PPP final report
PPPs that have been finalized need to deliver a factual and financial final report. For the financial report an overview of the project expenses on realisation and financing should be give in a separate format.
Final reports will be published in their entirety on the TKI/top-sector websites. Please make sure there are no confidential matters in the report.
PPP final reports have to be submitted - pooled for each research organisation - before 1 April 2019 to the TKIs at info@tkitu.nl, or at info@tki-agrifood.nl.

General data	
PPP number	AF-12516
Title	Reduced methane emission of dairy cows (extension)
Theme	Klimaatneutraal
Research Institute(s) involved	WUR
Project leader research (name + email address)	H. Bovenhuis (henk.bovenhuis@wur.nl)
Coordinator (on behalf of private parties)	G. Willems (FrieslandCampina)
Contact persons of government	In succession: H. Smit/T. Martens/P. Bruins/E. Theune
Total project budget (k€)	156
Project website address	--
Starting date	1-1-2013
Final date	31-12-2016

Approval coordinator/consortium The final report has to be discussed with the coordinator/consortium. The TKI(s) like to be informed regarding potential comments on the final report.	
The annual report is …… by the coordinator on behalf of the consortium	v approved □ not approved
Potential comments regarding the final report	--

Brief description content/aim PPP What is the matter and what does the project contribute? What does the project deliver and what are the effects of its delivery?
This project aimed at increasing knowledge about methane emission by dairy cows in order to reduce the ecological footprint in dairy production. It was hosted as a part in a large TIFN project on methane emission redcturion and concerned in particular testing of the applicability of Fourier transform infrared (FTIR) spectroscopy for the analysis of milk samples by establishing the relationship between FTIR profiles and an indicator for methane emission based on air expelled by cows developed in the hosting project. The advantage of using FTIR spectra of milk samples is that these spectra are already routinely collected at low cost for most Dutch dairy cows. In case a - causal - relationship extists, infrared spectra of milk may be used to estimate methane emission of individual dairy cows as well as emission at herd level. This may be used for breeding and management purposes, like the use of proper feeding, to reduce methane emission levels.

Mutations with respect to the original project plan and follow-up	
Have there been changes in the consortium/project partners? If so, which?	No
Have there been factual changes in the project?	No
Has a patent application been filed from this PPP (or a priority filing)?	No
Has a spin-off developed from this project (contract research, additional funding or spin-off activity)?	No
How many years will the private parties need in practice to use results from this project?	As soon as established relationships for breeding and feed management have proven to be sound enough, the application of this low cost monitoring tool for methane emission reduction purposes in practice may be implemented within a few years.
How did the project contribute to the development of the research organisation involved? (e.g. scientific track record, new technology, new collaboration?	It fitted well in the expertise base of the executing research organisation and will contribute to their knowledge base to connect the scientific basis of methane production with effective mitigation measures in dairy cattle breeding and management practice.
Will there be a follow-up for the project such as a new project or a new collaboration? If so, please explain.	Basic research regarding the topic will continue to unravel underlying mechanisms and their impacts, which will add to the robustness of milk infrared spectroscopy as an indicator in practical use.

Results

What tangible results the project has yielded?

It was shown that methane emission predicted via milk FTIR profiles has genetic variation. Prediction models for methane based on milk composition as determined by FTIR spectroscopy are sensitive to the diets of dairy cows.

What are the effects of these results and for whom?

Genetic variation in methane emission can be utilized in breeding programs by breeders to breed for reduced emission by dairy cows.
Dairy farmers may use the results from their milk FTIR data which are measured in a daily routine as a dairy cattle management tool regarding - individual - feeding regimes.

What has not been delivered according to the original project plan and for what reason(s)?

None

Deliverables (give a short description per project deliverable)

In the hosting project models were developed to predict methane emission based on milk fat composition. For the database underlying these models also data were used from an adjacent project using different feedstock sources varying in their respective contributions to methane production. To determine the relationship between FTIR spectra of milk and methane emission, a large data set containing methane phenotypes recorded in climate respiration chambers and FTIR profiles of milk samples from various experiments were used. This data set was also used to develop methane production models using milk fatty acids, which is the current 'state-of-the-art' methane proxy derived from milk. The results suggest that milk fatty acids can predict methane emission better than FTIR, although the difference is small for methane intensity.
The FTIR based methane production models were used for milk samples from commercial dairy farms that had also been analysed used by methane emission in expelled air to demonstrate and quantify the genetic background of methane production.

Number of delivered products in 2018 (give titles and/or descriptions of products, or a link to the products on the project website, or other public websites).			
Scientific articles	Reports	Articles in professional journals	Lectures/workshops
5			1

Annex:

1. Scientific articles

Van Gastelen, S. and J. Dijkstra (2016). Prediction of methane emission from lactating dairy cows using milk fatty acids and mid-infrared spectroscopy. J. Sci. Food Agric. 96: 3963 - 3968.

Van Gastelen, S., H. Mollenhorst, E.C. Antunes-Fernandes, K.A. Hettinga, G.G. van Burgsteden, J. Dijkstra and J.L.W. Rademaker (2018). Predicting enteric methane emission of dairy cows with milk Fourier-transform infrared spectra and gas chromatography-based milk fatty acid profiles. J. Dairy Sci. 101: 5582 – 5598.

Van Engelen, S., H. Bovenhuis, P.P.J. van der Tol and M.H.P.W. Visker (2018). Genetic background of methane emission by Dutch Holstein Friesian cows measured with infrared sensors in automatic milking systems. J. Dairy Sci. 101: 2226 - 2234.

Bovenhuis, H. and M.H.P.W. Visker (2018). Letter to the editor: A response to Huhtanen and Hristov. J. Dairy Sci. 101: 9621 – 9622.

Van Engelen, S., H. Bovenhuis and M.H.P.W. Visker. Genetic background of milk mid-infrared predicted methane emission and relationship with sensor measured methane emission in Dutch dairy cows. To be resubmitted.

2. Lectures/workshops

Van Gastelen, S., H. Mollenhorst, E.C. Antunes-Fernandes, K.A. Hettinga, G.G. van Burgsteden, J. Dijkstra and J.L.W. Rademaker (2017). Using mid FTIR spectra and gas chromatography-based MFA profiles to predict CH_4 emission of dairy cows. Methagene final meeting, Caserta, Italy.