Strategy'.

2 Codes allow the model to **choose the relevant parameters** from 'Profile', 'Prices', 'Options' or 'Calc' (where they have often been pre-calculated). The model integrates these parameters in various tables where calculations depend on the combination of options chosen each year.

The Excel formulas used to make choices are:
- "IF (the code is …) THEN (this parameter) OTHERWISE (this other one or do nothing)"
- "LOOKUP" tables

3 The two 'Results' pages use the calculations from those tables (following the process described p.3), including:

ryegrass germinating / controlled in each cohort, yields, rotations effects, fodder produced, etc.

grain, pasture & fodder income, production & weed control costs, machinery repayments, etc.

A list of all the tables is provided at the top of the 'Calc' page.
View additional comments by hovering over the red corners for more information.

'BIO RESULTS':
Ryegrass numbers,
yields, management benefits & penalties, **fodder**

'ECO RESULTS':
Gross margins

Most equations in RIM rely on relatively simple, straightforward calculations. Two important exceptions which are at the core of the model are:
● ryegrass seed production integrating crop competition
● yields integrating ryegrass competition

The Excel PMT function is used to calculate machinery repayments and the annual profit "average".

Building new control options

Start with Table 1 in 'Calc' then use the Excel tool 'Trace Precedents / Dependents' on existing similar options to identify linked tables and pages.

Macros

A number of VBA macros are included in RIM, allowing various features:

- **saving** several paddock profiles and strategies: all are stored on their respective page under the interface.

- **comparing** two sets of results: for each set, the relevant data are frozen in the 'Results' pages and used by the interface to generate graphs and tables.

- **general** software behaviour: auto-lock and zoom, navigation via buttons, tutorial, printing options. Some macros use indicators located on the edges of the interface.

⚠ Any modification of the macros requires extensive compatibility tests for the various versions of Excel.

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