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Pig Consulting Services

Facilities Health Management

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

In cooperation with HUMANOIA L'INTELLIGENCE ARTIFICIELLE AU SERVICE DE L'HUMAIN

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.**

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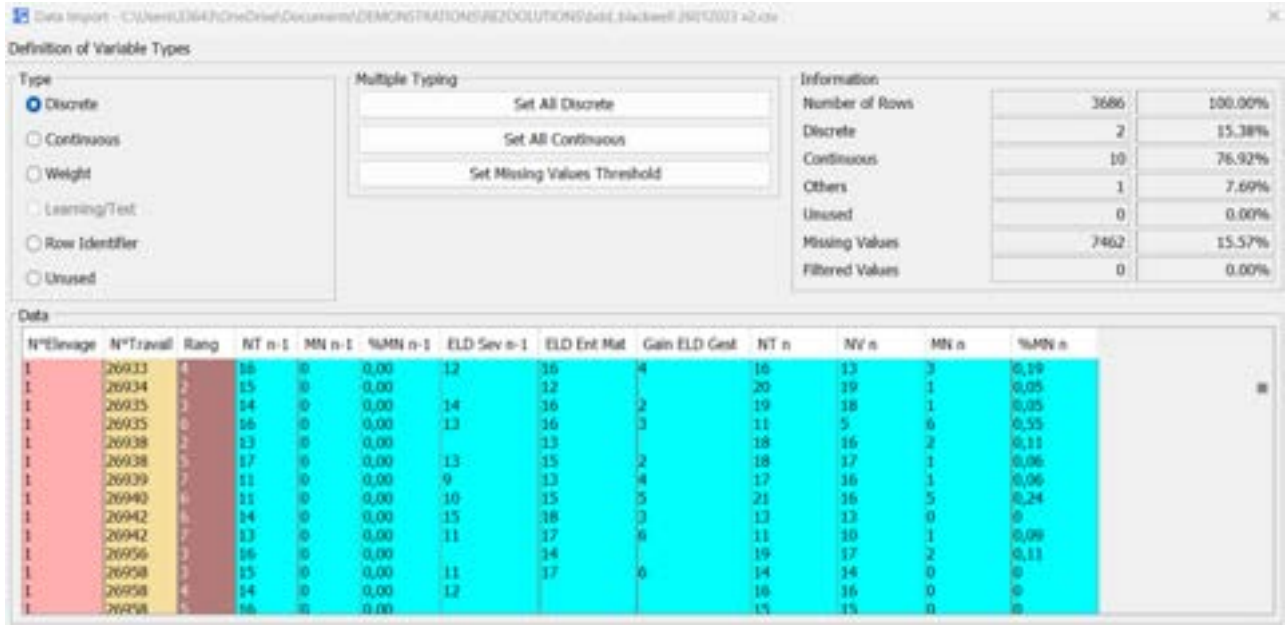
Material & method

- 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



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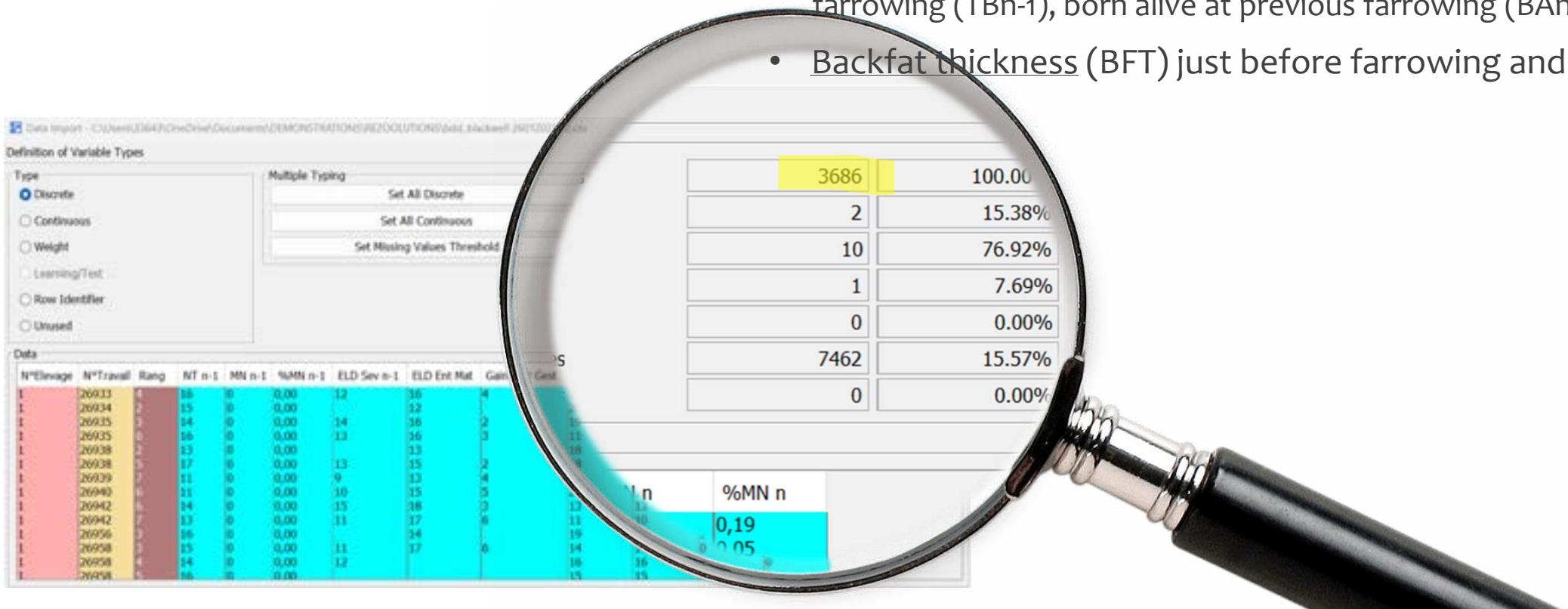
Material & method

- 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



Model design

Bayesian networks as an integrated modelling approach

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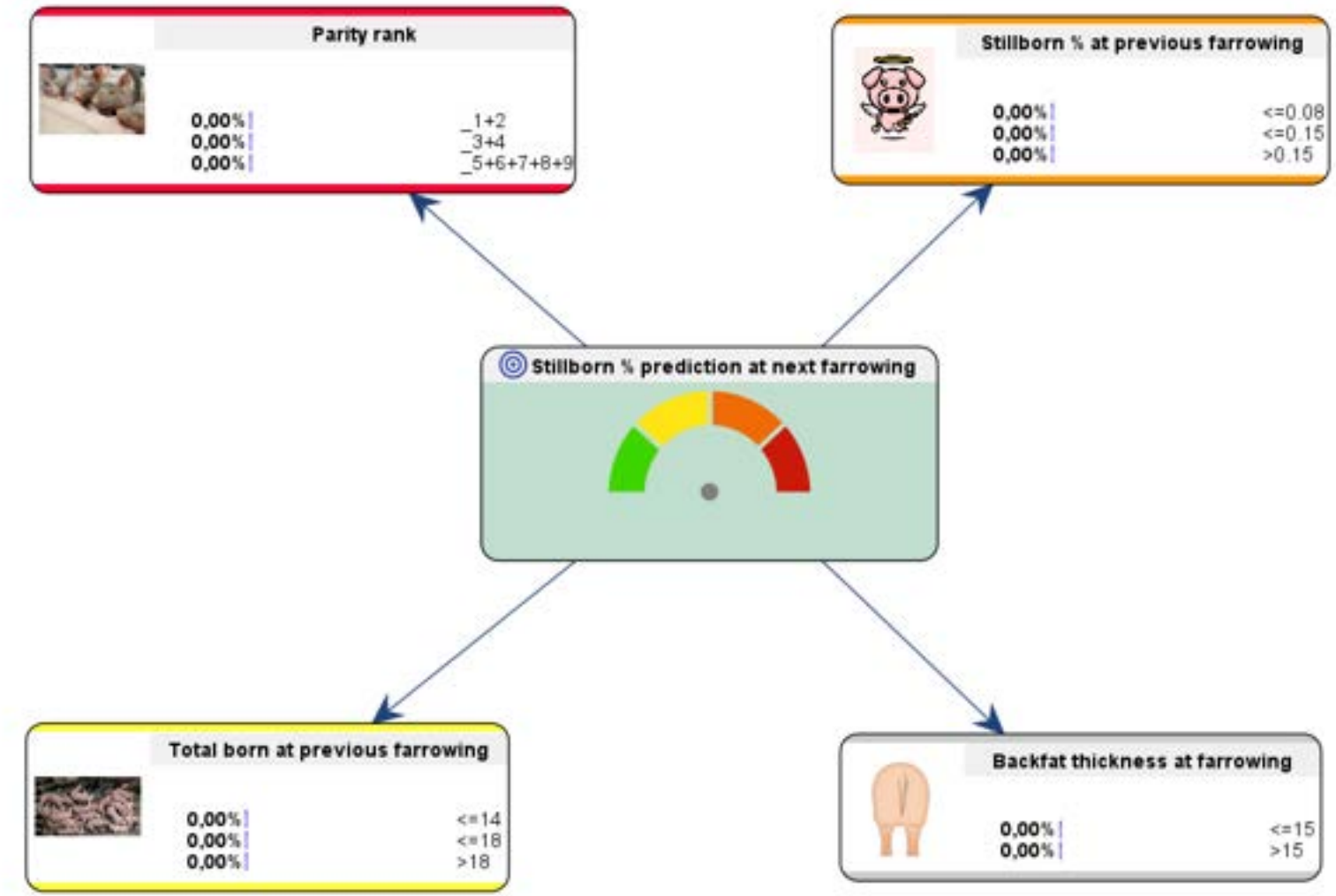
Final model obtained

Average calibration = 92%

Model accuracy = 72%



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%

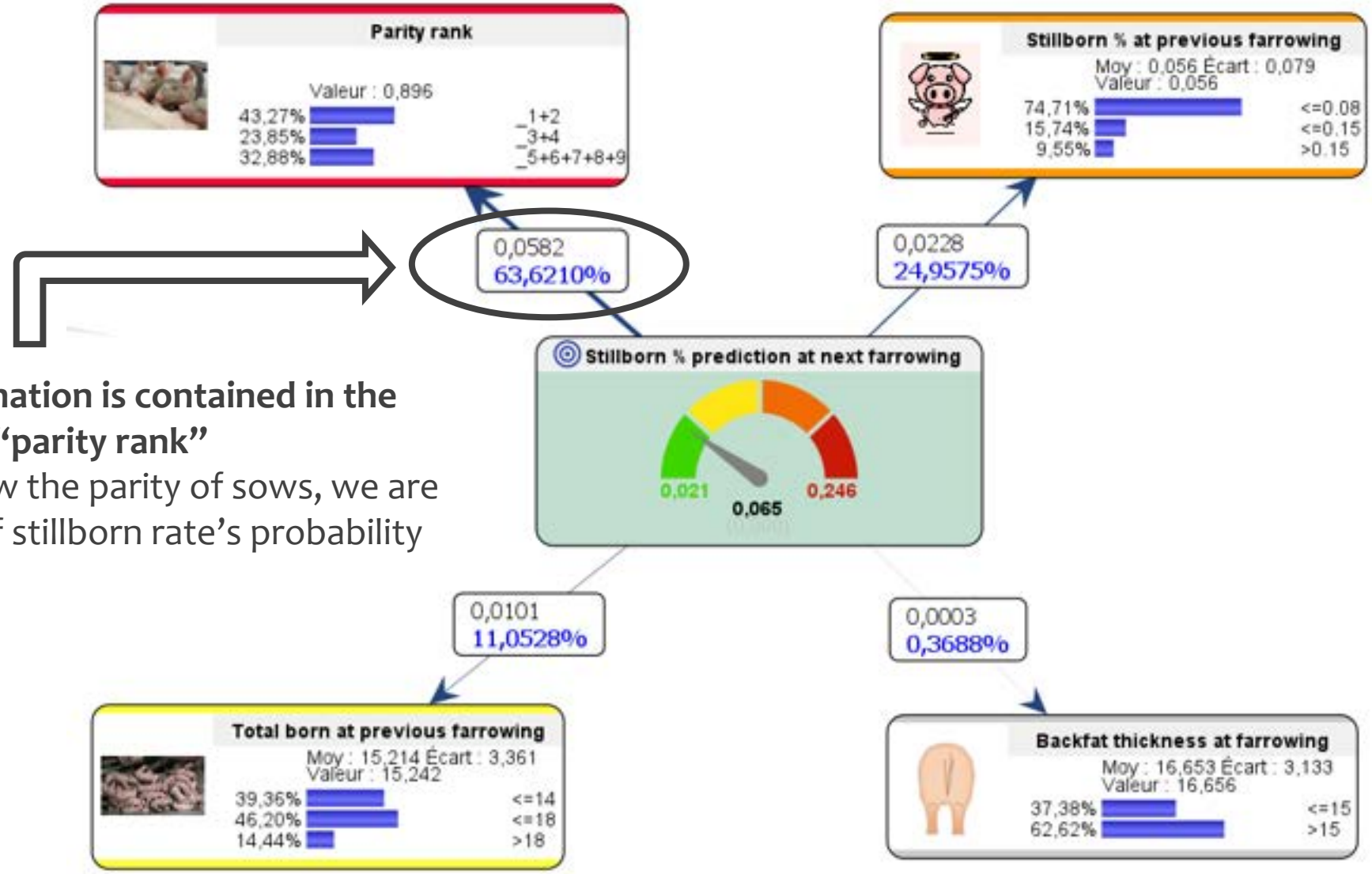
More details about variables

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



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

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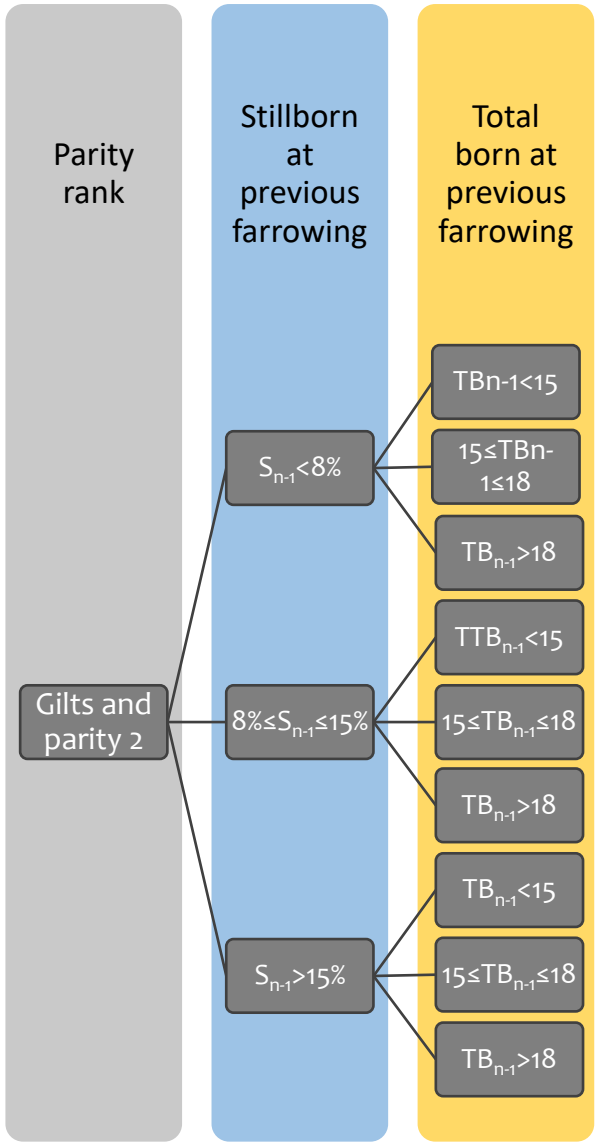
Risk factors and average deviations



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

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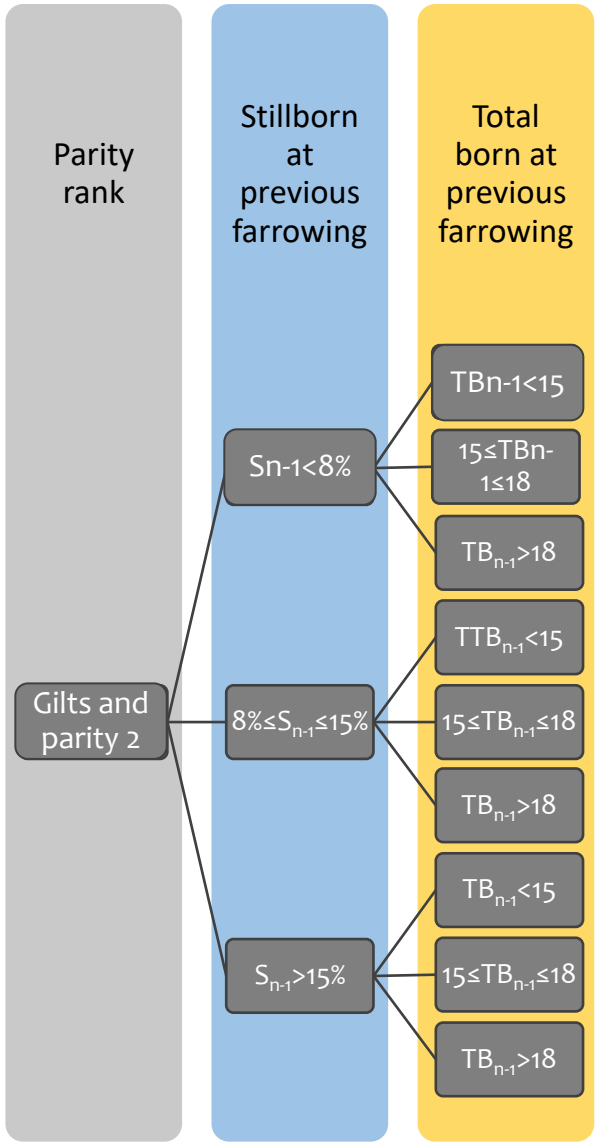
Risk factors and average deviations



-45%

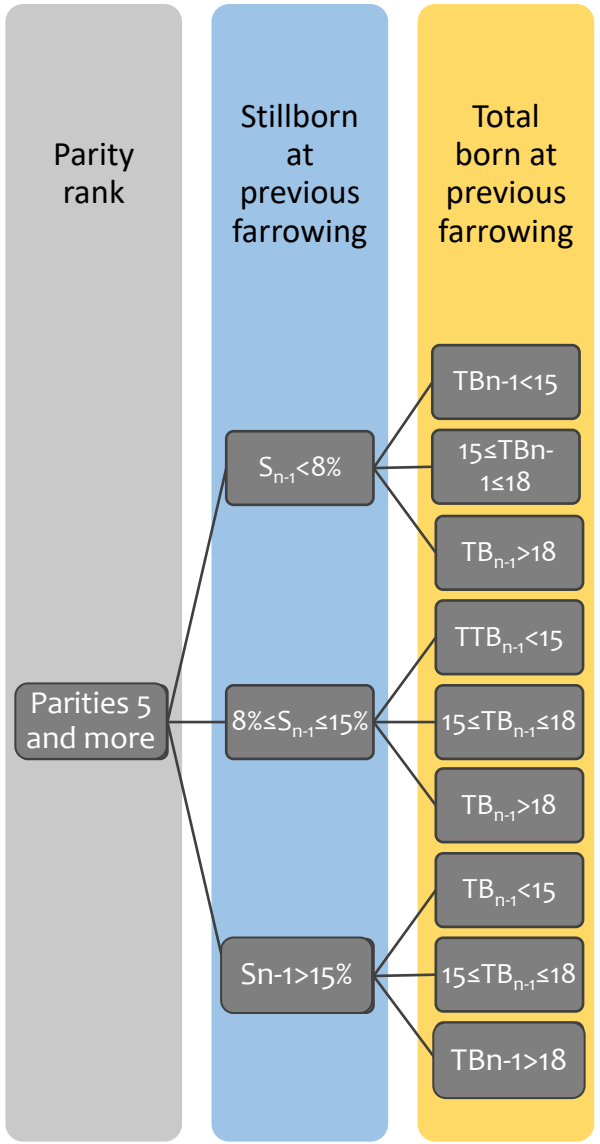
Explanatory variables

- **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



+142%

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%)

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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≤TB_{n-1}≤18	4,0%	-38%
		TB_{n-1}>18	4,9%	-25%
	8%≤S_{n-1}≤15%	TB_{n-1}<15	4,7%	-28%
		15≤TB_{n-1}≤18	5,4%	-27%
		TB_{n-1}>18	6,7%	3%
	S_{n-1}>15%	TB_{n-1}<15	5,4%	-17%
		15≤TB_{n-1}≤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≤TB_{n-1}≤18	5,7%	-12%
		TB_{n-1}>18	7,1%	9%
	8%≤S_{n-1}≤15%	TB_{n-1}<15	6,7%	3%
		15≤TB_{n-1}≤18	7,8%	20%
		TB_{n-1}>18	9,5%	46%
	S_{n-1}>15%	TB_{n-1}<15	8,4%	29%
		15≤TB_{n-1}≤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≤TB_{n-1}≤18	8,4%*	29%
		TB_{n-1}>18	10,2%*	57%
	8%≤S_{n-1}≤15%	TB_{n-1}<15	9,9%**	52%
		15≤TB_{n-1}≤18	11,4%**	75%
		TB_{n-1}>18	13,1%**	102%
	S_{n-1}>15%	TB_{n-1}<15	12,5%**	92%
		15≤TB_{n-1}≤18	14,1%**	117%
		TB_{n-1}>18	15,7%**	142%

* + 1% if BFT≤15mm

** + 2% if BFT≤15mm

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


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%MN final v3 avec 4 variables après input
Simulator
%MN final v3 avec 4 variables ap
Rang
_1+2
_3+4
_5+6+7+8+9
%MN n-1
Mean
0.0562
Observed
%MN n
<=0.08
71.67%
<=0.15
16.08%
>0.15
12.25%
%MN n
0.0211
0.2459
0.0647
NT n-1
Mean
15.2415
Observed
ELD Ent Mat
<=15
>15

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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