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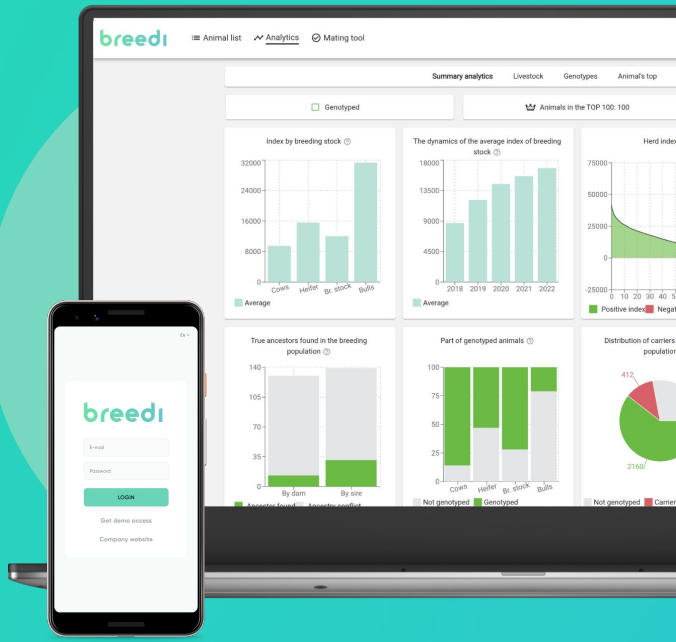
Development of analytical tool for dairy cattle genetic progress assessment



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Introducing GS on emerging markets often differ from developed countries

Developed markets

Institutions
Consortiums
Government support

GS service provider

Performs calculations and interpretations

Farmer

Build trust to new method and support transition to them

Emerging markets

GS service provider

Farmer

Top issues of GS introduction for farmers

Farmers don’t see instant production increase and don’t want to invest in long-term initiatives without instant profit

Farmers don’t understand how to use breeding values and how to make breeding decisions based on this information

Farmers’ breeding decisions often don’t comply to long-term strategic breeding goals they have

Transition to genomic methods means additional expenses

What if to show how introducing GS will overcome these issues on real farmer's data?

Historical farm data on animals' statuses

Analyse

Add GEBV's

Calculate different scenarios of herd progress

Show farmer how different breeding decisions influence his herd and how using GEBV's helps

Analytics hypothesis for every issue

Farmers don't see instant production increase and don't want to invest in long-term initiatives without instant profit	**Show them how profit will change on their exact herd, not some theoretical farm in other countries**
Farmers don't understand how to use breeding values and how to make breeding decisions based on this information	**Motivate them by showing how making breeding decisions without use of GEBV affect their herd**
Transition to genomic methods means additional expenses	**Show them what breeding decisions might actually help to achieve long term goals**
Farmers' breeding decisions often don't comply to long-term strategic breeding goals they have	**Show how soon these expenses will be returned with additional income from animals increased productivity, and how many additional money they can potentially get**

Livestock herd progress simulation

Mating

- Own bulls or external
- Percent of sexed semen
- Percent of surviving females

Heifers 1y.

- Plan of genotyping for several years

Heifers 2y.

- Plan of genotyping for several years

Cows

- Size of herd
- Mean current EBV
- Number of genotyped animals

Culling

Percent of not selecting animals for culling

Selling

Percent of selecting animals for selling

Simulation can be done only on mean values of animals' groups, it is not necessary to simulate each animal

Assume we are selecting worst $\boldsymbol{\alpha}$**%** of animals. Let say that $\boldsymbol{X}$ – the **real BV** of this animals, with mean of real BV is $\boldsymbol{\mu}$, and std of real BV is $\boldsymbol{\sigma}$. Then the mean of BV of selected animals we could calculate via $TVaR_\alpha$ (tail value at risk) formula

$$TVaR_\alpha = \mathbb{EE}[X|X < q_\alpha], \qquad \mathbb{P}(X < q_\alpha) = \alpha$$

We don't know the real BV, but we have **EBV** and could select animals by EBV. Assume that $\boldsymbol{corr(X, EBV) = \rho}$, which can be estimated with cross-validation techniques.

Make the assumption that X and EBV have Normal distribution, then we can get next decomposition

$$\widehat{TVaR_\alpha} = \mathbb{EE}[X|EBV < q_\alpha^{EBV}] = (1-\rho)\mu + \rho\mathbb{EE}[\mathrm{EBV}|EBV < q_\alpha^{EBV}]$$
$$= \mu + \rho\sigma \frac{\phi(\Phi^{-1}(\alpha))}{1 - \alpha}$$

where ϕ, Φ – pdf and cdf of standart normal distribution.

We would like to note, that such formula can be also applied if we make selection by $index = \sum w_i EBV_i$

Let’s compare two different farmers

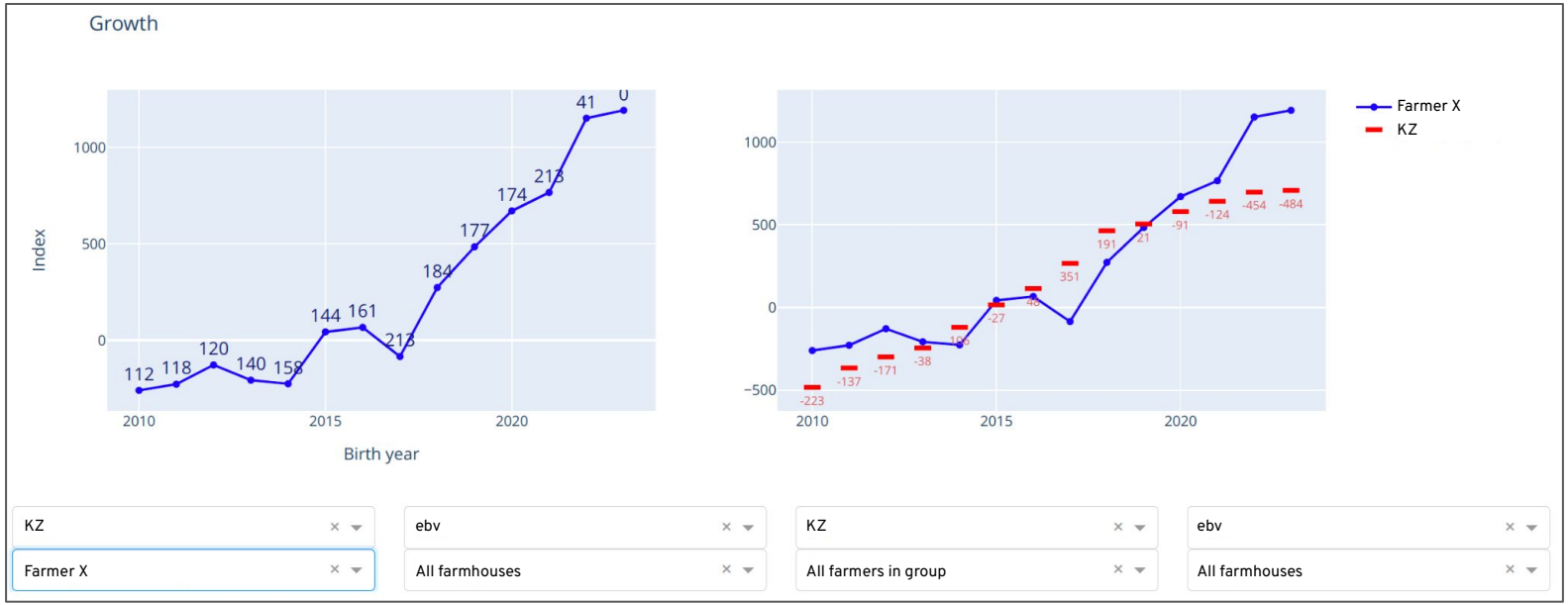
Farmer X

- About 1000 milking cows
- Started to genotype animals in 2017
- Actively uses local GEBV’s and indexes in breeding decisions
- Group animals to use sexed semen on best ones
- Was introduced to this analytical tool in 2021

Farmer Y

- About 1000 milking cows
- Started to genotype animals in 2021
- Use foreign breeding values and indices to pick the bulls, and actual yield or mother yield to rank animals within a herd
- Use AI and sexed semen on whole herd
- Was not yet introduced to this analytics

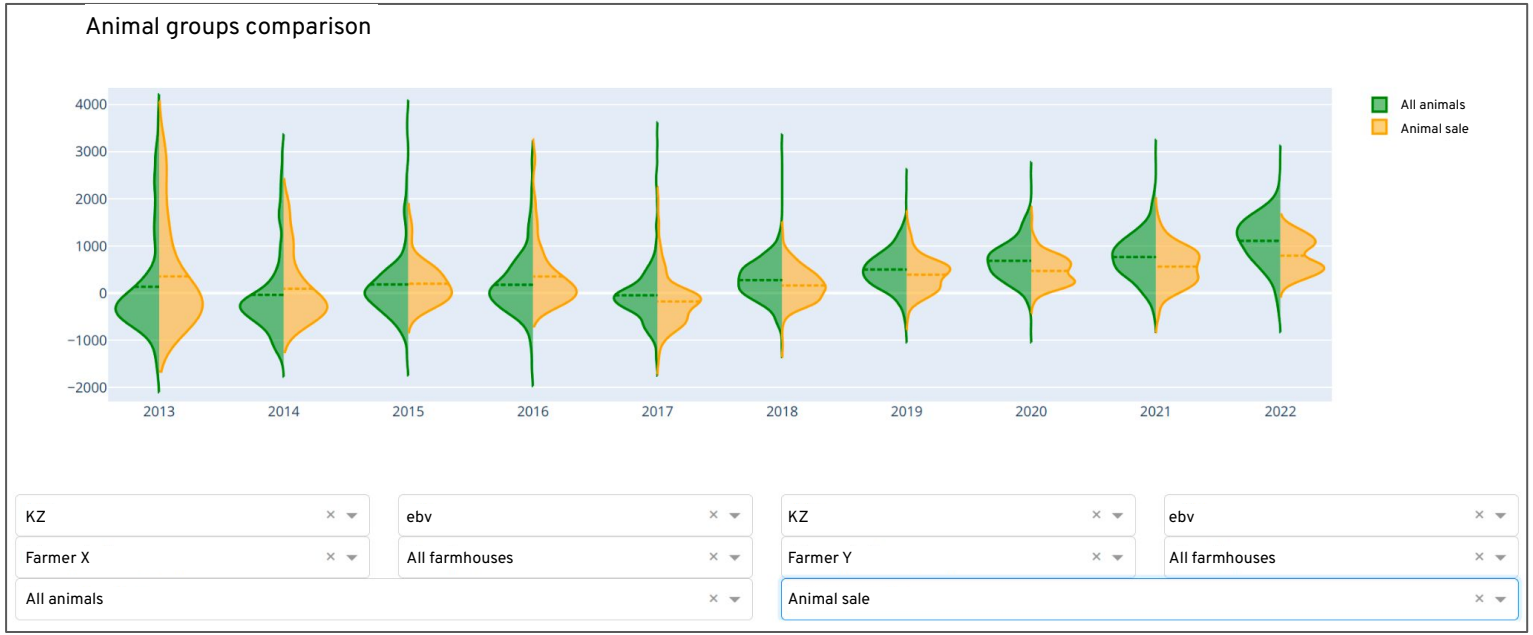
Farmer X genetic trends analytics



Comparing genetic progress of this exact farm to the region or to the other farms.

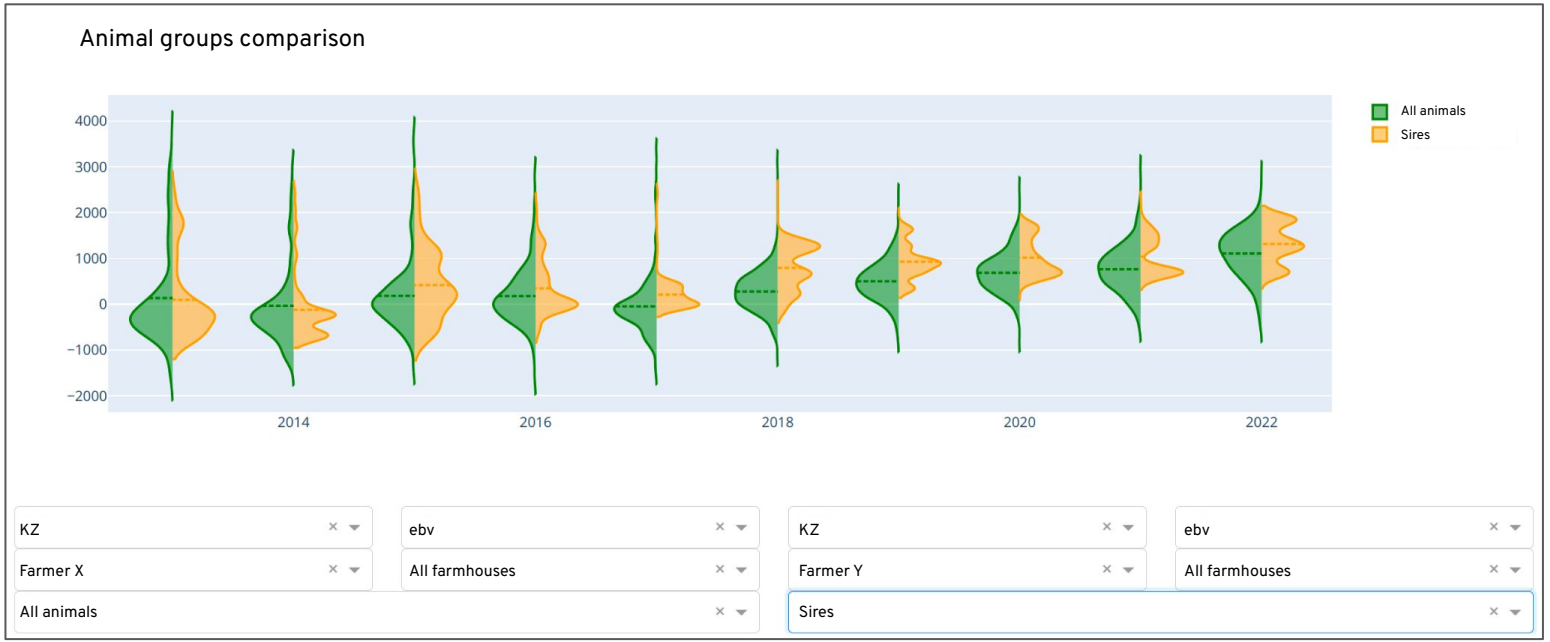
Shows where farmer potentially have made right breeding decisions that contributed to the growth, and where not.

Farmer X retrospective analytics and comparison of different animal groups



Poor culling decisions in past led to the loss of herd genetic potential.

Farmer X retrospective analytics and comparison of different animal groups

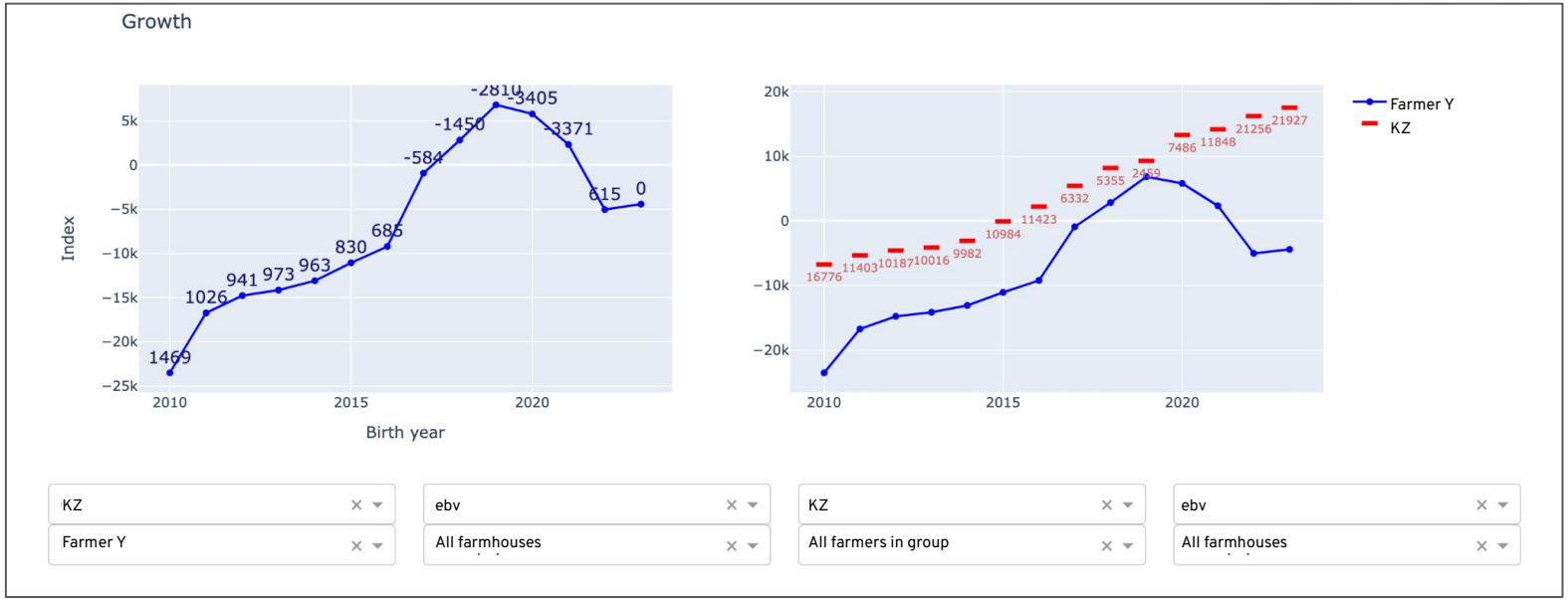


As well as poor mating decisions.

Farmer X different prognostic scenarios of herd development

Calculating different breeding decisions outcome in herd development can demonstrate to the farmer the importance of using accurate animal evaluations and the need to change breeding decision making process by introducing genomic selection methods.

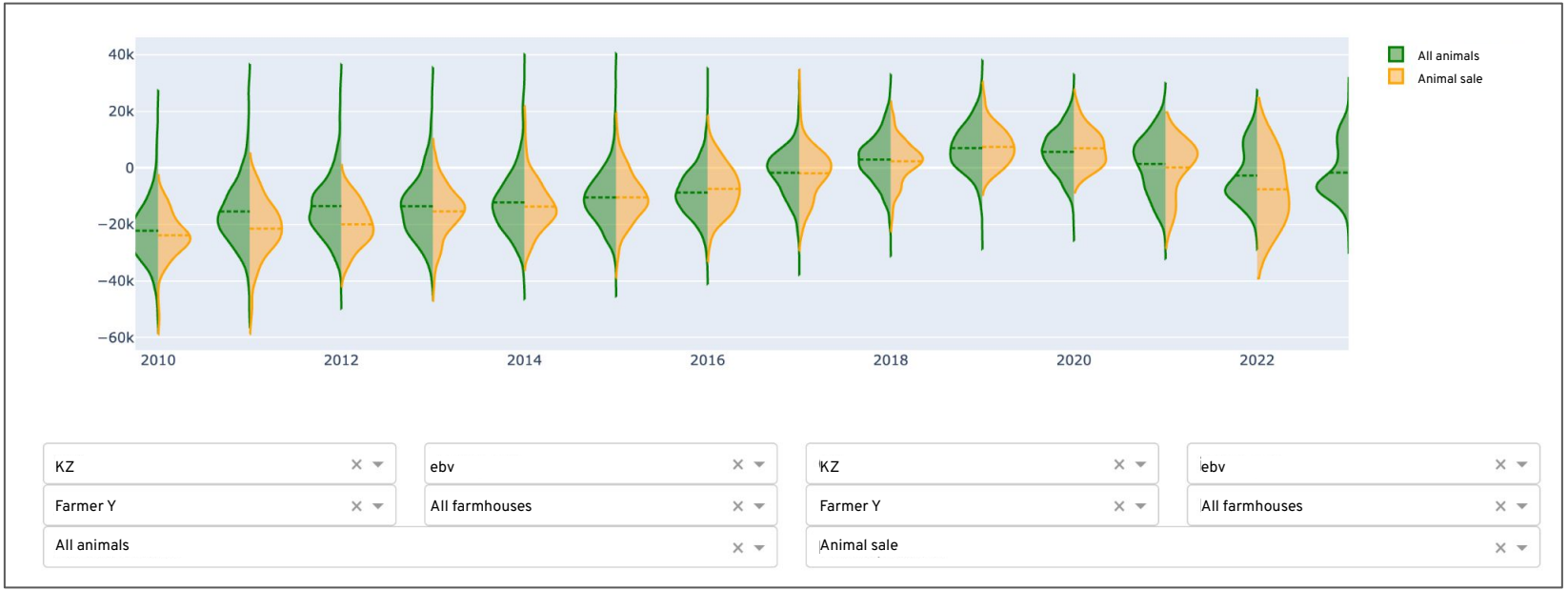
Farmer Y genetic trends analytics



Good breeding decisions were made in 2017-2019, but afterwards something went wrong.

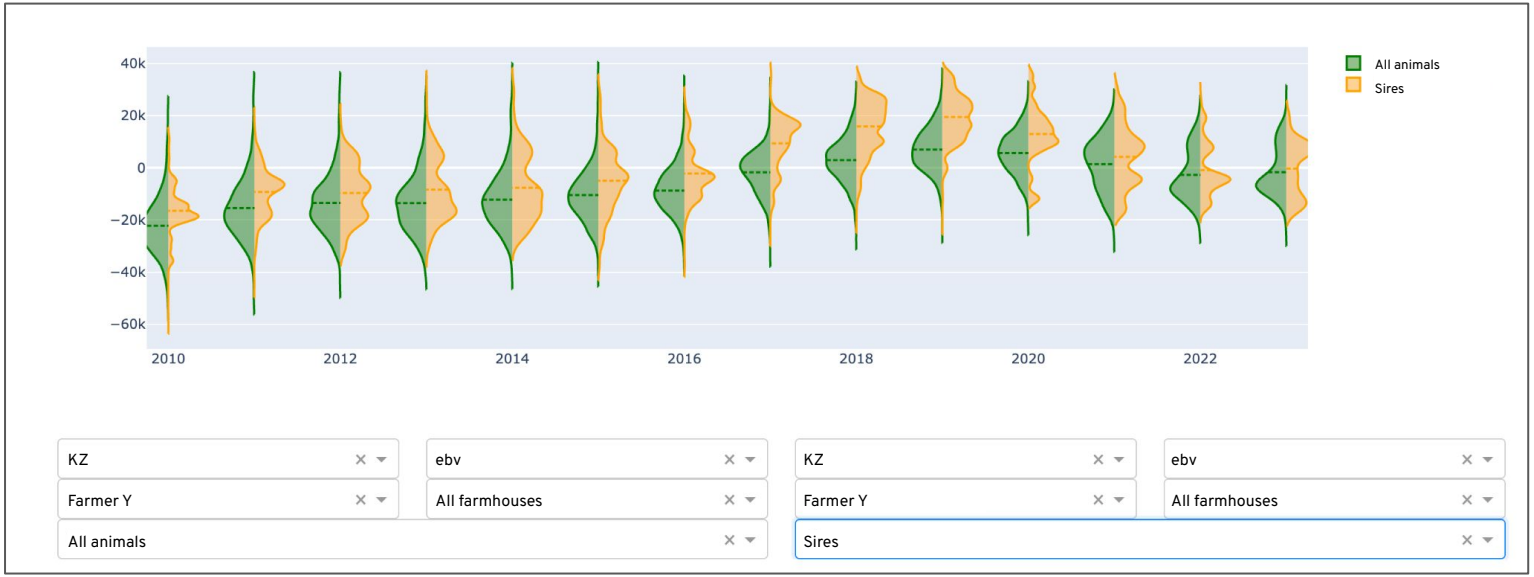
After the start of genotyping in 2021 worsening trend were broken.

Farmer Y retrospective analytics and comparison of different animal groups



Culling was made almost similarly throughout the years, culled animals are evenly distributed within a herd.

Farmer Y retrospective analytics and comparison of different animal groups



Used bulls in 2017-2019 were significantly better than previously used bulls, but after 2019 mating decisions were worse than in 2017-2019.

As conclusion

Retrospective analysis and scenarios modeling based on actual farmer's data could help with:

- Improve farmer's mistakes in selection process
- Increase understanding of impact of genomic selection on their specific herd
- Motivate with investment to genomic method and planning of genotyping
- Modeling genetic potential depending on the chosen strategy

Future perspectives:

- Adding farm economical data to calculate herd profit in scenarios modeling
- Adding genetic diversity constraints for scenario modeling

Thank you for your attention

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