WAGENINGEN UNIVERSITY & RESEARCH

Climate change effects on aflatoxins in the dairy supply chain

H.J. van der Fels-Klerx, L.C. Vermeulen, A.K. Gavai, C. Liu

Background

Climate change is estimated to result into increased temperatures and rainfall in general, with more drought periods and heavy showers, in Europe. These effects are expected to affect the presence of aflatoxin B_1 (AFB1) in maize grown in Europe, and might impact aflatoxin M_1 (AFM1) in milk as well.

Objective

The aim of this study was to estimate effects of climate change on the presence of AFB1 in maize and AFM1 in milk, using a full chain modelling approach. As a case study, the focus was on maize grown in Eastern Europe, and imported to the Netherlands where it was used in compound feed for dairy cows.

Materials and methods

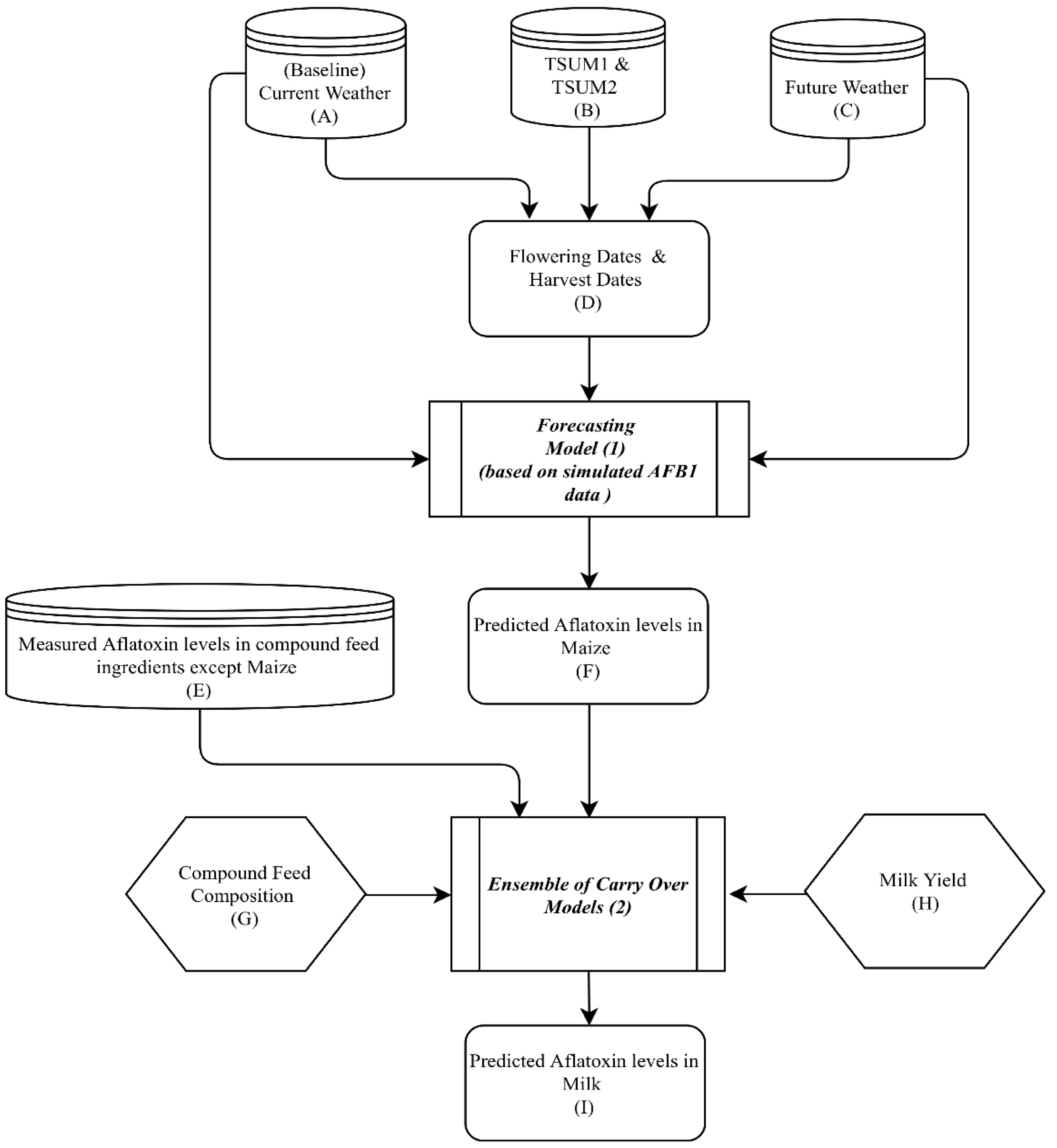

Figure 1. Schematic overview of the modelling framework.

Figure 1 presents the modelling approach. Data on current (A) and future (C) climate were used, together with TSUM data (B) to estimate maize flowering and harvest time (D). These dates were used as input into the forecasting model for AFB1 in maize (1). Predicted AFB1 levels in maize (F, Fig 2), together with AFB1 levels in other ingredients for compound feed (E) were used to estimate AFB1 intake of dairy cows, considering feed composition (G).Using transfer models (2), with the intake of AFB1 by dairy cows and data on milk yields as input, the levels of AFM1 in milk were estimated.

Three different climate models, one AFB1 forecasting model, and five transfer models, as published in literature, were used. Climate models considered were DMI, ETHZ, METO with 30 simulated years for 2030, and data from 2005-2017 as the baseline. Monte Carlo simulation with 10000 iterations was used to account for uncertainty and variation in input model parameters.

Results

All combinations of climate models (DMI, ETHZ, METO) and transfer models expected a similar or slight increase in the probability (+0.2%) of the AFM1 levels in milk exceeding EC legal limits (0.05 µg/kg) by 2030 (Table 1).

Table 1. Maximum weekly percentage of simulations above the EC limit of 0.05 µg/kg AfM1 in milk from the whole farm, assuming compound feed contains maize imported from Ukraine. This percentage is calculated as number of simulations above the threshold/10000 x 100%.

Transfer equation	Baseline	2030		
		DMI	ETHZ	METO
Masoero et al.2007	0.1	0.1	0.1	0.1
Veldman et al.1992	0.4	0.4	0.6	0.6
Britzi et al. 2013	0.1	0.1	0.2	0.2
Van Eijkeren et al. 2006	0.2	0.2	0.3	0.3
EFSA 2004	0.3	0.3	0.4	0.5

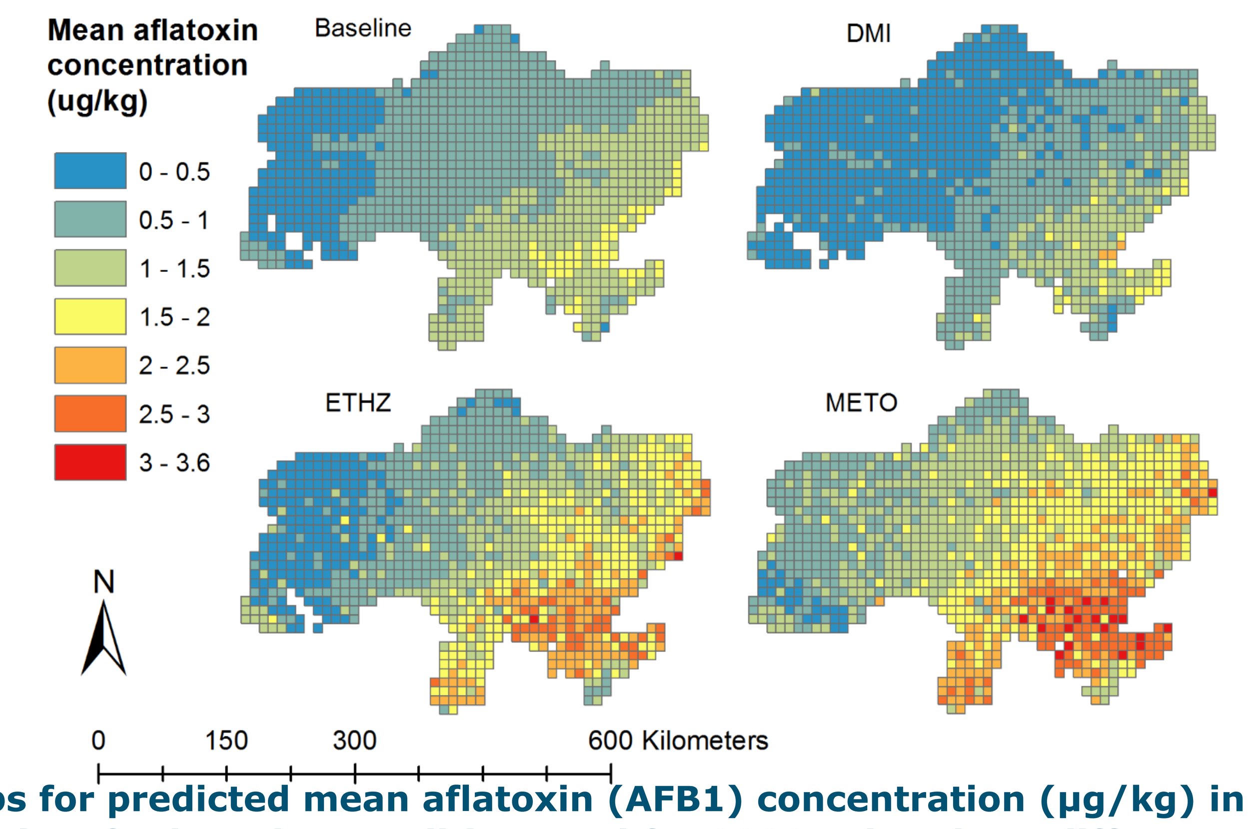

Figure 2. Maps for predicted mean aflatoxin (AFB1) concentration (µg/kg) in maize grown in Ukraine, for baseline conditions and for 2030 using three different climate models (DMI, ETHZ and METO)

Conclusions

- For 2 out of the 3 climate change models, maximum AFM1 in milk was expected to increase (up to 50%) by 2030, the other climate model suggested a decrease.
- The modelling framework is flexible and can be extended to other mycotoxins and supply chains.

Acknowledgements

This study was funded by Strategic Research funding of Wageningen Research, through the KB Big Data project. The authors acknowledge the Joint Research Centre of the European Commission for providing the calibrated temperature sums for maize from the MARS Crop Growth Monitoring System and its related database.

Wageningen Food Safety Research, part of
Wageningen University & Research
Contact: ine.vanderfels@wur.nl
T + 31 (0)317 481963, M +31 (0)6 23918224
www.wur.nl/food-safety-research

This study is published as:
Van de Fels-Klerx HJ, Vermeulen LC, Gavai AK, Liu C. 2019. Climate change impacts on aflatoxin B1 in maize and aflatoxinM1 in milk: A case study of maize grown in Eastern Europe and imported to the Netherlands. *PLOS ONE*. https://doi.org/10.1371/journal.pone.0218956.