



<b>General information</b>	
PPP-number	AF-16022
Title	Breed4Food
Theme	<b>Klimaatneutraal</b>
Implementing institute	<b>Wageningen Livestock Research</b>
Project leader research (name + e-mail address)	<b>Roel Veerkamp (Roel.Veerkamp@wur.nl)</b>
Coordinator (on behalf of private partners)	<b>Han Swinkels (han.swinkels@hswconsult.nl)</b>
Project-website address	<b>Françoise Divanach</b>
Start date	<b>www.breed4food.com</b>
Final date	<b>01-01-2017</b>
	<b>31-12-2021</b>

<b>Approval by the coordinator of the consortium</b>	
The annual report must be discussed with the coordinator of the consortium. The "TKI's" appreciate additional comments concerning the annual report.	
Assessment of the report by the coordinator on behalf of the consortium:	<input checked="" type="checkbox"/> Approved <input type="checkbox"/> Not approved
Additional comments concerning the annual report:	

<b>Summary of the project</b>	
Problem definition	Sustainable production of high-quality animal protein for a growing world population is the key challenge for livestock industry in the future. The aim of Breed4Food is to develop and apply innovations that utilize the genetic potential of cattle, pigs and poultry to breed production animals that are suited to meet future needs.
Project goals	The Breed4Food goals focus on: (1) providing tools to enable efficient breeding for sustainability traits, and (2) efficient utilization of DNA information and different sources of phenotypic data in breeding programmes. The anticipated innovations will generate effective breeding programmes and broad breeding goals that capture traits related to resource efficiency, health and welfare.

<b>Results</b>	
Planned results 2019	<p>New phenotype recording techniques, such as high-throughput robotic sensors, offer opportunities to collect complex and detailed animal data at a high or even real-time frequency. These data can be used to define and predict new phenotypes for sustainability traits, that were previously difficult and/or expensive to measure and analyse. novel data mining techniques facilitate the translation of Big Data into useful measures of animal performance by using combinations of observations or detection of specific patterns that yield accurate predictions for target traits. Practical examples include the utilization of longitudinal sensor data to collect information on individual and group behaviour to predict health, resilience and welfare.</p> <p>Likewise, recent advances in genomics and molecular biology, such as massive sequencing and genotyping technologies, offer unprecedented possibilities to create enormous genomic datasets. The utilization of</p>

	<p>new methods to collect and analyse phenotypic and genomic data will increase the efficiency of genetic improvement and herd management. Breed4Food has several subprojects centred around Utilizing DNA information and precisions phenotyping.</p>
<p>Achieved results 2019</p>	<p>Main results utilizing DNA information:  Great progress has been made regarding the development and implementation of algorithms and software for large scale genomic evaluations. Several single-step genomic evaluations using multi-trait routine evaluations datasets provided by CRV and ICBF were successfully completed within a few days. The so-called ssGTBLUP model is now also implemented in calc_grm and MiX99 and hpblup kernels. The collaborations of Jérémie Vandenplas with Kees Vuik from TU Delft and with VORtech were very valuable for this achievement. The newly implemented algorithms will become available through MiXBLUP as an easy-to-use interface. This makes these algorithms directly accessible for all Breed4Food industry partners.  Results with the developed karyotyping pipeline to detect abnormalities in karyotypes look promising. Optimizations to better filter false positives are in progress.  To reinforce the collaboration with external partners, several PhD students spent time abroad (Young Lim Lee will continue to work for another month with Michel Georges in Liege).  Pascal Duenk successfully defended his PhD thesis (March 13). Martijn Derks will defend on May 13, and Biaty Raymond on September 11.</p> <p>Main results precision phenotyping:</p> <ul style="list-style-type: none"> <li>• Data of activity of individual broilers was collected for a full round; from day 2 to day 35. This opened up opportunities to set up a large experiment with Cobb to collect data on genotyped birds for genetic analysis.</li> <li>• After organising an interesting seminar a pilot is set up with CRV on using an infrared thermography camera to phenotype efficiency. A pilot was started on Dairy Campus in October.</li> <li>• Mortality and clinical symptoms during an (induced) outbreak are heritable traits. Mortality is in itself a suitable resilience phenotype.</li> <li>• The collaboration with a PDeng from Eindhoven University, via Hendrix Genetics, refined the methodologies to identify steps of turkeys from IMU-data</li> <li>• Activity data of individual cows has now been arranged for 40 dairy farms</li> <li>• The organoids-lab of WUR-ABG is running very well; organoids are growing and can be frozen and unfrozen again</li> <li>• New and better IMU and video data collected in February 2020 for 300 turkeys with walking score</li> <li>• PhD defence of Esther van der Heide is set in September</li> </ul>
<p>Planned results 2020</p>	<p>Plans utilizing DNA information</p> <ul style="list-style-type: none"> <li>• Validation (and comparison) in practical data of earlier implemented options in calc_grm and other programs (e.g. allelefreq), including metafounders/genetic groups, in terms of accuracy, bias and computing effort.</li> <li>• Investigate the mechanisms through which pre-selection impacts accuracy and bias of SSGBLUP.</li> <li>• Develop bioinformatic filtering of possible reciprocal translocation breakpoints to automate pipeline further and identify ploidy abnormalities.</li> <li>• Make ssSNPBLUP models of hpblup available through MiXBLUP.</li> <li>• Evaluate QP-transformation of genomic matrices and metafounders for inclusion in routine evaluations</li> <li>• Continue the formal comparison of genomic methods that are able to handle &gt;1 million genotyped individuals.</li> </ul>

	<ul style="list-style-type: none"> <li>• Further tests of complex models (random regression) for ssSNPBLUP.</li> </ul> <p>Plans precision Phenotyping</p> <ul style="list-style-type: none"> <li>• Large experiment to estimate the heritability for activity in chickens and investigating the possibilities of using location data of cattle. Phenotyping devices for measuring locomotion in Turkeys are being validated.</li> <li>• Build walking score prediction models using IMU and video data on 300 turkeys. The individual tracking project made it possible to measure individual activity in broilers in a very detailed way. This activity data can be linked to important welfare and carcass traits which are of high value to the business and its breeding program. (Cobb)</li> <li>• Investigate a robust method for the transport study in organoids and test another biopsy method to collect tissue samples. Analyse gene expression data from colon organoids.</li> <li>• Pilot using Infrared thermography to study feed efficiency.</li> <li>• Feed efficiency is not only kg/kg or kJ/kJ conversion, but also N efficiency, and fiber digestion. Development of NIR digestibility and quantifying the influence of the microbiome create new ways to give (pigs) a niche in Western agriculture.</li> <li>• Using variation in daily milk records provides information of resilience on animal and herd level. At CRV discussions are ongoing how to include this into the current "better life health" breeding values, and it is investigated whether adding also cow activity data to the daily milk data gives more accurate information. These cow-specific results geared interest and internal discussions on the application to other species as well.</li> </ul>
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<p><b>Deliverables/products in 2019</b> (provide the titles and /or a brief description of the products/deliverables or a link to a website.)</p> <p><u>Scientific articles:</u></p> <p><b>A second-level diagonal preconditioner for single-step SNPBLUP.</b> / Vandenplas, Jeremie; Calus, Mario P.L.; Eding, Herwin; Vuik, Cornelis. In: Genetics Selection Evolution, Vol. 51, 30, 25.06.2019.</p> <p><b>Assessment of sire contribution and breed-of-origin of alleles in a three-way crossbred broiler dataset.</b> / Calus, Mario P.L.; Vandenplas, Jérémie; Hulsegge, Ina; Borg, Randy; Henshall, John M.; Hawken, Rachel. In: Poultry Science, Vol. 98, No. 12, 01.12.2019, p. 6270-6280.</p> <p><b>Comparing regression, naive Bayes, and random forest methods in the prediction of individual survival to second lactation in Holstein cattle.</b> / van der Heide, E.M.M.; Veerkamp, R.F.; van Pelt, M.L.; Kamphuis, C.; Athanasiadis, I.; Ducro, B.J. In: Journal of Dairy Science, Vol. 102, No. 10, 10.2019, p. 9409-9421.</p> <p><b>Effects of dietary supplementation of Gracilaria sp. extracts on fillet quality, oxidative stress, and immune responses in European seabass (Dicentrarchus labrax).</b> / Peixoto, Maria J.; Magnoni, Leonardo; Gonçalves, José F.M.; Twijnstra, Robert H.; Kijjoa, Anake; Pereira, Rui; Palstra, Arjan P.; Ozório, Rodrigo O.A. In: Journal of Applied Phycology, Vol. 31, No. 1, 02.2019, p. 761-770.</p> <p><b>Efficient and accurate computation of base generation allele frequencies.</b> / Aldridge, M.N.; Vandenplas, J.; Calus, M.P.L. In: Journal of Dairy Science, Vol. 102, No. 2, 02.2019, p. 1364-1373.</p> <p><b>Estimation of Muscle Scores of Live Pigs Using a Kinect Camera.</b> / Alsahaf, Ahmad; Azzopardi, George; Ducro, Bart; Hanenberg, Egiel; Veerkamp, Roel F.; Petkov, Nicolai. In: IEEE Access, Vol. 7, 8698234, 24.04.2019, p. 52238-52245.</p> <p><b>Genomic prediction for crossbred performance using metafounders.</b> / van Grevenhof, Elizabeth M.; Vandenplas, Jérémie; Calus, Mario P.L. In: Journal of Animal Science, Vol. 97, No. 2, 01.02.2019, p. 548-558.</p> <p><b>Imputation to whole-genome sequence using multiple pig populations and its use in genome-wide</b></p>
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**association studies.** / van den Berg, Sanne; Vandenplas, Jérémie; van Eeuwijk, Fred A.; Bouwman, Aniek C.; Lopes, Marcos S.; Veerkamp, Roel F.

In: Genetics, selection, evolution : GSE, Vol. 51, 2, 24.01.2019.

**Invited review: Big Data in precision dairy farming.** / Lokhorst, C.; De Mol, R.M.; Kamphuis, C.

In: Animal, Vol. 13, No. 7, 07.2019, p. 1519-1528.

**Invited review: Determination of large-scale individual dry matter intake phenotypes in dairy cattle.** /

Seymour, D.J.; Cánovas, A.; Baes, C.F.; Chud, T.C.S.; Osborne, V.R.; Cant, J.P.; Brito, L.F.; Gredler-Grandl, B.; Finocchiaro, R.; Veerkamp, R.F.; de Haas, Y.; Miglior, F.

In: Journal of Dairy Science, Vol. 102, No. 9, 09.2019, p. 7655-7663.

**Opportunities to improve resilience in animal breeding programs.** / Berghof, Tom V.L.; Poppe, Marieke; Mulder, Han A.

In: Frontiers in Genetics, Vol. 9, 692, 14.01.2019.

**Review of sensor technologies in animal breeding: Phenotyping behaviors of laying hens to select against feather pecking.** / Ellen, Esther D.; Van Der Sluis, Malou; Siegford, Janice; Guzhva, Oleksiy; Toscano, Michael J.; Bennewitz, Jörn; Van Der Zande, Lisette E.; Van Der Eijk, Jerine A.J.; de Haas, Elske N.; Norton, Tomas; Piette, Deborah; Tetens, Jens; de Klerk, Britt; Visser, Bram; Bas Rodenburg, T.

In: Animals, Vol. 9, No. 3, 108, 22.03.2019.

**Significance testing and genomic inflation factor using high-density genotypes or whole-genome sequence data.** / van den Berg, Sanne; Vandenplas, Jérémie; van Eeuwijk, Fred A.; Lopes, Marcos S.; Veerkamp, Roel F.

In: Journal of Animal Breeding and Genetics, Vol. 136, No. 6, 11.11.2019, p. 418-429.

**Validation of an ultra-wideband tracking system for recording individual levels of activity in broilers.** /

Van Der Sluis, Malou; De Klerk, Britt; Ellen, Esther D.; De Haas, Yvette; Hijink, Thijme; Rodenburg, Bas.

In: Animals, Vol. 9, No. 8, 580, 01.08.2019.

**Students', colleagues' and research partners' experience about work and accomplishments from collaborating with Robin Thompson.** / Hickey, John; Hill, William G.; Blasco, Agustin; Cameron, Neil; Cullis, Brian; McGuirk, Brian; Mäntysaari, Esa; Ruane, John; Simm, Geoff; Veerkamp, Roel; Visscher, Peter M.; Wray, Naomi R.

In: Journal of Animal Breeding and Genetics, Vol. 136, No. 4, 07.2019, p. 301-309.

**Advances in dairy cattle breeding to improve longevity.** / Veerkamp, Roel; van Pelt, Mathijs.

Advances in breeding of dairy cattle. ed. / J. van der Werf; J. Pryce. Burleigh Dodds Science Publishing Limited, 2019. p. 337-354.

External reports:

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Articles in professional journals/magazines:

Poster) presentations at workshops, seminars, or symposia.

**At-market sensor technologies to develop proxies for resilience and efficiency in dairy cows.** / Kamphuis, C.; de Haas, Y.; Ouweltjes, W.

Proceedings of the 2nd International Precision Dairy Farming Conference. University of Minnesota, 2019. p. 11-12.

**Assessing individual activity levels in two broiler lines using an ultra-wideband tracking system.** / Van Der Sluis, M.; De Klerk, B.; Ellen, E.D.; De Haas, Y.; Hijink, T.; Rodenburg, T.B.

Precision Livestock Farming 2019: Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019. ed. / Bernadette O'Brien; Deirdre Hennessy; Laurence Shalloo. Teagasc, 2019. p. 903-906 (Precision Livestock Farming 2019 - Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019).

**At-market sensor technologies to develop proxies for resilience and efficiency in dairy cows.** / Ouweltjes, W.; De Haas, Y.; Kamphuis, C.

Precision Livestock Farming 2019: Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019. ed. / Bernadette O'Brien; Deirdre Hennessy; Laurence Shalloo. Teagasc, 2019. p. 246-253 (Precision Livestock Farming 2019 - Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019).

**Developing sensor technologies to inform breeding approaches to reduce damaging behaviour in laying hens and pigs: The GroupHouseNet approach.** / Rodenburg, T.B.; Bennowitz, J.; De Haas, E.N.; Košťál, L.; Pichová, K.; Piette, D.; Tetens, J.; Visser, B.; De Klerk, B.; Van Der Sluis, M.; Van Der Zande, L.E.; Siegford, J.; Toscano, M.; Norton, T.; Guzhva, O.; Ellen, E.D.

Precision Livestock Farming 2019: Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019. ed. / Bernadette O'Brien; Deirdre Hennessy; Laurence Shalloo. Teagasc, 2019. p. 467-470 (Precision Livestock Farming 2019 - Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019).

**Using a data lake in animal sciences.** / Schokker, D.; Athanasiadis, I.N.; Visser, B.; Veerkamp, R.F.; Kamphuis, C.

Precision Livestock Farming 2019: Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019. ed. / Bernadette O'Brien; Deirdre Hennessy; Laurence Shalloo. Organising Committee of the 9th European Conference on Precision Livestock Farming (ECPLF), Teagasc, Animal and Grassland Research and Innovation Centre, 2019. p. 140-144 (Precision Livestock Farming 2019 - Papers Presented at the 9th European Conference on Precision Livestock Farming, ECPLF 2019).

**A diagonal preconditioner for solving single-step SNPBLUP efficiently.** / Vandenplas, J.; Calus, M.P.L.; Eding, H.; Vuik, C.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Vol. 25 Wageningen : Wageningen Academic, 2019. p. 595-595 (Book of Abstracts).

**A fast method to fit the mean of unselected base animals in single-step SNP-BLUP.** / Tribout, T.; Boichard, D.; Ducrocq, V.; Vandenplas, J.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Vol. 25 Wageningen : Wageningen Academic, 2019. p. 211-211 (Book of Abstracts).

**Automated tracking of individual activity of broiler chickens.** / van der Sluis, M.; de Klerk, B.; Rodenburg, T.B.; de Haas, Y.; Hijink, Thijme; Ellen, E.D.

Proceedings of the 53rd Congress of the International Society for Applied Ethology (ISAE): Animal Lives Worth Living. ed. / Ruth C. Newberry; Bjarne O. Braastad. Wageningen, The Netherlands : Wageningen Academic Publishers, 2019. p. 288-288.

**Common genomic regions underlie height in humans and stature in cattle.** / Raymond, Biaty; Yengo, Loic ; Costillo, R. ; Schrooten, C. ; Bouwman, A.C. ; Veerkamp, R.F. ; Hayes, Ben ; Visscher, P.M. .

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Ghent, Belgium : Wageningen Academic Publishers, 2019. p. 211-211 (EAAP Annual Meeting; Vol. 1, No. 25).

**Computation of many relationships between metafounders replacing phantom parents.** / Calus, M.P.L.; Vandenplas, J.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Vol. 25 Wageningen : Wageningen Academic, 2019. p. 596-596 (Book of Abstracts).

**Detection of reciprocal translocations in pigs using short read sequencing.** / Bouwman, A.C.; te Pas, M.F.W.; Derks, M.F.L.; Groenen, M. ; Veerkamp, R.F. ; Broekhuijse, M. ; Harlizius, B..

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen Academic Publishers, 2019. p. 255-255 (Book of abstracts EAAP; No. 25).

**Genomic prediction of a binary trait using a threshold model.** / ten Napel, J.; Strandén, I.; Taskinen, M.R.; Vandenplas, J.; Veerkamp, R.F.; Matilainen, K. .

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen : Wageningen Academic Publishers, 2019. p. 594-594 (Book of Abstracts).

**High resolution copy number variation analysis using two cattle genome assemblies.** / Lee, Y.L.; Bosse, M.; Veerkamp, R.F.; Mullaart, E.; Groenen, M.; Bouwman, A.C. .

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen Academic Publishers, 2019. (Book of abstracts EAAP; No. 25).

**Impact of data sub-setting strategies on variance component estimation for Interbeef evaluations.** / Bonifazi, Renzo; Vandenplas, J.; ten Napel, J.; Cromie, Andrew; Veerkamp, R.F.; Calus, M.P.L.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen Academic Publishers, 2019. p. 447-447 (EAAP Book of Abstracts; Vol. 25).

**Impact of preselection on genetic evaluation of selection candidates using single step GBLUP.** / Jibrila, I.; ten Napel, J.; Vandenplas, J.; Veerkamp, R.F.; Calus, M.P.L. .

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen : Wageningen Academic Publishers, 2019. p. 449-449 (Book of Abstracts).

**Investigating novel traits in single trait selection for their potential in selection indexes for feed efficiency of crossbred pigs.** / Aldridge, M.N.; Bergsma, R.; Calus, M.P.L. .

Proceedings of the AAABG 23rd Conference. Vol. 23 Armidale : AAABG, 2019. p. 218-221.

**Microbiability of faecal nutrient digestibility in pigs.** / Verschuren, L.M.G.; Schokker, D.; Jansman, A.J.M.; Bergsma, R.; Molist, F.; Calus, M.P.L.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Vol. 25 Wageningen : Wageningen Academic, 2019. p. 306-306 (Book of Abstracts).

**On-farm automated tracking of group-housed poultry.** / Ellen, E.D.; van der Sluis, M.; de Klerk, B.; de Haas, Y.; Hijink, Thijme; Rodenburg, T.B.

Book of abstracts of the 70th Annual Meeting of the European Federation of Animal Science (EAAP). Wageningen Academic Publishers, 2019. p. 136-136 (Book of Abstracts).

**Potential of DNA pooling for the inclusion of commercial slaughterhouse data in genetic improvement.** / Aldridge, M.N.; de Klerk, B.; de Haas, Y.; de Greef, K.H.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen Academic Publishers, 2019. p. 289-289 (EAAP Book of Abstracts; No. 25).

**Reduce damaging behaviour in laying hens and pigs by developing sensor technologies to inform breeding programs.** / Rodenburg, T.B.; van der Zande, Lisette; de Haas, E.N.; Kostal, L.; Pichova, Katarina;

Piette, Deborah; Tetens, Jens; Visser, Bram; de Klerk, Britt; van der Sluis, M.; Bennewitz, Jörn; Siegford, Janice; Norton, Tomas; Guzhva, Oleksiy; Ellen, E.D.

Proceedings of the 53rd Congress of the International Society for Applied Ethology (ISAE): Animal Lives Worth Living. ed. / Ruth C. Newberry; Bjarne O. Braastad. Wageningen, The Netherlands : Wageningen Academic Publishers, 2019. p. 364-364.

**Relevance of genotyping crossbred pigs for selection of nucleus purebred pigs for finisher traits.** / Sevillano, C.A.; Calus, M.P.L.; Neerhof, A.; Vandenplas, J.; Knol, E.F.; Bergsma, R.

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Vol. 25 Wageningen : Wageningen Academic, 2019. p. 288-288 (Book of Abstracts).

**Selective breeding as a mitigation tool for methane intensity of dairy cattle.** / de Haas, Y.; Koenen, Erwin; Veerkamp, R.F. .

Proceedings of the 7th GGAA – Greenhouse Gas and Animal Agriculture Conference: August 4th to 8th, Iguassu Falls/Brazil. ed. / Alexandre Berndt; Luiz Gustavo Pereira Ribeiro; Adibe Luis Abdalla. 2019. p. 43-43 (Documentos; No. 135).

**Whole genome sequence GWAS reveals muscularity in beef cattle differs across five cattle breeds.** / Doyle, J.L.; Berry, D.P.; Veerkamp, R.F.; Carthy, Tara R.; Walsh, S.W.; Purfield, Deirdre C. .

Book of Abstracts of the 70th Annual Meeting of the European Federation of Animal Science. Wageningen : Wageningen Academic Publishers, 2019. p. 210-210 (Book of Abstracts).

**Using a data lake stack in Animal Sciences.** / Schokker, D.; Athanasiadis, I.N.; Visser, B.; Veerkamp, R.F.; Kamphuis, C.

2019. 140-144 Paper presented at 9th European Conference on Precision Livestock Farming, ECPLF 2019, Cork, Ireland.

**Detection of reciprocal translocations using short read sequencing.** / Bouwman, A.C.; te Pas, M.F.W.; Derks, M.F.L.; Groenen, M.; Veerkamp, R.F.; Broekhuijse, Marleen L.W.J.; Harlizius, Barbara.

2019. Poster session presented at Gordon Research Conference, Lucca Barga, Italy.

**Big Data analytics in the animal production domain.** / Kamphuis, C.; Mollenhorst, H.; Veerkamp, R.F. 2019. Abstract from ICAR 2019, Prague, Czech Republic.

TV/ radio / social media / newspaper:

The Breed4Food research also significantly contributes to WUR-ABG's exposure to the outside world, most recently through the media attention related to the work on resilience indicators based on fine-scale measuring of phenotypes (in this case daily milk records).

### **NL Media**

Nieuwe Oogst - <https://www.nieuweoogst.nl/nieuws/2020/01/21/melkrobot-schat-aan-informatie-voor-fokkerij>

Boerderij - <https://www.boerderij.nl/Rundveehouderij/Nieuws/2020/1/Wageningen-UR-koeien-met-stabiele-melkproductie-gezonder-529563E/>

Landbouwleven België - <https://www.landbouwleven.be/6980/article/2020-01-20/data-van-melkrobot-helpt-om-probleemloze-koeien-te-fokken>

Melkvee - <https://www.melkvee.nl/artikel/233428-koeien-met-stabiele-productie-leven-langer-en-gezonder/>

Agriholland - <https://www.agriholland.nl/nieuws/artikel.html?id=219760>

Melkveebedrijf - <https://www.melkveebedrijf.nl/nieuwsartikel/2020/melkrobot-helpt-bij-het-fokken-van-probleemloze-koeien/b24g4c53o5935/>

Engineers Online - <https://www.engineersonline.nl/nieuws/id32400-melkrobots-helpen-melkkoeien-op-melkproductie-te-fokken.html>

### **ENG Media**

FeedStuffs - <https://www.feedstuffs.com/nutrition-health/milking-robot-data-help-select-trouble-free-cows>

FarmingUK - [https://www.farminguk.com/news/milking-robot-helps-breed-trouble-free-cows\\_54816.html](https://www.farminguk.com/news/milking-robot-helps-breed-trouble-free-cows_54816.html)

AgriLand Ireland - <https://www.agriland.ie/farming-news/robotic-milking-helps-breed-trouble-free-cows-study/>

Farmers Weekly Interactive - <https://www.fwi.co.uk/livestock/dairy/stable-daily-milk-yield-a-sign-of-trouble-free-cow>

Remaining deliverables (techniques, devices, methods, etc.):

New version of Mixblup and calc-GRM software