ENVIRONMENTAL FOOTPRINTS OF INNOVATIONS TO IMPROVE ANIMAL WELFARE

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ENVIRONMENTAL FOOTPRINTS OF INNOVATIONS TO IMPROVE ANIMAL WELFARE

Overview:

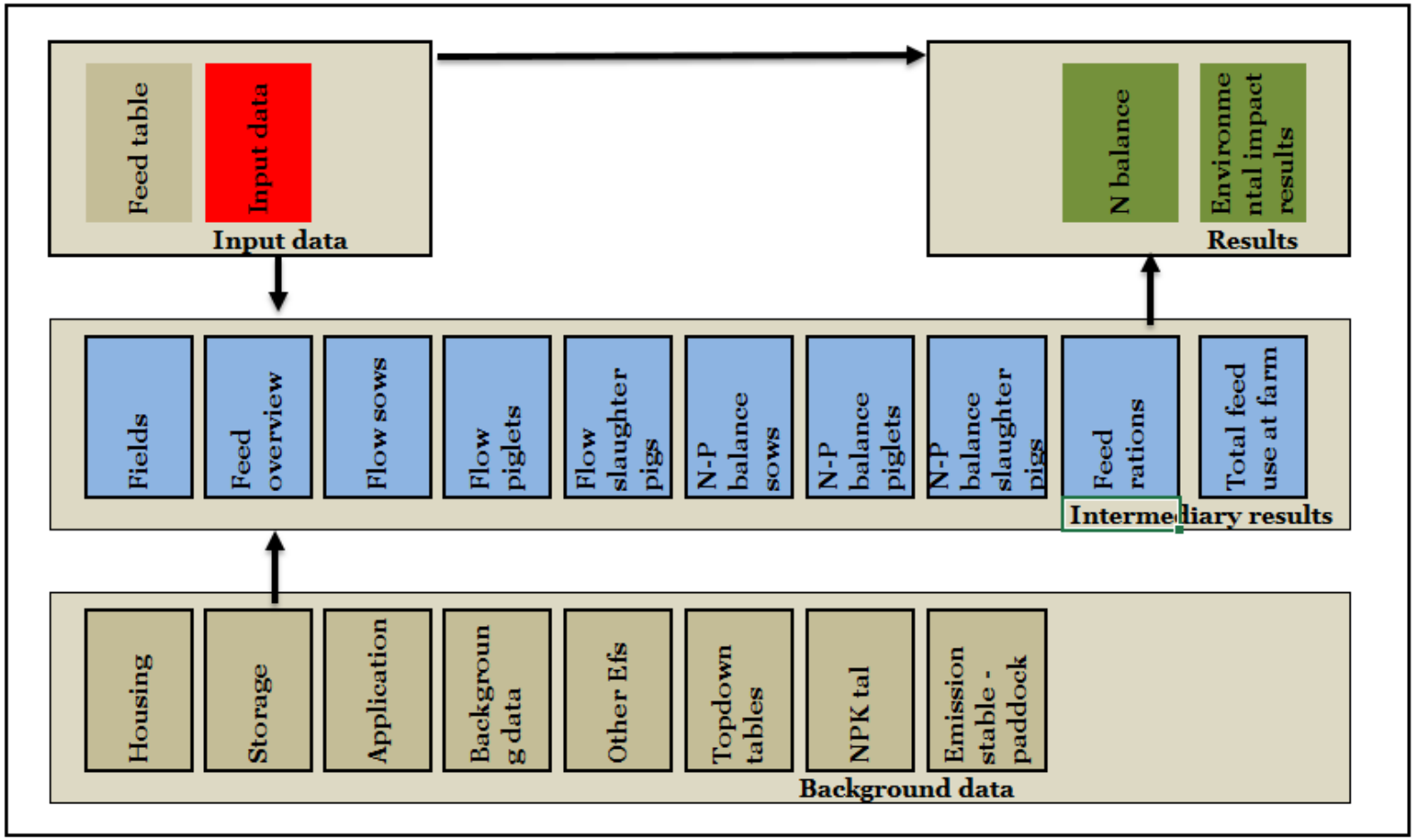
- Modelling the environmental impacts of systems innovations
  - need for modelling environmental impacts
- Scenarios for innovations
  - prolonged lactation
  - optimisation of feeding strategy

MODELLING THE ENVIRONMENTAL IMPACTS OF SYSTEMS INNOVATIONS

- There is a need of reducing the environmental impact of organic pig production
  - Huge variation in organic production systems
  - Limited knowledge in relation to the environmental impact of
    - different production systems
    - of innovations
- A tool is needed for decision making processes for farmers

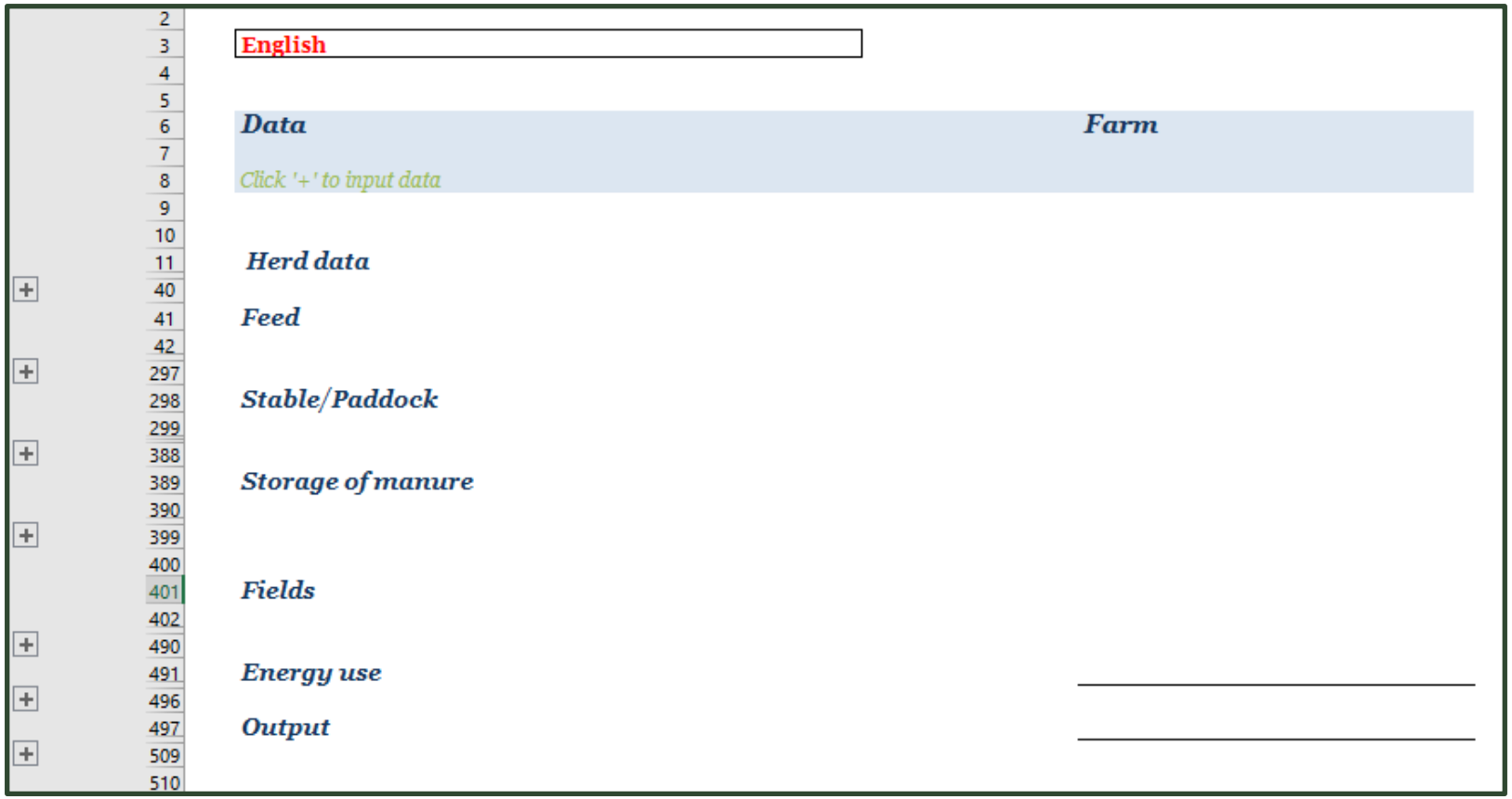



MODEL OVERVIEW



INPUT OF DATA

The model is built up in a spreadsheet, where consultant and farmer can enter the herd data



HERD DATA

Examples on input of the production data

English

Data	Farm
Click '+' to input data	

Herd data

Sows with piglets	
yearsows at farm, p.	100
litters per year, p.	1,92
liveborn piglets per litter, p.	14,9
dead piglets per litter, p.	
weaned piglets per litter, p.	11,85
piglets mortality, %	20,5
farrow/lactation period, days	53
weight at weaning, kg	14
piglets sold after weaning, p. per year	0
first parity sows, %	26,5
sow mortality, %	7
weight at culling, kg	233
Piglets/Weaners	
bought-in piglets, p.	
weight at purchase, kg	
weight out, kg	30,0
daily gain, g	520,0
mortality, %	2,8
sold piglets, p.	
Slaughter pigs	
bought-in pigs, p.	
weight at purchase, kg	
liveweight at slaughter, kg	113
daily gain, g	880
mortality, %	4,50

FEED

41	***Feed***
42	
43	*Lactating sows*
77	*Piglets with sow*
98	*Gestating sows*
154	*Indoor-piglets*
225	*Slaughter pigs*
226	Concentrated feed:
227	FU per kg gain
228	*mixture 1, for weight interval, kg:*
229	Composition:
230	feedstuff 1
231	feedstuff 2
232	feedstuff 3
233	feedstuff 4
234	feedstuff 5
235	feedstuff 6
236	feedstuff 7
237	feedstuff 8
238	feedstuff 9
239	feedstuff 10
240	feedstuff 11
241	feedstuff 12
242	feedstuff 13
243	feedstuff 14
244	feedstuff 15
245	Click '-' to finalize
246	
247	*mixture 2, for weight interval, kg:*
265	
266	*mixture 3, for weight interval, kg:*
284	
285	Roughage:
286	kg per animal per day
287	period of use, days per year
288	Roughage type, used:
289	roughage type 1
290	roughage type 2
291	roughage type 3
292	roughage type 4
293	roughage type 5
294	Click '-' to finalize
295	

	3,11		
from input, kg:	30	to, kg:	113

Composition:	% of kg	Avail
barley - onfarm	20	88336
BARLEY, winter, 2016	20	0
WHEAT, 2016	22,1	0
oats - on farm	5	26584
SOYBEAN MEAL, husked, toasted	20	0
BEANS, avg 2012, 2014, 2016	10	0
Std. mixture, 30-105 kg, SLAUGHTER PIGS	2,9	0
		0
		0
		0
		0
		0
		0
		0
		0
	100	

from, kg:	113	to, kg:	109

from, kg:	113	to, kg:	113

0,2	
365	

Composition:	% of kg	Avail
grass-clover silage - on farm	40	36296
GRASS SILAGE 1ST CUT	60	0
		0
		0
		0
	100	

HOUSING

Stable/Paddock

Lactating sows

Housing type (indoor/outdoor)	Outdoor - whole year
Housing, outdoor:	
paddock area for lactating sows, ha	6
paddock type	Paddock - grass clover
straw, kg per farrowing	50
straw type	STRAW, barley
Housing, indoor:	**Floor type:**
indoor area, type	Deep litter
outdoor area, type	Partly slatted floor with 25-49% solid
straw, kg per farrowing	
straw type	
manure delivered to biogas plants, %	
slurry, acidified in stable, %	
solid manure/deep litter, directly applied to fields, %	0

Solid floor
Partly slatted floor with 50-75% solid floor
Partly slatted floor with 25-49% solid floor
50 % solid floor, 50 % Slatted floor
50 % solid floor, 50% Slatted floor + hoppers
Drained floor + slots (33/67)
.....
.....

Gestating sows

Piglets

Slaughter pigs

RESULTS – N BALANCE

Intermediary results:

-herd flow;

-use of feed at farm level, etc.

Environmental impact:

-N balance

-Environmental impact

Farm

Farm				Total per farm	per ha
N input	Feed	bought-in	kg N	24506	291,74
	Seed		kg N	119,4	1,4
	Fixation		kg N	1929	23,0
	Deposition		kg N	1176	14,0
Total N input			kg N	27731	330,1
N output	Crops	sold	kg N	2348	28,0
	Manure	sold	kg N	0	0,0
	Animals	liveweight	kg N	9982	118,8
Total N output			kg N	12329	146,8
N losses	NH_3	manure + crop resic	kg N	1603	19,1
	direct N_2O-N	manure + crop resic	kg N	370	4,4
	Nox-N	manure + crop resic	kg N	55	0,7
	N_2-N	manure + crop resic	kg N	879	10,5
	soil C changes	manure + crop resic	kg N	-1404	-16,7
	trees uptake		kg N	0	0,0
Potential N leaching			**kg N**	**13898**	**165,4**

RESULTS – ENVIRONMENTAL IMPACT

Impact categories:

Global warming potential (GWP) (+ soil C change; iLUC): kg CO_2 eq.

Eutrophication potential (EP): g NO_3 eq.

Acidification potential (AP): g SO_2 eq.

Non-renewable energy use (NRE): MJ

Land use (LU): m^2

Contributors:

Piglet production

Feed production

Bedding materials

Energy use

Manure emissions: CH_4, N_2O, NH_3

SLAUGHTER PIGS

SLAUGHTER PIGS		Environmental impact						
INPUT	Amount	GWP, kg CO2-eq	soil C change, kg	iLUC, kg CO2-eq	EP, kg NO3-eq	NRE, MJ	AP, kg SO2-eq.	LU, m2
Piglets, p.	2211	205471	42785	127811	14661	1444776	1604	889531
Feed , kg DM	469398	205120	59091	174768	26067	1859017	2637	1214646
Bedding materials, kg	84353	5146	1012	3121	422	25306	34	21932
Energy use, kWh	35542	19939	19939	19939	228	282737	15354	0
TOTAL INPUT		435676	122828	325639	41378	3611836	19628	2126108
TRANSPORT, tkm	24671	6266			84	89308	47	0
EMISSIONS								
Enteric fermentation, kg CH4	637	16247						
CH4 manure, kg CH4	6971	177756						
N emission stable and storage								
N2O, kg	35	9218						
NH3, kg	1213				4417		2281	
Nox, kg	15				21		16	
Substitution of mineral fertilisers		*-66356*			*-4009*	*-386932*	*34*	
TOTAL EMISSIONS		136866	0	0	428	-386932	2332	0
TOTAL		578808	122828	325639	41890	3314212	22007	2126108
OUTPUT	Amount							
slaughter pigs, p.	2112							
slaughter pigs, kg LW	238020							
TOTAL OUTPUT, kg LW	238020							
Impact per slaughter pig		274,1	58,2	154,2	19,8	1569,2	10,4	1006,7
Impact per kg LW slaughter pig		2,43	0,52	1,37	0,18	13,92	0,09	8,93

Scenarios for innovations
-examples on the use of the model

ENVIRONMENTAL IMPACT PER KG LIVEWEIGHT PIG IN REFERENCE SYSTEM

Reference system:

- Sows outdoor whole year;
- Weaning age : 7 weeks;
- No phase feeding.

Contributors	Climate change, kg CO2 eq.	Eutrophication, g NO3 eq.	Acidification, g SO2 eq.	LU, m2
Piglets	0.5	56	5.1	1.8
Feed (incl. transport) + bedding materials	1.18	143	13.9	6.1
Energy use	0.08	1	64.3	
CH4, enteric fermentation	0.08			
CH4, N2O, NH3 manure (stable & storage)	0.5		9.4	
Total	2.35	200	93	7.9

PROLONGED LACTATION

- In DK the weaning age is normally 7 weeks (EU 6 weeks)
  - Problems with diarrhea at weaning
  - Under semi-natural condition the weaning age is between 9-22 weeks
- Prolonged lactation, how will it influence on the environment?
- Case for the estimation of the environmental impact

	Sow unit			Weaner unit		Slaughter unit			Feed FU per day		FU per kg gain	
Case	Weaning age, days	Weight at weaning, kg	Litters per year sow	Daily gain, g	mortality	Weight in, kg	Daily gain, g	mortality	Lactation sow	Piglet at sow	Wean piglets	Slaughter piglets
7 week	54	14	1,92	802	3%	24	871	3%	11.5	0.100	2.3	3.00
10 week	70	26	1,87	-	-	26	933	4%	13.0	0.357	-	2.83

Newberry & Wood-Gush, 1985, Jensen & Stangel, 1992

OPTIMISATION OF FEEDING STRATEGY

Phase feeding:

Several feed mixtures during the growing period

- better control the pig's current nutrient needs for a specified period and / or to allow for alternative feedstuffs combinations at different periods
- Reduced excretion of nitrogen and phosphorus

Differences in relation to standard

Specifications	Reference		Improved feeding					
Feeding strategy	Feed mixture 1, kg	CP, %	Feed mixture 1, kg	CP, %	Feed mixture 2, kg	CP, %	Total feed, kg	CP, %
Weaners 14-24 kg	22.9	20.6	13	20.6	10.1	20.4	23.1	20.5
Sl. Pigs 24-115 kg	307	20.4	89	20.4	214	18,7	303	19.2

**CP = crude protein*

RESULTS

Specification	Reference	Prolonged lactation	Improved feeding
Characteristics	Sows outdoor whole year	Sows outdoor whole year	Sows outdoor whole year
	Weaning age: 7 weeks	Weaning age: 10 weeks	Weaning age: 7 weeks
	No phase feeding	No phase feeding	Phase feeding
Environmental impact:			
Climate change, kg CO2 eq. per kg LW	2.35	2.19	2.35
Eutrophication potential, g NO3 eq. per kg LW	200	169	193
(N leaching, kg NO3 per ha)	133	120	121
Acidification potential, g SO2 eq. per LW	93	**91**	**91**
Land Use (LU), m2 per kg LW	7.96	7.64	7.94

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