Input parameters for sheep LCA model

Notes:
a. Input parameter values shaded in orange cells are obtained from surveys. Values shaded in grey are intermediate calculations for livestock population and annual product output. Unshaded values are environmental parameters obtained from external sources.
b. If SOURCE in table below is blank, value is obtained from surveys
c. Baseline values represent average Ontario sheep farming practices

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
	POPULATION				
ewes	Adult ewes (F)	#	*Number of adult ewes on farm(s)*	206	
ewes_per_ram	Ewes per ram	#	*Number of ewes per ram*	34	
lambs_per_ewe	Lambs per ewe	-	*Average number of lambs per ewe*	1.8	
P_male_lambs	Lamb M:total ratio	%	*Proportion of rams in lamb population*	50%	
lamb_mortality	Lamb mortality rate	%	*Proportion of lambs which do not survive*	7.50%	
ewe_mortality	Ewe (F) mortality rate	%	*Proportion of ewes which do no survive*	3.50%	
ewe_cull	Ewe (F) cull rate	%	*Proportion of ewes culled*	12.40%	
ram_cull	Ram (M) cull rate	%	*Proportions of rams culled*	10.10%	
	AVERAGE BODY WEIGHTS (BW)				
BW_ewe	BW - Adult Ewe	kg	*Average body weight of adult ewe*	72.4	
BW_ram	BW - Adult Ram	kg	*Average body weight of adult ram*	89.2	
BW_lamb_ewe	BW - Lamb Ewe	kg	*Average body weight of lamb ewe at age 1y*	38.6	
BW_lamb_ram	BW - Lamb Ram	kg	*Average body weight of lamb ram at age 1y*	38.6	
BW_weaning	BW - Lamb weaning	kg	*Average body weight of lamb at time of weaning*	24.6	
BW_birth	BW - Birth	kg	*Average body weight of lamb at time of birth*	3.8	
	PRODUCTS				
BW_LW_ewe	BW --> LW Ewe	%	*% of inputted BW which translates to LW for ewes*	100%	
BW_LW_ram	BW --> LW Ram	%	*% of inputted BW which translates to LW for lambs*	100%	
BW_LW_lamb	BW --> LW Lamb	%	*% of inputted BW which translates to LW for lambs*	100%	
	Annual wool production her head				
wool_per_ewe	Wool per Ewe	kg wool/ewe/year	*Average annual wool produced by ewe*	4.8	
wool_per_ram	Wool per Ram	kg wool/ram/year	*Average annual wool produced by ram*	6.4	
wool_per_lamb	Wool per Lamb	kg wool/lamb/year	*Average annual wool produced by lamb*	1	

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
	Annual milk production her head				
milk_per_ewe	Milk per Ewe	kg milk/ewe/year	*Average annual milk produced by ewe*	100	
	DIET INPUTS				
	Mass proportion of diet based on roughage / foraging				
P_forage_adult_ewe	Forage% - Adult Ewe	%	*Proportion of adult ewes' diet from foraging*	77.10%	
P_forage_adult_ram	Forage% - Adult Ram	%	*Proportion of adult rams' diet from foraging*	84.15%	
P_forage_lamb_ewe	Forage% - Lamb Ewe	%	*Proportion of lamb ewes' diet from foraging*	58.91%	
P_forage_lamb_ram	Forage% - Lamb Ram	%	*Proportion of lamb rams' diet from foraging*	58.84%	
	Roughage / forage type composition (by mass)				
forage_corn_silage	Corn (maize) %	%	*Percent of corn (maize) in roughage / forage*	17%	
forage_hay	Hay %	%	*Percent of hay in roughage / forage*	58%	
forage_tillable_pasture	Tillable pasture %	%	*Percent of tillable pasture in roughage / forage*	16%	
forage_rough_pasture	Rough pasture %	%	*Percent of rough pasture in roughage / forage*	9%	
-	Sum Check	%	*Should equal 100%*	100%	
	Daily grain intake per head				
grain_amount_ewe	Daily Grain Inktake - Ewe	kg/head/day	*Daily grain (concentrate) intake per adult ewe*	0.49	
grain_amount_ram	Daily Grain Inktake - Ram	kg/head/day	*Daily grain (concentrate) intake per adult ram*	0.33	
grain_amount_lamb	Daily Grain Inktake - Lamb	kg/head/day	*Daily grain (concentrate) intake per lamb*	0.51	
feeding_practice	Feeding practice	*logical*	*Feeding practice: 0 = specialized facilities (5% wastage); 1 = feed spread on ground (20% wastage)*	0	
	Grain composition (by mass)				
grain_corn	Corn %	%	*Percent of corn (maize) in grain*	55%	
grain_barley	Barley %	%	*Percent of barley in grain*	20%	
grain_oat	Oat %	%	*Percent of oat in grain*	20%	
grain_wheat	Wheat %	%	*Percent of wheat in grain*	3%	
grain_soybean	Soybean %	%	*Percent of soybean in grain*	2%	

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
-	Sum Check	%	*Should equal 100%*	100%	
	Energy content of dry matter intake				
DMI_energy_forage	Energy - forage/roughage	MJ/kg	*Energy content of roughage/forage*	12.00	AHDB (2018)
DMI_energy_grain	Energy - Grain concentrate	MJ/kg	*Energy content of grain concentrates*	18.45	AHDB (2018); IPCC (2006)
	Nitrogen content of feed				
N_silage	N content - silage	kg N/kg feed	*Nitrogen content of silage*	0.022	FAO (2018)
N_hay	N content - hay	kg N/kg feed	*Nitrogen content of hay*	0.010	FAO (2018)
N_till_pasture	N content - Tillable pasture	kg N/kg feed	*Nitrogen content of tillable pasture*	0.035	FAO (2018)
N_rough_pasture	N content - Rough pasture	kg N/kg feed	*Nitrogen content of rough pasture*	0.035	FAO (2018)
N_corn	N content - Corn	kg N/kg feed	*Nitrogen content of Corn*	0.020	FAO (2018)
N_barley	N content - Barley	kg N/kg feed	*Nitrogen content of Barley*	0.020	FAO (2018)
N_oat	N content - Oat	kg N/kg feed	*Nitrogen content of Oat*	0.020	FAO (2018)
N_wheat	N content - Wheat	kg N/kg feed	*Nitrogen content of Wheat*	0.035	FAO (2018)
N_soybean	N content - Soybean	kg N/kg feed	*Nitrogen content of Soybean*	0.020	FAO (2018)
	MANURE MANAGEMENT INPUT				
	Manure Management System				
MS_liquid	Liquid MS	%	*Proportion of manure managed using liquid systems*	0%	
MS_solid	Solid storage MS	%	*Proportion of manure managed using solid storage systems*	46%	
MS_drylot	Drylot MS	%	*Proportion of manure deposited on drylot*	14%	
MS_PRP	PRP MS	%	*Proportion of manure deposited on pasture, range and paddock (PRP)*	40%	
-	Sum Check	%	*Should equal 100%*	100%	
	Nitrogen Content in Products				
N_meat	N content in Meat	kg N / kg LW	*Nitrogen content in meat*	0.034	FAO (2016, sec. 11.2.3)
N_wool	N content in Wool	kg N / kg wool	*Nitrogen content in wool, assuming 16% of greasy wool is water*	0.134	FAO (2016, sec. 11.2.3)
N_milk	N content in Milk	kg N /L milk	*Nitrogen content in milk*	0.013	FAO (2016, sec. 11.2.3)
	Methane Conversion Factors (MCF)				
MCF_liquid	Liquid MCF	%	*MCF for liquid sys.*	25.0%	ECCC (2020)

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
MCF_solid	Solid storage MCF	%	*MCF for solid sys.*	2.0%	ECCC (2020)
MCF_drylot	Drylot MCF	%	*MCF for drylot sys.*	1.0%	ECCC (2020)
MCF_PRP	PRP MCF	%	*MCF for pasture/range/paddock (PRP) sys.*	1.0%	ECCC (2020)
	Manure CH4 Parameters				
UE	Urinary Energy	%	*Urinary energy (UE) as a fraction of gross energy (GE)*	4.0%	IPCC (2006)
ASH	Ash content	%	*Manure ash content*	8.0%	ECCC (2020, Table A3.4.-13)
Bo	Bo	m^3 CH4 / kg VS	*Max CH4 production capacity of manure*	0.19	IPCC (2006)
	Direct N2O Emissions Parameters				
N_excr	Nitrogen Excr. Rate	kg N / day / 1000 kg	*Daily Nitrogen excretion rate (Table 10.19)*	0.42	IPCC (2006)
EF3_liquid	Liquid EF3	kg N2O-N/kg N	*Direct N2O emission factor for liquid manure management*	0	ECCC (2020)
EF3_solid	Solid EF3	kg N2O-N/kg N	*Direct N2O emission factor for solid manure management*	0.005	ECCC (2020)
EF3_drylot	Drylot EF3	kg N2O-N/kg N	*Direct N2O emission factor for drylot manure management*	0.02	ECCC (2020)
EF3_PRP	PRP EF3	kg N2O-N/kg N	*Direct N2O emission factor for PRP (urine/dung) manure management*	0.01	ECCC (2020)
	Indirect Volatization N2O Emissions Parameters				
FracGas_liquid	%N vol. - liquid MS	%	*Fraction of manure that volatizes as NH3 and Nox in liquid MS*	0	ECCC (2020, Table A3.4-22)
FracGas_solid	%N vol. - solid MS	%	*Fraction of manure that volatizes as NH3 and Nox in solid MS*	0.12	ECCC (2020, Table A3.4-22)
FracGas_drylot	%N vol. - drylot MS	%	*Fraction of manure that volatizes as NH3 and Nox in drylot MS*	0.12	ECCC (2020, Table A3.4-22)
FracGas_PRP	%N vol. - PRP	%	*Fraction of manure that volatizes as NH3 and Nox in PRP MS*	0.2	ECCC (2020, Table A3.4-22)
EF4	EF4	kg N2O-N/(kg NH3-N+NOx-N)	*Emission factor from atm. Deposition*	0.01	IPCC (2006, ch. 11)
	Indirect Leaching N2O Emissions Parameters				
FracLeach_liquid	%N leach - liquid MS	%	*Fraction of manure N loss through leaching/runoff from liquid MS*	0.0%	ECCC (2020, Table A3.4-22)
FracLeach_solid	%N leach - solid MS	%	*Fraction of manure N loss through leaching/runoff from solid MS*	15.0%	ECCC (2020, Table A3.4-22)
FracLeach_drylot	%N leach - drylot MS	%	*Fraction of manure N loss through leaching/runoff from drylot MS*	15.0%	ECCC (2020, Table A3.4-22)
FracLeach_PRP	%N leach - PRP	%	*Fraction of manure N loss through leaching/runoff from PRP MS*	0.0%	ECCC (2020, Table A3.4-22)
EF5	EF5	kg N2O-N/(kg N leaching)	*Emission factor from N leaching/runoff*	0.0075	IPCC (2006, ch. 11)

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
	GROSS ENERGY / ENT.FERM INPUTS				
	Castrated% and Ambient Temperature inputs				
castrated_ram	castrated% - Adult ram	%	*Percent of adult rams castrated*	90.0%	
castrated_ram_lamb	castrated% - Lamb ram	%	*Percent of lamb rams castrated*	80.0%	
Tamb	Annual Ambient. Temp	degC	*Annual average ambient temperature*	15	
	Net energy for activity (NEa) inputs				
P_housed_ewe	Activity% - Housed ewes	%	*Proportion of time livestock is confined due to pregnancy*	35%	
P_flat	Activity% - flat grazing	%	*Proportion of time animals walk up to 1000m for feeding*	40%	
P_hilly	Activity% - hilly grazing	%	*Proportion of time animals walk up to 5000m for feeding*	5%	
P_fatten	Activity% - lamb fattening	%	*Proportion of time animals are housed for fattening*	20%	
-	Sum Check	%	*Should add up to 100%*	100%	
	Net energy for pregnancy (NEp) inputs				
P_gestation	Gestation / birth %	%	*Proportion of adult ewes that give birth / go through gestation*	80%	
P_single	Single births %	%	*Proportion of single births*	35%	
P_double	Double births %	%	*Proportion of double births*	55%	
P_triple	Triple births %	%	*Proportion of triple births*	10%	
-	Sum Check	%	*Should add up to 100%*	100%	
	Coefficient for Net Energy for Maintenance (NEm)				
Cfi_0_adult	Default Cfi - Adult ewe	MJ/kg/day	*Coefficient for calculating NE_m in adult sheep*	0.217	ECCC (2020)
Cfi_0_lamb	Default Cfi - Lamb ewe	MJ/kg/day	*Coefficient for calculating NE_m in lamb sheep*	0.236	ECCC (2020)
	Coefficient for Net Energy for Activity (NEa)				
Ca_housed_ewe	Ca - Housed ewe	MJ/kg/day	*Coefficient for calculating NE_a for housed ewes*	0.009	ECCC (2020)
Ca_flat	Ca - flat grazing	MJ/kg/day	*Coefficient for calculating NE_a for flat grazing sheep*	0.0107	ECCC (2020)
Ca_hilly	Ca - hilly grazing	MJ/kg/day	*Coefficient for calculating NE_a for hilly grazing sheep*	0.024	ECCC (2020)
Ca_fatten	Ca - fattening lambs	MJ/kg/day	*Coefficient for calculating NE_a for housed fattening lambs*	0.0067	ECCC (2020)

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
	Coefficient for Net Energy for Growth (NEg)				
a0_intact	a' - intact males	MJ/kg	*a' coefficient for intact male lambs*	2.50	ECCC (2020)
a0_castr	a' - castr males	MJ/kg	*a' coefficient for castrated male lambs*	4.40	ECCC (2020)
a0_female	a' - female males	MJ/kg	*a' coefficient for female lambs*	2.10	ECCC (2020)
b0_intact	b' - intact males	MJ/kg^2	*b' coefficient for intact male lambs*	0.35	ECCC (2020)
b0_castr	b' - castr males	MJ/kg^2	*b' coefficient for castrated male lambs*	0.32	ECCC (2020)
b0_female	b' - female males	MJ/kg^2	*b' coefficient for female lambs*	0.45	ECCC (2020)
	Coefficient for Net Energy for Lactation (NEl)				
EV_milk	EV milk	MJ/kg milk	*Energy req'd for milk*	4.60	IPCC (2006)
	Coefficient for Net Energy for Wool (NEw)				
EV_wool	EV wool	MJ/kg wool	*Energy req'd for wool*	24.00	IPCC (2006)
	Coefficient for Net Energy for Pregnancy (NEp)				
Cp_single	Cp - single birth	-	*Coefficient for calculating NE_a for single birth*	0.077	IPCC (2006)
Cp_double	Cp - double birth	-	*Coefficient for calculating NE_a for double birth*	0.126	IPCC (2006)
Cp_triple	Cp - triple birth	-	*Coefficient for calculating NE_a for triple or more birth*	0.15	IPCC (2006)
	Coefficient for Gross Energy (GE)				
DE_grain	DE - Grain	%	*Digestible energy for sheep on grain diet*	74.0%	ECCC (2020, Table A3.4-11)
DE_forage	DE - Forage/Roughage	%	*Digestible energy for sheep on roughage diet*	65.0%	ECCC (2020, Table A3.4-11)
	Ent.Ferm convserion factor, Ym				
Ym_adult	CH4 conversion - Adult sheep	%	*Methane conversion factor for adult sheep*	6.50%	IPCC (2006)
Ym_lamb	CH4 conversion - Lambs	%	*Methane conversion factor for lambs*	4.50%	IPCC (2006)
	FARM OPERATION INPUTS				
	Farm area/size				
area_out_rough	Farm area - Rough	m^2/head	*Rough outdoor grazing area per population on farm*	184.00	
area_out_imprvd	Farm area - Improved	m^2/head	*Improved outdoor grazing area per population on farm*	117.00	
area_out_arable	Farm area- Arable cropland	m^2/head	*Arable cropland area per population on farm*	700.00	

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
area_in	Farm area - indoors	m^2/head	*Indoor farm area (barns, sheds, etc.) per population on farm*	3.00	
shed_lifespan	Shed/barn lifespan	y	*Average lifespan of shed/barn on farm*	50	
	Fertilizer Inputs				
fert_per_area	Fertilizer application rate	kg/ha/year	*Annual application of fertilizer (combined weight) per outdoor area*	125.45	
fert_P	Phosphate (P) fertilizer	%	*Proportion of fertilizer that is phosphate-based*	28.0%	
fert_K	Potassium (K) fertilizer	%	*Proportion of fertilizer that is potassium-based*	24.0%	
fert_N	Nitrogen (N) fertilizer	%	*Proportion of fertilizer that is nitrogen-based*	45.0%	
fert_lime	Lime	%	*Proportion of fertilizer that is lime*	3.0%	
-	Sum Check	%	*Should equal 100%*	100%	
	Water Inputs				
water_sheep	Water intake, sheep	L/adult/day	*Daily water intake per adult sheep*	4.75	
water_lamb	Water intake, lamb	L/lamb/day	*Daily water intake per lamb*	2.84	
water_misc	Water intake, misc.	L/day	*Daily water intake for other miscellaneous tasks*	50.0	
	Electricity / heating consumption				
electricity_in	Electricity consumption	kWh/head/year	*Annual electricity consumption per population*	11.3	
heating_fuel_in	Heating fuel consumption	L/day	*Daily fuel (natural gas) used for heating*	50.0	
diesel_in	Diesel consumption	L/ha/year	*Annual diesel consumption on farm per outdoor area*	68.2	
diesel_HV	Diesel heating value	MJ/L	*Heating value of diesel*	38.6	
	Other misc. operational inputs				
bedding_in_adult	bedding straw - sheep	kg/adult/day	*Daily bedding straw req'd per adult sheep*	0.63	
bedding_in_lamb	bedding straw - lamb	kg/lamb/day	*Daily bedding straw req'd per lamb*	0.43	
plastic_in	Plastic usage	kg/head/year	*Annual plastic (LDPE) usage per population on farm*	1.31	
	Transportation inputs				
p_ewe_transport	#ewes transport	/year	*Percent of adult ewes bought/transported annually*	10.0%	
p_ram_transport	#rams transport	/year	*Percent of adult rams bought/transported annually*	10.0%	
p_lamb_transpo	#lambs transport	/year	*Percent of lambs bought/transported annually*	100.0%	

VARIABLE NAME	PARAMETER	UNIT	*COMMENTS*	BASELINE VALUE	SOURCE
rt					
dist_livestock	Livestock transport dist.	km	*Average transportation distance of livestock*	171	
P_transport_grain	%grain transported	%	*Percent of grain bought/transported externally*	55.0%	
dist_grain	Grain transport dist.	km	*Average transport distance of grain*	78	
P_transport_fert	%fertilizer transported	%	*Percent of fertilizers bought/transported externally*	92.0%	
dist_fert	Fertilizer transport dist.	km	*Average transport distance of fertilizers*	30	
mass_transport_other	Other transport mass	kg/year	*Other major mass transported annually*	5000	
dist_other	Other transport dist.	km	*Average transportation distance of other mass*	100	
	PROTEIN CONTENT OF PRODUCTS				
protein_LW	Meat (LW) - protein content	kg protein / kg LW	*Protein content of live weight meat*	0.18	Wiedemann et al. (2015b); FAO (2016)
protein_wool	Wool - protein content	kg protein / kg wool	*Protein content of wool*	0.65	Wiedemann et al. (2015b); FAO (2016)