



IntegrityAg

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PigBal 5 User Manual

Version 1.06



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Overview

The original PigBal model was developed in 1996. A subsequent publicly available version (PigBal 4) was developed by the Department of Agriculture and Fisheries (Queensland) in 2013.

The current version of the model (PigBal 5) was developed in 2025. PigBal 5 supersedes the original version and all subsequent versions of the model.

The PigBal model uses a mass balance approach to estimate piggery waste production (solids and nutrients) based on detailed dietary data and pig production information entered by the user. It is a Microsoft® Excel spreadsheet model which operates effectively on personal computers (PCs) with Excel 2003 (or later) installed.

PigBal 5 modelling results are typically used for:

- Designing piggery effluent treatment and reuse systems.
- Calculating nutrient production rates at various stages of the collection and treatment system.
- Estimating the energy output and economic viability of piggery biogas collection and reuse systems.
- Estimating piggery GHG emissions (Scope 1 and 2) for statutory reporting purposes.
- Preparing applications for new and expanding piggery developments.

This manual provides:

- Background information and guidance to assist users in selecting appropriate data to be entered into the various sheets.
- How to best input data and interpret results.
- How to check results returned are realistic.

Each chapter of this User Manual refers to a specific sheet of the spreadsheet model, numbered 1 to 20.

It is suggested that users progress through the sheets in numerical order, entering relevant data into the various sheets as required.

This User Manual is supported by a Technical Manual that provides greater technical detail used in PigBal, including underlying equations.

Navigation between the various sheets of PigBal is achieved by clicking on the buttons provided on the menu sheet or on the tabs at the bottom of the window. If required users can quickly return to the Menu sheet from each sheet by clicking on the [Menu](#) button at the top of each sheet.

Enabling macros

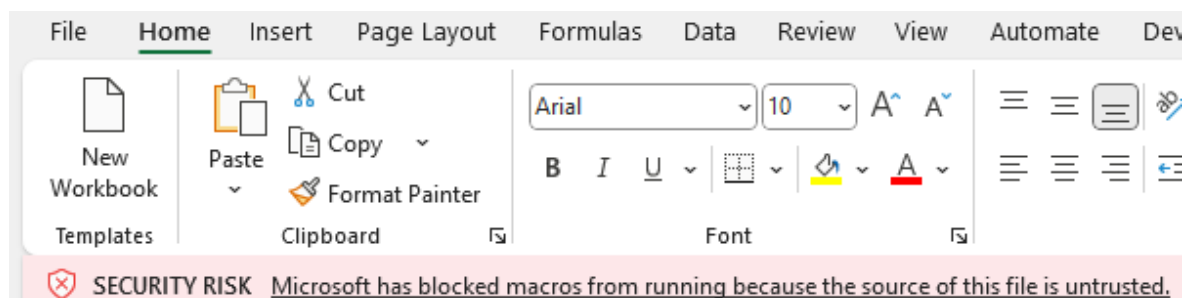
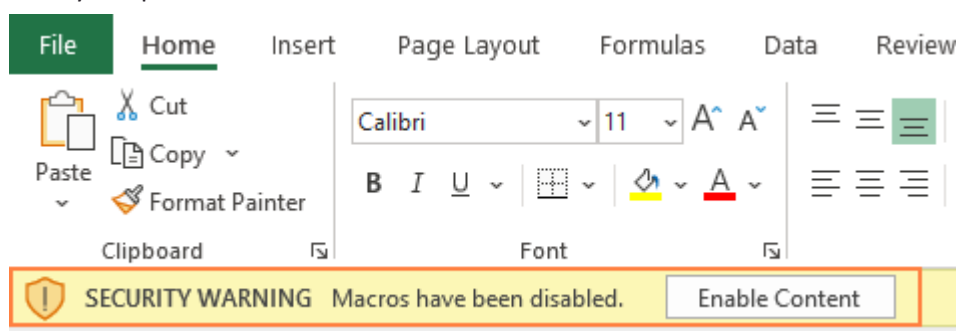
PigBal 5 contains macros that must be enabled in order for the calculations to run correctly. This means that PigBal 5 must be saved as an Excel Macro-Enabled Workbook (.xlsm file) rather than a standard .xlsx file. When you download PigBal 5 from the APL website, it should download in the .xlsm format, however, you may need to follow additional steps (outlined below) to ensure the file runs properly.

Save the file to an appropriate location

Macros will not run on a file saved to SharePoint, OneDrive or similar. PigBal 5 must be saved to a desktop, hard drive, USB, or another offline location, e.g., computer Documents folder or the like.

Unblock macros

After saving PigBal 5 to an offline location, you may encounter one of the following error messages after you open the workbook.



In most cases, you can unblock (enable) macros by:

1. Going to the folder / location where you have saved the file
2. Right clicking the file and selecting "Properties" from the menu
3. Selecting the "Unblock" checkbox at the bottom of the "General" tab and then selecting "OK".

In some cases, it may also be required to allow Macros to run on your computer from the website a file is downloaded from. In this case, the APL website.

Menu

The 'Menu' sheet provides general instructions on how to use the PigBal 5 model in addition to a Table of Contents to assist the user in navigating between the various sheets. No data entry is required on this sheet.

PigBal 5

A model for estimating piggery waste production

General instructions:

The user can navigate through the various worksheets, numbered 1 to 20, by using the scroll bar below.

Alternatively, the user can click on the links in the Table of Contents below. A 'Menu' link is provided in the upper left-hand corner of the relevant worksheets, to allow the user to return to this menu worksheet and navigate to the next relevant tab using the Table of Contents.

Data may be entered in each of the worksheets having yellow or green highlighted labels.

Note the green tabs are new worksheets that have been added since the last version PigBal 4).

The worksheets having grey shading provide output data, graphs and details of some of the model calculations.

Most users will progress through the worksheets in numerical order, entering relevant data in the grey shaded cells, as shown to the right.

All other cells are locked to prevent data entry and to protect the underlying calculations.

All cells with red triangles in the upper-right-hand corners, as shown to the right, contain explanatory comments to assist the user in selecting appropriate input values.

Some of the explanatory comments include typical / default data values and ranges.

The explanatory comments can be viewed by resting the pointer over these cells.

More comprehensive instructions are provided in the Technical manual (McGahan *et al.*, 2025).

Data entry cell

Explanatory
comments

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1. Cover

This sheet provides a general description of the model, an overview of typical uses and details regarding the model development. No data entry is required on this sheet.

Contact details are also provided for technical support purposes.

Technical enquiries about the model should be addressed to *DPI Customer Service Centre*,
phone 13 25 23 (cost of a local call within Queensland) or +61 7 3404 6999.

2. User licence

Details of the user licence are provided on this sheet, with full details provided in the Technical Manual.

3. Herd input

In this sheet, the user is required to enter data which defines the herd accommodated in the piggery. PigBal 5 calculates the numbers of pigs in the various classes, based on the total number of sows, breeding stock (gilts and boars purchased), mortality rates, pig sales data and various performance criteria entered by the user. The calculations cater for farrow-to-finish piggeries as well as specialised breeder and grower units. The calculated pig numbers for each class of pig accommodated in the piggery are shown on the 'Herd details' sheet. Users can override the PigBal 5 calculations by entering known numbers of pigs for the relevant classes on the 'Herd details' sheet. This includes the option to split the Gestating sow herd. This may be helpful if some dry sows are in conventional housing and others in deep litter.

It is important to enter data as correctly as possible on this sheet and only make minor edits to calculated pig numbers on the 'Herd details' sheet.

PigBal 5 allows for the entry of up to six classes of grower pigs between the weaner and finisher stages (inclusive). In general, separate classes should be assigned to groups of pigs that receive different diets, as defined in the 'Diet input' sheet. Names that are meaningful to the user can be assigned to each of these classes; e.g. weaner 1, weaner 2, grower 1, grower 2, finisher 1, finisher 2, porker, baconer, etc.

The starting and finishing ages and live weights for each of these pig classes are defined by entering the pig ages and live weights at the ends of each growth stage. In lieu of any other specific data for the piggery being modelled, the pig classes, ages and live weights specified in Table 1, may be adopted.

Ensure to enter weights and ages for the end of the stage, except for the last category where pigs are housed, the average age that pigs are sold or taken off-site should be entered to cater for pigs moved at a particular weight that may have slightly different ages.

Table 1. Standard pig classes, liveweights and age.

Pig class	Live weight range (kg. pig ⁻¹)		Age range (weeks)	
	Entry	Exit	Entry	Exit
Gilt	100	160	22	30
Boar	100	300	22	128
Dry sow	145	200		
Lac sow	145	200		
Sucker	1.4	7	0	3.5
Weaner	7	35	3.5	10
Porker	35	60	10	14
Grower	60	85	14	18
Finisher	85	110	18	22
Heavy finisher	110	130	22	26

To assist users who may not have the required live weight data for the various grower pig classes, PigBal 5 allows the entry of an average daily live weight gain (ADG), measured from birth to 100 kg live weight. Table 2 can assist in selecting a realistic ADG.

Table 2. Average daily live weight gain (ADG) ratings (birth to 100 kg live weight).

Average daily gain (g. day ⁻¹) [Birth to 100 kg live weight]	Rating
<600	Poor
600 – 650	Fair
650 – 700	Average
700 – 750	Good
> 750	Very good

Based on the entered ADG value, PigBal 5 uses Equation 1, provided in Appendix A, to predict live weights at the ends of each of the growth stages previously entered into the model. This equation was developed from standard growth curves published in the Australian pig industry diary by Richards (2012), with updates from Willis (2025). The user may choose to enter the live weight values predicted by the model or can enter alternative known values.

The numbers of pigs purchased annually for each of the grower pig classes must be entered in the 'Pig purchases' section of the sheet. In the case of specialised grower piggeries, the user needs to enter the number of weaner pigs purchased or imported annually from an external breeder unit. **Note that these values correspond to the number of pigs at the start of each class.**

PigBal 5 requires the user to enter the pre-weaning and post-weaning mortality rates. The pre-weaning mortality rate is used to calculate the number of sucker pigs that die prior to weaning. PigBal 5 distributes the post-weaning mortality rate, entered by the user, across the various classes of grower pigs, based on the length of time that the pigs spend in each of these classes.

The percentages of grower pigs sold at the end of each of the growth stages are entered in the 'Pig sales' section. In the case of a breeder unit, 100% of the pigs would normally be sold (or exported to an off-site grower unit) at the end of either the sucker or weaner stages.

PigBal 5 also allows for pigs to be sold at multiple live weights to supply a range of markets. For example, some producers may sell 50% of their grower pigs as porkers while retaining the remaining pigs until they reach a heavier bacon weight.

Note that the percentage that is input represents the percentage of pigs for that class, so for the last stage of progeny pigs, 100% should be entered.

The Technical Manual provides descriptions, ranges and typical values of the input data for the 'Herd Input' sheet.

Four macro buttons have been provided near the bottom of the herd input sheet. By clicking on one of the "1000 sow farrow to finish", "1000 sow breeder unit" or "Grower unit" buttons, PigBal 5 will automatically populate average data for that system. These standard scenarios are intended to provide a starting point and general reference to assist users in entering appropriate data to realistically model a range of piggery operations.

A fourth additional button ("Old PigBal 1000 sow farrow to finish") is provided if the user wishes to generate historical input data from the original version of PigBal.

4. Growth chart

On the 'Growth chart' sheet, PigBal 5 plots the pig age and live weight values entered in the 'Herd input' sheet, along with the predicted growth curve for the selected ADG. Standard growth curves for ADGs ranging from 600 to 750 g. day⁻¹ are also plotted on this chart for comparison purposes. These growth curves, originally derived from data presented by Richards (2012), have been updated with current data provided by Willis (2025), allow the user to evaluate whether the entered age and live weight values are realistic in comparison with typical growth curves.

In the example provided in Figure 1, the entered age and live weight values (blue triangular markers) closely follow the predicted growth curve (grey line) for the selected ADG value of 690 g. day⁻¹.

This visual allows the user to see that the pig weights entered on the Herd details sheet follow typical growth rates.

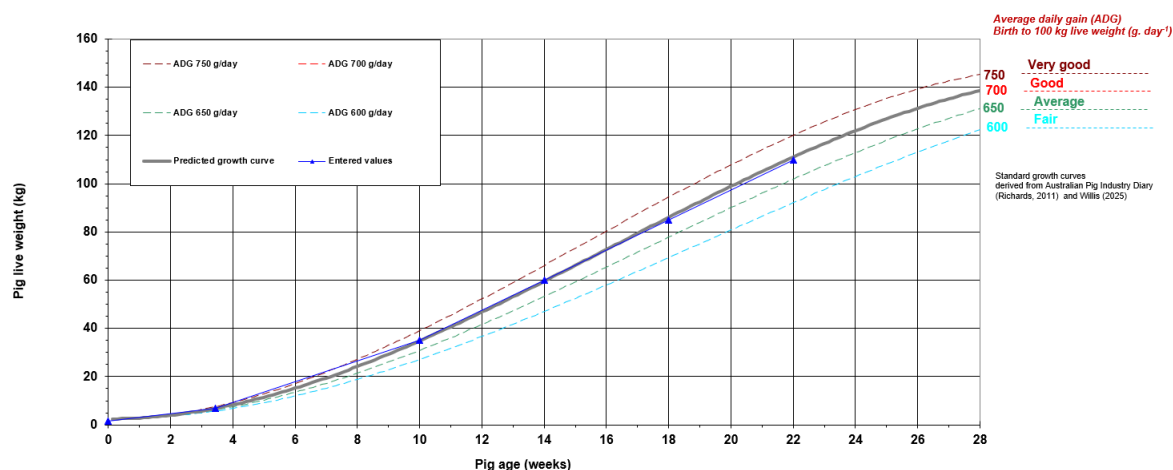


Figure 1. 'Growth chart' example for a selected ADG value of 690 g. day⁻¹ and entered age and live weight values that closely follow the predicted growth curve.

5. Herd details

The 'Herd details' sheet provides the numbers of pigs housed in the piggery at any point in time, calculated by the model, for each of the pig classes entered in the 'Herd input' sheet. On this sheet, the user has an opportunity to override the model calculations and enter known numbers of pigs for each of the classes. Note, an addition since PigBal 4 is that the Gestating sow herd can be spilt into two categories. This may be helpful if some dry sows are in conventional housing and some housed in deep litter.

It is important to only make minor changes to the pig numbers in each category, as the correct data entered on the Herd Input sheet should closely match the herd structure for the scenario being modelled. Also, if a Pig Class has no pigs, leave the cell blank.

The user is also required to enter the type of manure management system employed in the sheds housing the various classes of pigs. Drop-down lists for each pig class provide 3 choices; viz. 'Flushing', 'Pull plug / Static pit' or 'Deep litter'. Details of these shed types can be found in the Technical Manual.

The SPU multipliers used for the grower herd are determined using a regression equation based on the average live weights of pigs in each class. This regression equation was developed using the standard SPU multipliers and live weights published in Table 5.2 of the National Environmental Guidelines for Indoor Piggeries – Siting and Design (NEGIP-SD), reproduced in Table 3. . The regression equation and a plot of the resulting SPU multipliers are provided in the Technical Manual. The standard SPU multipliers outlined in Table 4 are used for the breeder herd.

Table 3. Standard pig classes, live weights and SPU conversion factors published in Table 5.2 of the NEGIP-SD (2025).

Pig class	Start live weight (kg)	Finish live weight (kg)	Average live weight (kg)	SPU multiplier
Gilt	100	160		1.8
Boar	100	300		1.6
Gestating sow	160	230		1.6
Lactating sow	230	160		2.5
Sucker	1.4	8.0	4.7	0.1
Weaner	8.0	25.0	16.5	0.5
Grower	25.0	55.0	40.0	1.0
Finisher	55.0	100.0	77.5	1.6
Heavy finisher	100.0	130.0	115.0	1.8

The 'Herd details' sheet summarises the ages, live weights, and numbers of standard pig units (SPU) for each class of pig, along with the pig purchases, mortalities and sales in terms of both pig numbers and live weight at the bottom of the sheet.

The values at the bottom of this sheet should be carefully checked by the user to ensure they match the piggery being modelled to obtain the most accurate results. PigBal is a mass balance model and requires the mass of pigs going in and out to determine both fixed solids (used to calculate volatile solids) and nutrients excreted.

6. Deep litter

If 'Deep litter' is selected for any of the 'Shed types' in the 'Herd details' sheet, the user needs to specify the type and amount of bedding material added to the relevant shed(s).

A drop-down list provides the following alternatives for bedding materials: hardwood sawdust, softwood sawdust/shavings, rice hulls, barley straw, wheat straw and shredded paper. In reality, the choice of bedding material generally depends on the availability and cost of suitable materials in the vicinity of the piggery.

Typical solid and nutrient contents of common deep litter bedding materials are provided in the Technical Manual. These values are used by PigBal 5 to estimate the composition of the spent deep litter and manure removed from the sheds.

To avoid animal welfare, production and environmental issues, piggery operators need to supply sufficient deep litter bedding material to maintain dry conditions. On average, this requires the addition of approximately 0.5 - 1.0 kg of bedding per SPU per day.

7. Assumptions

The Technical Manual outlines the values used in PigBal 5 to undertake the various calculations of nutrients and solids production. These are fixed values and cannot be edited by the user.

Some references are provided at the bottom of the sheet for these values.

8. Feed details

Along with ensuring that the correct mass of pigs is calculated on the Herd details sheet, having the correct amount of feed entered on this sheet is very important to ensure that PigBal returns the accurate results.

To assist in estimating feed wastage, this sheet includes provision for the user to enter a known average feed conversion (FC) for the progeny pigs, calculated from birth to 100 kg live weight, which is a common turn-off liveweight. The FC value is calculated by dividing the total feed fed to progeny pigs from birth to 100kg liveweight, by the live weight gain (birth to 100 kg liveweight).

Ratings are provided in the in-cell explanatory comments for a range of progeny FC values (birth to 100 kg liveweight) that could be. While pig producers may know the average FC values for their progeny pigs (birth to 100kg liveweight), the tabulated values are intended to assist users who don't have detailed knowledge of pork production standards, with the selection of realistic values.

Feed wastage in piggeries is practically impossible to measure objectively, and producers are generally unable to provide accurate, quantitative estimates. However, feed wastage can have a major influence on the characteristics of the waste stream discharged from piggery sheds. To assist users in estimating a realistic feed wastage value, a relationship was developed between feed wastage, the ADG value provided in the 'Herd input' sheet and the FCR value entered on this sheet. More details on the development of this relationship can be found in the Technical Manual.

Feed wastage values must be entered by the user for each class of pig. Users may choose to enter the calculated value for weaner, grower and finisher pigs. Alternatively, default values are provided in the in-cell explanatory comments and users must enter these in the relevant cells.

Note that the prediction of FC (birth to 100 kg liveweight) is very sensitive to the user inputs and may not always predict a realistic number (e.g. negative numbers), without very accurate production data. Feed wastage should generally be between 4% and 10%.

On this sheet, the user may enter either the **daily feed ingested** per pig for each pig class, or the **total annual tonnage of feed fed** to each pig class. For many piggeries, the latter figure may be available from feed commodity delivery records.

Alternatively, if these cells are left blank, the default values for the breeder pigs, and the calculated values for the grower pigs will be used

Estimates of the daily feed ingested and annual feed fed for the grower pigs are provided in the columns labelled 'Calculated / default values'. These values are calculated using equations supplied in the Technical Manual. The calculated values may be overridden by entering data in the 'Entered values' column.

It should be noted that all feed intake data is expressed on an 'as-fed' basis, rather than on a 'dry matter' basis. This means that the masses of feed fed include the moisture contents of the diet ingredients.

Annual feed usage values for individual classes of pigs and the whole piggery are provided in the table on the 'Feed details' sheet.

Feed Conversion Ratio (FCR) of the growing herd (wean to finish), Whole Herd Feed Conversion (HFC), which is reported on a dressed weight basis, and feed usage by breeders and progeny are provided below the table on this sheet. To assist users in ensuring a realistic FCR of the growing herd and HFC values are being calculated for the model run, a rating score is provided on the right based on current (2025) production data from Australian piggeries. These ratings are shown in Table 4 and are reported beside the calculated values at the bottom of the sheet

Table 4. Feed conversion ratio (FCR) - birth to finish and Whole Herd Feed Conversion (HFC) ratings.

Feed Conversion Ratio (FCR) (birth to finish)	Whole Herd Feed Conversion (HFC) (dressed weight basis)	Rating
< 1.95	< 3.0	very good
1.95 - 2.35	3.0 – 3.45	good
2.35 – 2.55	3.45 – 3.85	average
2.55 - 2.75	3.85 – 4.2	fair
2.7 – 3.0	4.2 – 4.5	poor
> 3.0	> 4.5	very poor

9. Water

The 'Water' sheet in PigBal 5 is not directly used in estimating the piggery manure production. It has been included to assist users in estimating the total water use in the piggery; a very important consideration for planning new or expanding developments and in assessing the environmental footprint of new and existing piggeries.

Details on the equations used to estimate water intake by pig class can be found in the Technical Manual.

Drinking water wastage is likely to be influenced by a number of factors including drinker design, environmental factors such as temperature, and a range of pig social/behavioural factors. An average drinking water wastage rate of 25% is suggested as a default value for use in PigBal 5. Individual drinking water wastage rates for the various pig classes can be entered into the 'Wastage' column of the 'Water' sheet.

PigBal 5 provides an estimate of the **cooling water use** and requires the user to enter the average number of hours per year that spray or drip cooling is likely to be used. The default figure is 540 hr per year, which is equivalent to 6 hr per day, over 90 days (3 months).

Known shed flushing and hosing volumes may be entered by the user in the appropriate cells. In some cases, it may be relatively simple to measure the dimensions of flushing tanks to determine the relevant flushing volume. It may be more difficult to measure hosing water without the use of a water meter. Because the hosing and drinking water may be supplied from the same pipeline in many piggeries, it may be difficult or impossible to accurately apportion the appropriate volumes to each use.

In cases where the daily flushing and hosing volumes are unknown or difficult to measure accurately, the user can estimate the shed effluent volume by choosing one of three different shed cleaning systems; viz. high flush, medium flush and low flush, from the drop-down list. PigBal 5 estimates the

volume of effluent discharged from conventional sheds using the estimated total solids (TS) output (manure + waste feed) from the sheds (calculated on the 'DMDAMP' sheet) and the typical TS concentrations shown in Table 5 for the selected type of shed cleaning system.

If daily shed flushing and hosing volumes are unknown, leave the cells blank, otherwise they will be used as the default.

Table 5. Typical total solids and volatile solids concentrations for a range of conventional shed cleaning systems.

Cleaning system	TS	VS
High flush	1.0%	0.7%
Medium flush	2.0%	1.4%
Low flush	3.0%	2.1%

Estimates of the moisture contents of the waste feed and manure, and the waste drinking water volume, are subtracted from the total effluent volume to determine the total cleaning (flushing + hosing) volume.

The user is also required to enter the percentage of the total cleaning water (flushing + hosing) obtained from recycled effluent. This is used to calculate the volume of clean (non-recycled effluent) water used for cleaning.

The % clean water for flushing from total clean water flushing and hosing is calculated below this entry cell. This value is only displayed only if values are entered in either of the cleaning water (Flushing and Hosing) cells.

The total clean water volume required for the operation of the piggery is determined by adding the volumes of drinking water intake, waste drinking water, clean water used for shed cleaning and water used for cooling.

10. Effluent pre-treatment

The raw effluent discharged from conventional piggery sheds may be processed in a pre-treatment system, to remove some of the suspended solids and nutrients, prior to discharge into an effluent pond. PigBal 5 allows the user to select, from a drop-down list, one of seven types of pre-treatment system. The pre-treatment options available in the drop-down list are detailed in the Technical Manual, along with typical solids and nutrient removal rates.

There is also provision for the user to enter alternative removal rates if more accurate performance data is available, or if an alternative pre-treatment system is being used. If the 'Known pre-treatment removal rates' cells are left blank, the typical values provided are adopted.

PigBal 5 subtracts the solids and nutrients removed by the pre-treatment system from the effluent loading entering the downstream effluent treatment pond. The total masses of separated solids and nutrients are provided on this sheet.

11. Pond design

PigBal 5 provides three options for selecting an appropriate anaerobic pond activity ratio (k) for the piggery site. The first option requires the user to select the Australian state and locality where the piggery is located, from the drop-down lists. PigBal 5 automatically selects a k value for this locality, based on values published in the original PigBal user manual detailed in the Technical Manual.

In the second option, which is consistent with the approach used in the NEGIP-SD. The user simply selects a climate type (cool, warm or hot), using the drop-down list. Table 6. provides example localities for these three climate descriptions, along with the corresponding anaerobic activity ratio (k) values, based on values in Table 12.2 of the 2025 NEGIP-SD.

Table 6. Climate descriptions, anaerobic pond activity ratio (k) values and example locations.

Climate	Anaerobic activity ratio (k)	Example localities
Cool	0.6	Armidale NSW, Southern & central Vic, Southern SA and Tasmania
Warm	0.8	Most of inland NSW, South-East Qld, SA and Southern WA
Hot	1.0	Central & northern Qld, Moree NSW and Goondiwindi Qld

The third option allows the user to enter a known k value for use in the model. The 'user selected' option overrides both of the previously described options.

The anaerobic activity ratio (k) value is multiplied by the volatile solids (VS) loading rate to give an adjusted VS loading rate that accounts for the climate at the piggery site. In this way, the suggested VS loading rates are lower for cooler localities, to account for the reduced biological activity at lower temperatures.

PigBal 5 calculates primary anaerobic pond volumes and dimensions based on three different design concepts, viz. 'conventional large', 'maximum loading' and 'covered anaerobic pond', which may be selected from a drop-down list. Table 7. outlines the recommended baseline VS loading rates and the adjusted VS loading rates for the various combinations of climates and design concepts. These loading rates were obtained by multiplying the anaerobic activity ratios from Table 6. , by the baseline loading rates provided in Table 7. .

Table 7. Recommended anaerobic pond volatile solids loading rates for the various combinations of design concepts and climates.

Pond design concept	VS loading rate (kg VS. m ⁻³ . d ⁻¹)			
	Baseline	Cool	Warm	Hot
Conventional large	0.10	0.06	0.08	0.10
Maximum loading	0.75	0.45	0.60	0.75
Covered anaerobic pond	0.40	0.24	0.32	0.40

The recommended VS loading rates for the 'conventional large' and 'maximum loading' options are consistent with the loading rates outlined in Tables 12.2 and 12.3 of the NEGIP-SD. The recommended baseline loading rate for covered anaerobic ponds, shown in Table 7. of 400 g VS. m⁻³. day⁻¹ is consistent with current design practice.

The minimum active treatment volume, based on VS loading, is calculated by dividing the VS loading entering the pond, by the suggested adjusted maximum VS loading rate.

In addition to the VS loading rate, the hydraulic retention time (HRT) is an important measure for designing anaerobic ponds. The HRT is calculated by dividing the active treatment volume by the pond inflow value determined in the 'Water' sheet. For effective anaerobic treatment, a minimum HRT of 40 days is suggested.

PigBal 5 assumes a sludge accumulation rate of 0.00137 m³ per kg of TS added which is consistent with the value given in the NEGIP-SD. The user is required to enter a pond desludging interval which is generally between two and ten years, depending on the producer's preferred sludge management practice. Shorter desludging intervals (e.g. 0.5 – 1.0 years) may be appropriate for covered anaerobic ponds equipped with suitable sludge extraction pipes. The desludging interval is used to determine the required sludge storage volume to be provided in the primary anaerobic pond.

PigBal 5 calculates the suggested total pond volume, which is the sum of the suggested active treatment and sludge storage volumes, based on meeting both the suggested VS loading rate and HRT design criteria. The user may then enter a selected total pond volume and PigBal 5 provides the resulting maximum and minimum VS loading rates and HRT values. The maximum VS loading rate occurs when the pond is storing the maximum sludge volume and the minimum VS loading rate occurs when the pond is storing no sludge, such as when it is first commissioned or directly following desludging. Conversely, the maximum HRT occurs when the pond is storing no sludge, and the minimum HRT occurs when the pond is storing the maximum sludge volume. If any of these values fall outside of the suggested ranges, the cells containing the non-compliant values are highlighted and a warning appears.

In order to determine the dimensions of a rectangular-shaped pond, the user is required to enter the total pond storage depth, batter gradient, freeboard, and one of the side dimensions of the pond,

measured at the embankment crest. PigBal 5 determines the other relevant dimensions for the proposed pond design, as shown in Figure 2.

If the user selects physically impossible pond dimensions for the required pond volume, resulting in negative dimensions for the pond base, PigBal 5 provides a warning message near the bottom of the sheet.

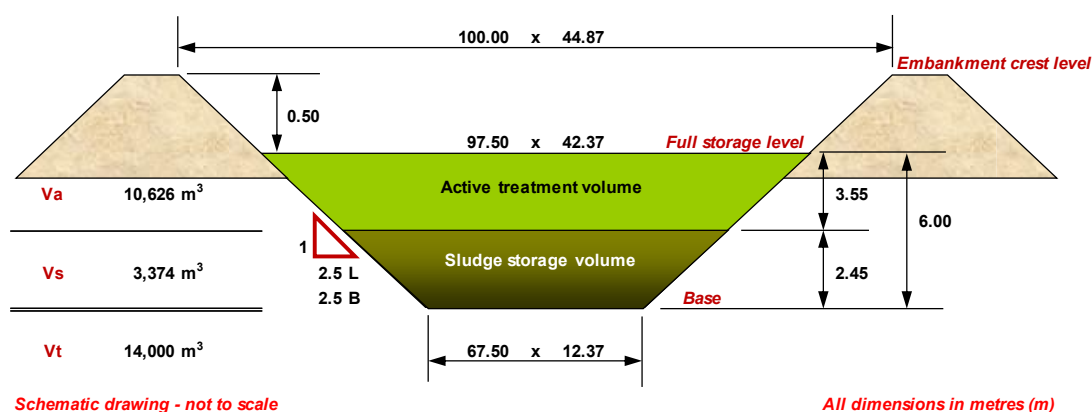


Figure 2. An example of the schematic drawing of the primary anaerobic pond provided on the 'Anaerobic pond design' sheet of PigBal 5.

Secondary treatment / holding ponds

Effluent which overflows from primary anaerobic ponds is unsuitable for direct discharge into the environment or natural watercourses. Overflow from primary ponds should generally be directed into a secondary treatment or holding pond where the effluent is temporarily stored prior to carefully managed irrigation onto land growing crop or pasture. Most conventional piggeries require at least one anaerobic treatment pond and one secondary treatment or holding pond. In some cases, the overflow from the secondary pond may be directed into one or more subsequent ponds (connected in series) for further treatment or to provide additional effluent holding capacity. The final pond in the effluent treatment / storage system may be referred to as a wet weather storage pond.

In general, the second and any subsequent ponds should be designed to store all effluent discharged from the primary pond until the land is sufficiently dry to receive the irrigated effluent, or until agronomic conditions are favourable. In the winter-dominant rainfall areas of southern Australia, secondary / holding ponds may be required to store all effluent discharged from the primary pond for a period of up to six months, from late autumn until early spring.

The design of secondary ponds is not an available function of PigBal. Secondary / holding ponds are generally designed using a (preferably daily) water balance approach, based on limiting overflows from secondary / holding ponds to a minimum interval of 10 years, on average, using historical rainfall and evaporation data for the piggery site. Various computer models may be used for this purpose. At environmentally sensitive sites, the minimum overflow interval may be increased to further reduce the potential for environmental harm.

12. Diet ingredient data

The 'Diet ingredient data' sheet is essentially a database providing the characteristics of a wide range of feed ingredients used in Australian pig diets. While a range of additional chemical concentrations and other data are provided on this sheet, PigBal 5 only uses the characteristics listed in Table 8. for estimating waste production. Various references for this data are listed at the bottom of the sheet.

Table 8. Diet ingredient characteristics used by PigBal 5.

Characteristic	Abbreviation	Units	Calculation
Dry Matter	DM	%	
Gross Energy	GE	MJ/kg	
Digestible Energy	DE	MJ/kg	
Dry Matter Digestibility	DMD	%	$DMD = DE / GE$
Crude Protein	CP	%	
Nitrogen	N	%	$N = CP / 6.25$
Ash (Fixed Solids)	Ash or FS	%	
Total Phosphorus	Total P	%	
Potassium	K	%	

Two additional rows (yellow shaded) are provided near the bottom of the sheet to allow users to enter data for extra diet ingredients that were not included in the original database.

13. Diet input

On the Diet input sheet, the user is required to enter the percentages of each ingredient included in the various diets fed to the pigs accommodated in the piggery. The proportions of each diet ingredient are entered as percentages of the 'as-fed' mass of the total diet for each class of pig. (The 'as-fed' mass, which includes the moisture content of each ingredient, is the feed mass generally used in diet formulation documentation produced by nutritionists and commercial feed companies.) The totals for each diet should add up to 100% and PigBal 5 gives a warning above any diet columns where this is not the case.

If the crude protein concentrations for any of the ingredients included in the diet formulation being entered into the model do not match the standard concentrations shown on the 'Diet input' sheet, alternate crude protein concentrations can be entered in the 'Alternate crude protein' column provided. For diet ingredients such as cereal grains, oilseed meals and animal and fish derived meals, crude protein percentages are commonly reported as a number following the diet ingredient name. For example, "sorghum 11", "soybean meal 46 solvent" and "fish meal 65" contain 11%, 46% and 65% crude protein, respectively. Crude protein levels entered in the 'Alternate crude protein' column override the standard values. The crude protein values are used to determine the nitrogen concentrations of the dietary ingredients, using the relationship outlined in Table 8. .

Four standard diets have been incorporated into PigBal 5 for use in cases when detailed dietary data for a particular piggery may not be available for entry into the model. These diets developed from typical pig feed ingredient use around Australia. Full details of these diets are provided in the Technical Manual, while the main diet ingredients are summarised below:

- Diet A: wheat, barley, soybean meal – typical Southern Australia and general diets
- Diet B: barley, wheat, chickpeas – typical Northern diets
- Diet C: barley, wheat, triticale, canola meal – typical South Australian diets
- Diet D: barley, wheat, lupins – typical Western Australia diets

Users can enter the standard diet data by clicking on one of the macro buttons provided at the top of the 'Diet input' sheet.

Standard diets A to D include data for suckers, weaners, porkers, growers, finishers, lactating sows, gestating sows and gilts. The same sucker diet is used for each of the standard diets A to D.

PigBal 5 selects the standard diet for each class of grower pig, using the end live weights entered on the 'Herd input' sheet, based on the standard live weights outlined in Table 9. .

Table 9. Ages and live weights for the pig classes used in formulating standard diets A to D.

Diet	Pig age (weeks)		Pig live weight (kg)	
	Start	End	Start	End
Sucker	2	6	2	19
Weaner	6	10	19	35
Porker	10	14	35	60
Grower	14	18	60	85
Finisher	18	22	85	110

14. DMDAMP

No data entries are required on the 'DMDAMP' sheet. The majority of calculations to determine the ingested feed, waste feed, excreted manure and total waste discharged from the sheds, are carried on this sheet using methods and equations found in the Technical Manual.

15. Output summary

No data entries are required on this sheet.

The 'Output summary' sheet provides summaries of the masses of TS, FS, VS, N, P and K in the feed ingested, feed wasted, manure excreted, manure excreted plus waste feed (before shed losses), effluent discharged from conventional sheds, separated solids, effluent discharged to primary pond, deep litter added to sheds and spent litter removed from deep litter sheds.

The total manure and waste feed (excluding shed losses) can be compared against a Standard 10,000 SPU farrow to finish model run using Diet A.

These predicted values from the standard run should be used to check the results returned for the model run. Variations are expected, but if > 25%, data inputs should be checked for accuracy. Note that these standard predictions are for conventional sheds only.

Stacked bar graphs show the proportions of waste feed and manure TS, FS, VS, N, P and K in the shed effluent. A second set of bar graphs compares the TS, FS, VS, N, P and K in the excreted manure plus the waste feed deposited in the sheds (excluding shed losses) predicted by the model, with values predicted by PigBal 5 using a 10,000 sow farrow to finish example using Diet A.

16. Nutrient and solids flow

On the Nutrients and solids flow sheet, the user is required to enter a number of percentages that are either loss rates or partitioning of nutrients and solids at various stages of treatment and management for effluent, separated solids, pond sludge, and spent deep litter.

The purpose of this sheet is to provide the user with estimates of the amount of nutrients and solids available for various by-products generated at a piggery, depending on the housing system and treatment/management processes.

This sheet uses the production of nutrients and solids from the 'Output summary' sheet. Typical solids and nutrients partitioning, loss rates and moisture content then used to estimate the amount and nutrient composition of the various by-products generated from the scenario piggery.

These values are pre-entered in PigBal but can be changed. Users should justify any major variations from the values provided.

provides the user with typical solids and nutrients partitioning, loss rates and moisture contents along the treatment and utilisation processes. These values are pre-entered in PigBal but can be changed. Users should justify any major variations from the values provided.

Table 10. Typical solids and nutrients partitioning, loss rates and moisture contents along the treatment and utilisation processes

Input variable (%)	m/c ¹	TS	VS	N	P	K	Notes/References
Separated solids							
Storage/drying/compost loss			20	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Moisture content	30						Piggery assessment spreadsheet (Skerman 2019)
Spreading loss rates	-	Calc ²	20	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Fresh effluent							
Irrigation loss rates	-	Calc ²	10	20	0	0	NEGIP-SD (Tucker <i>et al.</i> 2025)
Loss rates from soil surface	-	0	0	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Primary pond sludge							
Partitioned to sludge	-	Calc ³	Calc ³	23.5	85	5	Casey et al. (1996)
Removal/storage/drying/compost loss	-	Calc ²	5	25	0	0	Piggery assessment spreadsheet (Skerman 2019)
Moisture content	30						Piggery assessment spreadsheet (Skerman 2019)
Spreading loss rates	-	Calc ²	10	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Pond supernatant							
Evaporative pond loss rate ⁴	20						This value is site dependent and can be calculated from water balance modelling
Gaseous pond loss rate	-	Calc ²	70	60	0	0	Piggery assessment spreadsheet (Skerman 2019)
Irrigation loss rates	-	Calc ²	10	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Loss rates from soil surface	-	0	0	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Deep litter sheds/shelters							
Stockpile/compost loss	-	Calc ²	10	20	0	0	NEGIP-SD (Tucker <i>et al.</i> 2025)
Application loss rate	-	Calc ²	10	20	0	0	Piggery assessment spreadsheet (Skerman 2019)
Moisture content	40						NEGIP-SD (Tucker <i>et al.</i> 2025)

Notes:

1 - m/c = moisture content

2 Calc = Calculated from VS loss and VS:TS ratio

3 Calc = Calculated from Table 11.3 (NEGIP-SD, 2025) and assumed sludge density of 1,200 kg/m³

4 Evaporative pond loss rate = The nett evaporation loss, which is Pan evaporation minus rainfall.

17. GHG input

On the GHG Input sheet the user is required to input energy use and transport values, as well as manure management (both solids and effluent) in order to calculate both the Scope 1 and 2 greenhouse gas (GHG) emissions for the piggery. Standard values are not provided here due to the range in values between piggeries due to variability in climate, housing system, building materials, energy source, equipment installed, and efficiency measures employed.

Scope 1 emissions are the direct GHG emissions from sources a company/business it owns or controls. The main Scope 1 emissions for a piggery are those associated with manure management. Other Scope 1 emissions include the consumption (burning) of fossil fuels in stationary engines and transportation, including the transportation of pigs to processing plants.

Scope 2 emissions are those from the purchase of electricity. Although these emissions occur at the facility where energy is generated (e.g. power station), they are attributed to the company/business that consumes the energy.

The location (state) the farm is located is important, as each state electricity supply has a different GHG emission profile. If the farm is in one state and the electricity is supplied from a neighbouring state (e.g., the piggery is located on / very near to a state border), enter the state where the electricity is purchased from.

Ensure energy purchase values enter are in the correct units. Electricity consumption must be entered as kWh (these values should be available from invoices).

For the transport of pigs to processing plants, this may be contracted to commercial suppliers and the volume of diesel consumed unknown. If this is the case, enter the typical vehicle type (e.g. B-double, semi-trailer) and the average distance (one-way) from the farm to the processing plant. The amount of diesel used annually will then be estimated.

The secondary management of effluent / spent litter also generates Scope 1 emissions, including the stockpiling and composting of solids and the irrigation of liquid effluent. Land application of solid manure by-products is not considered a Scope 1 emission for the piggery enterprise, as these emissions are attributable to the crop or pasture that is grown on the utilisation area and this activity does not occur within the core pig production system.

18. GHG output – Scope 1 & 2

No data entries are required on this sheet.

The 'GHG Output – Scope 1 & 2' sheet provides a summary of the piggery operation's Scope 1 and 2 GHG emissions. These emissions are split into:

- Enteric methane
- Manure management methane
- Manure management nitrous oxide, and
- Piggery services

A stacked bar graph is also provided that shows the Scope 1 and 2 GHG emissions graphically.

Total Scope 1 and 2 emissions, also referred to as a **carbon account**, represents the total amount of GHG emissions arising from a business over a twelve-month period, and are typically reported in tonnes of carbon dioxide equivalent (t CO₂-e). The carbon account covers emissions associated with the activities within a business' control. For a piggery, this includes emissions from gas, electricity, and fuel use, enteric methane from pigs, and emissions from housing and manure management systems. It does not include emissions that occur outside the piggery boundary (e.g., crop production).

A **carbon footprint** measures the GHG emissions associated with a product across its lifecycle. A carbon footprint of pig production is typically reported as kg CO₂-e/kg liveweight. The carbon footprint of pig production would include all emissions that occur at the piggery, as well as 'upstream' and 'downstream' emissions (Scope 3). An example of an upstream emissions are emissions from feed grain production. An example of downstream emissions are emissions associated with meat processing. A carbon footprint includes all emissions relating to the production of the pigs, from extraction of raw materials up to the point where the pigs leave the producer's operation control. **PigBal 5 does not provide a carbon footprint, as Scope 3 emissions are not calculated.**

19. Covered pond GHG abatement and potential

The 'CAP Methane Potential' sheet performs the calculations to determine the potential GHG abatement by installing impermeable covers on uncovered anaerobic effluent treatment ponds (or lagoons) to capture the biogas emissions from the pond surface.

To achieve the abatement requires the installation and operation of covers and gas capture and combustion equipment for existing uncovered treatment lagoons or, alternatively, the replacement of conventional lagoons with covered lagoon systems or engineered digesters. Piggery operators can use the captured biogas to produce heat and electricity or destroy it through the use of flares.

PigBal 5 can assist proponents by determining the potential volume of methane abatement and the equivalent tonnage of carbon dioxide equivalent [CO₂-e] that would be released from the operation of an uncovered anaerobic treatment lagoon.

The current value of the global warming potential of methane (GWP_{CH4}) specified in the National Greenhouse Accounts Factors can be entered on this sheet. This value calculates the carbon dioxide equivalent of methane abatement. **The current (June 2025) value is 28; however, this value may change from time to time. Consequently, it is the user's responsibility to ensure that the current value is entered in this cell.**

PigBal also calculates the maximum theoretical methane potential generated from a CAP or digester.

20. References

A detailed reference list for computations used in PigBal can be found in the Technical Manual.



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