

**Environmental impacts and resource use from Australian pork production determined using life cycle assessment. 2. Energy, water and land occupation**

*Stephen G. Wiedemann<sup>A,D</sup>, Eugene J. McGahan<sup>B</sup> and Caoilinn M. Murphy<sup>C</sup>*

<sup>A</sup>Integrity Ag Services, 36a Highfields Road, Highfields, Qld 4352, Australia.

<sup>B</sup>2 Somerset Street, Toowoomba, Qld 4350, Australia.

<sup>C</sup>Point Advisory, 31 Queen Street, Melbourne, Vic. 3000, Australia.

<sup>D</sup>Corresponding author. Email: [stephen.wiedemann@integrityag.net.au](mailto:stephen.wiedemann@integrityag.net.au)

## **Uncertainty modelling**

### *Fresh water consumption*

The irrigation rate for cereal grains was 2.6 ML/ha based on ABS Water use on Australian farms data for 2009/10 (ABS 2011). To estimate the uncertainty, the irrigation rate for cereal grains from 2006 to 2010 was determined using the ABS data (ABS 2008, ABS, 2009, ABS, 2010, ABS, 2011), providing a mean and standard deviation. The uncertainty data were modelled using triangular distributions, with the 2009/10 value being the selected value, and the outer bounds being twice the standard deviation. This process was used for irrigated soybeans based on the 2009/10 broadacre ABS data. Uncertainty associated with water use at pig farms was based on the mean and S.D of water use per 100 kg live weight (LW) for the CSFs, with the uncertainty data included using a triangular distribution.

### *Fossil fuel energy demand*

Another factor that influences fossil fuel energy demand is piggery energy use. Operation inputs for the national herd were determined from an inventory of 33 piggeries (FSA Consulting, unpublished data) and the CSF inventory dataset. The uncertainty data were included using triangular distributions, with the mean being the selected value, and the outer bounds being twice the standard deviation.

### *Land occupation*

Uncertainty related to grain yields was determined using yields for the five years from 2006 to 2010 (ABS 2012) to provide a mean and standard deviation. The uncertainty data were modelled using triangular distributions, with the 2009/10 value being the selected value, and the outer bounds being twice the standard deviation. Table 1 provides the key environmental and resource parameters with uncertainty data that were used for this analysis.

**Table 1. Key environmental impact and resource parameters with uncertainty**

<b>Inputs</b>	<b>Mean <math>\pm</math> uncertainty</b>
<i>Fresh water consumption</i>	
Irrigation water for cereal grains (ML/ha).	2.60 $\pm$ 0.94
Irrigation water for soybeans (ML/ha).	2.40 $\pm$ 0.53
National herd water consumption (L/100 kg LW)	2210 $\pm$ 1100
<i>Fossil fuel energy demand</i>	
<b>Grain milling</b>	
Electricity (kWh/tonne <sup>A</sup> )	32 $\pm$ 5.5
Diesel (L/tonne)	4.2 $\pm$ 2.3
Gas (MJ/tonne)	67 $\pm$ 49.7
Transport of commodities to feedmill (km)	85 $\pm$ 49.4
<b>Farm inputs</b>	
Purchased feed (kg/100 kg LW)	313.5 $\pm$ 25.5
Straw (kg/100 kg LW)	18.9 $\pm$ 6.2
Diesel (L/100 kg LW)	0.41 $\pm$ 0.29
Petrol (L/100 kg LW)	0.1 $\pm$ 0.08
LPG (L/100 kg LW)	0.2 $\pm$ 0.19
Electricity (kWh/100 kg LW)	16.0 (6.3 - 26.5) <sup>B</sup>
Accounting, auditing & book keeping (\$/100 kg LW)	1.7 $\pm$ 0.09
Automotive repairs (\$/100 kg LW)	3.3 $\pm$ 1.04
Veterinary products and services (\$/100 kg LW)	8.3 $\pm$ 0.89
Distance staff travel to farm (km)	22 $\pm$ 9
Distance straw from supplier to farm (km)	85 $\pm$ 29
Distance from feedmill to farm (km)	85 $\pm$ 49
Distance to abattoir (km)	200 $\pm$ 138
<i>Land occupation</i>	
Yield for central east NSW wheat (tonne/ha)	1.50 $\pm$ 0.77
Yield for north west NSW wheat (tonne/ha)	1.66 $\pm$ 0.75
Yield for Darling Downs QLD wheat (tonne/ha)	1.98 $\pm$ 0.42
Yield for Kellerberrin region WA wheat (tonne/ha)	1.82 $\pm$ 0.57
Yield for Narrogin region WA wheat (tonne/ha)	2.62 $\pm$ 0.95
Yield for low rainfall zone SA wheat (tonne/ha)	1.13 $\pm$ 0.41
Yield for medium rainfall zone SA wheat (tonne/ha)	2.42 $\pm$ 0.81
Yield for north east NSW barley (tonne/ha)	1.44 $\pm$ 0.64
Yield for SE QLD barley (tonne/ha)	1.88 $\pm$ 0.84
Yield for WA barley(tonne/ha)	1.93 $\pm$ 0.31
Yield for SA barley (tonne/ha)	1.51 $\pm$ 0.47

<sup>A</sup> Reported on an 'as fed' ration basis inclusive of moisture.

<sup>B</sup> Range in electricity values produced a positively skewed distribution, hence first and third quartiles were used as the upper and lower bounds of the range. Values were assumed to follow a triangular distribution.

**Table 2. Aggregated diets per tonne of ration for the case-study piggeries**

For ration component, protein contents are given in parentheses. B, breeder ration; W, weaner ration; G–F, grower–finisher ration. See text for explanation of the case-study farm codes (Qld SMC, Qld LC, NSW C–DL, Vic. LC, WA LC and WA O–DL)

Ration component (kg)	Qld SMC			Qld LC			NSW C–DL			Vic. LC			WA LC			WA O–DL		
	B	W	G–F	B	W	G–F	B	W	G–F	B	W	G–F	B	W	G–F	B	W	G–F
Barley (11%)	223.6	33.9	41.3	416.8	0.0	45.7	177.3	33.0	0.0	589.7	0.0	229.7	418.2	122.8	493.3	397.9	27.9	499.2
Triticale (17.5%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.8	0.0	98.9	0.0	0.0	49.2
Maize (8%)	17.3	26.9	23.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sorghum (11%)	232.5	89.6	296.4	267.3	37.7	468.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wheat (11%)	366.4	617.5	419.9	170.8	754.4	232.5	687.6	629.1	640.2	273.8	775.1	575.9	215.1	469.2	52.5	214.7	586.2	76.5
Lupins (34%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.1	0.0	0.0	0.0	242.1	221.8	253.2	228.5	235.7	293.6
Millrun (17%)	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.0	82.8	0.0	0.0	0.0	0.0	4.7	0.0	117.1	0.0	26.2
Bloodmeal (85%)	4.7	15.3	4.4	6.2	27.5	10.1	4.1	16.2	0.9	0.0	3.5	5.0	0.0	1.6	0.6	0.0	0.0	0.0
Meat and bone meal (50%)	38.7	42.4	36.3	40.4	46.7	56.9	50.6	92.9	15.5	54.6	53.7	64.5	7.6	57.1	25.2	0.2	65.6	4.0
Canola meal (34%)	33.4	9.8	93.2	43.2	0.0	123.0	16.7	43.1	66.7	0.0	0.0	0.0	0.0	35.4	44.8	0.0	11.0	20.0
Soymeal (48%)	21.4	105.6	53.2	17.5	94.2	46.8	28.4	101.0	5.4	54.1	116.3	120.0	17.7	51.0	2.3	4.9	25.9	0.0
Sunflower meal (30%)	17.1	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other protein meal	5.4	24.0	0.0	5.0	25.0	0.0	6.2	36.4	0.0	15.6	36.6	0.0	0.8	1.6	0.0	0.2	10.0	0.0
Canola oil	10.4	13.6	7.4	5.8	5.0	3.1	5.3	39.7	6.1	6.5	10.6	0.6	15.1	18.3	6.9	8.3	13.8	2.2
Low-cost additives	17.6	3.5	12.7	16.9	2.0	8.9	12.7	3.3	30.1	5.2	2.5	3.2	26.6	9.9	19.4	25.8	11.7	22.8
High-cost additives	11.5	18.0	8.7	10.2	7.6	4.4	0.4	5.4	5.2	0.5	1.8	1.1	3.1	6.4	2.8	2.2	12.2	6.4
Total (kg)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Diet digestibility (%)	81.9	86.9	85.0	83.1	88.5	85.7	88.6	86.1	87.1	82.4	89.0	86.0	84.2	86.1	82.7	82.6	88.1	83.3
Crude protein (%)	15.2	18.9	16.9	14.6	21.5	17.1	14.9	22.7	17.9	14.6	18.0	16.8	14.0	18.7	15.6	13.7	18.5	16.4

**Table 3. Aggregated diets per tonne of ration for four diets used for national herd**

For ration component, protein contents are given in parentheses. B, breeder ration; W, weaner ration; G–F, grower–finisher ration

Ration component (kg)	NSW and Vic.			Qld			WA			SA		
	B	W	G–F	B	W	G–F	B	W	G–F	B	W	G–F
Barley (11%)	343.3	0.0	125.0	221.2	0.0	156.5	407.0	200.0	457.1	503.1	499.8	490.2
Sorghum (11%)	0.0	0.0	0.0	371.7	249.5	540.0	0.0	0.0	0.0	0.0	0.0	0.0
Wheat (12%)	517.0	825.1	737.3	231.6	539.5	132.3	332.8	535.1	263.9	236.7	235.2	230.7
Lupins (34%)	0.0	0.0	0.0	0.0	0.0	0.0	167.5	100.0	200.0	0.0	0.0	0.0
Field peas (20.5%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	167.5	100.0	200.0
Bloodmeal (85%)	9.4	24.0	14.0	9.7	25.0	18.5	6.0	11.5	2.5	6.0	11.5	2.5
Meat and bone meal (50%)	25.4	30.5	25.0	18.4	35.5	30.5	16.8	30.0	33.0	16.8	30.0	33.0
Canola meal (34%)	37.1	50.0	66.0	88.3	50.0	91.0	5.3	40.5	2.5	5.3	40.5	2.5
Soymeal (48%)	20.2	18.0	10.0	10.2	45.0	10.0	10.2	17.5	10.0	10.2	17.5	10.0
Other protein meal	15.0	25.0	0.0	15.0	25.0	0.0	17.5	25.0	0.0	17.5	25.0	0.0
Vegetable oil	10.5	9.0	1.0	8.9	13.5	1.5	11.9	21.5	11.0	11.9	21.5	11.0
Low-cost additives	12.4	7.0	15.0	14.8	5.6	13.1	15.5	7.0	12.0	15.5	7.0	12.0
High-cost additives	10.1	11.4	6.8	10.2	11.5	6.7	9.5	11.9	8.1	9.5	11.9	8.1
Total (kg)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Diet digestibility (%)	80.8	84.3	83.8	80.3	83.8	82.6	81.4	82.1	82.9	80.5	83.4	82.0
Crude protein (%)	14.4	18.9	17.0	14.2	19.4	16.1	14.9	17.5	16.3	14.2	18.1	15.6

## **References**

- ABS, 2008. Water Use on Australian Farms, 2006-07. Australian Bureau of Statistics, Canberra, ACT.
- ABS, 2009. Water Use on Australian Farms, 2007-08. Australian Bureau of Statistics, Canberra, ACT.
- ABS, 2010. Water Use on Australian Farms, 2008-09. Australian Bureau of Statistics, Canberra, ACT.
- ABS, 2011. Water Use on Australian Farms, 2009-10. Australian Bureau of Statistics, Canberra, ACT.
- ABS, 2012. Historical Selected Agriculture Commodities, by State (1861 to Present), 2009-10, Australian Bureau of Statistics, Canberra, ACT.