

SUPERVISED MACHINE LEARNING AS A TOOL TO IMPROVE FARROWING MONITORING AND STILLBORN RATE IN SOWS

In cooperation with



BACKGROUND

More than 60% of sows give birth to stillborn in French farms. **It is an important cause of piglet mortality.**

- In 2015, the average was around 1.1 stillborn per sow (all parity ranks combined) for 14.7 total births (7.4% of stillborn rate) (IFIP, 2015). On average, in 2023, reported stillbirth rates vary between 3 and 10% (PigCHAMP, 2023).
- Fat sows (BFT>21mm) have a higher risk of dystocia (Quiniou, 2013; Dourmad et al., 2021) which increases the number of stillborn. However, link between BFT and stillborn rate has changed (Thongkhuy, 2020).
- Farrowing duration increases the risk of stillbirths. Indeed, Langendijk et al. showed an increase of 10% between the first and the last piglet born (Langendijk et al., 2018).

The objective of this study was to **build a predictive model of stillborn rate.**

Material & method

- One farrowing farm (No. 1) and two farrow-to-finish farms (No. 2&3) located in Brittany, France

No. Farms	1	2	3
Number of sows	1000	550	600
Batch management	10 every 2 wk	20 each wk	10 every 2 wk
Days at weaning	21	21	21

Data Import - C:\Users\33643\OneDrive\Documents\DEMONSTRATIONS\REZOOLUTIONS\bdd_blackwell_26012023 v2.csv

Definition of Variable Types

Type

- Discrete
- Continuous
- Weight
- Learning/Test
- Row Identifier
- Unused

Multiple Typing

-
-
-

Information

Number of Rows	3686	100.00%
Discrete	2	15.38%
Continuous	10	76.92%
Others	1	7.69%
Unused	0	0.00%
Missing Values	7462	15.57%
Filtered Values	0	0.00%

Data

	N°Elevage	N°Travail	Rang	NT n-1	MN n-1	%MN n-1	ELD Sev n-1	ELD Ent Mat	Gain ELD Gest	NT n	NV n	MN n	%MN n
1	26933	4	16	0	0,00	12	16	4	16	13	3	0,19	
1	26934	2	15	0	0,00	12	12	12	20	19	1	0,05	
1	26935	3	14	0	0,00	14	16	2	19	18	1	0,05	
1	26935	6	16	0	0,00	13	16	3	11	5	6	0,55	
1	26938	2	13	0	0,00	10	13	3	18	16	2	0,11	
1	26938	5	17	0	0,00	13	15	2	18	17	1	0,06	
1	26939	7	11	0	0,00	9	13	4	17	16	1	0,06	
1	26940	6	11	0	0,00	10	15	5	21	16	5	0,24	
1	26942	6	14	0	0,00	15	18	3	13	13	0	0	
1	26942	7	13	0	0,00	11	17	6	11	10	1	0,09	
1	26956	3	16	0	0,00	12	14	3	19	17	2	0,11	
1	26958	3	15	0	0,00	11	17	6	14	14	0	0	
1	26958	4	14	0	0,00	12	16	4	16	16	0	0	
1	26958	5	16	0	0,00	12	16	4	15	15	0	0	

Material & method

- One farrowing farm (No. 1) and two farrow-to-finish farms (No. 2&3) located in Brittany, France
- Reproductive performances recorded:
 Number of total born (TB), born alive (BA), stillborn piglets (S), stillborn piglets at previous farrowing (Sn-1), number of total born at previous farrowing (TBn-1), born alive at previous farrowing (BAN-1)
- Backfat thickness (BFT) just before farrowing and at weaning

The screenshot shows a software interface for data import. On the left, there is a 'Definition of Variable Types' panel with radio buttons for 'Discrete', 'Continuous', 'Weight', 'Learning/Test', 'Row Identifier', and 'Unused'. Below this is a 'Data' table with columns: N°Elevage, N°Travail, Rang, NT n-1, MN n-1, %MN n-1, ELD Sev n-1, ELD Ent Mat, Gain, and Gest. A magnifying glass is positioned over a summary table on the right side of the interface. The summary table has two columns: a numerical value and a percentage. The values are: 3686 (100.00%), 2 (15.38%), 10 (76.92%), 1 (7.69%), 0 (0.00%), 7462 (15.57%), and 0 (0.00%).

Value	Percentage
3686	100.00%
2	15.38%
10	76.92%
1	7.69%
0	0.00%
7462	15.57%
0	0.00%



Model design


Bayesian networks as an integrated modelling approach

Final model obtained

Average calibration = 92%


Model accuracy = 72%

Parity rank

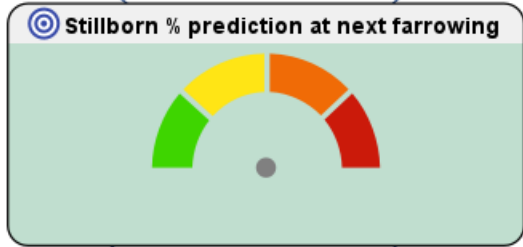


0,00%		_1+2
0,00%		_3+4
0,00%		_5+6+7+8+9


Stillborn % at previous farrowing



0,00%		<=0.08
0,00%		<=0.15
0,00%		>0.15




Total born at previous farrowing



0,00%		<=14
0,00%		<=18
0,00%		>18

Backfat thickness at farrowing



0,00%		<=15
0,00%		>15

More details about variables

Target variable

- The percentage of stillborn
 - It was calculated by divided the number of stillborn with the number of total born
 - In our population, the mean was 6.5% [min:0% – max:92%]

Explanatory variables

- Parity rank
- Stillborn and total born at the previous farrowing
- Backfat thickness at farrowing

Overall Analysis with Stillborn % prediction at next farrowing											
Node	Mutual Information	Normalized Mutual Information	Relative Mutual Information	Relative Significance	Prior Mean Value	G-test	df	p-value	G-test (Data)	df (Data)	p-value (Data)
Parity rank	0.0582	3.6749%	5.1112%	1.0000	0.8961	297.6309	4	0.0000%	294.4724	4	0.0000%
Stillborn % at previous farrowing	0.0228	1.4416%	2.0050%	0.3923	0.0562	116.7558	4	0.0000%	106.6717	4	0.0000%
Total born at previous farrowing	0.0101	0.6384%	0.8880%	0.1737	15.2415	51.7071	4	0.0000%	39.5835	4	0.0000%
Backfat thickness at farrowing	0.0003	0.0213%	0.0296%	0.0058	16.6557	1.7252	2	42.2061%	1.8937	2	38.7964%

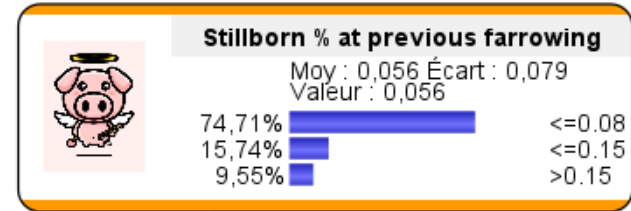
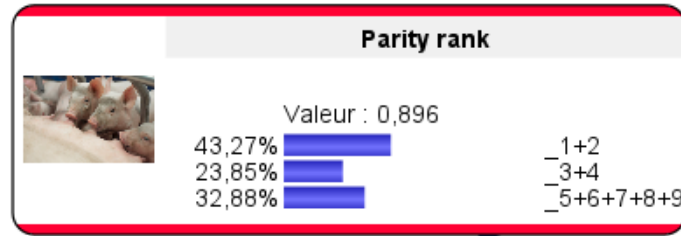
More details about variables

Nodes 5					
	Row Identifier				
Parity	Discrete	States	Aggregates		
		_1+2	1, 2		
		_3+4	3, 4		
		_5+6+7+8+9	5, 6, 7, 8, 9		
TB _{n-1}	Continuous	States	Intervals	Discretization	
		<=14	3.0	14.0	Asked: Manual - 5 - [14.0, 18.0] Obtained: Manual - 5 - [14.0, 18.0]
		<=18	14.0	18.0	
>18	18.0	30.0			
%S _{n-1}	Continuous	States	Intervals	Discretization	
		<=0.08	0.0	0.08	Asked: Manual - 5 - [0.08, 0.15] Obtained: Manual - 5 - [0.08, 0.15]
		<=0.15	0.08	0.15	
>0.15	0.15	1.0			
BFT (farrowing)	Continuous	States	Intervals	Discretization	
		<=15	6.0	15.0	Asked: Manual - 6 - [15.0] Obtained: Manual - 6 - [15.0]
		>15	15.0	31.0	
%S _n	Continuous	States	Intervals	Discretization	
		<=0.08	0.0	0.08	Asked: Manual - 6 - [0.08, 0.15] Obtained: Manual - 6 - [0.08, 0.15]
		<=0.15	0.08	0.15	
>0.15	0.15	1.0			

Explanatory variables

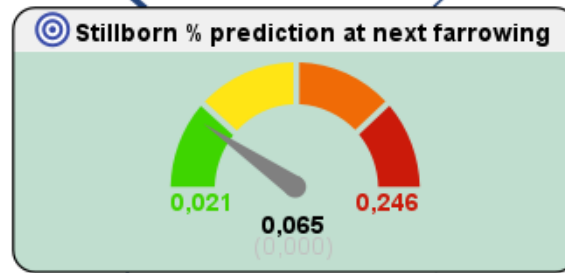
- Parity rank
 - Three groups were used for analysis considering gilts and parity 2 as a group, parities 3 and 4 as another and a last one with sows of parties 5 and more.
- Stillborn and total born at the previous farrowing
 - Data from previous farrowing were included in the model. As we usually used an alert threshold was fixed at 8%. Another determined by the software was fixed at 15%. Concerning TB, threshold were fixed at 14 and 18 piglets.
- Backfat thickness at farrowing
 - Usually, we used 3 categories of BFT: thin (BFT<15mm), correct (15≤BFT≤20mm) and fat (BFT>20mm). The model considered only two groups defined as: thin or correct/fat sows.

Kullback-Leibler divergence measures



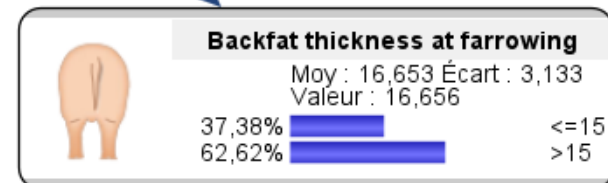
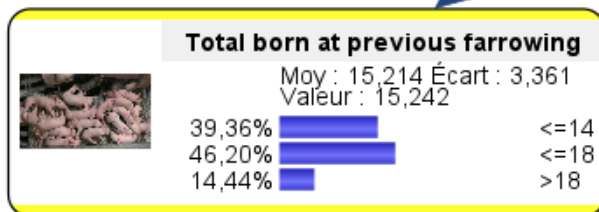
0,0582
63,6210%

0,0228
24,9575%



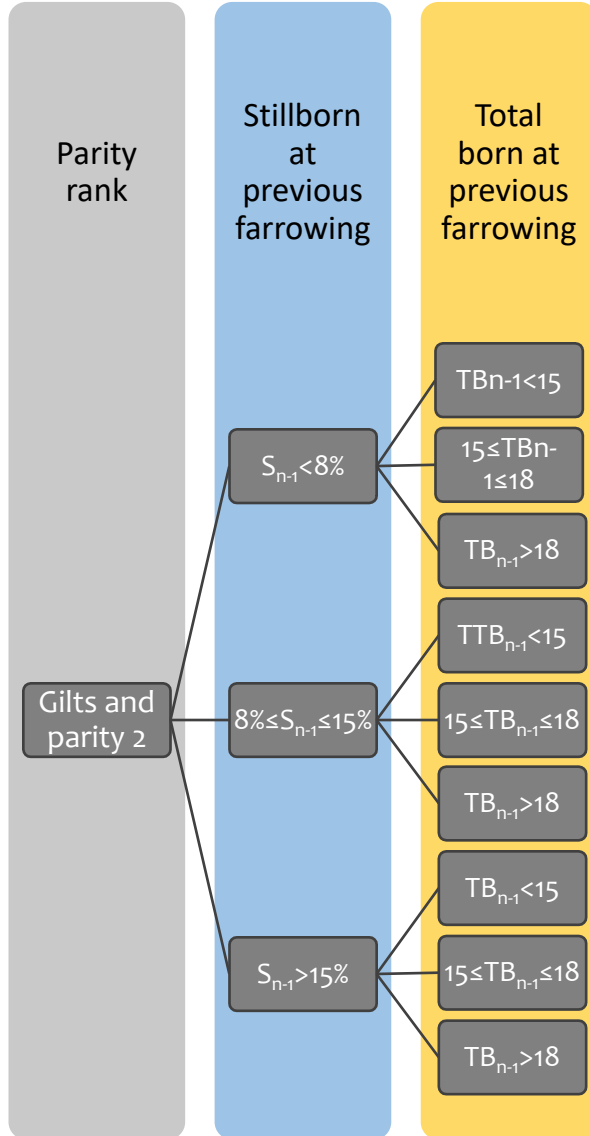
0,0101
11,0528%

0,0003
0,3688%



64% of mutual information is contained in the variable “parity rank”
 It means that if we know the parity of sows, we are able to describe 64% of stillborn rate’s probability

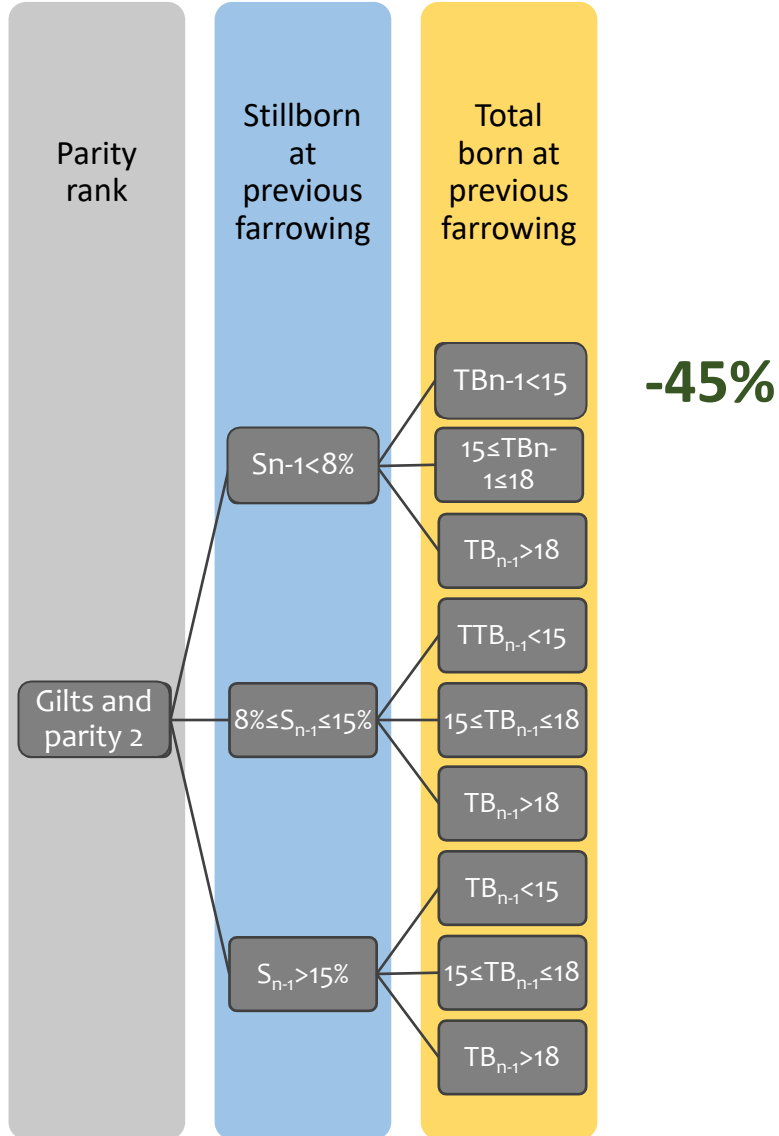
Risk factors and average deviations



Explanatory variables

- This model allows us to determine a grid which made it possible to anticipate at-risk sows regarding stillborn rates and monitor them more effectively
- For each situation, deviations from the average are available

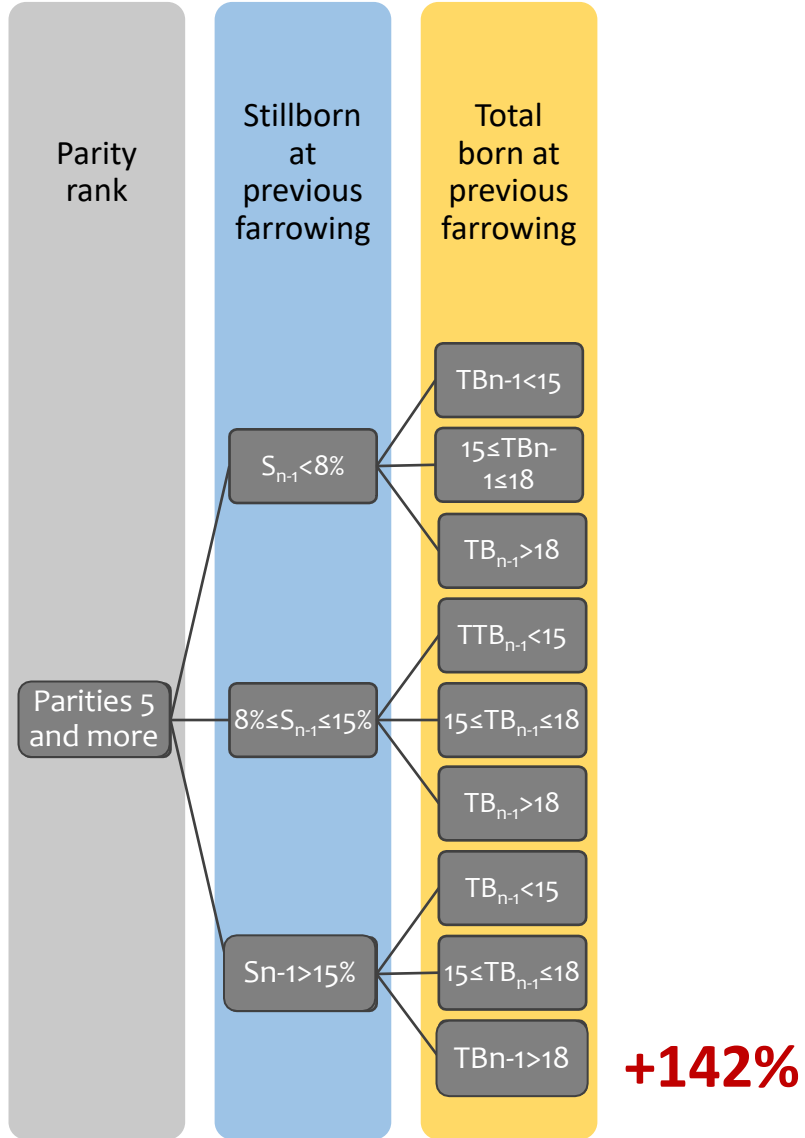
Risk factors and average deviations



Explanatory variables

- This model allows us to determine a grid which made it possible to anticipate at-risk sows regarding stillborn rates and monitor them more effectively
- For each situation, deviations from the average are available
For example, in the best conditions : 3,6% (-45%)

Risk factors and average deviations



Explanatory variables

- This model allows us to determine a grid which made it possible to anticipate at-risk sows regarding stillborn rates and monitor them more effectively
- For each situation, deviations from the average are available
 - For example, in the best conditions : 3,6% (-45%)
 - Conversely, in the worst-case scenario : 15,7% (+142%)

Final grid

In total, **36 situations** were **described** according to the three risk factors in this following grid.

In addition, thanks to **the development of an online app**, farmers and his professional environment will be able to apply the model for all sows.

Factor risk 1	Factor risk 2	Factor risk 3	Stillbirth rate with highest probability	Deviations from average
Gilts and parity 2	$S_{n-1} < 8\%$	$TB_{n-1} < 15$	3,6%	-45%
		$15 \leq TB_{n-1} \leq 18$	4,0%	-38%
		$TB_{n-1} > 18$	4,9%	-25%
	$8\% \leq S_{n-1} \leq 15\%$	$TB_{n-1} < 15$	4,7%	-28%
		$15 \leq TB_{n-1} \leq 18$	5,4%	-27%
		$TB_{n-1} > 18$	6,7%	3%
	$S_{n-1} > 15\%$	$TB_{n-1} < 15$	5,4%	-17%
		$15 \leq TB_{n-1} \leq 18$	6,9%	6%
		$TB_{n-1} > 18$	8,5%	31%
Parities 3 and 4	$S_{n-1} < 8\%$	$TB_{n-1} < 15$	4,9%	-25%
		$15 \leq TB_{n-1} \leq 18$	5,7%	-12%
		$TB_{n-1} > 18$	7,1%	9%
	$8\% \leq S_{n-1} \leq 15\%$	$TB_{n-1} < 15$	6,7%	3%
		$15 \leq TB_{n-1} \leq 18$	7,8%	20%
		$TB_{n-1} > 18$	9,5%	46%
	$S_{n-1} > 15\%$	$TB_{n-1} < 15$	8,4%	29%
		$15 \leq TB_{n-1} \leq 18$	9,8%	51%
		$TB_{n-1} > 18$	11,6%	78%
Parities 5 and more	$S_{n-1} < 8\%$	$TB_{n-1} < 15$	7,2%*	11%
		$15 \leq TB_{n-1} \leq 18$	8,4%*	29%
		$TB_{n-1} > 18$	10,2%*	57%
	$8\% \leq S_{n-1} \leq 15\%$	$TB_{n-1} < 15$	9,9%**	52%
		$15 \leq TB_{n-1} \leq 18$	11,4%**	75%
		$TB_{n-1} > 18$	13,1%**	102%
	$S_{n-1} > 15\%$	$TB_{n-1} < 15$	12,5%**	92%
		$15 \leq TB_{n-1} \leq 18$	14,1%**	117%
		$TB_{n-1} > 18$	15,7%**	142%



Application and perspectives

- An application is already available on-line
- This version will allow us to test the model in some farms and improve our data if necessary




%MN final v3 avec 4 variables après input

Simulator

%MN final v3 avec 4 variables après input



Rang




_1+2

_3+4

_5+6+7+8+9

Observed


%MN n-1



Mean

Observed


NT n-1



Mean

Observed

ELD Ent Mat



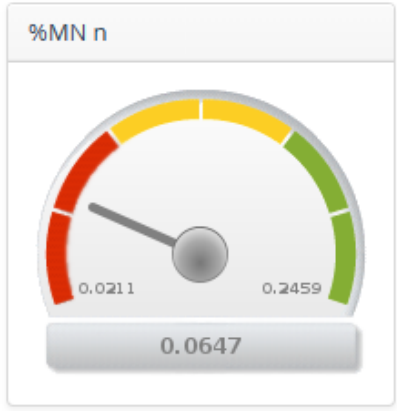
<=15

>15

Observed

%MN n

<=0.08	<div style="width: 71.67%;"></div>	71.67%
<=0.15	<div style="width: 16.08%;"></div>	16.08%
>0.15	<div style="width: 12.25%;"></div>	12.25%



Conclusion

1/ Our results highlight the **impact of previous prolificacy and stillborn rate**

2/ It is important to consider backfat thickness, especially for old sows

→ These hopeful results will allow farmers to classify sows and to manage them in order to decrease pre-weaning mortality



THANK YOU FOR
YOUR ATTENTION

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