National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

WAGENINGEN
UNIVERSITY & RESEARCH

FRONT OFFICE FOOD AND PRODUCT SAFETY

RISK ASSESSMENT OF PFASs IN FEED: TRANSFER OF PFASs DETECTED IN FEED TO EDIBLE PRODUCTS OF FOOD PRODUCING ANIMALS AND POSSIBLE ANIMAL HEALTH RISKS - PART I: Pig

Assessment requested by:	Office for Risk Assessment & Research (BuRO)
Assessment performed by:	RIVM and WFSR
Date of request:	13-12-2021
Date of assessment:	14-01-2022 (draft version)[1] 29-03-2023 (final)
Project number:	V/093130

Nederlandse samenvatting

Poly- en perfluoralkyl stoffen (PFAS) zijn een door de mens gemaakte groep chemicaliën die door hun gunstige chemische eigenschappen in veel producten verwerkt zijn of worden. Uitstoot naar het milieu vindt plaats door de productie en het gebruik van deze producten. PFAS worden aangetroffen in grond, grondwater, oppervlaktewater, drinkwater en voedsel, maar ook in biologische matrixen. Een eerdere *Front Office Voedsel- en Productveiligheid* (FO) beoordeling over de overdracht van GenX[1], perfluoroctaanzuur (PFOA) en perfluoroctaansulfonzuur (PFOS) uit slootwater en gras naar voedselproducerende dieren liet mogelijke gezondheidsrisico's zien voor consumenten die voor een lange periode veel zuivelproducten en vlees consumeren van (melk)koeien die uitsluitend worden blootgesteld aan vervuild slootwater en gras (RIVM 2021b). Vanuit het nationaal plan diervoeder zijn PFAS-concentraties in maiskuil, graskuil, lucerne en vismeel onderzocht. Naar aanleiding van deze meetgegevens heeft *Bureau Risicobeoordeling & Onderzoek* (BuRO) aan het FO gevraagd om vast te stellen in welke mate er overdracht is van PFAS in het geanalyseerde voer naar landbouwhuisdieren, of er risico's zijn voor de gezondheid van landbouwhuisdieren na blootstelling aan met PFAS besmet voer, en welke concentraties PFAS in het diervoeder aanwezig mogen zijn voordat maximumgehalten (ML's) in eetbare producten van landbouwhuisdieren overschreden worden. Deze ML's zijn sinds 1 januari 2023 van kracht (EC 1881/2006). In deze beoordeling (deel I) worden deze vragen beantwoord voor varkens. Deel II zal gaan over leghennen en vleeskuikens en deel III over vleesrunderen en melkvee.

Analyse van de vier diervoeders liet zien dat in graskuil en maiskuil geen PFAS boven de kwantificatielimieten zijn aangetroffen. Hetzelfde was het geval voor lucerne, met uitzondering van PFOS. In vismeel zijn veel PFAS gedetecteerd, boven detectielimieten. Aan reguliere vleesvarkens wordt geen graskuil, maiskuil en lucerne gevoerd. Echter wordt er incidenteel graskuil en maiskuil aan biologisch gehouden vleesvarkens gevoerd. Vismeel wordt soms toegevoegd aan het voer van biggen, maar dit wordt maar in hele

[1] For the completion of the assessment, it was decided to wait until the maximum levels were established.

[1] GenX refers to hexafluoropropyleneoxide dimer acid (HFPO-DA), or to its ammonium salt, as used in the GenX technology.

kleine hoeveelheden gedaan. Aangezien er voor lucerne geen innamegegevens bekend zijn voor vleesvarkens is voor dit ingrediënt geen overdracht berekend.

Om de effecten van PFAS op de diergezondheid voor varkens in te schatten is een literatuurstudie uitgevoerd en zijn experts geraadpleegd. Vier artikelen zijn gevonden (waarvan 1 review) die de gezondheidseffecten van PFAS of de kinetiek van PFAS beschrijven. Er zijn geen effecten op het welzijn van varkens vastgesteld, enkel werd in een studie een significant verlaagd *high-density*-lipoproteïne cholesterolgehalte in bloed vastgesteld in relatie tot de controlegroep. Deze effecten zijn echter gevonden bij een blootstelling van microminivarkens die een miljoen keer hoger was dan de worst-case blootstelling via het geanalyseerde voer. Ook de immuuneffecten die bij knaagdieren na blootstelling aan PFAS voorkomen, komen voor bij een blootstelling via voer die minimaal 700 keer hoger is dan de berekende maximale blootstelling en bij bloedconcentraties vele malen hoger dan geschat voor de berekende blootstelling. Op basis van deze gegevens zijn geen diergezondheidseffecten te verwachten na blootstelling aan de geanalyseerde concentraties in voer.

Om de overdracht van PFOS, PFOA, PFNA en PFHxS naar vlees en organen (lever en nier) van (biologische) varkens te kunnen schatten na blootstelling via voer (graskuil, maiskuil en vismeel) is gebruik gemaakt van een lineaire berekeningsmethode. In graskuil en maiskuil zijn geen PFAS aangetroffen boven de kwantificatielimiet (LOQ). Echter, overschrijding van de maximumgehalten (maximum levels; ML's) voor eetbare producten van biologisch gehouden vleesvarkens door consumptie van graskuil verontreinigd met PFNA en PFHxS op het huidige LOQ niveau, kan niet worden uitgesloten. Dit geldt ook voor maiskuil verontreinigd met PFOA, PFNA en PFHxS op het huidige LOQ niveau. Dit betekent dat de gevoeligheid van de gebruikte meetmethode onvoldoende is om overschrijding van de ML's voor vlees en orgaanvlees uit te sluiten. De ML's voor eetbare producten worden niet overschreden door blootstelling van vleesvarkens in een eerdere levensfase (als big) via vismeel.

Om de concentratie PFOS, PFOA, PFNA, en PFHxS in graskuil, maiskuil en vismeel resulterend in concentraties gelijk aan de ML's voor vlees en orgaanvlees te berekenen is eveneens gebruik gemaakt van een lineaire berekeningsmethode. De berekende concentraties van PFNA en PFHxS in graskuil en PFOA, PFNA en PFHxS in maiskuil waren 1.5 tot 23 keer lager dan de LOQ's van de gebruikte analysemethoden. De concentraties van PFAS in vismeel lagen boven de LOQ's van de gebruikte analysemethoden. WFSR werkt aan een verdere verlaging van de LOQ's voor diervoer.

Voor beide berekeningen zijn verschillende (worst-case) aannames gedaan die kunnen leiden tot een overschatting van de daadwerkelijke concentraties in dierlijke producten en daardoor tot een onderschatting van de concentraties in voer die resulteren in vleesgehaltes gelijk aan de ML's. Het verder ontwikkelen van kinetische modellen, meer kwantitatieve innamegegevens, het analyseren van relevante voeringrediënten voor varkens, het verlagen van de LOQ's en het includeren van precursors van PFAS in de analyse zullen bijdragen aan een beter inzicht in de daadwerkelijke blootstelling van varkens via diervoeder en resulterende gehaltes in vlees en orgaanvlees.

Subject

Within the Animal Feed National Plan (NP), various types of animal feed (maize silage, grass silage, lucerne and fishmeal) have been analysed for the presence of PFASs. The Office of Risk Assessment and Research (BuRO) would like to know whether there are risks for animal health following the consumption of PFAS-contaminated feed and whether maximum levels (MLs) in animal derived products are exceeded when animals are exposed to PFAS-contaminated feed at the reported levels. Recently MLs have been established for meat and offal originating from pig, poultry and bovine animals by the European Commission (EC 1881/2006).

Questions

BuRO asked FO the following questions:

1. Is there a risk to animal health when maize silage, grass silage, lucerne and fishmeal contaminated with PFASs (at levels found in the NP 2020) are fed to meat cows, dairy cows, pigs, laying hens and broilers?

2a. What is the transfer of the PFASs (PFOS, PFOA, PFNA, PFHxS) in the above mentioned contaminated feed ingredients to bovine meat/offal and milk, pig meat/offal, chicken eggs and chicken meat/offal. Compare the estimated concentrations with the MLs of these products.

2b. What is the level of PFASs (PFOS, PFOA, PFNA, PFHxS) in feed (maize silage, grass silage, lucerne and fishmeal) resulting in levels equal to the MLs for PFAS in products of animal origin? In the absence of an ML, please use the current LOQ in that product.

In this assessment (Part I), these questions are answered for pigs. In Part II and Part III, the questions will be answered for laying hens and broilers, and beef cattle and dairy cows. The conclusions in the box below only apply to pigs.

Conclusions

1. No health effects in pigs are expected based on the relatively low PFAS concentrations in feed obtained in the NP 2020 and the estimated blood concentrations in pigs following exposure through these feeds compared to the PFAS exposure in studies resulting in adverse effects of PFAS.

2a. Lucerne is not fed to pigs and was therefore not included in this assessment. No PFASs were detected in grass silage and maize silage above the limit of quantification (LOQ). Calculations using the LOQ levels as exposure concentrations show that exceedances of the MLs for edible products, following exposure of organically raised meat pigs to PFNA and PFHxS via grass silage and to PFOA, PFNA, PFHxS and the sum thereof via maize silage, cannot be excluded. This implies that LOQs should be lowered in the future. The MLs are not exceeded following exposure of piglets to fishmeal. Notably, regular meat pigs are not exposed to three out of four feed materials. To better assess feed to food transfer and risk to animal health, other feed ingredients fed in higher quantities should be included in the PFAS analysis.

2b. The concentrations in feed materials provided to (organically raised) meat pigs resulting in levels equal to the MLs in meat and offal can be found in the table below (average and incidental[2] exposure scenarios are separated by a slash symbol).

	Product	**PFOS (µg/kg)**	**PFOA (µg/kg)**	**PFNA (µg/kg)**	**PFHxS (µg/kg)**
Piglet fed fishmeal	Meat	789 / 79	2103 / 210	526 / 53	526 / 53
	Offal	502 / 50	59 / 5.9	33 / 3.3	42 / 4.2
Organically raised meat pig fed grass silage	Meat	0.77	2.06	0.51	0.51
	Offal	0.49	0.06	0.03	0.04
Organically raised meat pig fed maize silage	Meat	0.31	0.82	0.21	0.21
	Offal	0.20	0.02	0.01	0.02

Calculated concentrations of PFNA and PFHxS in grass silage, and PFOA, PFNA and PFHxS in maize silage, resulting in levels equal to the MLs for offal when fed to organically raised meat pigs, were below the LOQ. In addition, the calculated concentration of PFNA in maize silage resulting in levels equal to the ML for meat was below the LOQ.

[2] High intake that occurs only sporadically.

1. Introduction

Poly- and perfluoroalkyl substances (PFASs) are a diverse group of man-made chemicals with carbon-fluorine bonds, one of the shortest and strongest bonds known. The fluorinated tail and functional headgroup make PFASs both hydrophobic and hydrophilic, and highly persistent in the environment. As a result of these chemical properties, PFASs are used in many products and industrial processes (e.g. household products, textiles, fire-fighting foam, food packaging materials, construction) and are emitted to the environment through industries and the (re-)use of many PFAS-containing products. Due to these emissions, in combination with the highly persistent nature of PFASs, soil, water and vegetation may be polluted.

PFASs have also been detected in human matrixes, such as blood. For humans, one of the main routes of exposure to PFASs is through the consumption of contaminated food. Food can become contaminated through contaminated soil and water during cultivation of plants, through the accumulation of these substances in animals via feed, water and soil, through PFAS-containing food packaging and/or through PFAS-containing processing equipment. In 2021, the Front Office Food and Product Safety (FO) published the results of a revised risk assessment of GenX and perfluorooctanoic acid (PFOA) in food since the European Food Safety Authority (EFSA) established a tolerable weekly intake (TWI) for the sum of four PFASs (hereafter referred to as EFSA-4; PFOA, perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS)) (EFSA 2020; RIVM 2021a).

The transfer of several PFASs in ditch water and silage to edible products of food producing animals was determined in an earlier report (RIVM 2021b). The results of this report showed potential health risks for consumers regularly consuming dairy products and meat from dairy cows solely exposed to contaminated ditch water and grass in a worst-case scenario. Transfer of PFASs to edible products was also seen in meat pigs (Numata et al., 2014).

Within the National Plan Animal Feed in 2020, the presence of PFASs in animal feed (grass silage, maize silage, lucerne and fish meal) was determined. The results showed that several PFASs were detected in some of the analysed feed materials. As a result, BuRO asked the FO to determine whether the transfer of PFASs from these feed materials to food products of farm animals (pigs, dairy cows, meat cattle, laying hens and broilers) could result in levels above the maximum levels (MLs), whether there are health risks for farm animals due to intake of these feed materials, and what the levels of PFASs in feed should maximally be before the MLs for PFASs in products of animal origin are exceeded. Recently MLs have been established for meat and offal originating from pig, poultry and bovine animals by the European Commission (EC 1881/2006). In this Part I of the assessment, the questions in relation to pigs are addressed.

2. Methods

The methods are described in more detail in Appendix I. Other information used as input and to support the analysis and calculations can be found in Appendices II-VII.

a. Analysis of feed samples

In total, 25, 30, 40 and 32 samples of grass silage, maize silage, lucerne and fishmeal, respectively, were analysed according to an internal procedure, SOP-A-1114, at WFSR. Fresh material was extracted using acidified methanol. The final extracts were analysed by liquid chromatography coupled to tandem mass spectrometry. Isotopically labelled internal standards were added to all samples and quality control samples (^{13}C-PFOA and ^{13}C-GenX) to allow a more accurate quantification. The complete description of the analysis of the feed samples can be found in Appendix I. The LOQs of the analysis in the four feed materials can be found in Appendix II.

b. Feed consumption data for pigs and weight (of food products) at the time of slaughter

An overview of intake of grass silage, maize silage, lucerne and fishmeal for pigs is given in Appendix I, Table A1. The intake, the estimated slaughter time and the weight at which food products are produced are based on expert judgement (Department of Animal Nutrition, Wageningen University and Research) (Appendix I, Table A2). In short, piglets can be temporarily exposed to PFASs via fishmeal, and are slaughtered at an age of 6 months. Conventionally raised meat pigs are not fed any of the included feed materials. However, organically raised meat pigs can be fed grass and/or maize silage. Occasionally, pregnant and lactating sows are fed the four feed materials. However, since the number of sows used for meat at the end of their fertile lives compared to the number of meat pigs is negligible, and meat of sows is always incorporated in processed meat i.e. with meat of meat pigs, the concentrations of PFASs in meat of sows were not calculated. A more detailed description of the feed intake including the duration can be found in Appendix I.

c. Calculus

i. Maximum levels of PFASs in meat and offal

The transfer of PFASs to food products following exposure to each feed type during each life phase (Question 2a) was calculated with an average and incidental scenario[3], when available. The PFAS concentrations in meat and offal were thereafter compared with the MLs (EC 1881/2006). In this document the term offal summarises only the liver and kidney. In addition, the estimated concentrations in feed to prevent exceedance of these MLs in food are also calculated. In Table 1, the MLs for PFASs are listed (EC 1881/2006). Since only MLs for PFOS, PFOA, PFNA and PFHxS were established, and BuRO is only interested in these four PFASs, this assessment will not include calculations for other PFASs measured in the feed materials.

Table 1. Maximum levels (MLs) for PFASs in µg/kg wet weight (EC 1881/2006).

	PFOS (µg/kg)	**PFOA (µg/kg)**	**PFNA (µg/kg)**	**PFHxS (µg/kg)**	**Sum of 4⁺ PFASs**
Meat of bovine animals, pig and poultry	0.30	0.80	0.20	0.20	1.3

[3] High intake that occurs only sporadically. For more information see Appendix I, Table A1.

Offal of bovine animals, sheep, pig and poultry		0.70	0.40	0.50	8.0

$^{+}$: Sum of PFOS, PFOA, PFNA and PFHxS

i.i. *Transfer of PFASs from feed to pig meat and offal*

It is unlikely that pigs are fed several contaminated feed materials that are only fed occasionally, i.e. fishmeal in piglets and grass- and maize silage in organically raised meat pigs. Therefore, in the calculations, the concentrations of PFASs in food products of pigs are based on exposure to one single type of feed during one period in their life. In addition, it is assumed that the animals have no internal PFAS levels due to previous PFAS exposure (other feed materials, drinking water, soil, or in utero and during lactation). For meat pigs, the available transfer model was found unsuitable due to the short exposure duration (explained in chapter 7). The following method was used to calculate the transfer to edible products:

Piglets exposed through feed are slaughtered at a later stage in life. Due to the anticipated growth of the piglets, and the intake over a relatively short period of time, initial levels will decrease in time. The concentration (C_x) in meat/offal was determined using the following equation:

$$C_x = I_{cum,PFAS} \,/\, w_x \qquad (1)$$

in which $_x$ stands for meat or offal, $I_{cum,PFAS}$ represents the cumulative intake of PFASs of an animal during a specific life phase, and w_x represents the weight of the meat or offal (liver plus kidneys) at the moment of slaughter. For this calculation it is assumed that all PFASs will distribute to either meat or offal and no elimination will take place (worst-case assumptions). The intake and the weight of the edible products in relation to the total body weight can be found in Appendix I (Table A1 and A2).

i.i.i. *Concentrations in feed resulting in levels equal to the MLs*

The concentrations of PFOS, PFOA, PFNA and PFHxS in feed based on the MLs for pig meat and pig offal were calculated for the various feeds. These concentrations were also compared to the current LOQs (Appendix II) in feed.

Using the following equations, the concentrations ($C_{equal,x}$) in feed for piglets and organically raised meat pigs resulting in levels equal to the MLs were calculated:

$$I_{max,PFAS} = ML_x \cdot w_x \qquad (2a)$$

$$C_{equal,x} = I_{max,PFAS} \,/\, (T \cdot I_{daily\ feed}) \qquad (2b)$$

in which $_x$ stands for meat or offal, $I_{max,PFAS}$ is the maximum intake amount of a certain PFAS during the exposure period, ML_x is the maximum level of each PFAS in meat or offal (Table 1), w_x is the weight of the meat or offal at the time of slaughter, T is the period in days during which the animal is fed a certain feed type and $I_{daily\ feed}$ is the amount of feed consumption per day (T times $I_{daily\ feed}$ is the exposure scenario found in Table A1 of Appendix I). The weight of the edible products in relation to the total body weight can be found in Appendix I, Table A2. Also for this calculation it is assumed that all PFASs will distribute to either meat or offal, and no elimination will take place (worst-case assumptions).

d. Literature search for health effects of PFASs in pigs and transfer from feed to food in pigs

A (non-systematic) literature search was carried out to capture relevant literature to determine the health effects of PFASs in pigs and relevant transfer parameters/models of PFASs in pigs. The search terms were as follows: 'chemical name' AND pig(let) AND (health OR model). In total, two papers and one review describing health effects of pigs exposed to PFASs were identified. One paper described a transfer study and a kinetic model for meat pigs.

3. Results: PFASs in grass silage, maize silage, lucerne and fishmeal

The highest concentrations of each chemical detected per feed type above the LOQ or otherwise the LOQ (< number) is listed in Table 2. The results of the chemical analysis per sample of the four feed materials can be found in Appendices III-VI. The highest concentrations were combined with the maximum feed intakes to calculate the worst-case intake of PFASs. In grass silage and maize silage, the levels did not exceed the LOQs. Regarding lucerne, two out of 40 samples showed detectable levels of PFOS with a concentration of 0.068 µg/kg and 0.076 µg/kg. In fishmeal, 30 out of 32 samples showed detectable levels of PFASs. The other two samples were fishmeal made out of shrimp. One fishmeal sample contained ten different PFASs, of which five PFASs showed the highest concentrations in all analysed fishmeal samples. The number of samples in which certain PFASs were detected above the LOQ can be found in in brackets in Table 2.

Table 2. Highest concentrations found in the analysed feed samples in ng/g. When not detected above the limit of quantification (LOQ), the LOQs were listed (in italic, with <). The number of lucerne and fishmeal samples in which a certain PFAS was detected above the LOQ is listed in brackets.

PFAS	***Grass silage (µg/kg)***	***Maize silage (µg/kg)***	***Lucerne (µg/kg)***	***Fishmeal (µg/kg)***
n	*25*	*30*	*40*	*32*
PFPeA	*<4.00*	-	-	-
PFHxA	*<1.50*	*<1.30*	*<1.50*	2.70 (1)
PFHpA	*<0.15*	*<0.30*	*<0.10*	*<0.30*
PFOA	*<0.05*	*<0.10*	*<0.05*	0.44 (25)
PFNA	*<0.15*	*<0.30*	*<0.20*	1.50 (26)
PFDA	*<0.50*	*<0.30*	*<0.20*	1.40 (27)
PFUnDA	*<0.50*	*<0.30*	*<0.10*	3.10 (27)
PFDoDA	*<0.50*	*<0.10*	*<0.10*	0.58 (16)
PFTrDA	*<0.10*	*<0.30*	*<0.10*	2.00 (24)
PFTeDA	*<0.05*	*<0.10*	*<0.20*	0.29 (14)
PFHxDA	*<0.10*	-	*<0.10*	*<0.02*
PFODA	-	-	-	*<1.00*
PFBS	*<0.05*	*<0.20*	*<0.20*	*<1.00*
PFHxS	*<0.15*	*<0.10*	*<0.10*	0.55 (7)
PFHpS	*<0.05*	*<0.10*	*<0.20*	0.18 (6)
PFOS	*<0.15*	*<0.10*	0.076 (2)	12.00 (19)
PFDS	*<0.20*	*<0.10*	*<0.20*	*<0.04*
11Cl-PF3OUdS	*<0.50*	*<0.60*	*<0.50*	*<0.20*
9Cl-PF3ONS	*<1.00*	*<0.30*	*<1.00*	*<0.10*
NaDONA	*<0.05*	*<0.20*	-	-
GenX	*<2.00*	-	*<1.00*	-

n: number of samples analysed; - : not determined.

4. Results: Transfer of PFASs

The highest measured concentrations or concentrations at the LOQs for feed (in case all concentrations were below LOQ), were combined with the maximum feed intakes to calculate the highest (potential) intakes for piglets and organically raised meat pigs. Table 3 shows the estimated concentrations in meat and offal and whether they exceed the MLs. Table 4 shows the concentration in each type of feed that would result in concentrations in meat or offal equal to the MLs. To evaluate the current sensitivity of the analytical method, it is also shown whether (and to what extent) these calculated feed concentrations are below the current LOQs. The results are explained in more detail in Appendix I.

a. Piglets

i. *Transfer of PFASs from feed to meat and offal*

Piglets are not fed grass silage, maize silage or lucerne but may be exposed to PFASs through fishmeal during a relatively short period. Fishmeal is considered a luxury feed type and is not regularly fed to piglets. The concentrations in meat and offal were calculated using equation 1, assuming that all ingested PFOS, PFOA, PFNA, PFHxS is retained in the body and all PFASs distribute to either the meat or offal. The individual concentrations and the sum of the four PFASs in meat or offal in a pig at the time of slaughter (6 months) are all below the MLs (Table 3).

i.i. *Concentrations in feed resulting in levels equal to the MLs*

The concentrations in fishmeal fed to piglets resulting in levels equal to the MLs for PFOS, PFOA, PFNA, PFHxS were calculated using equation 2a and b. All of the calculated concentrations in fishmeal are above the LOQs (Table 4).

b. Meat pigs

i. *Transfer of PFASs from feed to meat and offal*

Conventional meat pigs are not fed the analysed feed materials. Organically raised meat pigs are not fed lucerne and fishmeal, but may be exposed through grass silage and maize silage. The concentrations of PFOS, PFOA, PFNA and PFHxS in meat and offal were calculated using equation 1. Feeding of grass silage and maize silage at LOQ levels leads to the exceedance of the MLs for offal of PFNA and PFHxS when fed grass silage, and of PFOA, PFNA, PFHxS and sum of 4 PFASs when fed maize silage. In addition, exceedance of the ML of PFNA in meat is seen when fed maize silage. This implies that the LOQs for some PFASs are too high to exclude exceedance of MLs in meat products.

i.i. *Concentrations in feed resulting in levels equal to the MLs*

The concentrations in feed were calculated using equation 2a and b. The concentrations of PFOA, PFNA and PFHxS in grass silage, and PFNA and PFHxS in maize silage resulting in levels equal to the MLs for offal are below the reported LOQs. In addition, the concentrations of PFNA in maize silage not causing exceedance of the MLs for meat is below the LOQ (Table 4).

Table 3. Overview of the MLs and the concentrations in meat and offal in a pig at the time of slaughter following exposure of a piglet through fishmeal or exposure of an organically raised meat pig through grass or maize silage. When multiple intake scenarios (average and incidental) are applicable, these are separated by a slash symbol. When the MLs for meat and offal are exceeded, the fold exceedance is added between brackets.

	Product	**PFOS (µg/kg)**	**PFOA (µg/kg)**	**PFNA (µg/kg)**	**PFHxS (µg/kg)**	**Sum 4⁺ PFASs (µg/kg)**
MLs	*Meat*	0.30	0.80	0.20	0.20	1.3
	Offal	6.0	0.70	0.40	0.50	8.0
*Piglet fed fishmeal**	*Meat*	*0.005 / 0.05*	*0.0002 / 0.002*	*0.0006 / 0.006*	*0.0002 / 0.002*	*0.0055 / 0.055*
	Offal	*0.143 / 1.43*	*0.005 / 0.05*	*0.018 / 0.18*	*0.007 / 0.07*	*0.173 / 1.73*
Organically raised meat pig fed grass silage#	*Meat*	*0.06*	*0.02*	*0.06*	*0.06*	*0.19*
	Offal	*1.83*	*0.61*	*1.83 [4.6x]*	*1.83 [3.7x]*	*6.11*
Organically raised meat pig fed maize silage#	*Meat*	*0.10*	*0.10*	*0.29 [1.5x]*	*0.10*	*0.58*
	Offal	*3.06*	*3.06 [4.4x]*	*9.17 [23x]*	*3.06 [6.1x]*	*18.3 [2.3x]*

+: Sum of PFOS, PFOA, PFNA and PFHxS

*: Concentrations of PFASs in a meat pig at the time of slaughter following exposure to PFASs through fishmeal fed during the piglet phase for 49 days.

#: Calculations based on LOQs, since no PFOS, PFOA, PFNA and PFHxS were detected above their LOQs in feed.

Table 4. Overview of the current feed LOQs and concentrations in the feed materials provided to pigs at various life stages resulting in levels equal to the MLs for meat and offal at the time of slaughter. When multiple intake scenarios (average and incidental) are applicable, these are separated by a slash symbol. When the calculated concentration in feed is below the LOQ, the fold difference is added between brackets.

	Product	**PFOS (µg/kg)**	**PFOA (µg/kg)**	**PFNA (µg/kg)**	**PFHxS (µg/kg)**
Current LOQs	*Fish meal*	*1.00*	*0.02*	*0.02*	*0.05*
	Grass silage	*0.15*	*0.05*	*0.15*	*0.15*
	Maize silage	*0.10*	*0.10*	*0.30*	*0.10*
Piglet fed fishmeal	*Meat*	*789 / 79*	*2103 / 210*	*526 / 53*	*526 / 53*
	Offal	*502 / 50*	*59 / 5.9*	*33 / 3.3*	*42 / 4.2*
Organically raised meat pig fed grass silage	*Meat*	*0.77*	*2.06*	*0.51*	*0.51*
	Offal	*0.49*	*0.06*	*0.03 [4.6x]*	*0.04 [3.7x]*
Organically raised meat pig fed maize silage	*Meat*	*0.31*	*0.82*	*0.21 [1.5x]*	*0.21*
	Offal	*0.20*	*0.02 [4.4x]*	*0.01 [23x]*	*0.02 [6.1x]*

5. Question 2a: Transfer of PFASs from feed to edible pig products

The results of the NP 2020 show that PFASs in grass silage and maize silage were not measured above the LOQ in any of the analyzed samples. However, when basing the calculations for grass silage and maize silage on the LOQ levels to determine whether exposure at these concentrations could lead to exceedance of the MLs, exceedance cannot be excluded for the included PFASs, except PFOS, in meat pigs. This indicates the need for the lowering of the quantification limits of the used analytical methods. It is important to consider that only organically raised meat pigs may be exposed to PFASs through grass and maize silage. Exposure of piglets through fishmeal does not lead to the exceedance of the MLs in meat or offal at the time of slaughter. Conventionally raised meat pigs are not fed any of the investigated feed materials.

Uncertainties in the PFAS transfer in pigs
In this assessment, assumptions for intake and transfer had to be made for PFOS, PFOA, PFNA and PFHxS. First of all, the intake was calculated based on the highest PFAS concentration detected in fishmeal or, in the case of grass silage and maize silage, on the LOQs. Based on the current concentrations in these feed ingredients, the actual exposure will likely be lower leading to lower transfer to meat and/or offal. Secondly, it was assumed that no elimination of PFASs took place. However, elimination is seen in pigs, depending on the specific PFAS (Numata et al. 2014). The elimination is, however, negligible in relatively short duration periods (including the exposure scenarios of the piglet and organically raised pig). Therefore, it is thought that the assumption only leads to a small overestimation of the concentrations in meat and/or offal. Thirdly, it was assumed that PFASs do not distribute throughout the body, but distributed solely to either the meat or offal. Numata et al. (2014) and Ehlers (2012) actually showed that a considerable part of most of the PFASs is present in the blood, and, depending on the PFAS, they were also present in meat, liver and kidneys after 22 days of exposure. They report that for PFOA and PFHxS around 50% accumulated in blood plasma, <7% in liver and <2% in kidney. PFOS accumulated for 23% in blood plasma, around 37% in liver and <2% in kidney. These three PFASs accumulated for 40-50% in meat (muscle and fat). The accumulation of PFNA is difficult to describe since all detected amounts were very low and even below the detection limit in meat. This implies that the assumption that the PFASs solely distribute to either meat or offal may be a rough overestimation of a factor 1.5 - 2 for meat for PFOA, PFHxS and PFOS. For offal, this will be at least a 17- and 33-fold overestimation for, respectively, PFOA and PFHxS, but only a 3-fold overestimation for PFOS. All assumptions combined will lead to an overestimation of the actual concentrations of individual PFASs in food products.

On the other hand, the assumption that meat pigs were only exposed through one feed material in their life time and were not exposed in utero and during lactation, can lead to an underestimation of the actual concentration of individual PFASs in food products. The actual exposure to PFASs is likely to be higher when exposure to other possible sources such as water and soil, or other feed (materials) is taken into account.

Numata et al. (2014) describe biomagnification factors (factors describing the link between concentrations in feed and in certain tissues). However, these are not applicable, since steady-state is not reached following the relatively short exposure periods applied in this assessment. In the future, the model by Numata et al. (2014) or generic physiologically-based kinetic models could be used to refine the calculations.

Notably, Kowalczyk et al. (2020) showed in their study with laying hens that precursors of some of the PFASs were found in the feed. They suggested that these precursors can be biotransformed in laying hens to PFOS and PFHxS. Numata et al. (2014) suggest that biotransformation of precursors in pigs could be slow, since it is not seen in the 21 days of the experiment. Whether biotransformation of precursors following long-term exposure adds to the total PFAS level is unclear. When determining PFAS transfer into edible products, feed should ideally also be analysed for possible precursors.

6. Question 2b: PFASs concentrations in feed of pigs resulting in levels equal to the MLs

The feed concentrations that would result in levels in meat and offal equal to the MLs are shown in Table 4. The results show that the calculated concentrations of PFNA and PFHxS in grass silage, and PFOA, PFNA and PFHxS in maize silage resulting in levels in meat and offal equal to the MLs are below the reported feed LOQs. Concentration in fishmeal resulting in levels equal to the MLs are all above the feed LOQs. Improving analytical methods to lower the feed LOQs will provide insight into the possible exceedance of MLs in meat and offal following exposure through feed.

Uncertainties in concentrations in feed resulting in levels equal to the MLs
The concentrations in feed resulting in levels in meat and offal exceeding the MLs are for some PFASs a lot lower than the LOQs. Lowering the analytical LOQs in combination with more insight into the feed consumption may reduce the uncertainty in the intake of PFAS's.

Similar assumptions as for Question 2a were made about the distribution and elimination of PFASs in meat pigs. These assumptions can lead to an underestimation of the calculated concentrations in feed (too low) resulting in levels equal to the MLs following transfer. For instance, the calculated level for PFHxS is 6-fold lower than the current LOQ for this PFAS in maize silage, but the difference could also be less than 6-fold due to the overestimation of transfer to offal.

However, the assumption that animals were only exposed through one type of feed in their life time, might cause that the calculated concentrations in feed, resulting in levels equal to the MLs, are not low enough, as animals can be exposed through various sources and to multiple PFASs. To take into account co-exposure to several PFASs via several feeds/sources, the PFAS concentrations in feed of meat pigs resulting in levels equal to the MLs may need to be even lower.

In this assessment, transfer of PFASs from grass silage, maize silage, and fishmeal were estimated for meat pigs. However, these feed ingredients are not consumed at all or not consumed in big quantities by meat pigs. It would be useful to analyse feed materials that are consumed by conventional meat pigs (in higher quantities) or compound feed. The feed ingredients fed to the selected animals can be found in Appendix VII.

7. Question 1: Health effects of PFASs in pigs

Three studies described animal welfare or toxic effects in pigs following exposure to PFASs. The studies of Numata et al. (2014) and Guruge et al. (2016) reported no clinical effects. The study of Sakuma et al. (2019) found effects at a cellular level in microminipigs.

Numata et al. (2014) determined the kinetics of PFASs in pigs (fattening pigs; German Landrace breed). Pigs (females, and castrated and uncastrated prepubescent males, body weight around 100 kg) were exposed to PFAS-contaminated feed or PFAS-free feed for 21 days (2 kg/day). The concentrations (in µg/kg) in the feed were 137 PFOS, 132 PFBS, 91.3 PFHxS, 47.8 PFHxA, 22.4 PFOA, 10.2 PFHpA and 3.99 PFHpS. The articles states that the health status of the fattening pigs was checked daily, however, the authors do not describe any effects on animal health, welfare or behavior. Since the health status was monitored and no animals were removed from the experiment, it can be assumed that no overt adverse effects were observed.

Guruge et al. (2016) determined the kinetics of perfluoroalkyl acids (PFASs) using microminipigs. In this study, three mature female microminipigs were exposed using a single gelatin capsule containing a nominal mixture of 3 mg/kg bw of each of the 10 tested substances (perfluorobutanoic acid (PFBA), PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFOS, see Appendix II for abbreviations). Two microminipigs were given a capsule without PFASs as control. Effects on microminipigs cannot fully be compared to meat pigs due to obvious (physiological) differences, but there are no studies investigating the effects on meat pigs. The article states that the health of the pigs was checked daily. Overall, no treatment-related clinical signs of sickness were observed during the entire time period of 21 days.

Using the same animal study it was investigated whether hepatic and renal gene expression, histopathology, as well as plasma clinical biochemistry was influenced following exposure to the PFASs mixture (Sakuma et al., 2019). Biochemistry analysis of plasma revealed significant reduction in lower high-density lipoprotein (HDL) cholesterol levels compared to the control group. Other markers such as LDL-cholesterol and triglyceride levels showed no consistent changes. Histopathology only showed a slight but insignificant decrease in liver glycogen content compared to the control group. Gene expression analysis showed that hepato-renal transcription of genes associated with cell proliferation, peroxisome proliferation, lipid metabolism, kidney injury and apoptosis were affected 21 days after PFASs exposure. The exposure at which these effects were seen were a thousand-fold higher than the study of Numata et al. (2014). Based on the analysed feed and assuming a body weight of 26 kg for piglets (49 day exposure to fishmeal), the estimated exposure levels would be 0.08 ng/kg bw/day for PFOA, 0.29 ng/kg bw/day for PFNA and 2.31 ng/kg bw/day for PFOS. Assuming a body weight of 110 kg for organically raised meat pigs (113 day exposure to maize silage) the estimated maximal exposure levels would be 0.45 ng/kg bw/day PFOA and PFOS, and 1.36 ng/kg bw/day PFNA. The highest exposure of 2.31 ng PFOS/kg bw based on the analysed feed is one million times smaller than the concentration of PFOS in the study of Sakuma et al. (2016). It is therefore unlikely that adverse health effects are expected.

This is also strengthened by the results of the latest PFAS risk assessment by EFSA (EFSA, 2020). In this risk assessment, it was concluded that the mice study by Peden-Adams et al. (2008), is the critical study for immune effects, i.e. reduced specific antibody response. The reported highest daily PFOS exposure with no effect was 0.166 µg PFOS/kg bw and the daily exposure at which a significant effect was observed was 1.66 µg PFOS/kg bw following 28 days of exposure. Based on the analysed feeds, the highest daily PFOS exposure for piglets is 0.002 µg PFOS/kg bw via fishmeal. For organically raised meat pigs this is 0.0003 µg PFOS/kg bw through grass silage and 0.0005 µg PFOS/kg bw through maize silage. Thus, the highest daily PFOS exposure used in the current assessment is at least 700 times lower than the exposure at which an immunological effect was observed in rats. This is more than the 100x uncertainty factor used for intra- and interspecies variation (Lautz et al., 2021), making occurrence of health effects in pigs after consumption of fishmeal, grass silage and maize silage highly unlikely.

Considering plasma levels potentially related to adverse effects, Guruge et al. (2016) reported that at the maximum blood concentrations of 0.38 mg/L PFOS no detrimental health effects were seen in pigs. In addition, recorded PFOS 'No Observable Adverse Effect Levels' (NOAELs) in rats include a blood concentration of 40 mg/L (Luebker et al., 2005a, 2005b; ToxConsult, 2016a). NTP (2019) observed a number of PFASs effects on the liver and thyroid hormones in rats at plasma levels in the lower range of 23.7 mg/L. However, at a blood concentration of 0.017 mg/L no effect regarding a reduced immune response by PFOS in mice were observed. Notably, these PFOS blood concentrations are much higher than the calculated blood PFOS concentration for piglets fed fishmeal (0.0006 mg/L), for organically raised meat pigs fed grass silage (0.00077 mg/L) and for organically raised meat pigs fed maize silage (0.00128 mg/L). The concentrations in porcine blood were calculated using the same approach as was done for the transfer calculation to meat and offal, i.e. it was assumed that PFASs do not distribute throughout the body, but distributed solely to blood. This additionally suggests that health effects for meat pigs exposed through the analysed feeds are highly unlikely.

8. Recommendations

- To reduce the number of assumptions made, and go from worst-case to a more realistic scenario, more insight in exposure and transfer are needed:
    - In the future, the model by Numata et al. (2014) or generic physiologically-based kinetic models could be used to refine the calculations.
    - It would be useful to analyse feed materials that are consumed in higher quantities by pigs and to gain even more insight in the feed intake for pigs for these and other more relevant feed materials.
- Since exposure to precursors of PFASs, next to PFASs, can affect the total concentration of PFASs in pigs, it is recommended to include known precursors in the analysis of the various feeds.
- It is advised that the LOQs of analytical method for the various feed materials are lowered.

9. Conclusions and answers

1. Is there a risk to animal health when maize silage, grass silage, lucerne and fishmeal contaminated with PFASs (at levels found in the NP 2020) are fed to pigs?

No health effects in pigs are expected based on the relatively low PFAS concentrations in feed obtained in the NP 2020 and the estimated blood concentrations in pigs following exposure through these feeds compared to the PFAS exposure in studies resulting in adverse effects of PFAS.

2a. What is the transfer of the PFASs (PFOS, PFOA, PFNA, PFHxS) in the above mentioned contaminated feed ingredients to pig meat/offal? Compare the estimated concentrations with the maximum levels (MLs) of these products.

Lucerne is not fed to pigs and was therefore not included in this assessment. No PFASs were detected in grass silage and maize silage above the limit of quantification (LOQ). Calculations using the LOQ levels as exposure concentrations show that exceedances of the MLs for edible products, following exposure of organically raised meat pigs to PFNA and PFHxS via grass silage and to PFOA, PFNA, PFHxS and the sum thereof via maize silage, cannot be excluded. This implies that LOQs should be lowered in the future. The MLs are not exceeded following exposure of piglets to fishmeal. Notably, regular meat pigs are not exposed to three out of four feed materials. To better assess feed to food transfer and risk to animal health, other feed ingredients fed in higher quantities should be included in the PFAS analysis.

2b. What is the maximum level of PFASs (PFOS, PFOA, PFNA, PFHxS) allowed in feed (maize silage, grass silage, lucerne and fishmeal) before the MLs for PFASs in porcine products are exceeded?

The concentrations in feed materials provided to (organically raised) meat pigs resulting in levels equal to the MLs in meat and offal can be found in the table below (average and incidental[4] exposure scenarios are separated by a slash symbol).

	Product	**PFOS (µg/kg)**	**PFOA (µg/kg)**	**PFNA (µg/kg)**	**PFHxS (µg/kg)**
Piglet fed fishmeal	Meat	789 / 79	2103 / 210	526 / 53	526 / 53
	Offal	502 / 50	59 / 5.9	33 / 3.3	42 / 4.2
Organically raised meat pig fed grass silage	Meat	0.77	2.06	0.51	0.51
	Offal	0.49	0.06	0.03	0.04
Organically raised meat pig fed maize silage	Meat	0.31	0.82	0.21	0.21
	Offal	0.20	0.02	0.01	0.02

Calculated concentrations of PFNA and PFHxS in grass silage, and PFOA, PFNA and PFHxS in maize silage, resulting in levels equal to the MLs for offal when fed to organically raised meat pigs, were below the LOQ. In addition, the calculated concentration of PFNA in maize silage resulting in levels equal to the ML for meat was below the LOQ.

[4] High intake that occurs only sporadically.

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Appendix 1: Detailed description of methods and results of transfer of PFASs in feed to edible products of pigs

1. Methods

a. Analysis of feed samples

The samples were analysed according to an internal procedure SOP-A-1114 at WFSR. One to five grams of fresh material (depending on the product) were extracted using acidified methanol. The extracts were cleaned using weak anion-exchange (WAX) solid phase extraction. After evaporation of the eluate, the residue was dissolved in mobile phase. The final extracts were analysed by liquid chromatography coupled to tandem mass spectrometry. Two ion transitions per compound were monitored according to international guidelines. Isotopically labelled internal standards were added to all samples and quality control samples (^{13}C-PFOA and ^{13}C-GenX) to allow a more accurate quantification.

As quality control, a calibration line was prepared in a relevant related product (e.g. silage or fishmeal) with addition of the PFASs from 0 to 5 ng/g. Additionally, chemical blanks were included in duplicate. Furthermore, with every series of samples, a random selection of samples was analysed as is and with addition of a relevant concentration of the PFASs (in some cases additional lower spike levels). Methods used for analysis were validated and accredited under the flexible scope. The limits of quantification (LOQs) can be found in Appendix II.

In total, 25, 30, 40 and 32 samples of grass silage, maize silage, lucerne (chunks, bales, pellets or packs) and fishmeal (fishmeal, salmon meal, pure shrimps, shrimp meal, tuna meal), respectively, have been analysed. The choice to analyse these four animal feeds within the National Plan Animal Feed is based on the conclusion of a report on the risks in the animal feed chain (BuRO 2019). In this report it is concluded that contamination of animal feed plays a role when animals are fed crops (grass, maize) from contaminated locations, and that fishmeal applied in feed can contribute to the exposure to PFASs (BuRO 2019). To answer question 1, 2a and 2b, only the concentrations of PFOS, PFOA, PFNA, PFHxS and the sum thereof were used, since for these PFASs MLs for animal derived products are available (EC 1881/2006).

b. Feed consumption of pigs

There is hardly any recent published information on the composition of the feed of pigs. As a results, the amount, duration and type of feed fed to pigs described in this section is estimated based on the expert judgement of (Department of Animal Nutrition, Wageningen Livestock Research). Intake is displayed as 88% dry matter (dm). An overview of the intake of grass silage, maize silage, lucerne and fishmeal for the piglets and organically raised meat pigs is given in Table A1.

Piglets are not fed grass silage, maize silage or lucerne. Since fishmeal is considered a luxury feed, piglets are not regularly fed this feed type. However, occasionally, fishmeal can be fed in the 7 weeks (49 days) after weaning. On average, max 0.1% of the feed during this stage is fishmeal. Incidentally, max 1% fishmeal can be fed to piglets. Based on an overall daily feed intake of 0.5 kg, piglets can be fed a total of max 0.0245 kg (0.1% * 0.5 kg/day * 49 days; average situation) or max 0.245 kg (1% * 0.5 kg/day * 49 days; incidental situation) of fishmeal during this life phase (Table A1).

Conventionally raised meat pigs are not fed any of the analysed feed materials. Organically raised meat pigs can be fed grass and maize silage at, respectively, max 0.2 kg dm and max 0.5 kg dm per day from week 11 to slaughter at 6 months of age. This amounts to max 22.6 kg dm grass silage (0.2 kg dm/day * (6 months * 30.5 days/month – 10 weeks * 7 days/week)) and max 56.5 kg dm maize silage (0.5 kg dm/day * (6 months * 30.5 days/month – 10 weeks * 7 days/week)) in total (Table A1).

Table A1. Feed consumption of pigs when fed the various feed materials

Phase	***Scenario***	***Grass silage***	***Maize silage***	***Lucerne***	***Fishmeal***
Piglet	*Average*	-	-	-	0.1% * 0.5 kg * 49 days = 0.0245 kg
	Incidental	-	-	-	1% * 0.5 kg * 49 days = 0.245 kg
Organically raised meat pig	*Average*	-	-	-	-
	Incidental	0.2 kg dm * (6 months * 30.5 days/month – 10 weeks * 7 days/week) = 22.6 kg dm	0.5 kg dm * (6 months * 30.5 days/month – 10 weeks * 7 days/week) = 56.5 kg dm	-	-

- : not fed, dm: dry matter.

c. Calculus (input values)

Table A2. Weight and age at which pigs are slaughtered for production.

Animal (phase)	***What type of food (products)?***	***When are these produced?***	***% of weight is meat***	***% of weight is offal (liver + kidneys)***
Meat pig(let)*	Meat + liver + kidney	At 122 kg, at 6 months[1]	52.8%[1]	1.68%[1]
Organically raised meat pig	Meat + liver + kidney	At 110 kg, at 6 months[2]	52.8%[1]	1.68%[1]

*: Piglet is not slaughtered as a piglet, but slaughtered as a (regular) meat pig. Suckling piglets are not exposed to feed and therefore not included in this assessment.

1: Source: van Raamsdonk et al. (2007): For a meat pig of 110 kg: 52.8% meat (43.0% muscle + 9.8% fat) and 1.68% offal (1.40% liver + 0.28% kidney).

2: Source: Het Varkensloket.be.

2. Results: Transfer of PFASs

a. Piglet fed fishmeal

i. *Transfer of PFAS from feed to meat and offal*

Piglets are not fed grass silage, maize silage or lucerne but may be exposed to PFASs through fishmeal. The concentration in the edible products (C_x) of meat pigs at the time of slaughter, exposed through fishmeal as piglets, were calculated using the following equation:

$$C_x = I_{cum.PFAS} / w_x \qquad (1)$$

in which $_x$ stands for meat or offal, $I_{cum.\ PFAS}$ represents the cumulative intake of PFAS of an animal during a specific life phase, and w_x represents the weight of the meat and offal at the moment of slaughter.

The highest concentrations detected in fishmeal can be found in Table 2 (main text). These concentrations (in µg/kg) were multiplied by the cumulative intake amount of the two intake scenario's (average intake: 0.0245 kg; incidental intake: 0.245 kg; Table A1) to obtain $I_{cum.\ PFAS}$ (Table A3, a). The cumulative intake is the combined intake of fishmeal over the 49 days in which fishmeal is fed. $I_{cum.\ PFAS}$ of the two scenarios was divided by the amount of meat (52.8% of 122 kg= 64.42 kg) or offal (kidneys + liver, 1.68% of 122 kg= 2.05 kg) of a meat pig at the time of slaughter (Appendix I, Table A2) to calculate the concentration in meat and offal (Table A3, b and c). This calculation was made under the worst-case assumption that no elimination will take place and that all PFASs will go into either the meat (b) or the offal (c).

The results show that none of the concentrations found in meat or offal following exposure of piglets to fishmeal leads to exceedance of the MLs of meat and offal.

Table A3. MLs and concentrations of PFASs in a meat pig at the time of slaughter following exposure to PFASs through feed containing fishmeal during the piglet phase.

	(a) Cumulative PFAS intake amount (µg)		***(b) Concentration in meat (µg/kg)***		***(c) Concentration in liver and kidney (µg/kg)***		***(d) MLs (µg/kg)***	
	Average scenario	*Incidental scenario*	*Average scenario*	*Incidental scenario*	*Average scenario*	*Incidental scenario*	*Meat*	*Offal*
PFOS	0.29	2.94	0.0046	0.046	0.143	1.43	0.30	6.0
PFOA	0.01	0.11	0.0002	0.002	0.005	0.05	0.80	0.70
PFNA	0.04	0.37	0.0006	0.006	0.018	0.18	0.20	0.40
PFHxS	0.01	0.13	0.0002	0.002	0.007	0.07	0.20	0.50
Sum PFOS, PFOA, PFNA, PFHxS	0.36	3.55	0.0055	0.055	0.173	1.73	1.3	8.0

i.i. *Concentration in feed resulting in levels equal to the MLs*
Piglets are not fed grass silage, maize silage or lucerne but may be exposed to PFASs through fishmeal. Therefore, only the concentrations in fishmeal that would lead to levels equal to the MLs for meat or offal were calculated. The concentrations were calculated using the following equations:

$$I_{max,PFAS} = ML_x \cdot w_x \qquad (2a)$$
$$C_{equal,x} = I_{max,PFAS} \,/\, (T \cdot I_{daily\ feed}) \qquad (2b)$$

In which $_x$ stands for meat or offal, $I_{max,PFAS}$ is the maximum intake amount of a certain PFAS during the set period, ML_x is the maximum level of each PFAS in meat or offal (Table 1, main text), w_x is the weight of the meat or offal at the time of slaughter, T is the period in days during which the animal is fed a certain feed type and $I_{daily\ feed}$ is the amount of feed consumption per day (T times $I_{daily\ feed}$ is the exposure scenario found in Table A1). Piglets are only exposed to PFASs through fishmeal since they are not fed grass silage, maize silage or lucerne.

The $I_{max,PFAS}$ of piglets during the 49 days period was calculated by multiplying the MLs for the corresponding PFAS for meat and offal (Table 1, main text) with the amount of meat (52.8% of 122 kg= 64.42 kg, Table A2) or offal (kidneys + liver, 1.68% of 122 kg= 2.05 kg) of a meat pig at the time of slaughter, respectively (Table A4, a). Next, these maximal intakes of PFASs when exposed at the ML for meat and offal were divided by the maximal intake of the two intake scenario's (average intake: 0.0245 kg; incidental intake: 0.245 kg; Table A1) to obtain the concentration in feed resulting in levels equal to the MLs for PFAS in meat of pigs (Table A4, b). This was repeated for the ML of PFASs in offal of pigs (Table A4, c). Since the maximal intake of the scenarios were used, the concentration in feed would be higher when the actual intake (of fishmeal) is lower. For this calculation it was assumed that no elimination of PFASs took place between intake and slaughter and all PFASs accumulate in either meat or offal.

None of the concentrations in fishmeal resulting in levels equal to either ML are below the LOQ.

Table A4. Current LOQs and concentrations of PFASs in fishmeal fed to a piglet resulting in levels equal to the MLs for meat or offal of a meat pig at the time of slaughter.

	(a) Max. intake amount (µg) in both scenarios		***(b) Concentration in feed (µg/kg) resulting in meat ML levels***		***(c) Concentration in feed (µg/kg) resulting in offal ML levels***		***(d) Current LOQs in fishmeal (µg/kg)***
	Meat ML	*Offal ML*	*Average scenario*	*Incidental scenario*	*Average scenario*	*Incidental scenario*	
PFOS	19.325	12.298	789	78.9	502	50.2	1.00
PFOA	51.533	1.435	2103	210	58.6	5.86	0.02
PFNA	12.883	0.820	526	52.6	33.5	3.35	0.02
PFHxS	12.883	1.025	526	52.6	41.8	4.18	0.05

b. Organically raised meat pig fed grass silage
i. *Transfer of PFASs from feed to meat and offal*
Organically raised meat pigs are not fed lucerne and fishmeal, but may be fed grass silage and maize silage. However, PFOS, PFOA, PFNA and PFHxS were not detected in grass silage above the LOQ (Table 2, main text) and the major question remaining is whether the sensitivity of the method was low enough to ensure that the MLs in meat and offal are not exceeded. The concentrations in the edible products of meat pigs at the

time of slaughter exposed through grass silage were calculated using equation 1 in combination with the LOQs of the method (Table A5, a).

These LOQs (in µg/kg) were multiplied by the cumulative intake amount of the intake scenario (incidental intake: 22.6 kg; Table A1) to obtain $I_{cum.\ PFAS}$ (Table A5, b). $I_{cum.\ PFAS}$ was divided by the amount of meat (52.8% of 110 kg= 58.08 kg) or offal (kidneys + liver, 1.68% of 110 kg= 1.85 kg) of an organically raised pig at the time of slaughter (Table A2) to calculate the concentration in meat and offal (Table A5, c and d). This calculation was made under the worst-case assumption that no elimination will take place and that all PFASs will go to either the meat (c) or offal (d).

The results show that PFNA and PFHxS could be found in offal at concentrations exceeding the MLs following exposure to grass silage with PFASs present at LOQ levels.

Table A5. MLs and concentrations of PFASs in a meat pig at the time of slaughter following exposure to PFASs at LOQ levels through grass silage. When the MLs for meat and offal are exceeded, the fold exceedance is added between brackets.

	(a) LOQs in grass silage (µg/kg)	***(b) Cumulative PFAS intake amount (µg)***	***(c) Concentration in meat (µg/kg)***	***(d) Concentration in liver and kidney (µg/kg)***	***(e) MLs (µg/kg)***	
		Incidental scenario	*Incidental scenario*	*Incidental scenario*	*Meat*	*Offal*
PFOS	0.15	3.39	0.0584	1.834	0.30	6.0
PFOA	0.05	1.13	0.0195	0.611	0.80	0.70
PFNA	0.15	3.39	0.0584	1.834 [4.6x]	0.20	0.40
PFHxS	0.15	3.39	0.0584	1.834 [3.7x]	0.20	0.50
Sum PFOS, PFOA, PFNA, PFHxS	na	11.30	0.1946	6.115	1.3	8.0

na: not applicable

i.i. *Concentration in feed resulting in levels equal to the MLs*

Organically raised meat pigs are not fed lucerne and fishmeal, but may be exposed to PFASs through grass silage and maize silage. The concentrations in grass silage that may lead to MLs levels for meat or offal were calculated using equation 2.

The $I_{max,PFAS}$ during the 6 month minus 10 week period was calculated by multiplying the MLs for the corresponding PFAS for meat and offal (Table 1, main text) with the amount of meat (52.8% of 110 kg= 58.08 kg, Table A2) or offal (kidneys + liver, 1.68% of 110 kg= 1.85 kg) of an organically raised pig at the time of slaughter, respectively (Table A6, a). Next, the maximal intake of each PFAS was divided by the maximal intake (incidental intake: 22.6 kg; Table A1) to obtain the concentration in grass silage resulting in levels equal to the MLs for PFASs in meat of pigs (Table A6, b). This was repeated for the ML of PFASs in offal of pigs (Table A6, c). Since the maximal intake was used to calculate these levels in feed, the concentrations in grass silage would be higher when the grass silage intake is lower. For this calculation it was assumed that no elimination of PFASs took place between intake and slaughter and that all PFASs will go to either the meat or offal.

The concentrations of PFNA and PFHxS in grass silage resulting in levels equal to the MLs for offal are, respectively, 4.6 and 3.7-fold lower than the respective LOQs.

Table A6. Current LOQs and concentrations of PFASs in grass silage fed to a organically raised meat pig resulting in equal levels to the MLs for meat or offal at the time of slaughter. The numbers in brackets symbolise the times the concentration is lower than the respective LOQ.

	(a) Max. intake amount (µg)		***(b)Concentration in feed (µg/kg) with meat ML***	***(c) Concentration in feed (µg/kg) with offal ML***	***(d) Current LOQs in maize silage (µg/kg)***
	Meat MLs	*Offal MLs*	*Incidental scenario*	*Incidental scenario*	
PFOS	17.424	11.088	0.77	0.49	0.15
PFOA	46.464	1.294	2.06	0.06	0.05
PFNA	11.616	0.739	0.51	0.03 [4.6x]	0.15
PFHxS	11.616	0.924	0.51	0.04 [3.7x]	0.15

c. Organically raised meat pig fed maize silage

i. *Transfer of PFAS from feed to meat and offal*

Organically raised meat pigs are not fed lucerne and fishmeal, but may be fed to grass silage and maize silage. However, PFOS, PFOA, PFNA and PFHxS were not detected in maize silage above the LOQ and the major question remaining is whether the sensitivity of the method was low enough to ensure that the MLs in meat and offal are not exceeded. The concentrations in the edible products of meat pigs exposed through maize silage were calculated using equation 1 in combination with the LOQs of the method (Table A7, a).

These LOQs (in µg/kg) were multiplied by the cumulative intake amount of the intake scenario (incidental intake: 56.5 kg; Table A1) to obtain $I_{cum.\ PFAS}$ (Table A7, b). $I_{cum.\ PFAS}$ was divided by the amount of meat (52.8% of 110 kg= 58.08 kg) or offal (kidneys + liver, 1.68% of 110 kg= 1.85 kg) of an organically raised pig at the time of slaughter (Table A2) to calculate the concentration in meat and offal (Table A7, c and d). This calculation was made under the worst-case assumption that no elimination will take place and that all PFASs will go to either the meat (c) or the offal (d).

The results show that PFOA, PFNA and PFHxS could be found in offal at concentrations exceeding the MLs following exposure to maize silage at LOQ levels. Concentrations of PFNA in meat exceeding the ML can also be found following exposure through maize silage.

Table A7. MLs and concentrations of PFASs in an organically raised meat pig at the time of slaughter following exposure to PFASs through maize silage. When MLs for meat and offal are exceeded, the fold exceedance is added between brackets.

	(a) LOQs in maize silage (µg/kg)	**(b) Cumulative PFAS intake amount (µg)**	**(c) Concentration in meat (µg/kg)**	**(d) Concentration in liver and kidney (µg/kg)**	**(e) MLs (µg/kg)**	
		Incidental scenario	*Incidental scenario*	*Incidental scenario*	*Meat*	*Offal*
PFOS	0.10	5.65	0.10	3.06	0.30	6.0
PFOA	0.10	5.65	0.10	3.06 [4.4x]	0.80	0.70
PFNA	0.30	16.95	0.29 [1.5x]	9.17 [23x]	0.20	0.40
PFHxS	0.10	5.65	0.10	3.06 [6.1x]	0.20	0.50
Sum PFOS, PFOA, PFNA, PFHxS	na	33.90	0.58	18.34	1.30	8.0

na: not applicable

i.i. *Concentration in feed resulting in levels equal to the MLs*

Organically raised meat pigs are not fed lucerne and fishmeal, but may be exposed to PFASs through grass silage and maize silage. The concentrations in maize silage that may lead to the ML levels for meat or offal were calculated using equation 2.

The $I_{max,PFAS}$ during the 6 month minus 10 week period was calculated by multiplying the MLs for the corresponding PFAS for meat and offal (Table 1, main text) with the amount of meat (52.8% of 110 kg= 58.08 kg, Table A2) or offal (kidneys + liver, 1.68% of 110 kg= 1.85 kg) of an organically raised meat pig at the time of slaughter, respectively (Table A8, a). Next, the maximal intake of each PFAS was divided by the maximal intake (incidental intake: 56.5 kg; Table A1) to obtain the concentration in maize silage leading to the ML level for PFASs in meat of pigs (Table A8, b). This was repeated for the ML of PFAS in offal of pigs (Table A8, c). Since the maximal intake was used to calculate the concentration in feed, the concentrations in maize silage will be higher when the intake of maize silage is lower. For this calculation it was assumed that no elimination of PFASs took place between intake and slaughter and that all PFASs will go to either the meat or the offal.

The concentrations of PFOA, PFNA and PFHxS in maize silage based on the MLs for offal are, respectively, 4.4, 23 and 6.1-fold lower the respective LOQs. In addition, the concentration of PFNA in maize silage based on the ML for meat is 1.5-fold below the LOQ.

Table A8. Current LOQs and concentrations of PFASs in maize silage fed to a organically raised meat pig resulting in levels equal to the MLs for meat or offal at the time of slaughter. The numbers in brackets symbolise the times the concentration is lower than the respective LOQ.

	(a) Max. intake amount (µg)*		**(b)Concentration in feed (µg/kg) with meat ML**	**(c) Concentration in feed (µg/kg) with offal ML**	**(d) Current LOQs in maize silage (µg/kg)**
	Meat MLs	*Offal MLs*	*Incidental scenario*	*Incidental scenario*	
PFOS	17.424	11.088	0.31	0.20	0.10
PFOA	46.464	1.294	0.82	0.02 [4.4x]	0.10
PFNA	11.616	0.739	0.21 [1.5x]	0.01 [23x]	0.30
PFHxS	11.616	0.924	0.21	0.02 [6.1x]	0.10

*: Values are the same as the values in Table A6, a as the MLs for meat and offal and the weights of the organically raised meat pigs are the same.

References Appendix I

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Appendix II – LOQs for PFAS analysis in µg/kg in feed

Full name	***Abbreviation***	***Grass silage***	***Maize silage***	***Lucerne***	***Fishmeal***
Perfluoropentanoic acid	PFPeA (C5)	4.00	-	-	-
Perfluorohexanoic acid	PFHxA (C6)	1.50	1.30	1.50	1.20
Perfluoroheptanoic acid	PFHpA (C7)	0.15	0.30	0.10	0.30
Perfluoroctanoic acid	PFOA (C8)	0.05	0.10	0.05	0.02
Perfluornonanoic acid	PFNA (C9)	0.15	0.30	0.20	0.02
Perfluordecanoic acid	PFDA (C10)	0.50	0.30	0.20	0.02
Perfluorundecanoic acid	PFUnA (C11)	0.50	0.30	0.10	0.04
Perfluordodecanoic acid	PFDoA (C12)	0.50	0.10	0.10	0.06
Perfluortridecanoic acid	PFTrDA (C13)	0.10	0.30	0.10	0.04
Perfluortetradecanoic acid	PFTeDA (C14)	0.05	0.10	0.20	0.03
Perfluorhexadecanoic acid	PFHxDA (C16)	0.10	-	0.10	0.02
Perfluoroctadecanoic acid	PFODA (C18)	-	-	-	1.00
Perfluorbutane sulfonic acid	PFBS (C4)	0.05	0.20	0.20	1.00
Perfluorhexane sulfonic acid	PFHxS (C6)	0.15	0.10	0.10	0.05
Perfluorheptane sulfonic acid	PFHpS (C7)	0.05	0.10	0.20	0.06
Perfluoroctane sulfonic acid	PFOS (C8)	0.15	0.10	0.05	1.00
Perfluordecane sulfonic acid	PFDS (C10)	0.20	0.10	0.20	0.04
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	0.50	0.60	0.50	0.20
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	1.00	0.30	1.00	0.10
Sodium dodecafluoro-3H-4, 8 dioxanonanoate	NaDONA	0.05	0.20	-	-
Hexafluoropropylene oxide dimer acid	GenX/HFPO-DA	2.00	-	1.00	-

- : not determined.

Appendix III – Analytical results of PFASs in grass silage

Number	1	2	3	4	5	6	7	8	9	10
SAMPLE_ID	200606737	200606738	200606739	200606979	200606980	200606981	200606982	200606983	200606984	200606985
VWA CODE	75090994	75091001	75091028	75091036	75091044	75091052	75179448	75179421	75179456	75411391
PRODUCT:	graskuil	graskuil	graskuil	graskuil	graskuil	graskuil	plantaardig voedermiddel eu=graskuil	plantaardig voedermiddel eu=graskuil	plantaardig voedermiddel eu=grakuil	graskuil
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	12-11-20	12-11-20	12-11-20	16-11-20	16-11-20	16-11-20	17-11-20	17-11-20	17-11-20	17-11-20
PFPeA (ng/g)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
PFUnDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
PFDoDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)										
PFBS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFHxS (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFHpS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFOS (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
GenX (ng/g)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Number	11	12	13	14	15	16	17	18	19	20
SAMPLE_ID	200606986	200606987	200607556	200607557	200607558	200607559	200607560	200607561	200607762	200607763
VWA CODE	75411375	75411383	75091079	75179502	75179472	75179499	75411413	75411367	75173164	75173148
PRODUCT:	graskuil	graskuil	graskuil	plantaardig voedermiddel eu=grassilage (graskuil)	plantaardig voedermiddel eu=grassilage (graskuil)	plantaardig voedermiddel eu= grassilage (graskuil)	kuilgras	kuilgras	graskuil	graskuil
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	17-11-20	17-11-20	18-11-20	19-11-20	19-11-20	19-11-20	19-11-20	19-11-20	20-11-20	20-11-20
PFPeA (ng/g)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
PFUnDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
PFDoDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)										
PFBS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFHxS (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFHpS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFOS (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
GenX (ng/g)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Number	21	22	23	24	25
SAMPLE_ID	200607928	200607929	200607930	200607936	200608374
VWA CODE	75173172	75173199	75179529	75411456	75173229
PRODUCT:	graskuil	graskuil	plantaardig voedermiddel eu=grassilage (graskuil)	kuilgras	graskuil
LAND VAN HERKOMST:	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	24-11-20	24-11-20	24-11-20	24-11-20	24-11-20
PFPeA (ng/g)	<4.0	<4.0	<4.0	<4.0	<4.0
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15
PFDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50
PFUnDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50
PFDoDA (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)					
PFBS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050
PFHxS (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15
PFHpS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050
PFOS (ng/g)	<0.15	<0.15	<0.15	<0.15	<0.15
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050
GenX (ng/g)	<2.0	<2.0	<2.0	<2.0	<2.0

Appendix IV – Analytical results of PFASs in maize silage

Number	1	2	3	4	5	6	7	8	9	10
SAMPLE_ID	200603930	200603931	200603932	200603933	200603934	200603935	200603936	200603937	200603938	200603939
VWA CODE	75410867	75410794	75090633	75172478	75090692	75090684	75090706	75410808	75410816	75090676
PRODUCT:	snijmais	snijmais	snijmais	maiskuil	snijmais	snijmais	snijmais	snijmais	snijmais	snijmais
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	13-10-2020	6-10-2020	6-10-2020	15-10-2020	12-10-2020	12-10-2020	12-10-2020	12-10-2020	7-10-2020	6-10-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
PFHpA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFOA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFNA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFUnDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFTeDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHxDA (ng/g)										
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
11Cl-PF3OUdS (ng/g)	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60
9Cl-PF3ONS (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
NaDONA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
GenX (ng/g)										

Number	11	12	13	14	15	16	17	18	19	20
SAMPLE_ID	200603940	200603941	200603942	200603943	200603944	200604424	200604425	200604426	200604427	200604428
VWA CODE	75410786	75078757	75090641	75078722	75090668	75179278	75411073	75179235	75179146	75410956
PRODUCT:	snijmais	snijmaiskuil	snijmais	snijmaiskuil	snijmais	plantaardig voedermiddel eu= snijmais	snijmais	plantaardig voedermiddel eu= snijmais	plantaardig voedermiddel eu=snijmais	snijmais
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	6-10-2020	1-10-2020	2-10-2020	1-10-2020	2-10-2020	22-10-2020	21-10-2020	21-10-2020	20-10-2020	19-10-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
PFHpA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFOA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFNA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFUnDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFTeDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHxDA (ng/g)										
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
11Cl-PF3OUdS (ng/g)	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60
9Cl-PF3ONS (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
NaDONA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
GenX (ng/g)										

Number	21	22	23	24	25	26	27	28	29	30
SAMPLE_ID	200604429	200604430	200604432	200604433	200604686	200604825	200604829	200605180	200605468	200605839
VWA CODE	75179138	75411111	75172486	75172516	75172648	75179286	75179294	75411235	75411251	75173067
PRODUCT:	plantaardig voedermiddel eu= snijmais	snijmais	snijmais	snijmais	snijmaiskuil	plantaardig voedermiddel eu=snijmais	plantaardig voedermiddel eu= snijmais	snijmais	snijmais	maiskuil
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	19-10-2020	22-10-2020	16-10-2020	16-10-2020	23-10-2020	26-10-2020	27-10-2020	29-10-2020	2-11-2020	4-11-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
PFHpA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFOA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFNA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFUnDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFTeDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHxDA (ng/g)										
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
11Cl-PF3OUdS (ng/g)	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60
9Cl-PF3ONS (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
NaDONA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
GenX (ng/g)										

Appendix V – Analytical results of PFASs in lucerne

Number	1	2	3	4	5	6	7	8	9	10
SAMPLE_ID	200598296	200598297	200598298	200598299	200598300	200598718	200599402	200599403	200599404	200599405
VWA CODE	75090498	75090536	75090471	75090528	75090501	75421745	75180829	75180802	75180772	75180799
PRODUCT:	lucerne brok	timothee brok	lucerne brok	esparcette brok	lucerne pakken	plantaardig voedermiddel eu=lucerne	lucernepellets	lucernepellets	lucernepellets	lucernepellets
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	18-08-2020	18-08-2020	18-08-2020	18-08-2020	18-08-2020	20-08-2020	26-08-2020	26-08-2020	26-08-2020	26-08-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFUnDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFOS (ng/g)	<0.050	<0.050	<0.050	0.068	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)										
GenX (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Number	11	12	13	14	15	16	17	18	19	20
SAMPLE_ID	200599406	200599407	200599408	200599465	200599466	200599467	200599469	200599470	200600119	200600120
VWA CODE	75180764	75421753	75421761	75421877	75421893	75421915	75421907	75421842	75410697	75410719
PRODUCT:	lucernepellets	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	lucerne	lucerne
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	26-08-2020	26-08-2020	26-08-2020	27-08-2020	27-08-2020	27-08-2020	27-08-2020	27-08-2020	03-09-2020	03-09-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFUnDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFOS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)										
GenX (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0				

Number	21	22	23	24	25	26	27	28	29	30
SAMPLE_ID	200600121	200600122	200600123	200600124	200604092	200604094	200604123	200604124	200604126	200604462
VWA CODE	75410689	75180837	75410727	75410743	75410921	75410883	75410913	75410891	75410905	75179197
PRODUCT:	lucerne	lucerne	lucerne	lucernepellets	lucernepellets	lucernepellets	lucernepellets	lucernepellets	lucernepellets	plantaardig voedermiddel eu= lucerne
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
DATUM MONSTERNAME:	03-09-2020	03-09-2020	03-09-2020	03-09-2020	15-10-2020	15-10-2020	15-10-2020	15-10-2020	15-10-2020	20-10-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFUnDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFOS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)										
GenX (ng/g)										

Number	31	32	33	34	35	36	37	38	39	40
SAMPLE_ID	200604830	200604831	200604832	200605761	200605764	200605766	200610448	200610449	200610450	200610455
VWA CODE	75411154	75411162	75411189	75090951	75090935	75090919	75419899	75419902	75419872	75419864
PRODUCT:	lucerne	lucerne	lucerne	lucerne balen	timotee brok	lucerne brok	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne	plantaardig voedermiddel eu= lucerne brok
LAND VAN HERKOMST:	NL	NL	NL	NL	NL	NL	FR	NL	NL	NL
DATUM MONSTERNAME:	27-10-2020	27-10-2020	27-10-2020	03-11-2020	03-11-2020	03-11-2020	03-11-2020	03-12-2020	03-12-2020	03-12-2020
PFPeA (ng/g)										
PFHxA (ng/g)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
PFHpA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFOA (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
PFNA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFUnDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFDoDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTrDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFTeDA (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxDA (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFODA (ng/g)										
PFBS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFHxS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PFHpS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PFOS (ng/g)	<0.050	<0.050	<0.050	<0.050	0.076	<0.050	<0.050	<0.050	<0.050	<0.050
PFDS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
11Cl-PF3OUdS (ng/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
9Cl-PF3ONS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NaDONA (ng/g)										
GenX (ng/g)					<1.0					

Appendix VI – Analytical results of PFASs in fishmeal

Number	1	2	3	4	5	6	7	8	9	10
SAMPLE_ID	200578884	200580520	200580521	200582336	200587859	200587860	200590948	200593209	200593333	200596980
VWA CODE	86426226	86026872	86026899	86266997	86198509	86198487	86124637	86210851	86287897	86098547
PRODUCT:	vismeel	vismeel	vismeel``	vismeel	vismeel	vismeel	vismeel	vismeel	vismeel	vismeel
LAND VAN HERKOMST:	PE	NL	NL	DE	PE	MA	NL	DE	DE	NL
DATUM MONSTERNAME:	07-01-20	20-02-20	20-02-20	09-03-20	11-05-20	07-05-20	08-06-20	02-07-20	02-07-20	21-07-20
PFPeA (ng/g)										
PFHxA (ng/g)	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	2.7	<1.2	<1.2	<1.2
PFHpA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
PFOA (ng/g)	0.057	<0.020	0.14	0.066	0.080	0.11	0.088	0.20	0.18	0.068
PFNA (ng/g)	0.058	0.81	0.79	0.23	0.14	0.15	<0.020	0.68	0.57	0.10
PFDA (ng/g)	0.039	0.45	1.0	0.28	0.041	0.10	<0.020	0.66	0.68	0.13
PFUnDA (ng/g)	0.11	0.90	1.8	0.49	0.080	0.20	<0.040	1.6	1.7	0.42
PFDoDA (ng/g)	<0.060	0.24	0.49	0.11	<0.060	<0.060	<0.060	0.46	0.52	0.068
PFTrDA (ng/g)	0.063	0.67	1.3	0.29	<0.040	0.11	<0.040	0.57	0.95	0.17
PFTeDA (ng/g)	<0.030	0.14	0.25	0.064	<0.030	<0.030	<0.030	0.20	0.20	0.075
PFHxDA (ng/g)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
PFODA (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PFBS (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
PFHxS (ng/g)	<0.050	0.099	<0.050	0.10	0.083	0.070	<0.050	<0.050	<0.050	<0.050
PFHpS (ng/g)	<0.060	<0.060	0.076	<0.060	x	x	<0.060	0.066	0.078	<0.060
PFOS (ng/g)	<1.0	2.8	7.3	1.9	<1.0	<1.0	<1.0	5.9	6.0	<1.0
PFDS (ng/g)	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
11Cl-PF3OUdS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
9Cl-PF3ONS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
NaDONA (ng/g)										
GenX (ng/g)										

x: detected

Number	11	12	13	14	15	16	17	18	19	20
SAMPLE_ID	200596987	200596989	200596998	200597076	200597078	200597081	200597082	200597300	200599759	200599954
VWA CODE	86089726	86089661	86550393	86592223	86592258	86426617	86089718	86426625	86287935	86550407
PRODUCT:	vismeel batchnum mer: l:b5/20-07-03 tht-datum 03-07-2021 seelowe bioceval cuxhaven de 03 352 0001 08	vismeel cpsp90 handelsdo cument 9709 15-05-2020 1000 kg	fischmehl/ fishmeal zak 25 kg vismeel batchnr. 200094 - a8507	voedermid del vismeel 65% re batch 200140. zakgoedle verdatum 28-07-2020	voedermid del vismeel 65% re zakgoed tht 17/8/2020	salmonme al	garnalenm eel batchnum mer 15-01-2020produ ctiedatum: 12-01-2020produ ctnummer : 43010300	pure shrimp	vismeel gehydrolis eerd	garnalenm ehl batchnum mer 17.03.2020
LAND VAN HERKOMST:	-	-	DK	MA	PE	NL	NO	NL	FR	DE
DATUM MONSTERNAME:	22-07-20	22-07-20	27-07-20	29-07-20	29-07-20	25-07-20	22-07-20	25-07-20	31-08-20	31-08-20
PFPeA (ng/g)										
PFHxA (ng/g)	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2			<1.2	
PFHpA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<7.0	<7.0	<0.30	<7.0
PFOA (ng/g)	0.22	<0.020	0.067	0.11	0.12	0.088	<1.5	<1.5	<0.020	<1.5
PFNA (ng/g)	0.67	1.1	0.12	0.12	0.28	<0.020	<1.0	<1.0	0.73	<1.0
PFDA (ng/g)	0.56	0.92	0.11	0.092	0.17	<0.020	<1.0	1.4	0.60	1.4
PFUnDA (ng/g)	1.2	3.1	0.39	0.20	0.46	<0.040	<1.0	1.5	1.5	1.4
PFDoDA (ng/g)	0.27	0.58	0.077	<0.060	0.12	<0.060	<1.0	<1.0	0.38	<1.0
PFTrDA (ng/g)	0.77	2.0	0.17	0.071	0.28	<0.040			1.5	
PFTeDA (ng/g)	0.16	0.29	0.068	<0.030	0.080	<0.030	<1.0	<1.0	0.17	<1.0
PFHxDA (ng/g)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.50	<0.50	<0.020	<0.50
PFODA (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			<1.0	
PFBS (ng/g)										
PFHxS (ng/g)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<2.5	<2.5	<0.050	<2.5
PFHpS (ng/g)	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060			<0.060	
PFOS (ng/g)	3.3	3.3	<1.0	<1.0	2.0	<1.0	<2.0	5.2	3.4	4.9
PFDS (ng/g)	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<3.0	<3.0	<0.040	<3.0
11Cl-PF3OUdS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			<0.20	
9Cl-PF3ONS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10			<0.10	
NaDONA (ng/g)							<2.0	<2.0		<2.0
GenX (ng/g)										

Number	21	22	23	24	25	26	27	28	29	30
SAMPLE_ID	200599955	200599993	200600924	200601493	200601505	200601507	200601509	200604197	200604821	200604822
VWA CODE	86550423	86550415	86111934	86552566	86287978	86112043	86112078	86529432	86548526	86548534
PRODUCT:	vismeel	zalmmeel	vismeel (marokko fishmehl 65% behandelt)	vismeel (fishbone meal)	zalmmeel	tonijnmeel	garnalenmeel	vismeel batchnr: l:b5/20.03.03productiedatum: 03-03-2020	vismeel. 2202. export.	vismeel. 31287.
LAND VAN HERKOMST:	NO	NO	MA	NL	NL	IT	IT	DE	-	DK
DATUM MONSTERNAME:	31-08-20	31-08-20	08-09-20	14-09-20	14-09-20	14-09-20	14-09-20	12-10-20	23-10-20	23-10-20
PFPeA (ng/g)										
PFHxA (ng/g)	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2	<1.2	<1.2
PFHpA (ng/g)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<7.0	<0.30	<0.30	<0.30
PFOA (ng/g)	0.44	0.13	0.15	0.060	0.039	0.16	<1.5	0.20	0.15	0.20
PFNA (ng/g)	1.5	0.055	0.21	0.26	0.16	0.25	<1.0	0.55	0.27	0.52
PFDA (ng/g)	0.75	<0.020	0.11	0.21	0.14	0.33	<1.0	0.38	0.15	0.34
PFUnDA (ng/g)	1.1	<0.040	0.28	0.43	0.35	1.2	<1.0	1.2	0.55	0.84
PFDoDA (ng/g)	0.24	<0.060	<0.060	0.10	<0.060	0.27	<1.0	0.19	<0.060	0.12
PFTrDA (ng/g)	0.32	<0.040	0.095	0.24	0.20	0.40		0.44	0.36	0.27
PFTeDA (ng/g)	0.068	<0.030	<0.030	0.055	<0.030	0.11	<1.0	<0.030	<0.030	<0.030
PFHxDA (ng/g)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.50	<0.020	<0.020	<0.020
PFODA (ng/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0
PFBS (ng/g)	<1.0							<1.0	<1.0	<1.0
PFHxS (ng/g)	0.55	<0.050	<0.050	0.065	<0.050	<0.050	<2.5	<0.050	<0.050	0.34
PFHpS (ng/g)	0.18	<0.060	<0.060	<0.060	<0.060	<0.060		<0.060	<0.060	0.14
PFOS (ng/g)	12	<1.0	1.0	1.4	<1.0	1.5	<2.0	2.8	2.0	9.8
PFDS (ng/g)	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<3.0	<0.040	<0.040	<0.040
11Cl-PF3OUdS (ng/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20	<0.20
9Cl-PF3ONS (ng/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
NaDONA (ng/g)							<2.0			
GenX (ng/g)										

Number	31	32
SAMPLE_ID	200606480	20060668 7
VWA CODE	86529645	86553104
PRODUCT:	marokkaan s vismeel	vismeel
LAND VAN HERKOMST:	MA	-
DATUM MONSTERNAME:	11-11-20	11-11-20
PFPeA (ng/g)		
PFHxA (ng/g)	<1.2	<1.2
PFHpA (ng/g)	<0.30	<0.30
PFOA (ng/g)	0.19	0.14
PFNA (ng/g)	0.22	0.13
PFDA (ng/g)	0.11	0.11
PFUnDA (ng/g)	0.29	0.29
PFDoDA (ng/g)	<0.060	<0.060
PFTrDA (ng/g)	0.10	0.10
PFTeDA (ng/g)	<0.030	<0.030
PFHxDA (ng/g)	<0.020	<0.020
PFODA (ng/g)	<1.0	<1.0
PFBS (ng/g)	<1.0	<1.0
PFHxS (ng/g)	<0.050	<0.050
PFHpS (ng/g)	<0.060	<0.060
PFOS (ng/g)	1.3	<1.0
PFDS (ng/g)	<0.040	<0.040
11Cl-PF3OUdS (ng/g)	<0.20	<0.20
9Cl-PF3ONS (ng/g)	<0.10	<0.10
NaDONA (ng/g)		
GenX (ng/g)	31	32

Appendix VII – Feed regularly fed to pigs (in Dutch)

Feed composition, for pigs. Qualitative, global by descending proportion

Varkens
tarwe
gerst
mais
tarwebijproducten (m.n. tarwegries)
sojaschroot en -schillen/hullen
raapzaadschroot/schilfers
zonnebloemzaadschroot
bietenpulp
bakkerijbijproducten (bijv. broodmeel)
Vochtrijk krachtvoer, 10-15%
tarwezetmeel
aardappelstoomschillen
tarwegistconcentraat
weiproducten

Provided by the department of Animal Nutrition, Wageningen Livestock Research. Based on the availability of the products and the prices in 2020.