



## 1 The APSIM STOCK Model

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## 2 Acknowledgements

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## 3 Introduction

The Stock model is an implementation of the CSIRO's Australian Feeding Standards as expressed in the Grazplan (<https://grazplan.csiro.au/>) model. The technical document for Grazplan is available at <https://grazplan.csiro.au/wp-content/uploads/2007/08/TechPaperMay12.pdf>. The model has been ported into APSIM NextGeneration to allow full interaction with other models within the APSIM environment. Animals in Stock show the full range of growth, reproduction and death processes (see Grazplan) and the basic management actions (mating, weaning, moving, feeding supplements, selling and buying) have been implemented. All crop/plant models in APSIM NextGeneration have a 'damage' interface implemented and so allow grazing as soon as the Stock are moved to the same location (zone or paddock) as the crop.

Different animal species, genotypes and ages can be modelled together and various management systems implemented, including, but not limited to, forage crop grazing, rotational grazing, moving stock from paddock to feedlot and back again. Management can be simulated via Operations managers as in the simulations here or scripts. The collection of simulations in the Stock example shows examples of simulating three different management regimes (forage grazing, rotational grazing and a wheat/feedlot system) using scripts.

Management of animal groups is done by user-assigned tag values that take integer values. Tag values have two purposes:

\* They can be used to manage distinct groups of animals in a common fashion. For example, all lactating ewes might be assigned the same tag value, and then all animals with this tag value might undergo the same supplementary feeding regime.

\* If tag values are assigned sequentially (starting at 1), they can be used to generate summary variables. For example, `WeightTag[1]` gives the average live weight of all animals in groups with a tag value of 1.

Note that animal groups with different tag values are never merged, even if they are otherwise similar.

\* To set the tag value of an animal group, use the `Tag` method.

\* To determine the tag value of an animal group, use the `TagNo` variable.

Animal groups that become sufficiently similar are automatically merged into a single group. Animals are similar if all these criteria are the same:

- \* Occupy the same paddock
- \* Reproduction status (Castrated, Male, Empty, Early Preg, Late Preg)
- \* Number of foetuses
- \* Mating cycle (day in the mating cycle)
- \* Days to mating (Days left in joining period)
- \* Pregnancy (Days since conception)
- \* Lactation status (Days since parturition (if lactating)) – within 7 days

- \* Has (not) young
- \* If young exist, their reproductive status must be the same
- \* Implants (hormone implants)
- \* Mean age (if the animals are less than one year old )

These two simulations in this file are validations of the Stock model in APSIM Next Gen. A description of the validation dataset can be found in the "Description" memo of the "Validation" node. Descriptions of the two validation simulations ("LUDF" and "StockSlurp") can be found in the memos of the respective simulations.

The parameters and variables that can be specified in the Stock model are in the auto-generated APSIM Next Gen documentation which can be found at <https://apsimnextgeneration.netlify.app/> under the "Model documentation" link; the "Stock" model is near the bottom of the first table.

## 4 Changing Stock Parameters

### 5 Overview

The Stock model is an implementation of the CSIRO's Australian Feeding Standards as expressed in the Grazplan (<https://grazplan.csiro.au/>) model.

The technical paper describing Grazplan can be found at <https://grazplan.csiro.au/wp-content/uploads/2007/08/TechPaperMay12.pdf>

The structure of the stock parameter strings (which can be found after adding a "Genotype" model to the "Stock" node) is not user friendly but they are needed so the code stays aligned with Grazplan.

A useful resource to decipher the stock parameter strings are the Sheep and Cattle Explorer Excel spreadsheets. The Explorers are also useful to explore the effect of changing parameter values and they can be found at:

- \* <https://grazplan.csiro.au/wp-content/uploads/2007/08/SheepExplorer.xlsx> for sheep and
- \* <https://grazplan.csiro.au/wp-content/uploads/2007/08/CattleExplorer.xlsx> for cattle

### 6 Example

An example on how to change a parameter value is shown below. In the example, the Growth rate constant (CN1), which controls growth (and hence potential intake) will be changed from its default of 0.0115 to 0.015

1. in the Cattle Explorer Excel sheet, go to the "Pot.Intake" worksheet and confirm that the default Growth rate constant (CN1) is 0.0115 (cell B6). Note also any other numbers listed above or below the desired parameter - this is to double check you have the right value in the Stock GUI
2. in the genotype node (in the validation example "Friesian" under the main Stock node; this is where the animal's default parameters are defined) look for the appropriate name in the left hand column i.e. Growth
3. this name is followed by notation ("Growth C c-n-") in which the last two characters match that in the Explorer (CN)
4. ensure that the default value (0.0115) in the Cattle Explorer is found in the array in the right hand column along with the other numbers next to the default value of interest. This is just to ensure that you are dealing with the right parameter value
5. double click the array and change the default value to the new, desired value (0.015)
6. click away to save the changed value

## 7 Validation

### 7.1 Validation Data Set Description

This vignette describes the origins and development of the Stock Model validation dataset. A high-level overview of the Stock Model itself can be found by clicking the Stock node.

The observed data set used for this validation simulation is based on publicly available data from New Zealand's Lincoln University Dairy Farm [LUDF](#). The LUDF is a commercial demonstration dairy farm established in 2001 and operated by the South Island Dairying Development Centre (SIDDC) on behalf of Lincoln University to showcase sustainable and profitable dairy farming.

The LUDF is located at 1504 Shands Road, Lincoln (New Zealand; 43°38'S 172°26'E). The property is 186 ha of which 160 ha is the milking platform. The different soil types on the farm represent most of the common soil types in the surrounding Canterbury region. The farm operates in the top 2% of NZ dairy farms on profitability. The farm's targets and goals have varied over the years but in the 2019/20 season the target stocking rate was 3.5 cows/ha (peak milked), milk production of 1750 kg MS/ha (equivalent to 500kg MS/cow i.e. >100% liveweight in milk production), application of 160kg N/ha plus 300kg DM/cow imported supplement. Most cows are wintered off farm.

Average annual rainfall of 666 mm per annum is supplemented by an average irrigation input of 450 mm; average evapotranspiration for Lincoln is 870 mm/year. The milking platform was sown at conversion from a sheep operation (March 2001) in a mix of ryegrasses with white clovers, and a small amount of Timothy. The breed of cows at the LUDF are "KiwiCross" which was established as a separate breed in 2005 and is now New Zealand's most popular breed. In the 2019/20 season peak number of cows milked was 555 with the average days in milk of 282 days. The stocking rate of 3.5 cows/ha is equivalent to 1,665 kg liveweight/ha. In terms of feeding, in 2019/20 the cows ate 4.4 t DM/cow as pasture and 0.2 t DM/cow as supplement. Off-farm grazing was 0.7 t DM/cow giving a total feed intake of 5.4 t DM/cow.

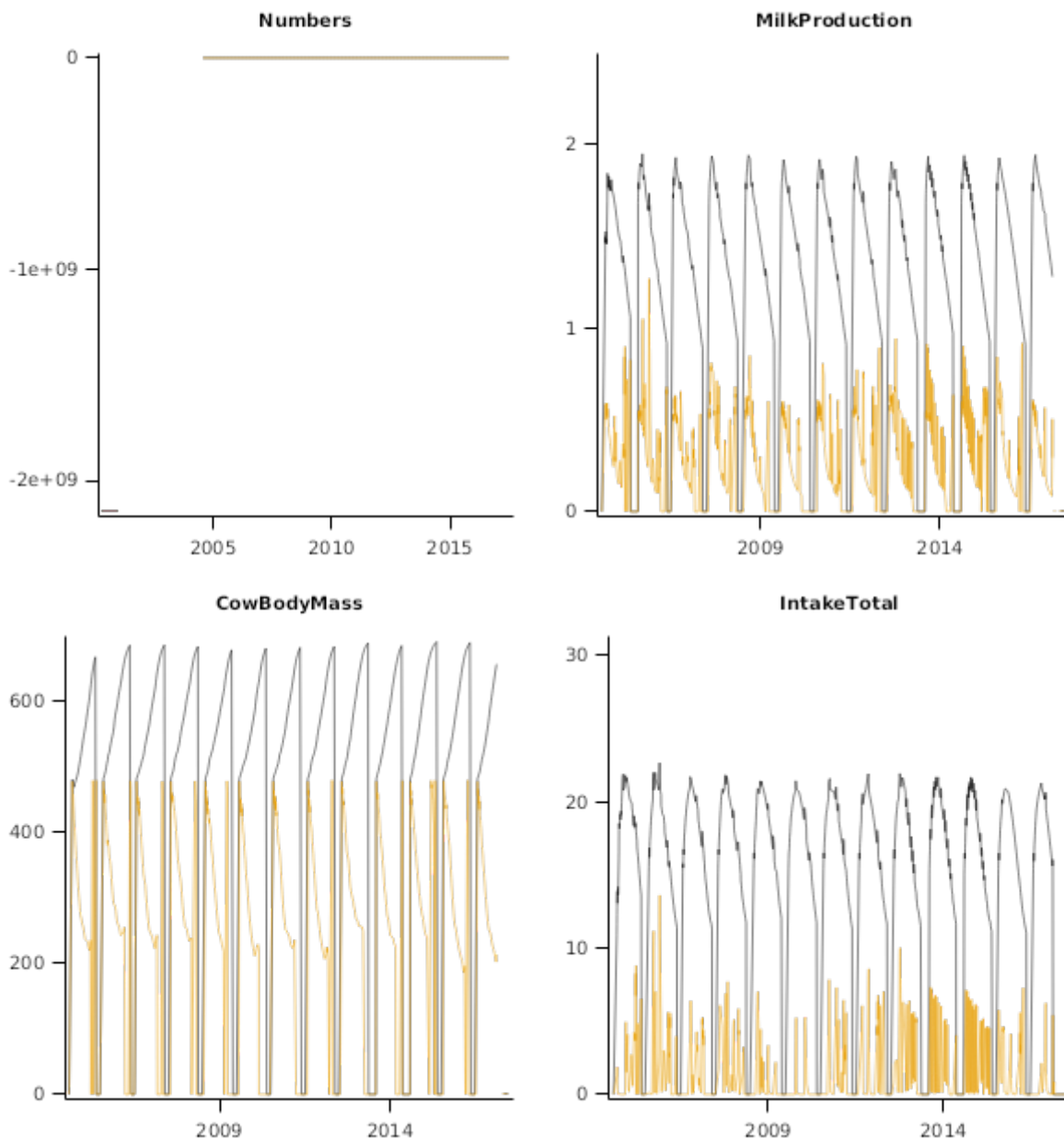
Weekly farm data from the LUDF is available at <http://www.sidc.org.nz/lu-dairy-farm/weekly-data/> as PDF reports. The data for the years 2004 to 2017 was transcribed and collated into an validation dataset.

Note that for these validation simulations, one stock parameter was changed from the original values in [M Freer et al., 1997](#) to reflect modern dairy cow genetics. This, which can be accessed via the GUI in the "Friesian" node in the Stock model, was "Potential intake (Intake C c-i-[2])" which was increased from 0.025 to 0.04. Also note that "Dairy intake peak (c-idy-0)" was set to 1.

#### Acknowledgements

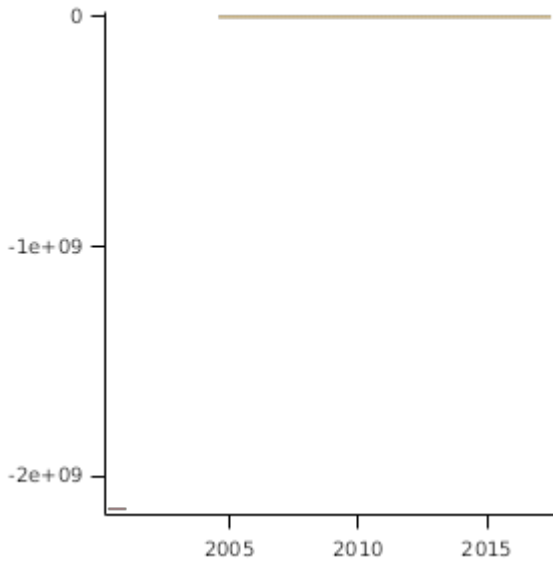
South Island Dairying Development Centre (SIDDC) and Lincoln University for making the dairy farm's production data available. Scott Rains, Samuel Dennis, Anna Taylor, Rogerio Cichota and Ronaldo Vibart for collating the LUDF data when working at AgResearch. Ron Pellow (SIDDC) for comments on the collated data set. David Pacheco and Ronaldo Vibart (AgResearch) for further discussions about the data.

#### LUDF

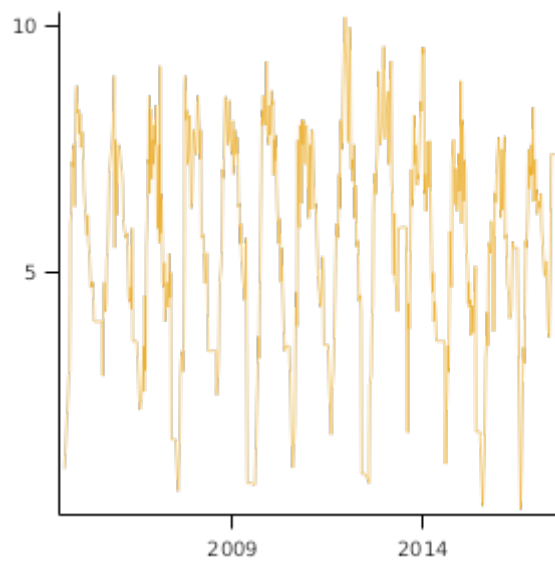


#### StockSlurp

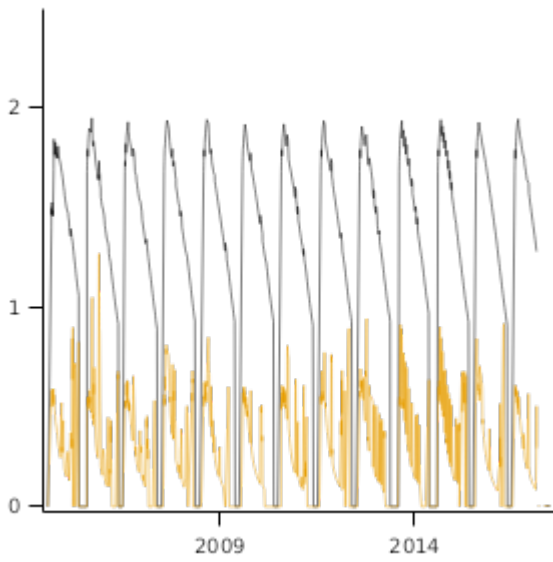
**Numbers**



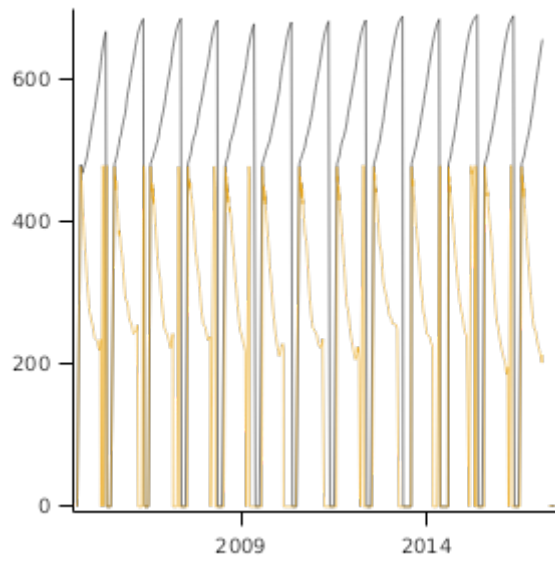
**GrazedArea**



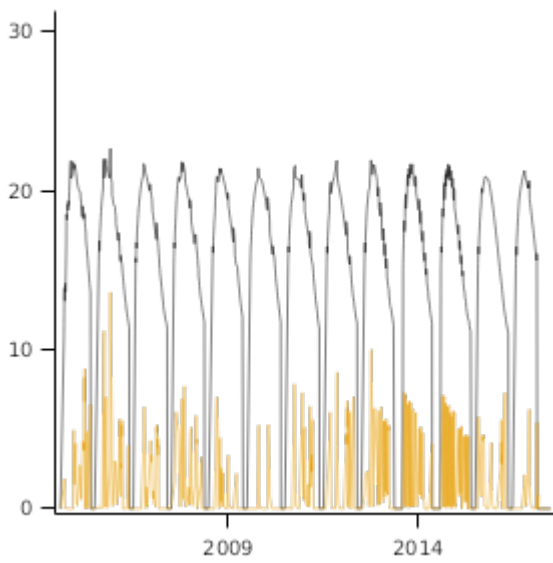
**MilkProduction**



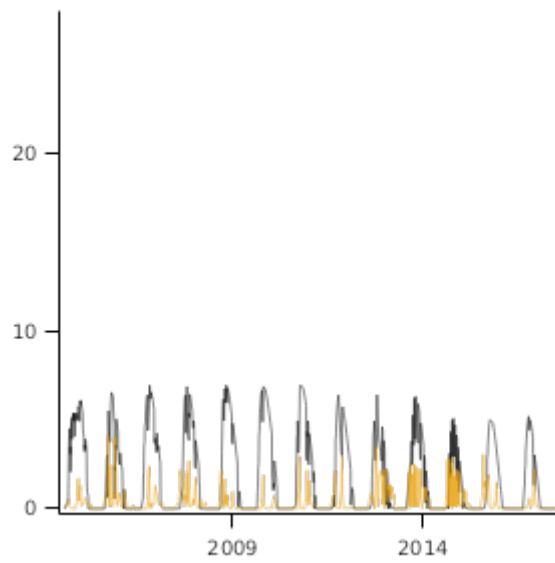
**CowBodyMass**

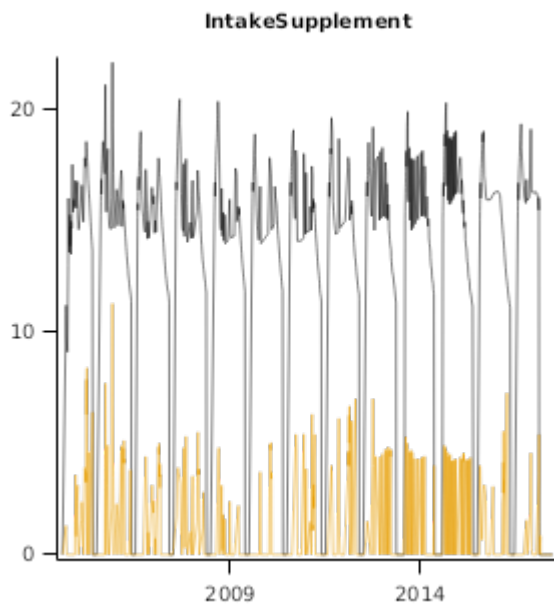


**IntakeTotal**



**IntakePasture**





## 7.2 FeedlotTests

List of experiments.

| Experiment Name | Design (Number of Treatments) |
|-----------------|-------------------------------|
| Hersom1         | (3)                           |
| Hersom2         | (3)                           |
| Sharman1        | (4)                           |
| Sharman2        | (4)                           |
| Coleman         | (2)                           |
| Paco            | (5)                           |

## 8 Sensibility

This sensibility test explores dual-purpose wheat in a high rainfall livestock system in south-eastern Australia.

It is based on [Sprague et al., 2015](#)

*Sheep grazing wheat and fed in feedlot*

In this example simulation sheep are bought and sold on specified date. They are fed supplement in a feedlot at a set rate, but graze a wheat crop when crop biomass  $\geq 2.4$  t/ha. Sheep are moved from the wheat crop and back to feedlot when crop biomass reaches 0.5 t/ha or crop zadok = 31.

*Activities in this manager:*

1. Buy animals at start of year & put in feedlot
2. Move animals from feedlot to crop when ready to graze
3. Move animals from crop to feedlot
4. Shear all animals on specified date
5. Sell all animals at end of year

*NOTES*

1. When the animals are in the feedlot and an animal dies during the day, the supplement has already been fed into the feedlot based on the number of animals in the feedlot at the start of the day. This means the remaining animals have access to slightly more supplement and causes a spike in supp intake graph.
2. When sheep are culled for age + purchased to maintain stocking rate, several groups of sheep are created. This causes irregular amounts of supplement to be fed.

**WheatSheepFeedlot**

## 8.1 TemperatureResponse

List of experiments.

| Experiment Name               | Design (Number of Treatments) |
|-------------------------------|-------------------------------|
| BeefCattleTemperatureResponse | (5)                           |
| SheepTemperatureResponse      | (5)                           |

## 9 MassBalanceCheck

MassBalanceForage

MassBalanceFeedlot

## 10 References

M Freer, A.D Moore, J.R Donnelly, 1997. GRAZPLAN: Decision support systems for Australian grazing enterprises—II. The animal biology model for feed intake, production and reproduction and the GrazFeed DSS. *Agricultural Systems* 54 (1), 77 - 126.

Sprague, S. J., Kirkegaard, J. A., Dove, H., Graham, J. M., McDonald, S. E., Kelman W. M., 2015. Integrating dual-purpose wheat and canola into high-rainfall livestock systems in south-eastern Australia. 1. Crop forage and grain yield. *Crop and Pasture Science* 66, 365-376.