A stochastic animal life cycle simulation model for RuFaS

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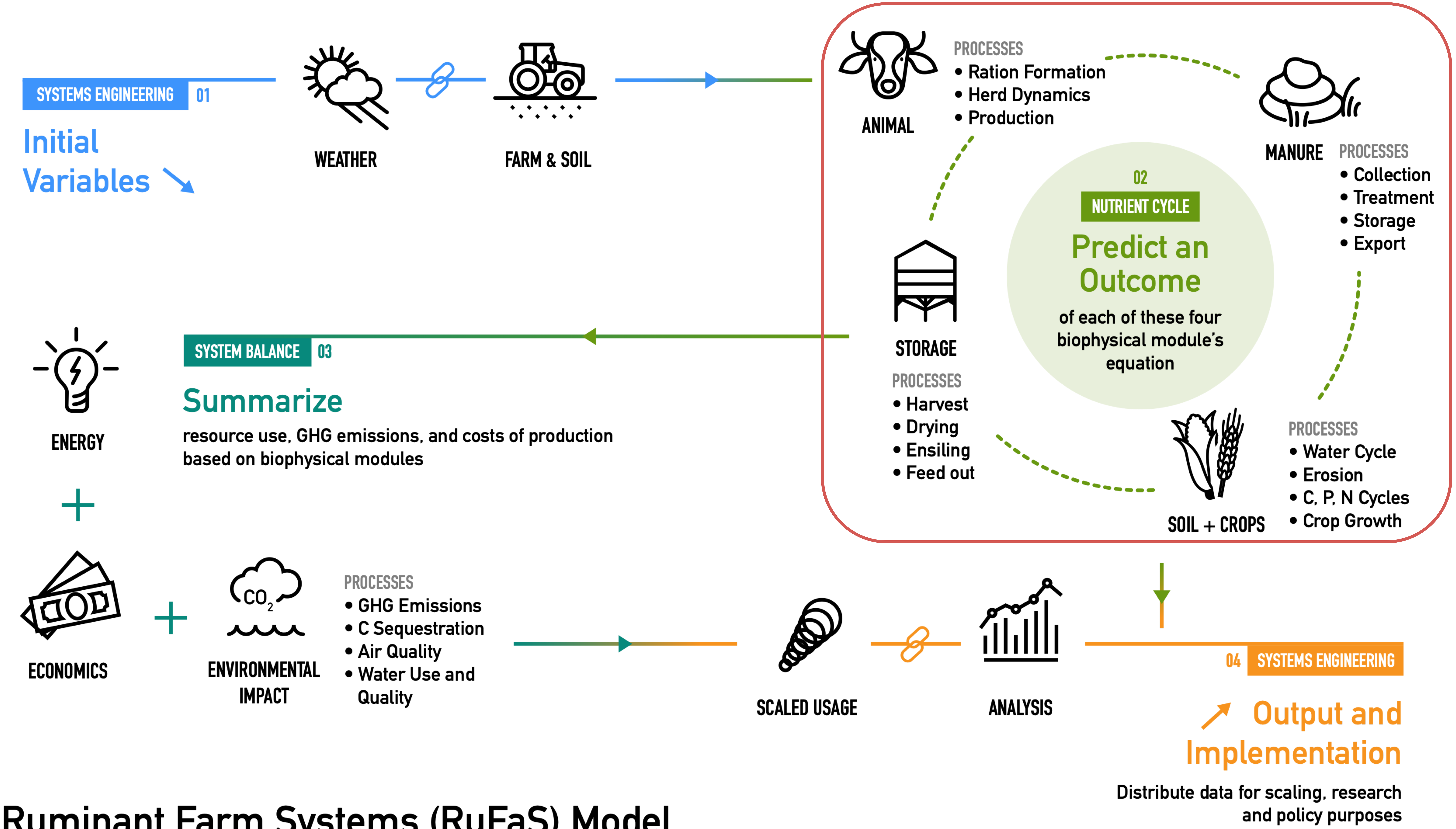
May 10th, 2022

Ruminant Farm System (RuFaS) Model



Ruminant Farm Systems (RuFaS) Model

RuFaS Nutrient Cycle

ANIMAL

PROCESSES
- Ration Formation
- Herd Dynamics
- Production

MANURE

PROCESSES
- Collection
- Treatment
- Storage
- Export

02

NUTRIENT CYCLE

Predict an Outcome

of each of these four biophysical module's equation

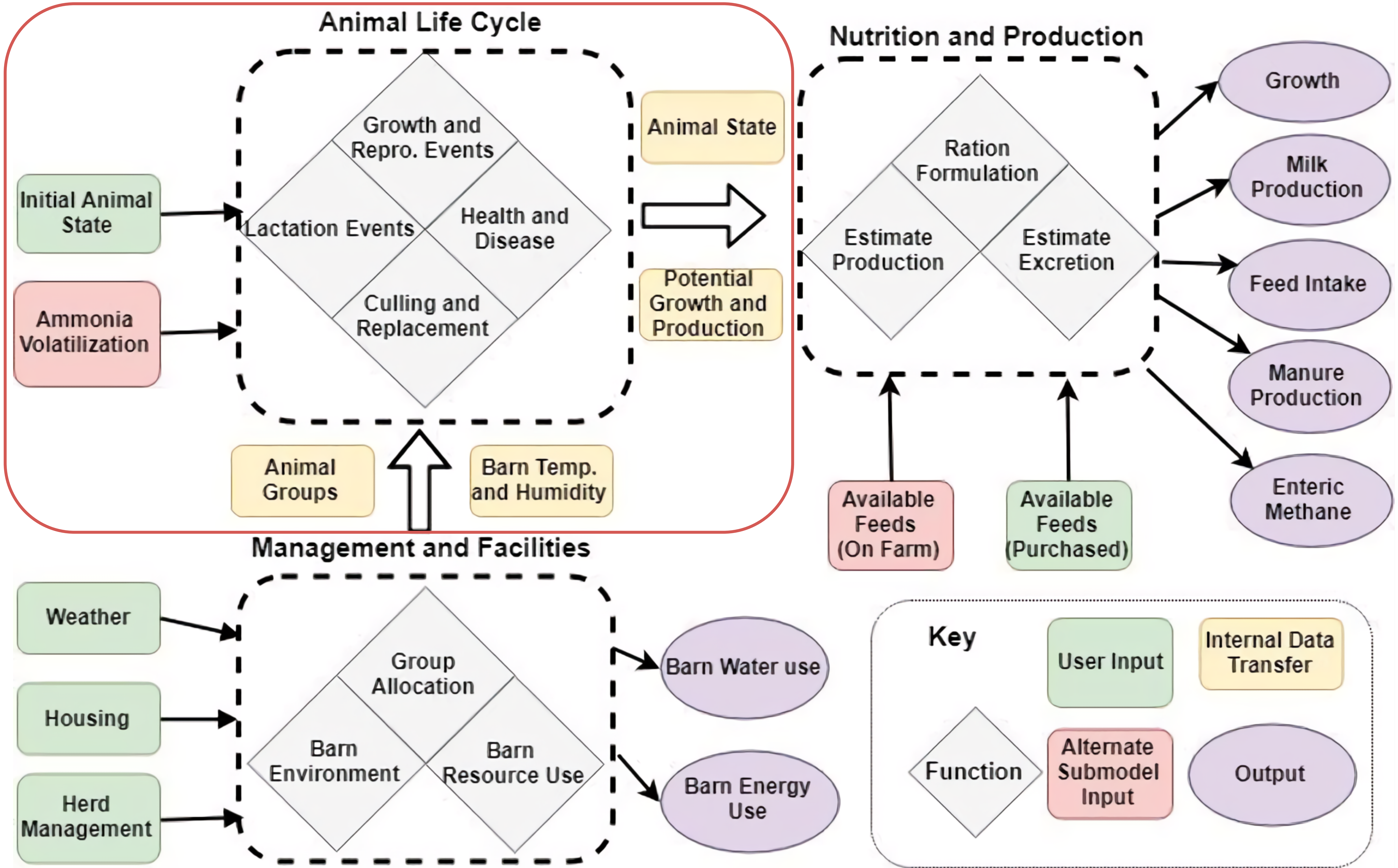
STORAGE

PROCESSES
- Harvest
- Drying
- Ensiling
- Feed out

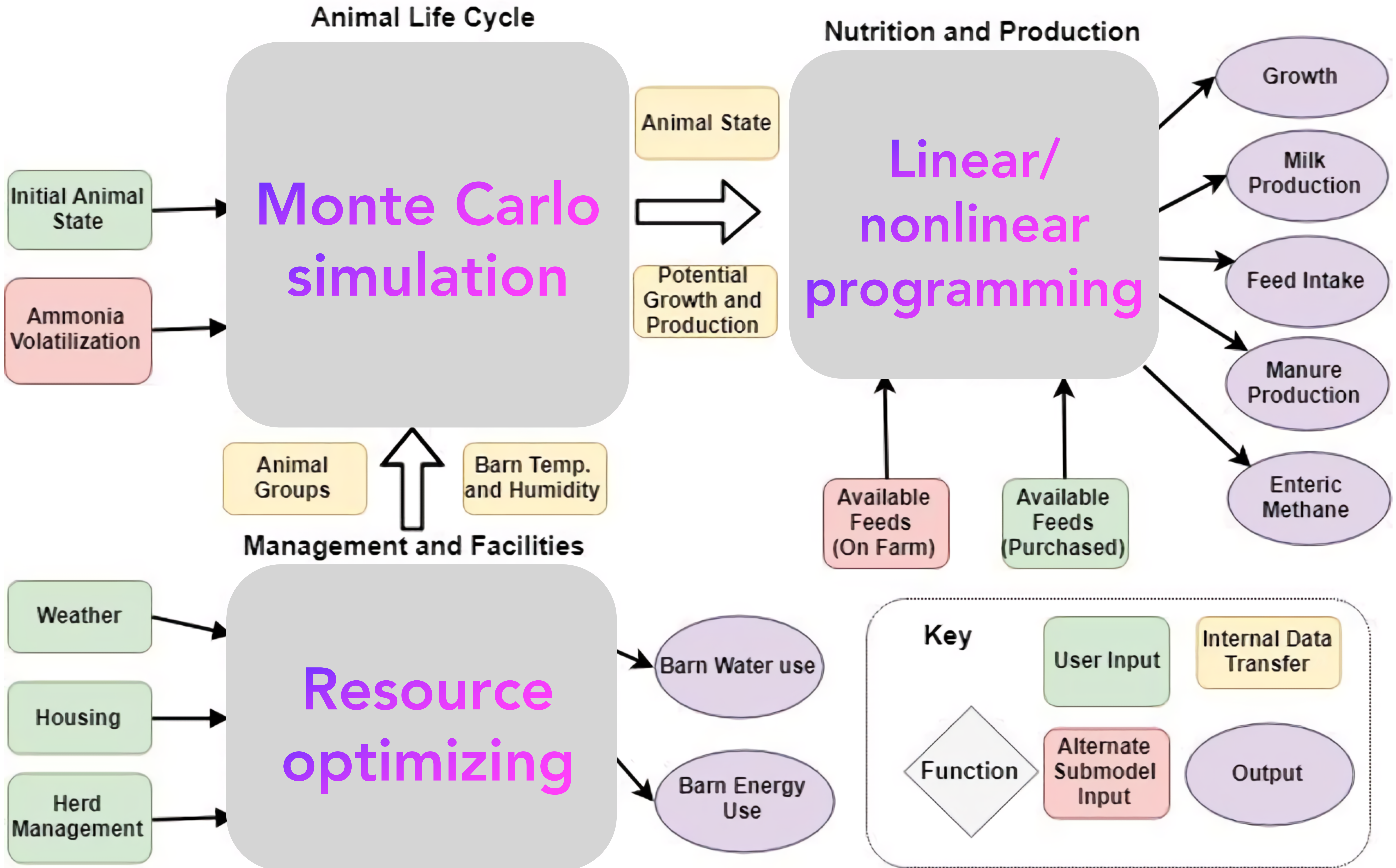
SOIL + CROPS

PROCESSES
- Water Cycle
- Erosion
- C, P, N Cycles
- Crop Growth

RuFaS Animal module



RuFaS Animal module



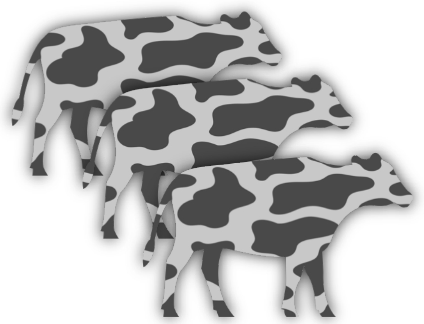
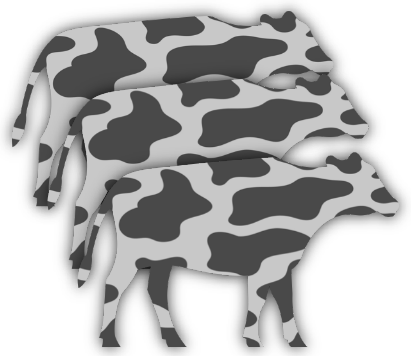
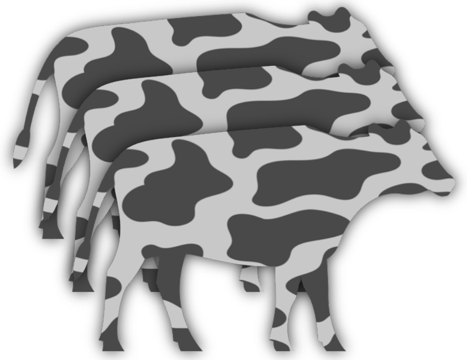
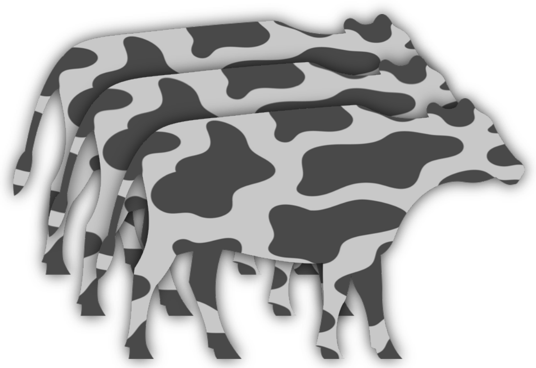
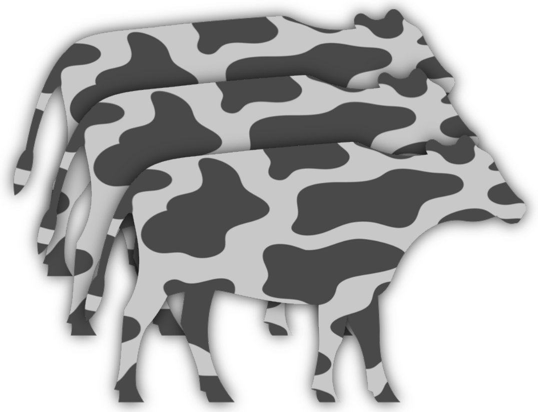
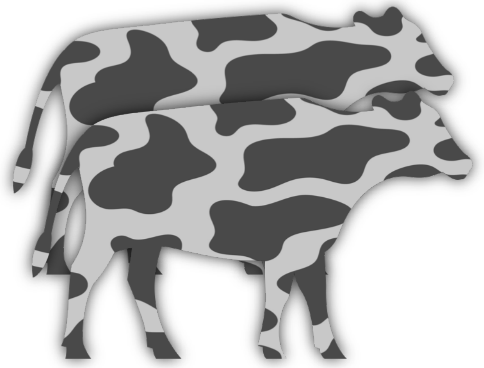
Animal life cycle submodel

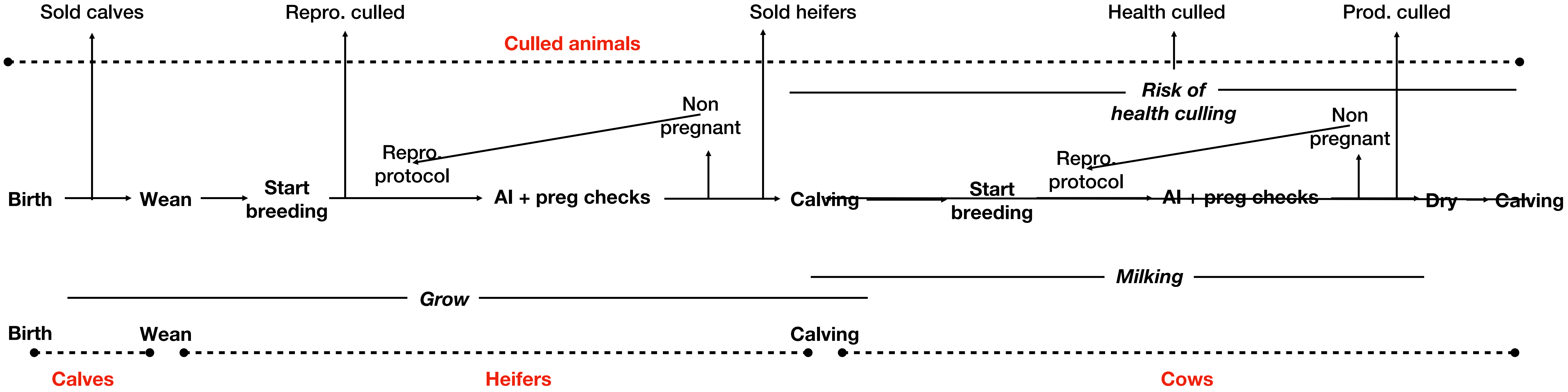
Monte Carlo simulation

- Monte Carlo method refers to any method that makes use of random numbers
- Monte Carlo simulation process methods
  - Compare a random draw from the uniform distribution U(0,1) to the probability of an event occurring
  - Select a random draw from a known distribution of animal attributes and assign the value to the instantiation of an individual animal
- Iterations are need for the Monte Carlo simulation to obtain output distributions

Animal life cycle sub-model

Individual animal life story

Calves	Heifers I	Heifers II	Heifers III	Cow	Culled
					
Birth - wean	Wean - breed	Breed - replacement	Close to calving	Start lactating	After culling
0 - 60	60 - 400	400 - replacement	to 1st calving	Calved - cull	Culled - sell



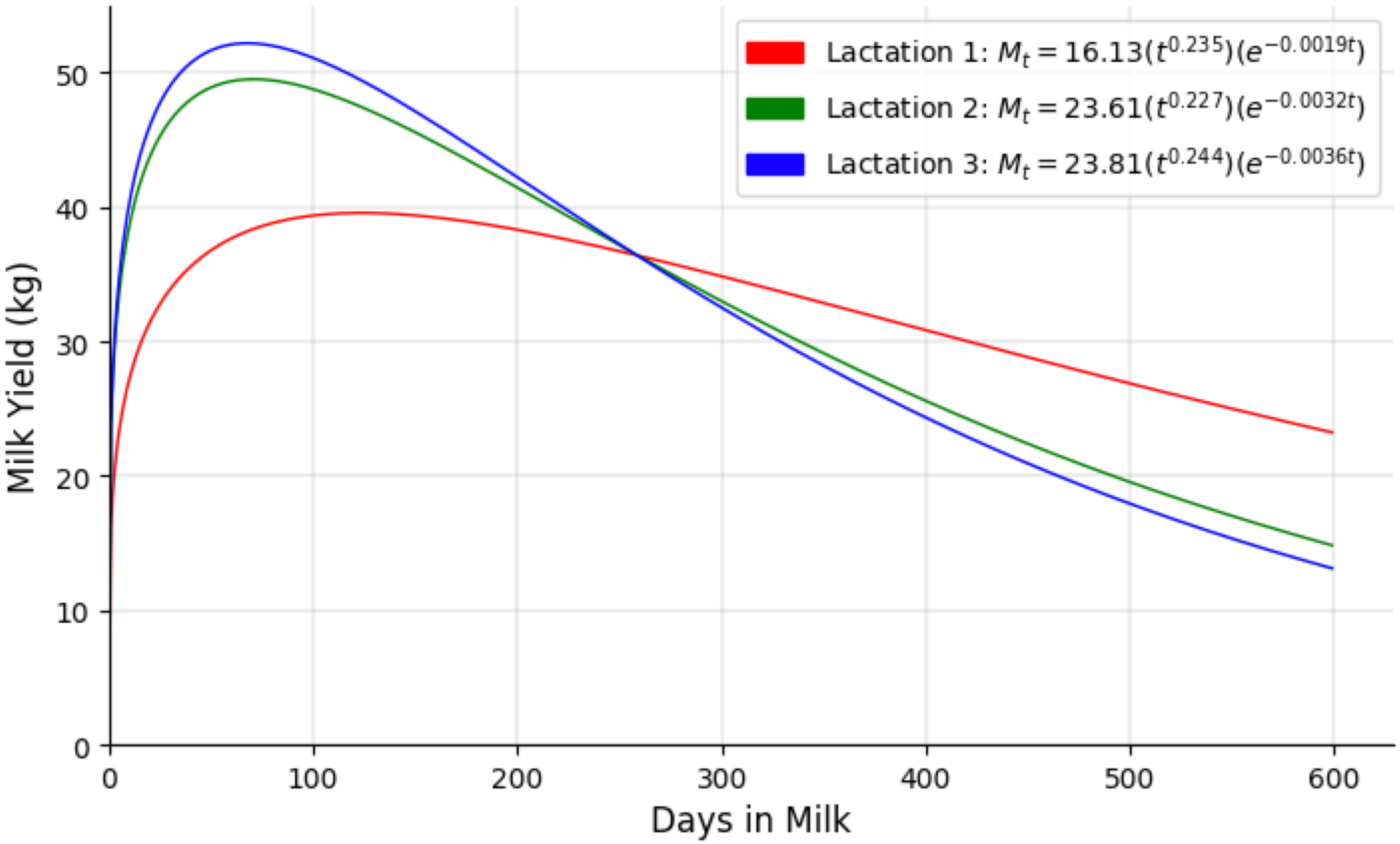
Animal life cycle sub-model

Components of simulation

- Lactation curve
- Reproduction programs
- Culling events
- Bodyweight change

Animal life cycle sub-model

Lactation curve



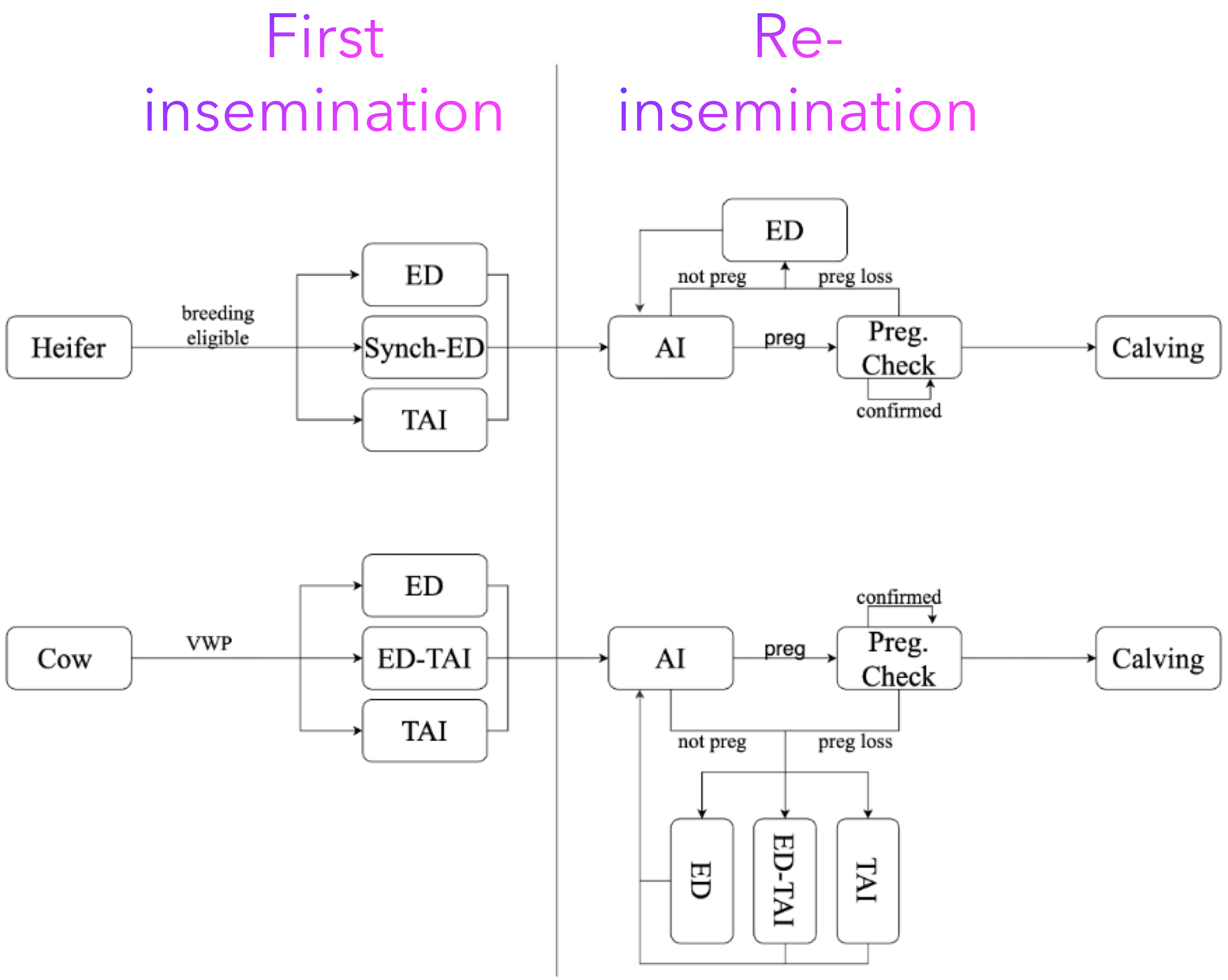
Wood's lactation curve model:

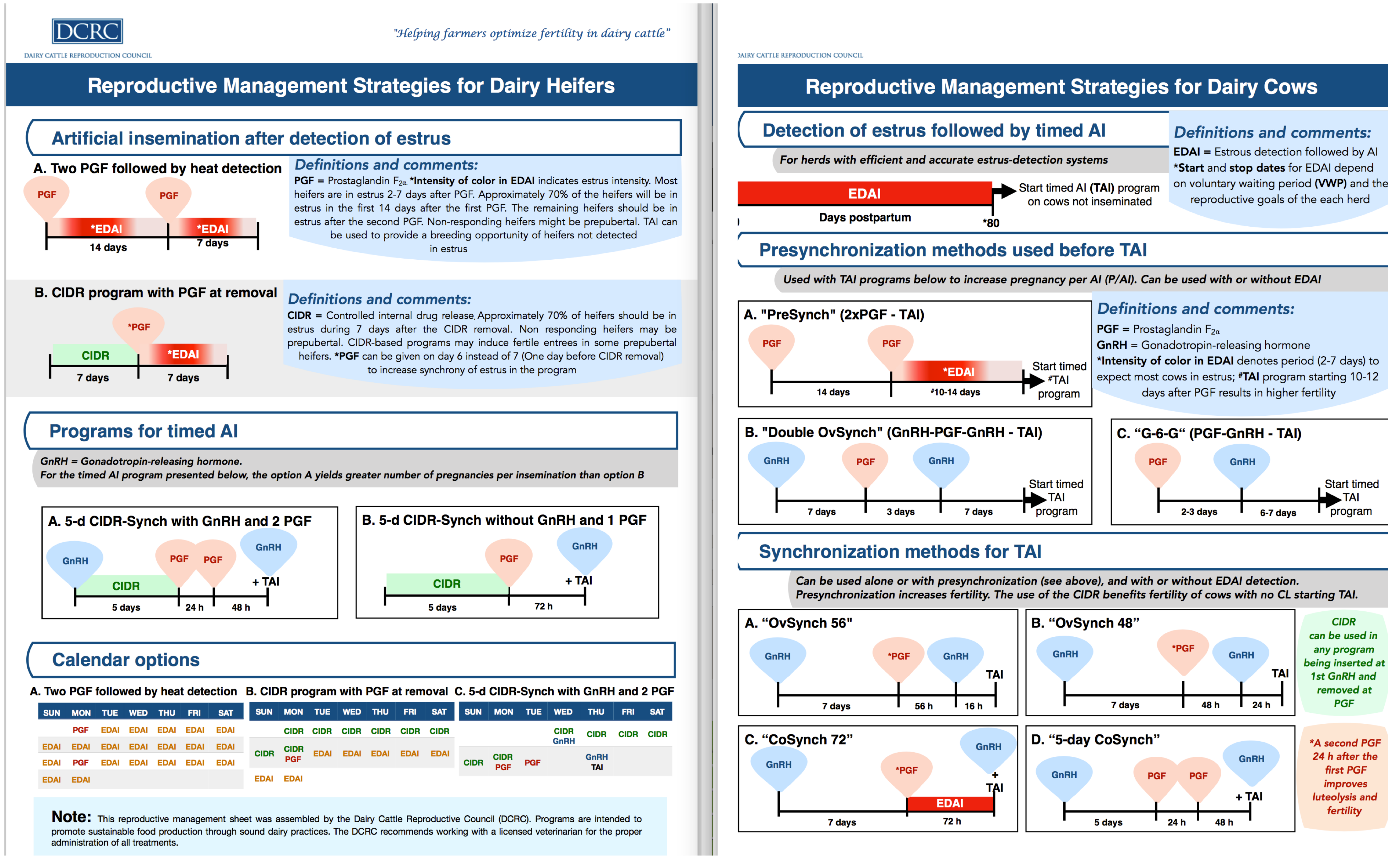
$$y = at^b e^{-ct}$$

Wisconsin, Holstein, 2016

Animal life cycle sub-model

Reproductive programs





Dairy Cattle Reproduction Council, 2018

Animal life cycle sub-model

Culling events

- **3 culling types: reproductive, health, and death**
  - **Reproductive**
    - Heifers: happens when non-pregnant heifer reaches to user-defined culling age
    - Cows: happens when milk production drop below user-defined benchmark for marked ‘do-not-breed’ cows

Animal life cycle sub-model

Culling events

- **Health** (adopt from Kalantari et al., 2016)
  - lameness, injury, mastitis, udder problems, other diseases, or unknown causes
  - Random 1 ~ U(0,1) compare with parity specific thresholds - determine whether to cull in this parity

	Parity 1	Parity 2	Parity 3	Parity > 3
Threshold	16.9%	23.3%	30.1%	40.8%

  - Random 2 ~ U(0,1) compare with reverse distribution - determine which reason for this animal to be culled in this parity

Lameness	Injury	Mastitis	Udder	Unknown	Others
0 – 0.16	0.16 – 0.45	0.45 – 0.69	0.69 – 0.83	0.83 – 0.90	0.90 – 1

  - Random 3 ~ U(0,1) compare with reverse distribution of lactation length- determine in which day of this culling will occur in this parity

days	0	5	15	45	90	135	180	225	270	330	380	430	480	530
Mastitis CDF	0	0.06	0.12	0.19	0.30	0.43	0.56	0.68	0.78	0.85	0.90	0.94	0.97	1
Lameness CDF	0	0.03	0.08	0.16	0.25	0.36	0.48	0.59	0.69	0.78	0.85	0.90	0.95	1
Injury CDF	0	0.08	0.18	0.28	0.38	0.47	0.56	0.64	0.71	0.78	0.85	0.90	0.95	1
Disease CDF	0	0.04	0.12	0.24	0.34	0.42	0.50	0.57	0.64	0.72	0.81	0.89	0.95	1
Udder CDF	0	0.12	0.24	0.33	0.41	0.48	0.55	0.62	0.68	0.76	0.82	0.89	0.95	1
Unknown CDF	0	0.05	0.11	0.18	0.27	0.37	0.45	0.54	0.62	0.70	0.77	0.84	0.92	1

- **Death**

	Parity 1	Parity 2	Parity 3	Parity > 3
Threshold	3.9%	5.6%	8.5%	11.7%

Animal life cycle sub-model

Bodyweight change

For calf:

$$calf\ ADG(kg/d) = \frac{birth\ weight * 2 - birth\ weight}{age\ at\ weaning - 0}$$

For heifer:

1. $$heifer\ ADG(kg/d) = \begin{cases} \frac{0.55 * MBW - BW}{target\ age\ at\ first\ pregnancy\ -\ days\ born} & \text{non-pregnant heifer} \\ \frac{0.82 * MBW - BW}{gestation\ length\ - DIP} & \text{pregnant heifer} \end{cases}$$

2. $$conceptus\ growth(kg/d) = \begin{cases} 0 & \text{if } DIP < 50 \\ 3 * conceptus\ parameter^3 * (DIP - 50)^2 & \text{if } DIP > 50 \\ -\ total\ conceptus\ weight & \text{if } DIP = gestation\ length \end{cases}$$

Where $total\ conceptus\ weight(kg) = (0.0148 * gestation\ length - 2.408) * calf\ birth\ weight$

$$conceptus\ parameter = \frac{total\ conceptus\ weight^{\frac{1}{3}}}{gestation\ length} - 50$$

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Animal life cycle sub-model

Bodyweight change

For cow:

1. $$cow\ ADG(kg/d) = \begin{cases} \frac{(0.92-0.82)*MBW}{average\ calving\ interval} & \text{if } parity = 1 \text{ and non-pregnant} \\ \frac{0.92*MBW-BW}{gestation\ length-DIP} & \text{if } parity = 1 \text{ and pregnant} \\ \frac{(1-0.92)*MBW}{average\ calving\ interval} & \text{if } parity = 2 \text{ and non-pregnant} \\ \frac{MBW-BW}{gestation\ length-DIP} & \text{if } parity = 2 \text{ and pregnant} \\ 0 & \text{else} \end{cases}$$

2. $$Lactation\ BW\ change(kg/d) = \begin{cases} -\frac{P_1}{P_2}*exp(1-\frac{DIM}{P_2}) + \frac{P_1}{P_2^2}*DIM*exp(1-\frac{DIM}{P_2}) & \text{Lactating cow} \\ \frac{P_1*\frac{DIM}{P_2}*exp(1-\frac{DIM\ when\ dry}{P_2})}{gestation\ length-DIP\ when\ dry} & \text{Dry cow} \end{cases}$$

3. *Conceptus growth (kg/d) — same as heifer*

Animal life cycle submodel

Herd simulation

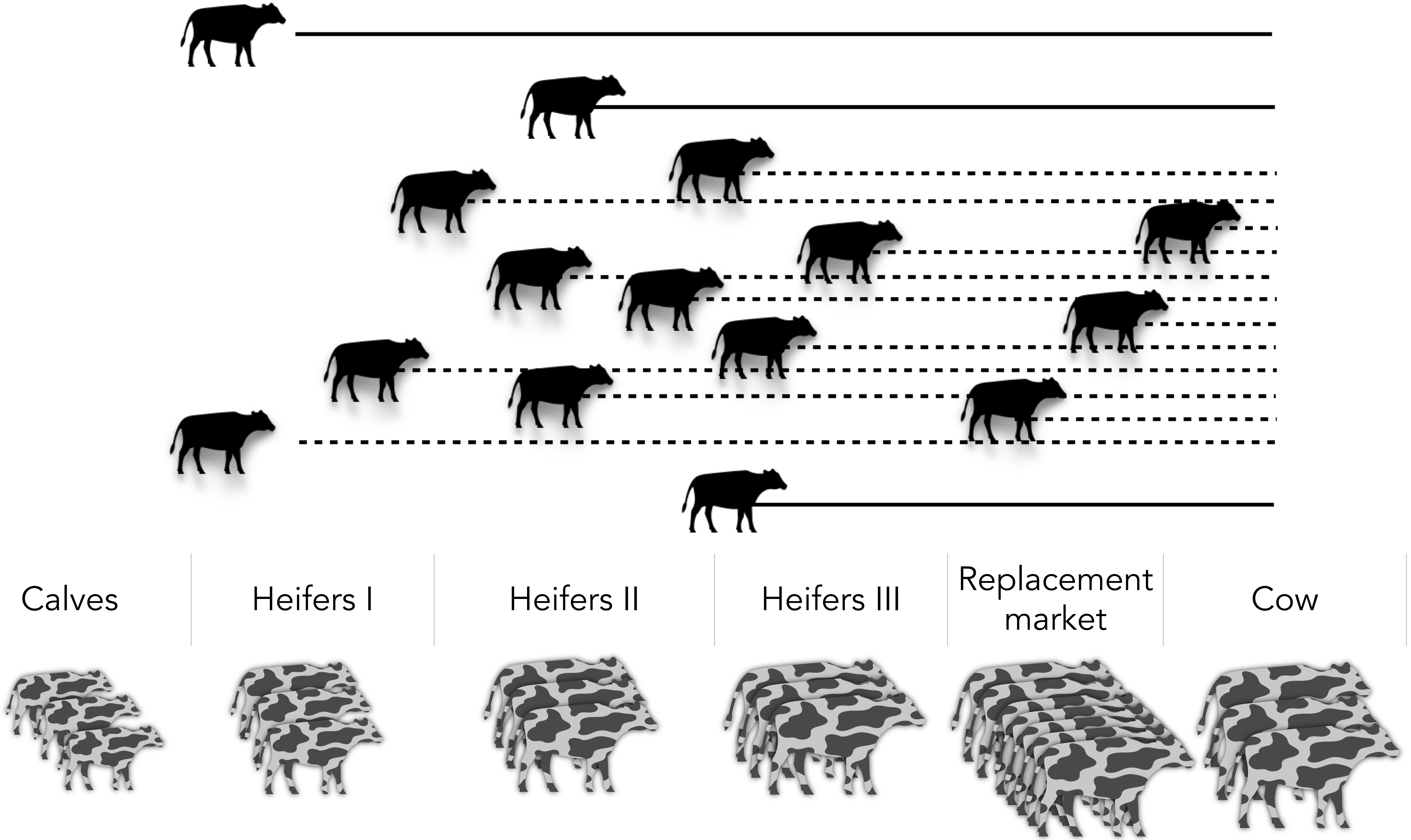
Animal life cycle submodel

Initial animal database

- Created through the regular simulation process
- Simulates a large number of animals
- The core status information and life history of each animal at the end of the simulation are stored in the database
- Goal: to reduce the time for the simulation to reach a steady-state by initializing the herd with animals of different ages, stages in pregnancy, DIM, and parities

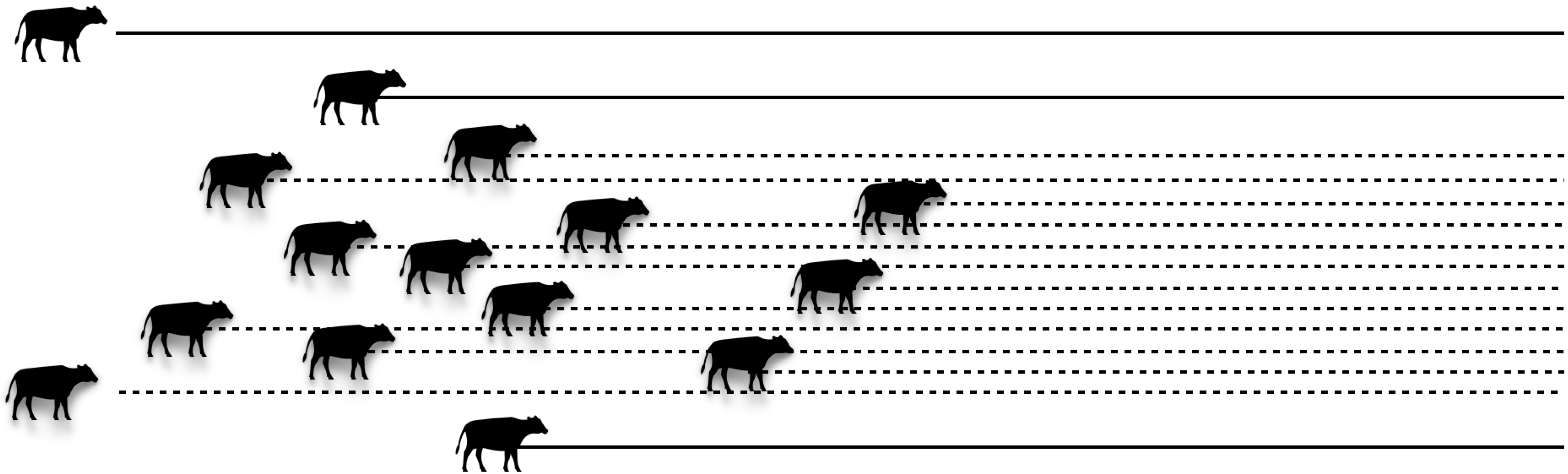
Animal life cycle submodel

Initial animal database



Animal life cycle submodel

Herd simulation with initial database



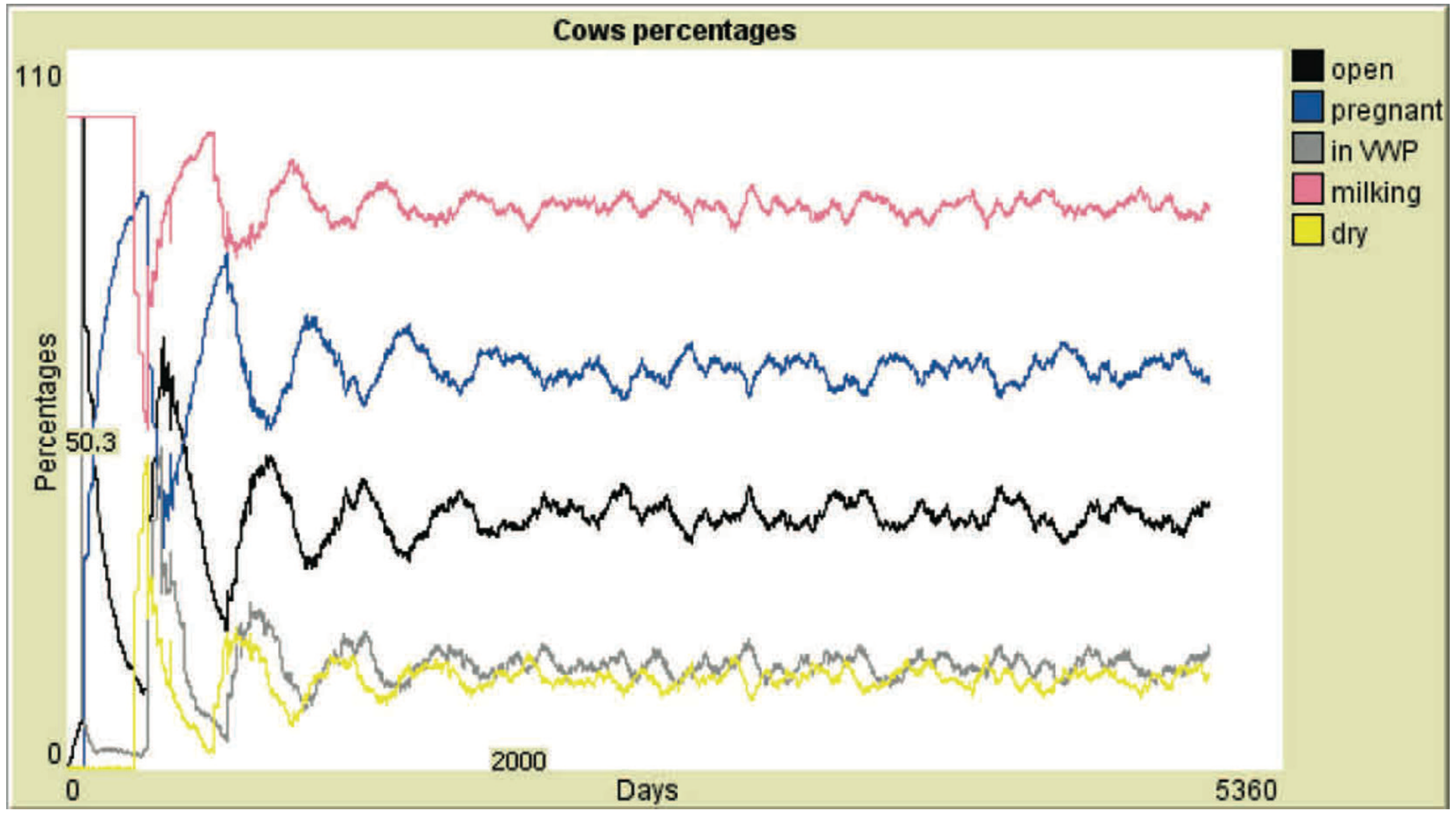
Animal life cycle submodel

Herd simulation steady state

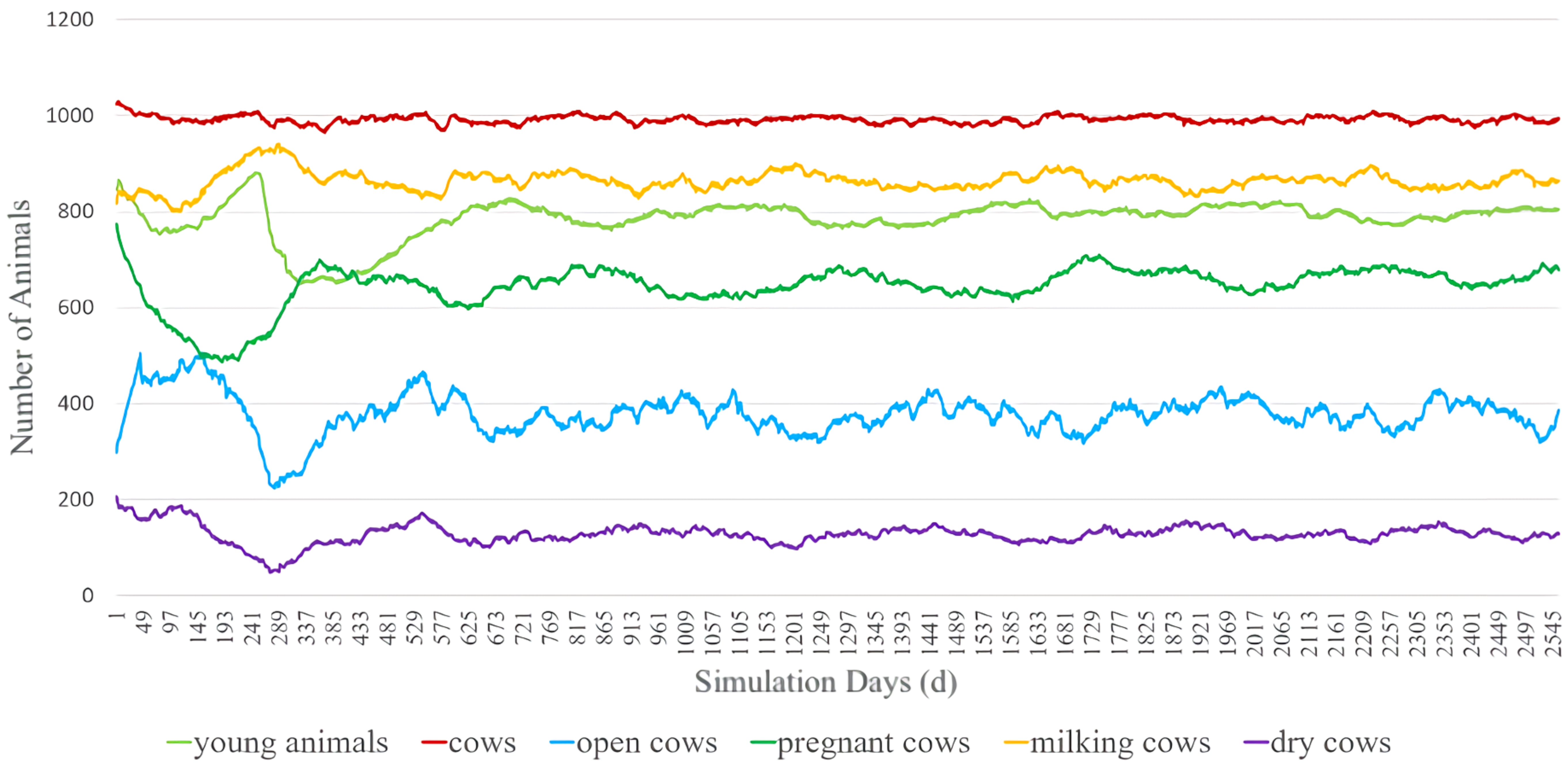
- Identify the time when a steady-state is reached with a limit on the coefficient of variation to be below 10% for 30 days for all the indicators
- We used cow age, 1st/2nd lactation cow percentage, milking cow percentage, pregnant cow percentage, and culling rate as indicators
- The date of reaching overall steady state is defined as the latest date for the last indicator reached steady state
- The Net Return (NR) is calculated for 365 d since overall steady state date

Animal life cycle submodel

Herd simulation steady state — 1000 adult cow herd



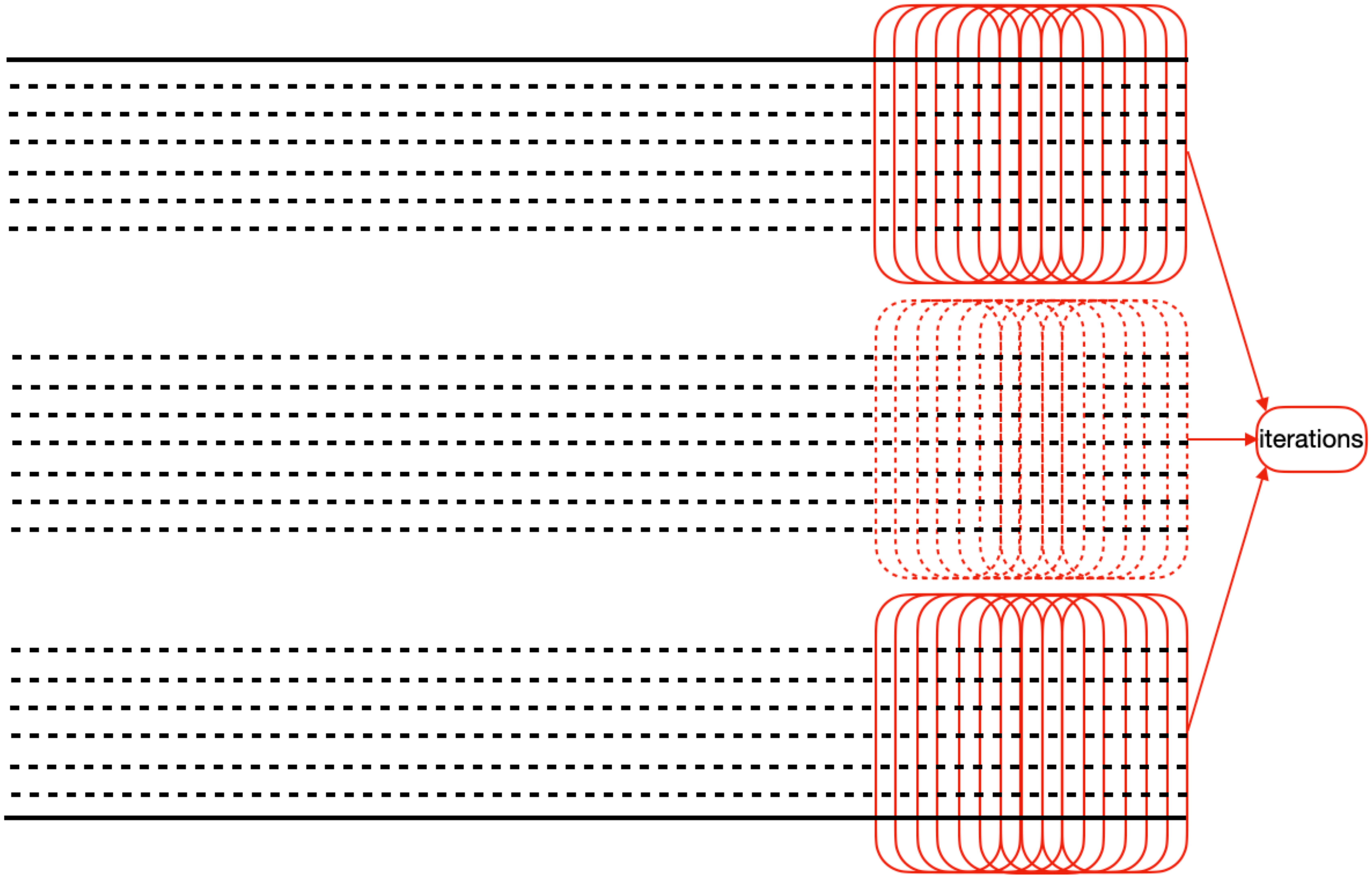
Steady state reached around 3000 d, Galvão et al., 2013



Steady state reached around 700 d, Example from RuFaS

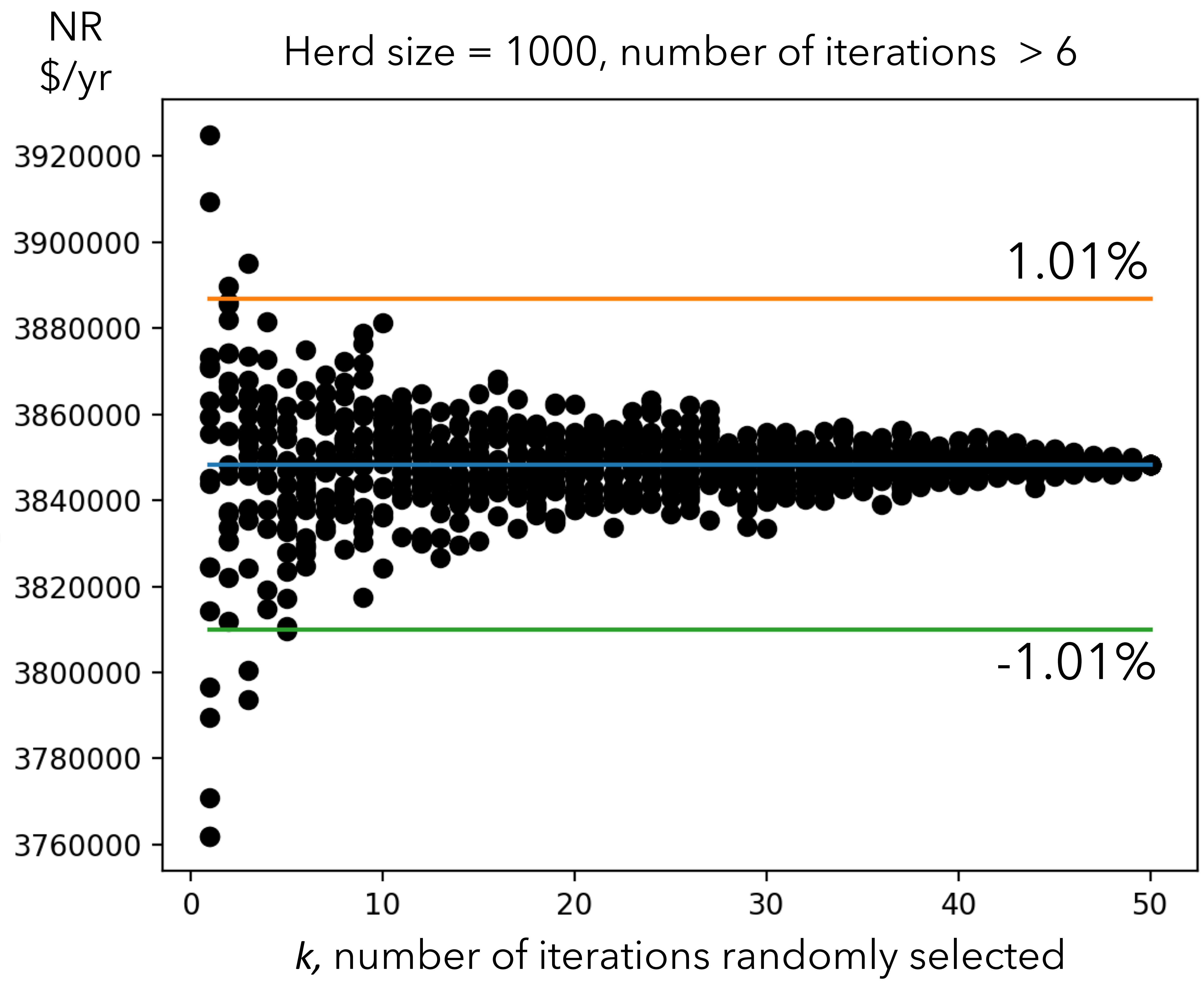
Animal life cycle submodel

Herd simulation iterations



Animal life cycle submodel

Herd simulation iterations



To determine the number of replications needed:

1. Calculate the NR for each of the 100 replications
2. Randomly select *k* values of the NR and take the average 20 times where *k* = 1-100
3. Plot the 20 average NR against the value of *k*
4. Plot Horizontal lines for the (i) overall average, (ii) +/- 1% of the overall average
5. The selected value for R is the smallest value of *k* when most of the NR points are within +/- 1% of the mean

Case study - combine cow and heifer repro programs

Objectives

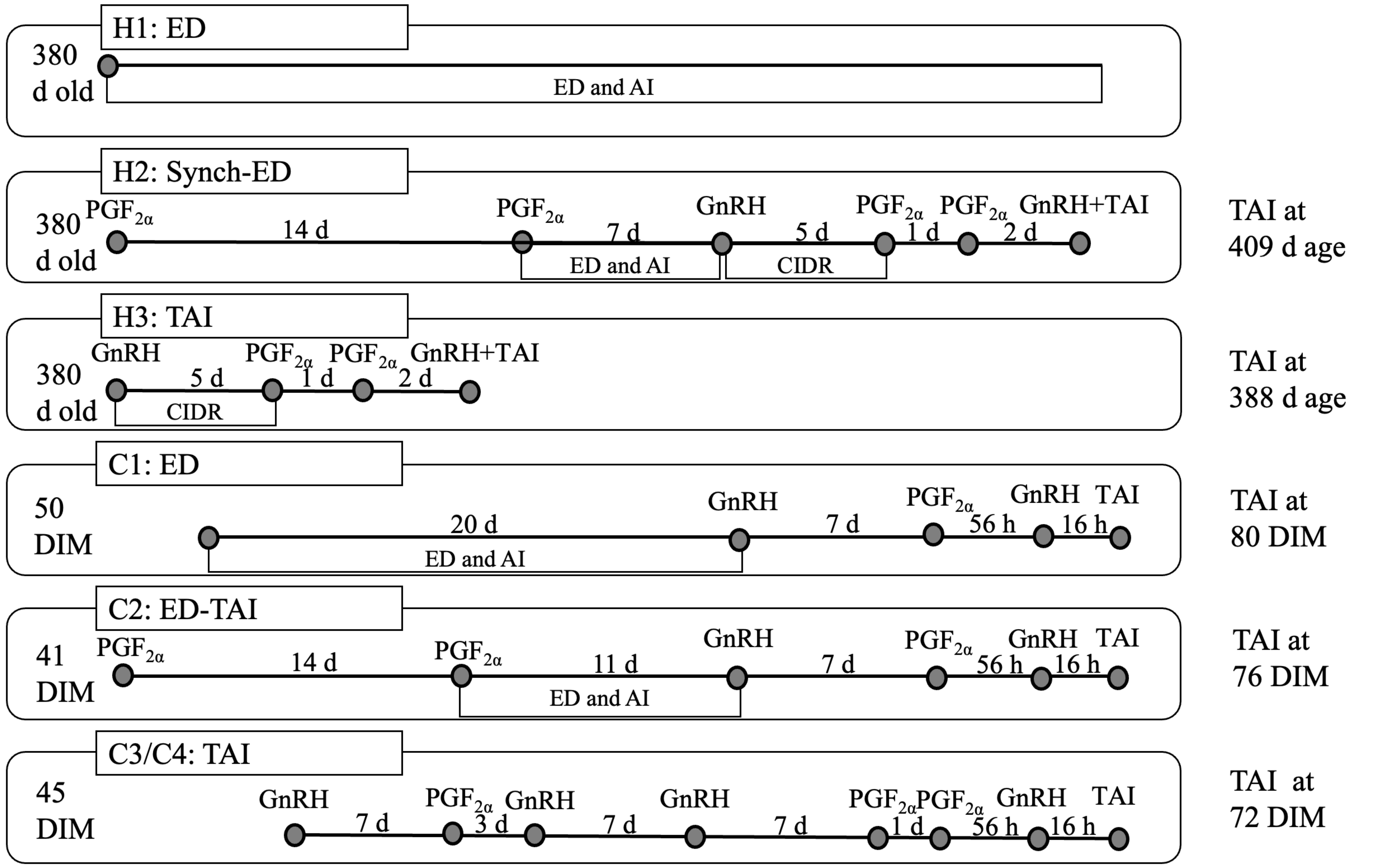
- We investigated how the interaction between different reproductive management programs with relatively similar overall reproductive performance affected herd performance and profitability
- We compared how re-inseminating cows after a Double-Ovsynch protocol using either Ovsynch or ED + Ovsynch influenced farm outcomes
  - ✦ 10 scenarios were compared that ranged from minimal to high hormonal manipulation for both heifers and lactating cows
  - ✦ All analyses were conducted with outputs from a simulated dairy herd of 1,000 adult cows and their corresponding calves and heifers.
  - ✦ Simulated 7 yrs for 30 iterations

Case study - combine cow and heifer repro programs

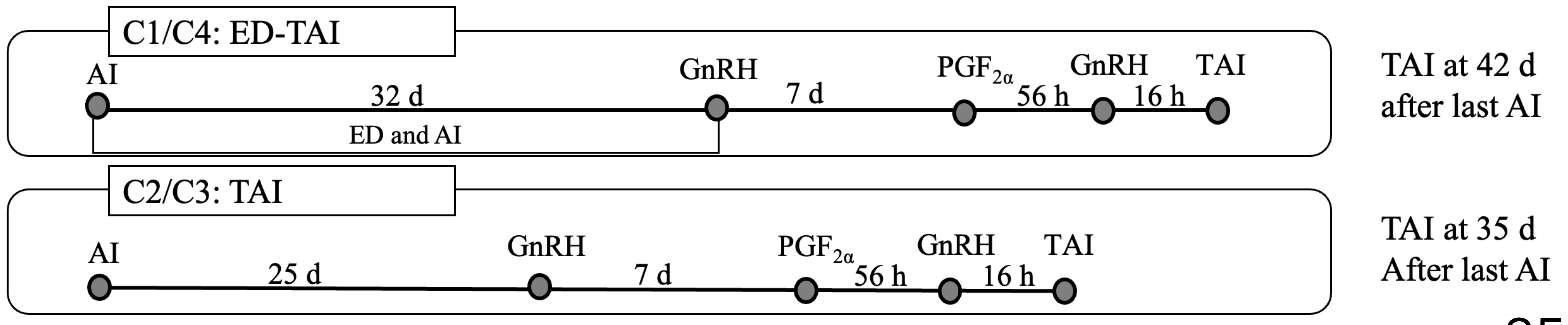
Reproductive programs settings

	Strategy	Program	Settings for simulations: SR[2] (%)	First insemination P/AI (%)	Re-inseminations, P/AI (%)	
			Heifer nulliparous			Start age (d)
H1	ED	ED	60	60	ED, 60	380
H2	Synch-ED	$PGF_{2\alpha}$- $PGF_{2\alpha}$ - finish with TAI	70	60		380
			100	50		
H3	TAI	GnRH-CIDR- $PGF_{2\alpha}$- $PGF_{2\alpha}$ - GnRH+TAI	100	60		380
			Cow primiparous[3]			VWP(DIM)
C1	ED	ED + Ovsynch	60	50	ED + Ovsynch, 45, 45	50
			100	40		
C2	ED-TAI	Synch-ED + Ovsynch	60	50	Ovsynch, 45	55
			100	50		
C3	TAI	Double-Ovsynch + $PGF_{2\alpha}$	100	60	Ovsynch, 45	72
C4	TAI-ED	Double-Ovsynch + $PGF_{2\alpha}$	100	60	ED + Ovsynch, 45, 45	72

First insemination



Re-insemination



Case study - combine cow and heifer repro programs

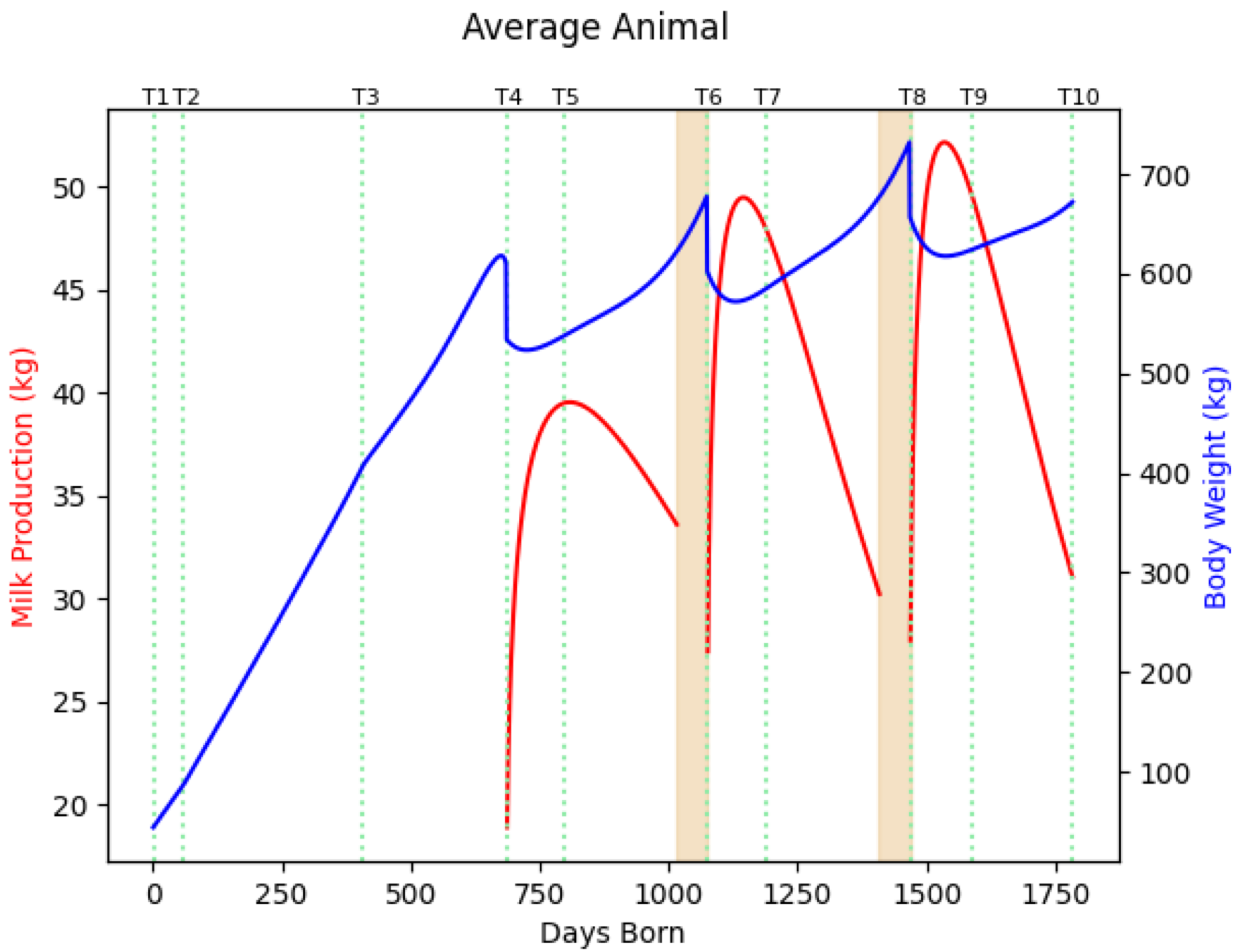
Economic settings for case study

Variables related to cost		Value	Unit
Feed	Calves	0.02	$/kg BW
	Heifers	0.0068	
	Lactating cow		
	Dry cow		
Hormone + labor	CIDR	12.27 + 0.26	$/treatment
	GnRH	1.6 + 0.23	
	PGF	2.06 + 0.23	
Heat watch	Labor	0.11	$/d
Semen	Conventional	15	$/straw
AI	Labor	10	$/AI
Pregnancy check	Labor	4.37	$/diagnosis
Replacement heifer	Purchase	1,500	$/head

Variables related to income		Value	Source
Calf	Male Holstein	50	$/ head
	Female Holstein	120	
Culled	Heifer	487	
	Cow	1.49	$/ kg liveweight
Milk		0.35	$/ kg

Repro case study — Results

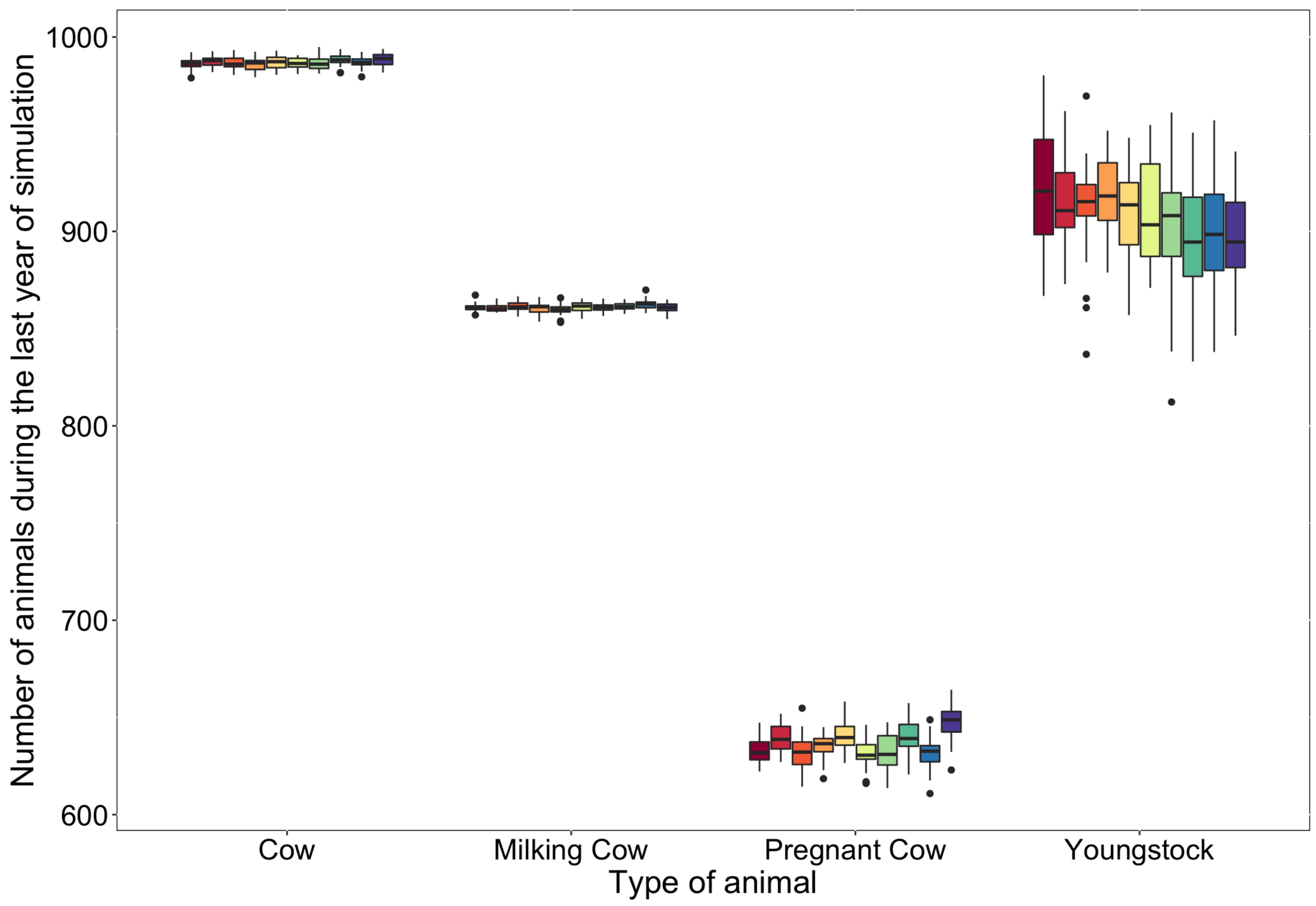
Average animal from the scenario H3-C3

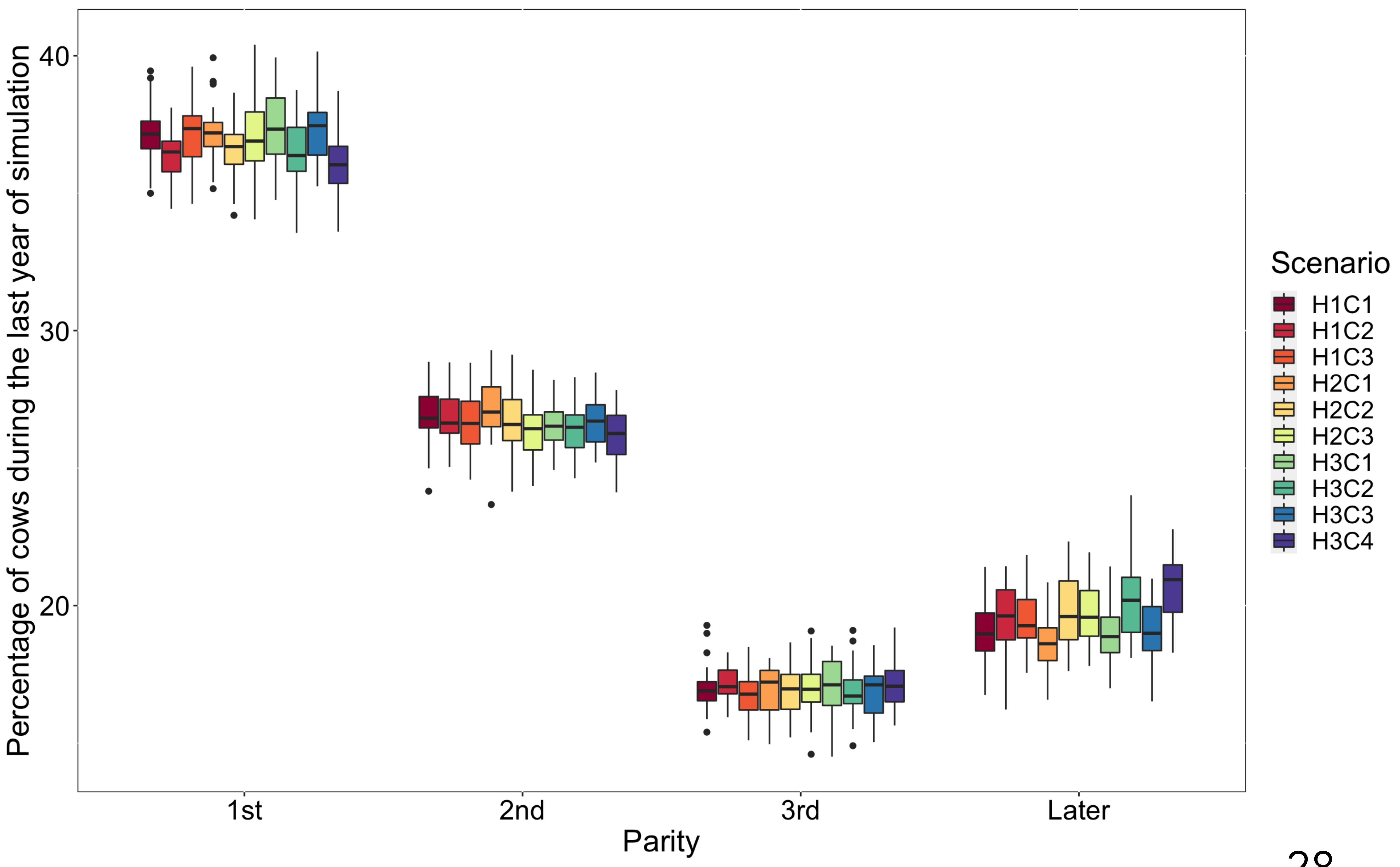


Time	Average age at
T1	Birth
T2	Wean
T3	Heifer pregnant
T4	1st Calving
T5	Cow pregnant
T6	2nd Calve
T7	Cow pregnant
T8	3rd Calve
T9	Cow pregnant
T10	Culled as a cow

Repro case study — Results

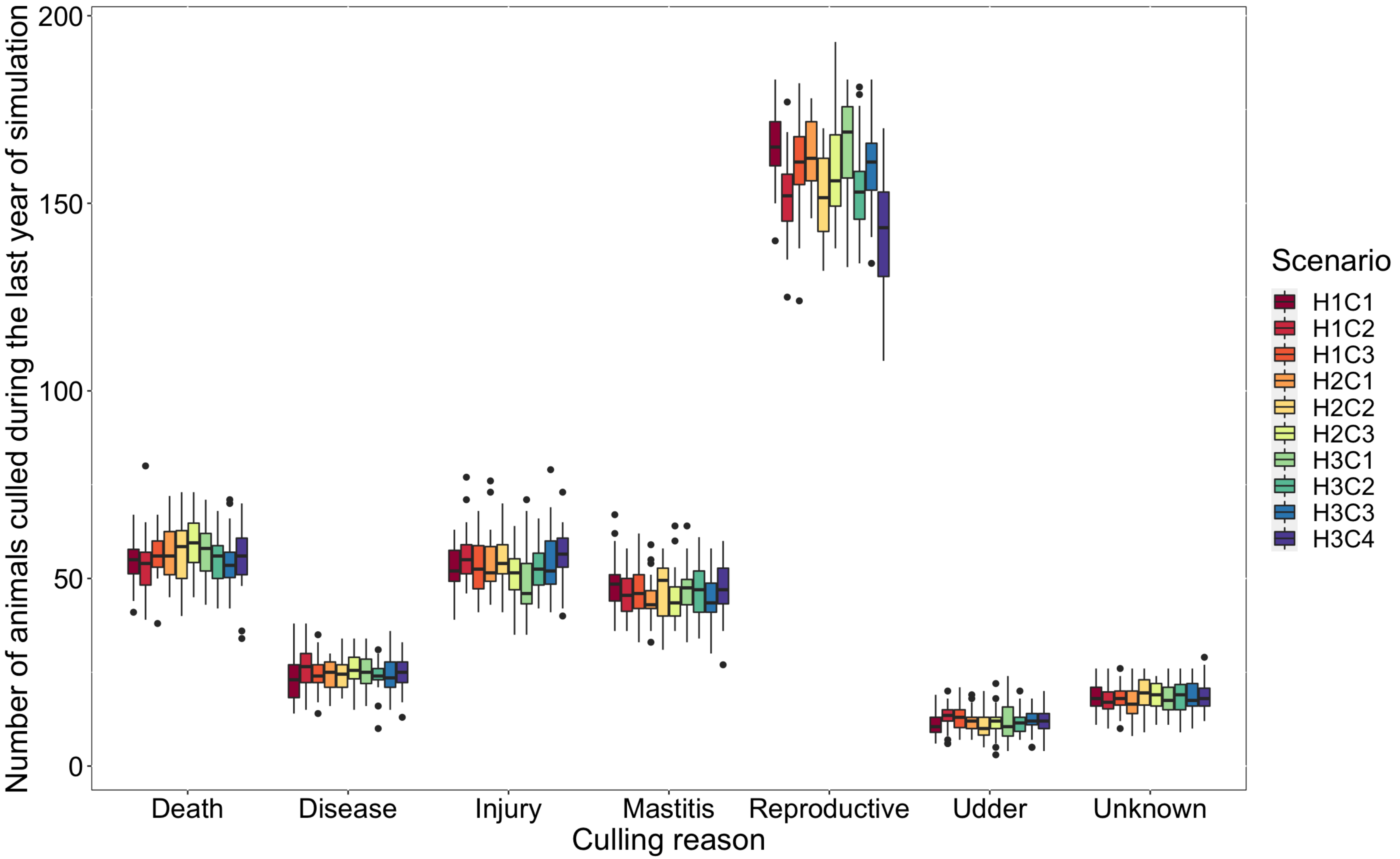
Box-and-whisker plot (median, first and third percentiles, range) of studied reproductive programs





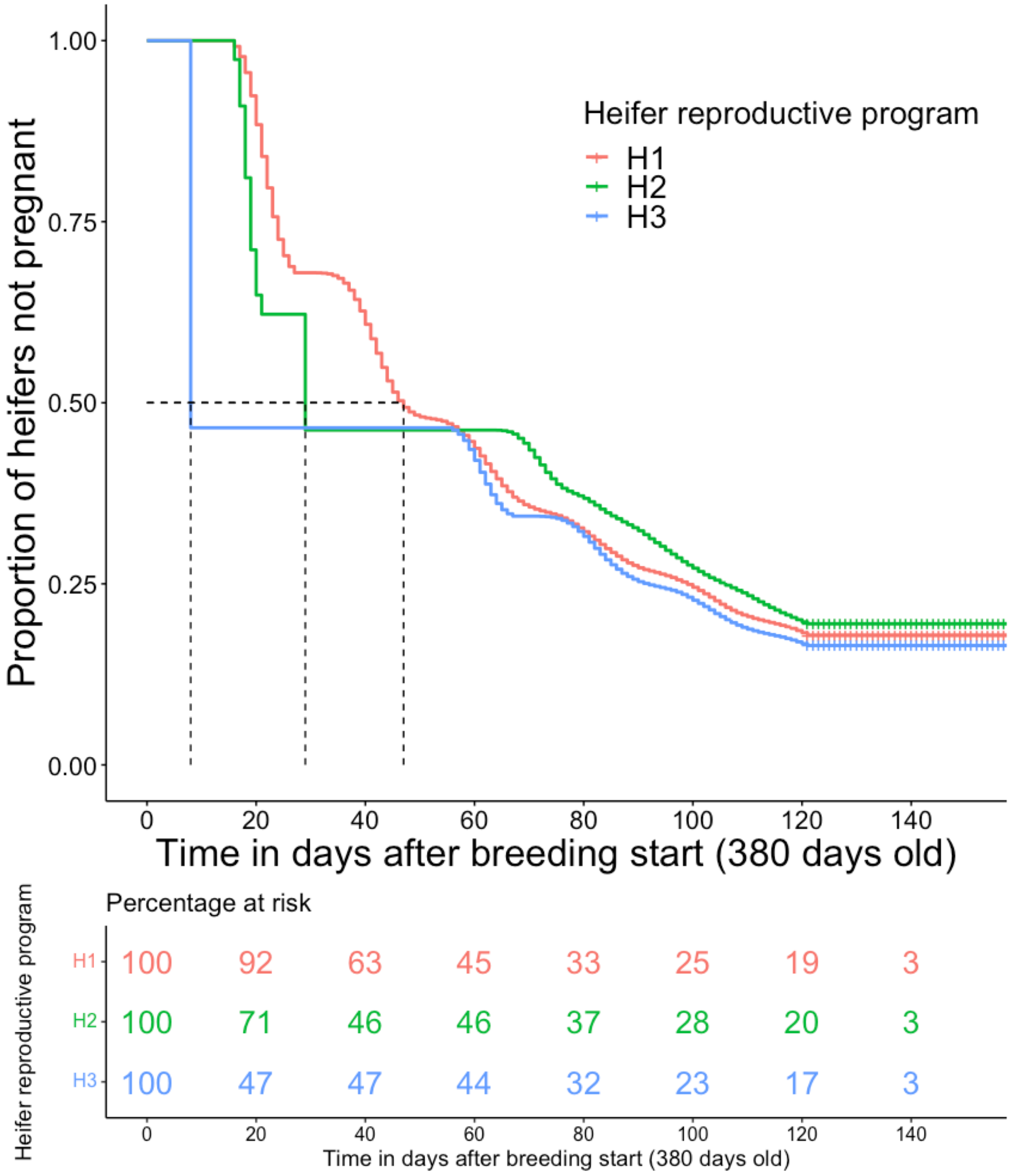
Repro case study — Results

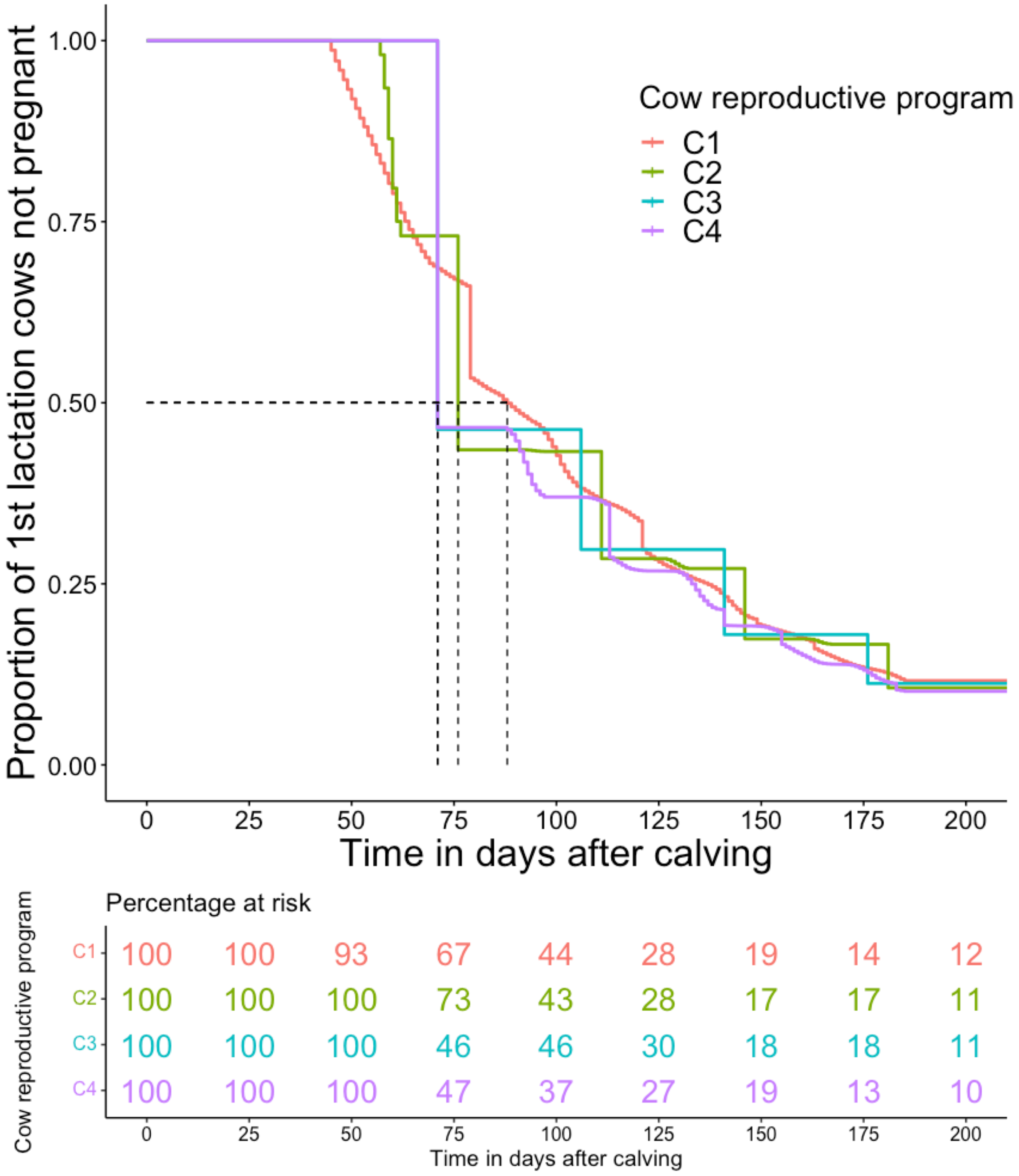
Box-and-whisker plot (median, first and third percentiles, range) of studied reproductive programs

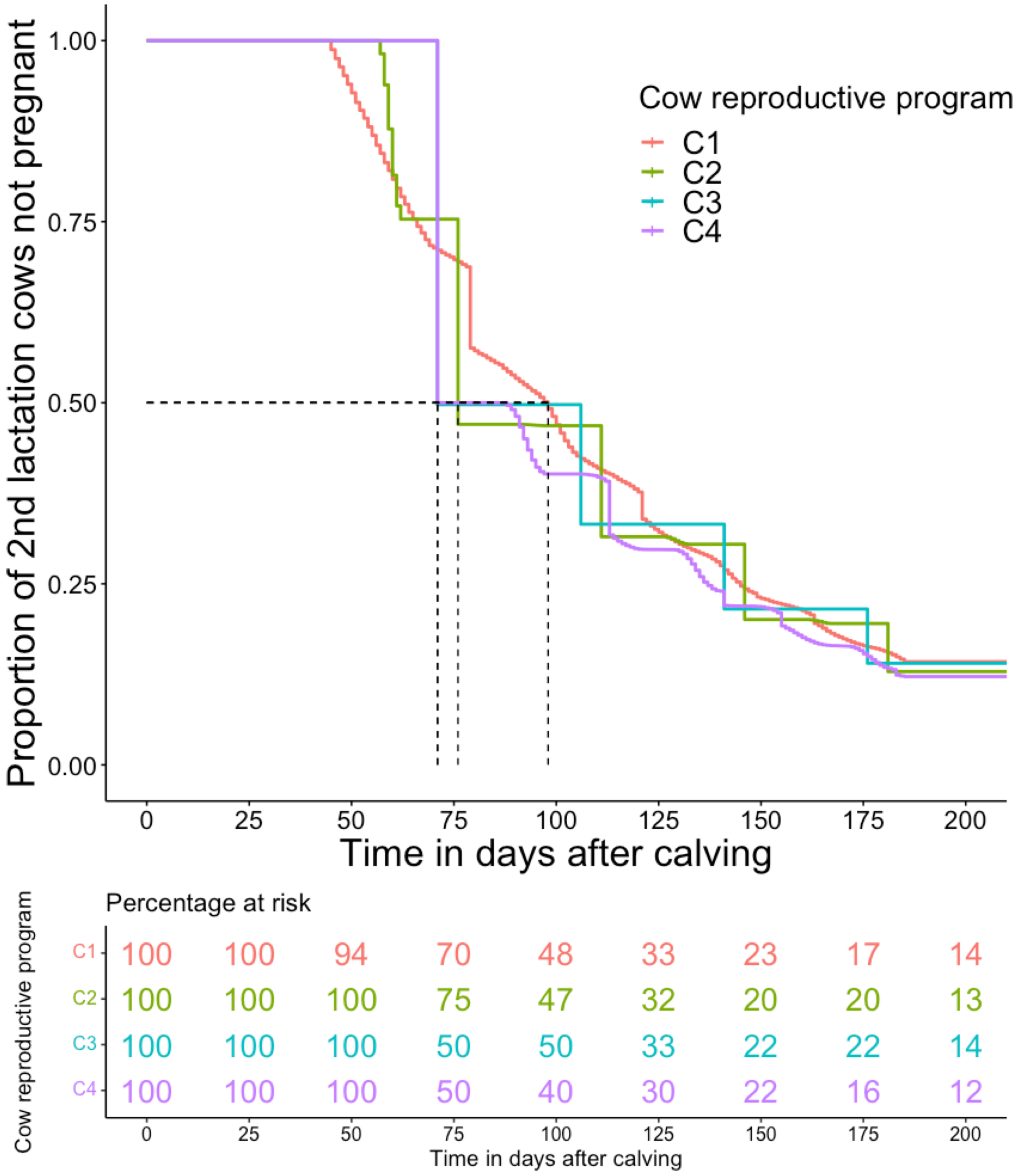


Repro case study — Results

Survival analysis of studied reproductive programs on days to pregnancy







Repro case study — Results

Herd dynamics [average (SD)] - the last year of simulation with 30 iterations for e

Scenario	Heifer service rate (%)	Heifer conception rate (%)	Heifer pregnancy rate (%)	Cow service rate (%)	Cow conception rate (%)	Cow pregnancy rate (%)	Parity (#)	Calving interval (d)	DIM (d)	Culling rate (%)	'Do not breed' cows, (#)
H1-C1	59.4(1.1)	57.8(1.5)	34.3(1.1)	**91.3(0.7)**	40.2(0.7)	36.7(0.9)	2.37(0.04)	371.9(1.3)	154.6(0.9)	41.1(2.0)	53.3(3.4)
H1-C2	59.0(1.2)	**58.3(1.3)**	34.4(1.2)	89.9(0.8)	41.9(0.7)	37.7(0.9)	2.40(0.04)	373.0(1.2)	155.0(0.9)	40.4(1.6)	48.6(3.2)
H1-C3	59.4(1.1)	58.0(1.9)	34.5(1.5)	76.0(0.5)	47.2(1.2)	35.9(1.2)	2.39(0.04)	373.9(1.2)	155.1(0.9)	40.1(1.5)	52.2(4.4)
H2-C1	59.8(1.0)	58.2(1.2)	34.8(1.2)	91.1(1.0)	40.6(0.8)	36.9(1.0)	**2.36(0.04)**	371.9(1.2)	154.8(0.9)	41.3(2.0)	52.7(3.2)
H2-C2	59.3(1.0)	58.1(1.4)	34.5(1.3)	89.9(0.8)	41.9(0.9)	37.7(1.0)	2.41(0.04)	372.4(1.2)	155.0(0.9)	40.1(2.6)	48.7(3.9)
H2-C3	59.2(0.9)	57.1(1.3)	33.8(1.1)	76.0(0.5)	47.1(1.1)	35.8(1.0)	2.40(0.04)	374.2(1.2)	155.5(0.9)	40.4(1.8)	51.7(4.4)
H3-C1	78.8(1.5)	58.0(1.4)	45.7(1.8)	91.2(0.7)	40.2(0.8)	36.7(0.8)	2.37(0.04)	**371.5(1.2)**	154.5(0.9)	40.7(2.1)	56.2(4.2)
H3-C2	**79.9(1.9)**[3]	58.2(1.7)	**46.6(2.3)**	89.8(0.8)	41.8(0.8)	37.5(0.9)	2.42(0.04)	372.9(1.2)	155.2(1.0)	40.4(1.3)	49.5(3.5)
H3-C3	79.2(1.6)	58.1(1.5)	46.1(1.9)	76.1(0.5)	**47.3(1.2)**	36.0(1.2)	2.37(0.04)	373.9(1.2)	155.3(1.0)	40.3(1.7)	51.8(4.0)
H3-C4	79.4(1.9)	58.0(2.0)	46.1(2.6)	83.0(0.8)	47.0(1.2)	**39.1(1.3)**	2.45(0.04)	372.3(1.3)	**154.3(1.0)**	**39.4(1.8)**	**45.7(4.2)**

Repro case study — Results

Income and cost variables of baseline (H1-C1) and difference from other studied scenarios

	Income					Cost															
		Sold calf		Culled		Heifer								Cow							Bought heifer
Scenario	Milk	male	female	heifer	cow	CIDR	GnRH	PGF	ED	AI	Preg. check	Calf feed	Heifer feed	GnRH	PGF	ED	AI	Preg. check	Milking cow feed	Dry cow feed	
	$/herd/yr																				
H1-C1	4,498,341	30,868	784	50,375	384,933	**0**	**0**	**0**	3,233	19,625	6,106	38,645	705,880	3,521	2,150	11,094	75,961	25,438	159,026	1,846,042	**0**
H1-C2	1,430	-133	452	-731	-9,558	**0**	**0**	**0**	-16	-205	**-99**	-238	-9,665	4,654	6,673	-10,690	-16,849	597	2,069	892	**0**
H1-C3	-448	47	-448	-1,495	-3,407	**0**	**0**	**0**	-42	-172	-94	-286	-7,246	9,661	7,395	**-11,094**	**-24,480**	910	-63	1,231	**0**
H2-C1	-4,793	-208	-784	3,234	-3,633	1,887	551	3,022	-1,225	-214	421	546	-5,239	**-28**	**-18**	-78	777	-127	351	**-672**	2,650
H2-C2	-2,384	300	-344	3,754	-7,530	1,807	528	2,931	-1,227	**-564**	326	-280	-15,198	4,599	6,630	-10,692	-17,218	53	2,472	59	**0**
H2-C3	238	-5	-784	**5,135**	-6,002	1,883	550	3,005	-1,174	-136	369	-117	-11,619	9,668	7,392	**-11,094**	-24,283	709	-153	2,184	4,600
H3-C1	-1,681	**228**	1,128	-4,826	**965**	6,119	1,787	2,237	-1,234	252	571	-509	-22,513	-13	-5	4	1,818	-319	451	-451	**0**
H3-C2	5,993	172	**2,480**	-4,810	-10,416	6,067	1,772	2,218	-1,236	16	443	**-1,418**	-32,967	4,627	6,655	-10,689	-17,046	323	2,051	3,060	**0**
H3-C3	4,021	-177	1,120	-3,851	-4,882	6,063	1,771	2,216	**-1,242**	1	485	-823	-29,112	9,713	7,419	**-11,094**	-24,198	1,470	**-681**	3,786	**0**
H3-C4	**11,717**	42	1,816	-3,916	-15,030	6,063	1,771	2,216	**-1,242**	101	461	-895	**-33,263**	5,945	6,148	-8,098	-18,573	**-814**	3,261	4,284	**0**

Repro case study — Results

Income and cost variables of baseline (H1-C1) and difference from other studied scenarios

	Income					Cost															
		Sold calf		Culled		Heifer								Cow							Bought heifer
Scenario	Milk	male	female	heifer	cow	CIDR	GnRH	PGF	ED	AI	Preg. check	Calf feed	Heifer feed	GnRH	PGF	ED	AI	Preg. check	Milking cow feed	Dry cow feed	
										$/herd/yr											
H1-C1	4,498,341	30,868	784	50,375	384,933	**0**	**0**	**0**	3,233	19,625	6,106	38,645	705,880	3,521	2,150	11,094	75,961	25,438	159,026	1,846,042	**0**
H1-C2	1,430	-133	452	-731	-9,558	**0**	**0**	**0**	-16	-205	**-99**	-238	-9,665	4,654	6,673	-10,690	-16,849	597	2,069	892	**0**
H1-C3	-448	47	-448	-1,495	-3,407	**0**	**0**	**0**	-42	-172	-94	-286	-7,246	9,661	7,395	**-11,094**	**-24,480**	910	-63	1,231	**0**
H2-C1	-4,793	-208	-784	3,234	-3,633	1,887	551	3,022	-1,225	-214	421	546	-5,239	**-28**	**-18**	-78	777	-127	351	**-672**	2,650
H2-C2	-2,384	300	-344	3,754	-7,530	1,807	528	2,931	-1,227	**-564**	326	-280	-15,198	4,599	6,630	-10,692	-17,218	53	2,472	59	**0**
H2-C3	238	-5	-784	**5,135**	-6,002	1,883	550	3,005	-1,174	-136	369	-117	-11,619	9,668	7,392	**-11,094**	-24,283	709	-153	2,184	4,600
H3-C1	-1,681	**228**	1,128	-4,826	**965**	6,119	1,787	2,237	-1,234	252	571	-509	-22,513	-13	-5	4	1,818	-319	451	-451	**0**
H3-C2	5,993	172	**2,480**	-4,810	-10,416	6,067	1,772	2,218	-1,236	16	443	**-1,418**	-32,967	4,627	6,655	-10,689	-17,046	323	2,051	3,060	**0**
H3-C3	4,021	-177	1,120	-3,851	-4,882	6,063	1,771	2,216	**-1,242**	1	485	-823	-29,112	9,713	7,419	**-11,094**	-24,198	1,470	**-681**	3,786	**0**
H3-C4	**11,717**	42	1,816	-3,916	-15,030	6,063	1,771	2,216	**-1,242**	101	461	-895	**-33,263**	5,945	6,148	-8,098	-18,573	**-814**	3,261	4,284	**0**

Repro case study — Results

Net return (NR) of studied programs and sensitivity analysis

S	Base price	NR											
		CIDR (12.27)		GnRH (1.60)		$PGF_{2\alpha}$ (2.06)		Calf feed (0.02)		Heifer feed (0.0068)		Female calf (120)	
	Test price	6.135	18.405	0.8	2.4	1.03	3.09	0.01	0.03	0.0034	0.0102	60	180
	Base NR[2]	($/insert)		($/injection)				($/kg BW)				($/head)	
H1-C1	2,068,579	2,068,579	2,068,579	2,070,118	2,067,040	2,069,546	2,067,612	2,087,901	2,049,256	2,421,519	1,715,639	2,068,187	2,068,971
H1-C2	14,336	14,336	14,336	16,370	12,302	17,338	11,334	14,217	14,455	9,504	19,168	14,110	14,562
H1-C3	18,528	18,528	18,528	22,752	14,305	21,855	15,202	18,385	18,672	14,905	22,152	18,752	18,304
H2-C1	-8,788	-7,864	-9,712	-8,559	-9,017	-7,436	-10,139	-8,515	-9,061	-11,407	-6,168	-8,396	-9,180
H2-C2	19,568	20,453	18,683	21,809	17,326	23,869	15,267	19,428	19,708	11,969	27,167	19,740	19,396
H2-C3	16,796	17,718	15,874	21,263	12,329	21,473	12,120	16,738	16,855	10,987	22,606	17,188	16,404
H3-C1	7,620	10,615	4,624	8,395	6,844	8,623	6,616	7,365	7,874	-3,637	18,876	7,056	8,184
H3-C2	29,542	32,513	26,572	32,340	**26,745**	33,533	25,552	28,834	30,251	13,059	**46,026**	28,302	30,782
H3-C3	**30,456**	**33,425**	**27,488**	**35,477**	25,436	**34,790**	**26,123**	**30,045**	**30,868**	**15,900**	45,013	**29,896**	**31,016**
H3-C4	27,263	30,231	24,294	30,636	23,890	31,025	23,501	26,815	27,710	10,631	43,894	26,355	28,171

IOFC of studied programs and sensitivity analysis

	Base price	NR				IOFC				
		Feed / milk ($/kg) 0.24/ 0.35								
	Base NR[2]	0.18/ 0.26	0.18/ 0.44	0.30/ 0.26	0.30/ 0.44	Base IOFC	0.18/ 0.26	0.18/ 0.44	0.30/ 0.26	0.30/ 0.44
H1-C1	2,068,579	1,413,130	3,726,562	410,596	2,724,028	2,493,272	1,837,823	4,151,255	**835,288**	3,148,721
H1-C2	14,336	14,709	15,444	13,228	13,963	-1,532	-1,159	-423	-2,640	-1,904
H1-C3	18,528	18,936	18,705	18,352	18,121	-1,616	-1,209	-1,439	-1,792	-2,023
H2-C1	-8,788	-7,636	-10,101	-7,475	-9,940	-4,472	-3,320	-5,785	-3,159	-5,624
H2-C2	19,568	20,814	19,588	19,548	18,322	-4,915	-3,669	-4,895	-4,934	-6,160
H2-C3	16,796	17,243	17,365	16,227	16,350	-1,793	-1,347	-1,224	-2,362	-2,240
H3-C1	7,620	8,052	7,187	8,052	7,187	-1,681	-1,249	-2,114	-1,249	-2,114
H3-C2	29,542	29,279	**32,361**	26,724	29,806	883	619	3,701	-1,936	1,146
H3-C3	**30,456**	**30,199**	32,266	**28,646**	**30,714**	916	659	2,726	-894	1,174
H3-C4	27,263	26,136	32,162	22,363	28,389	4,172	**3,045**	**9,071**	-728	**5,299**

Case study - sexed/beef semen use

Interest

- The use of beef semen with sexed dairy semen has become a popular management choice in the dairy industry in recent years
- Improved reproductive performance, causing an oversupply of heifers
- The beef cattle demand projected to remain high in the next ten years
  - ✦An arbitrary and randomly assigned attribute was added
    - modified each animal's baseline production level and determined the ranking system
    - a random draw from N(1.0, 0.1) within the range of (0.8, 1.2) to indicate the animal's relative production level amongst the original herd

Case study - sexed/beef semen use

Scenarios

	Heifer	1st lactation cow	2nd lactation cow
C-h	Conventional		
SB-h	Sexed	Top 45% Sexed	Top **10%** Sexed
SCB-h	Sexed	Top 25% Sexed, next top **25%** Conventional	Top 35% Conventional
SCB-h2	Sexed	Top 25% for 3 AI Sexed, following AI and next top **25%**, Conventional	Top 35% Conventional

	Heifer	1st lactation cow	2nd lactation cow
C-m	Conventional		
SB-m	Sexed	Top 45% Sexed	Top **15%** Sexed
SCB-m	Sexed	Top 25% Sexed, next top **30%** Conventional	Top 35% Conventional
SCB-m2	Sexed	Top 25% for 3 AI Sexed, following AI and next top **30%**, Conventional	Top 35% Conventional

*C: conventional semen; S: sexed semen; B: beef semen; h: high reproductive; m: moderate reproductive

Semen case study — Results

Herd dynamics [average (SD)]

Scenarios	Mean pregnancy rate (%)	Estimated milk production (kg/ cow per yr)	Average parity	Average calving interval (d)	Average days in milk (d)	Average culling rate (%)
C-h	28.4(0.8)	12,630(70.6)	2.36(0.05)	397.1(2.5)	172.5(3.6)	38.4(1.9)
SB-h	26.4(0.9)	12,992(69.7)	2.34(0.05)	399.7(2.7)	175.0(3.7)	38.5(1.6)
SCB-h	27.4(1.0)	12,985(86.9)	2.35(0.05)	398.4(2.8)	173.7(4.2)	38.6(2.2)
SCB-h2	27.5(1.0)	12,933(73.5)	2.36(0.05)	398.8(1.9)	173.7(3.8)	38.1(1.7)
C-m	24.5(0.9)	12,606(95.4)	2.30(0.05)	402.2(2.5)	177.3(3.5)	38.7(1.7)
SB-m	22.5(0.8)	12,979(72.2)	2.28(0.05)	405.5(2.8)	180.4(4.3)	39.0(1.7)
SCB-m	23.6(0.9)	12,942(81.2)	2.29(0.05)	403.8(2.5)	178.1(4.1)	39.1(1.7)
SCB-m2	23.7(0.8)	12,940(80.5)	2.30(0.05)	403.7(2.6)	178.0(4.5)	38.8(1.7)

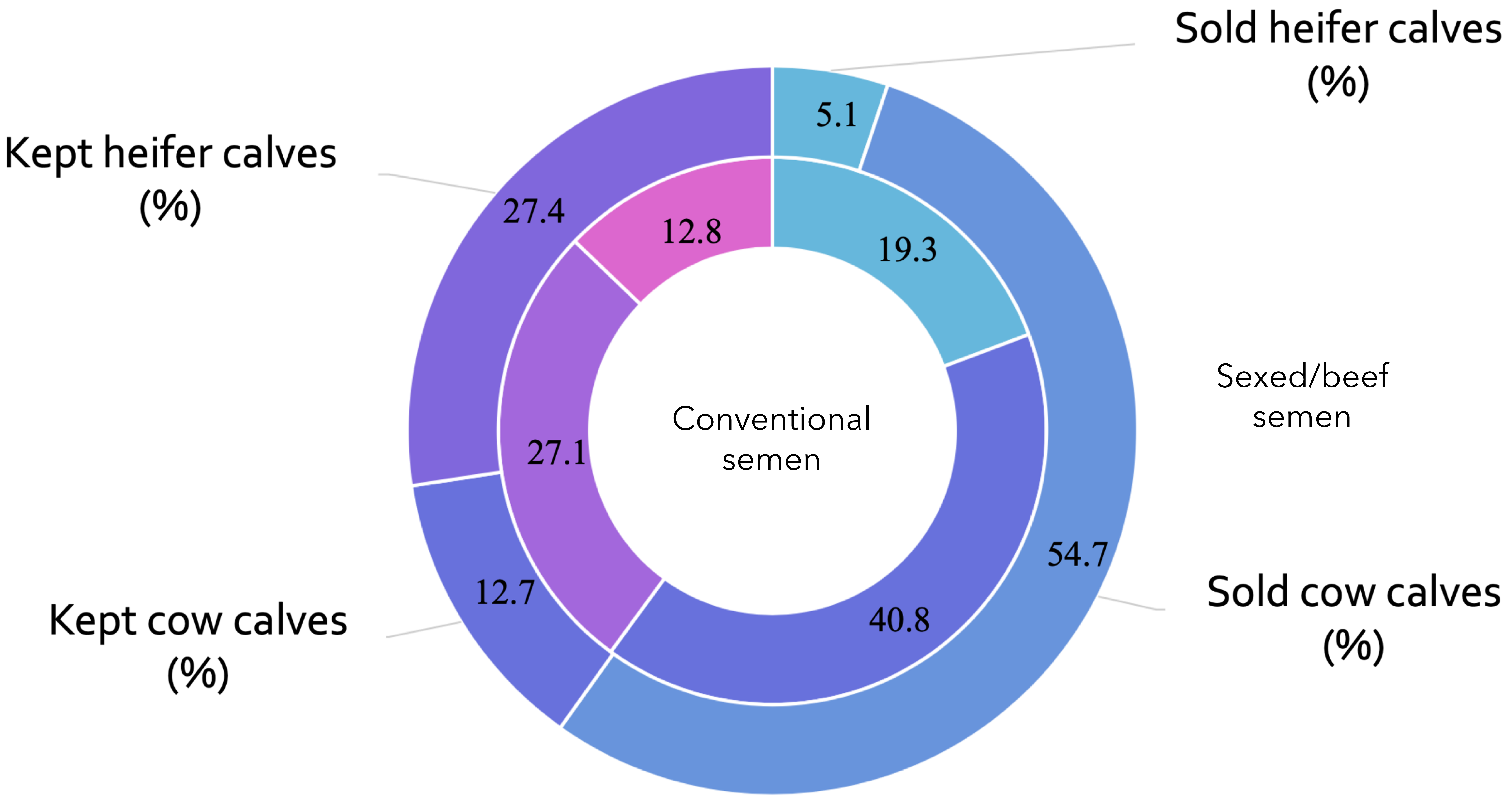
Semen case study — Results

Economic variables

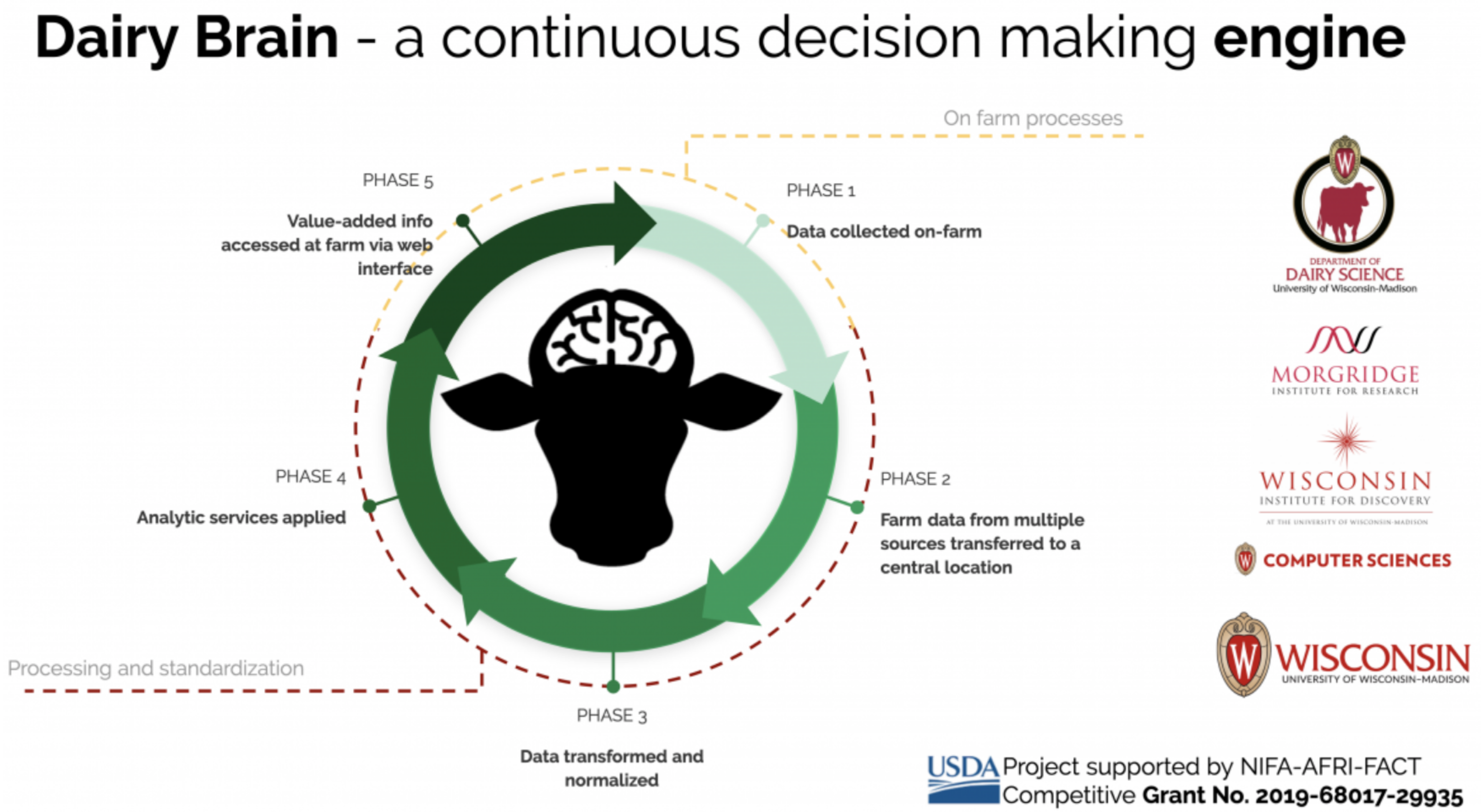
Scenarios	Income ($/cow per yr)				Cost ($/cow per yr)					Net Return ($/cow per yr)
	Milk	Slaughter	Heifer	Calf	Feed	Breeding	Semen	Rearing	Fixed	
C-h	4,673	332	70	36	1,353	52	35	890	913	1,867
SB-h	4,807	334	71	133	1,352	56	62	931	913	2,027
SCB-h	4,805	335	73	122	1,351	55	57	930	913	2,023
SCB-h2	4,807	331	71	123	1,354	56	58	924	913	2,024
C-m	4,664	337	70	35	1,350	55	38	905	913	1,840
SB-m	4,802	340	73	126	1,349	59	68	956	913	1,992
SCB-m	4,789	340	72	112	1,347	59	62	962	913	1,969
SCB-m2	4,788	338	72	115	1,350	59	62	951	913	1,973

Semen case study — Results

Youngstock whereabout

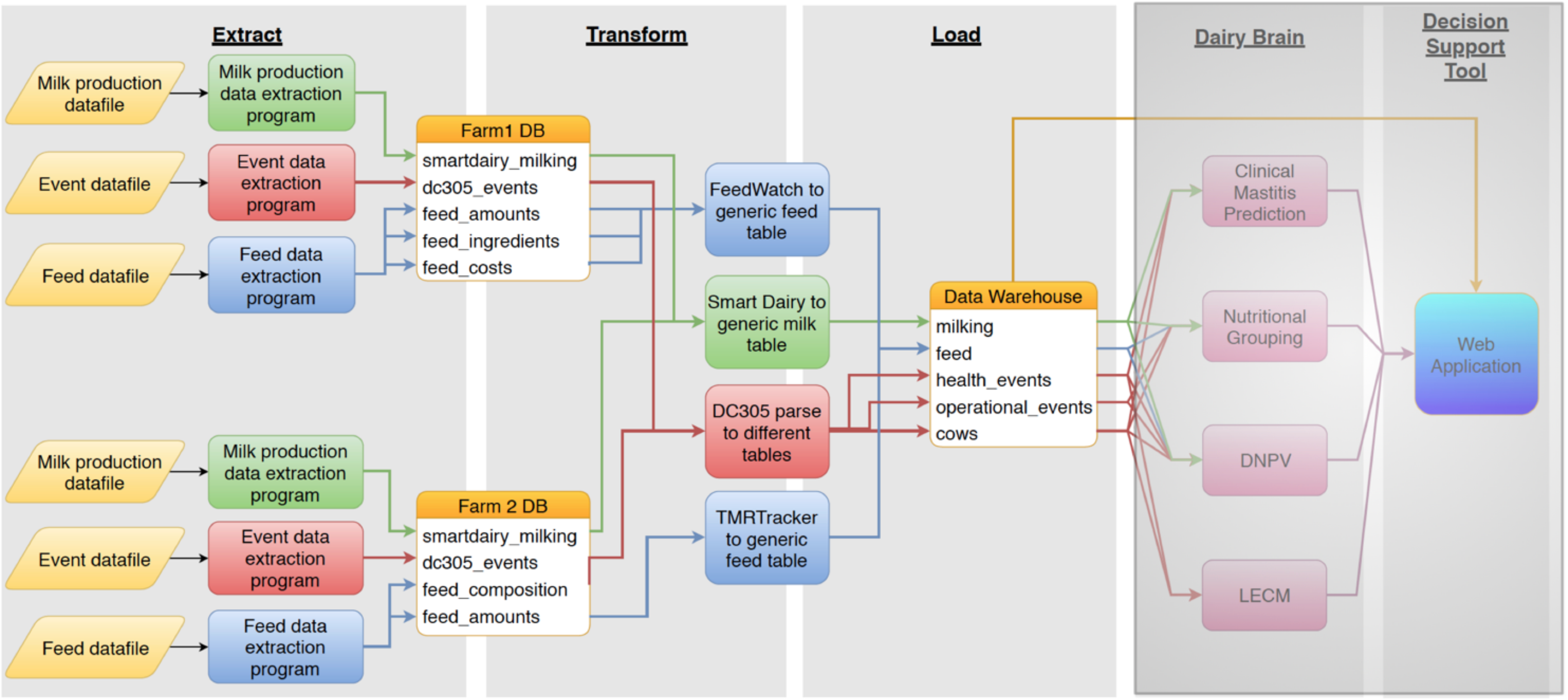


Dairy Brain


Dairy Brain - a continuous decision making engine
On farm processes
PHASE 1
Data collected on-farm
PHASE 2
Farm data from multiple sources transferred to a central location
PHASE 3
Data transformed and normalized
PHASE 4
Analytic services applied
PHASE 5
Value-added info accessed at farm via web interface
Processing and standardization
DEPARTMENT OF DAIRY SCIENCE
University of Wisconsin-Madison
MORGRIDGE
INSTITUTE FOR RESEARCH
WISCONSIN
INSTITUTE FOR DISCOVERY
COMPUTER SCIENCES
WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON
USDA
Project supported by NIFA-AFRI-FACT
Competitive Grant No. 2019-68017-29935

Dairy Brain framework

- Data **warehouse** - develop an Extraction, Transformation, and Loading (ETL) process that will ready the data for access via a programmatic interface



➔Managed by an automation framework which runs on the server in the background, monitoring specified directories

➔The HTCondor places files transferred from the farm into specific directories on the server, whose structure is determined

➔The framework identifies the arrival of a new set of data files, and based on the directory structure implements a predetermined 'recipe' of one or more programs to extract the information from those files

Data extracted from the original source file

Data cleaned
Data harmonized:
Relational framework
Consistent format

Data loaded to a database


Thank you!