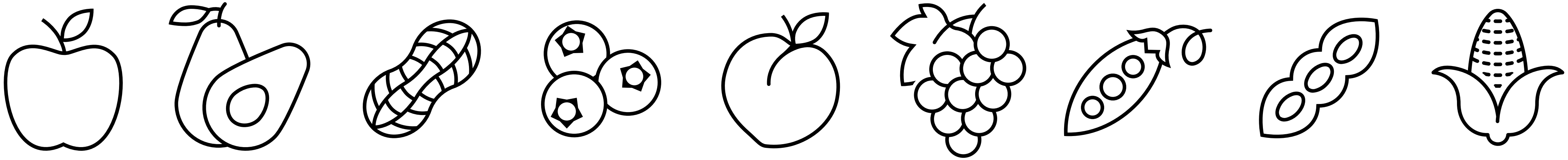

Underestimated human exposure to fluoroethers through garden produce near a fluorochemical manufacturer in North Carolina

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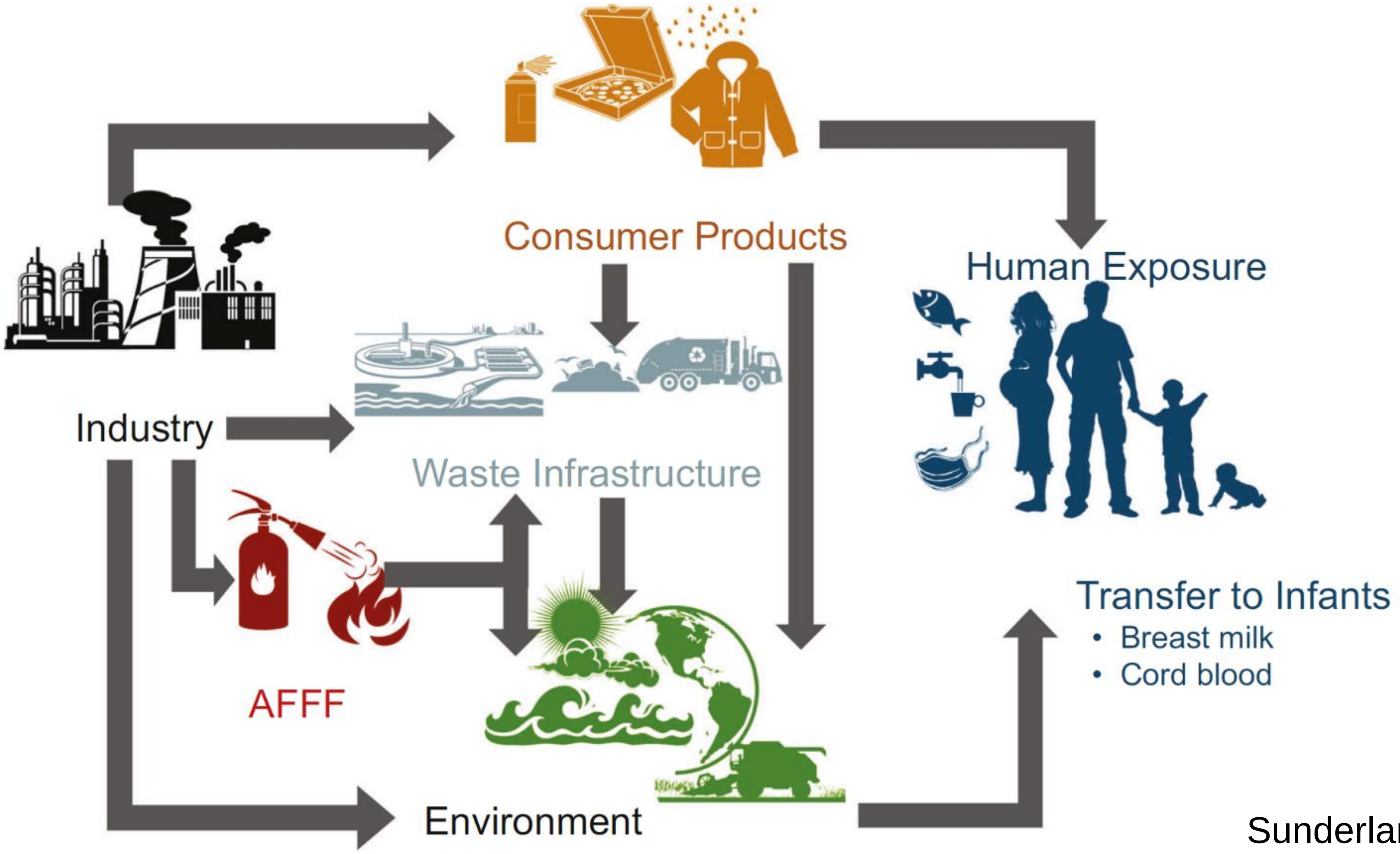
[4] Dept of Civil and Environmental Engineering, Colorado School of Mines

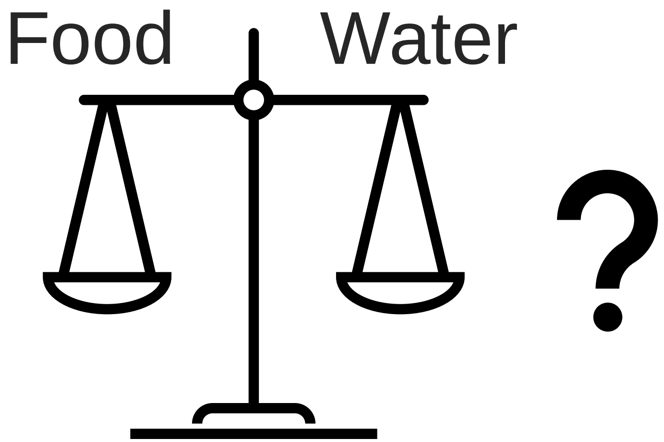
Washington DC
September 10, 2024

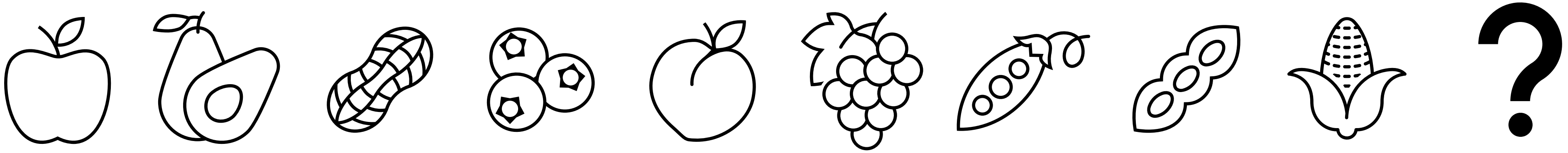
Humans can be exposed to PFAS through many pathways



Sunderland et al., 2018

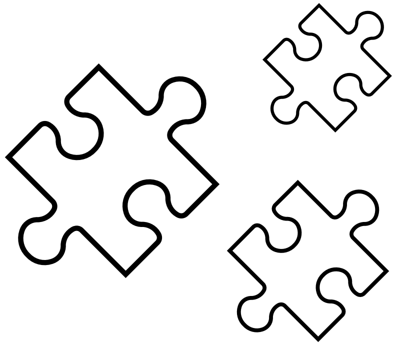
PFAS exposure through diet, particularly via agricultural crops, remains less understood





Sunderland et al., 2018

Challenges in understanding PFAS exposure through agricultural crops



- ❑ PFAS analysis in complicated matrices
- ❑ Legacy PFAS vs. emerging PFAS
- ❑ PFAS mitigation pathways from groundwater/soil to edible parts of agricultural products
- ❑ Abatement technology in reducing PFAS in edible parts of agricultural products

……

PFAS exposure in frontline communities

Michigan: Investigation of PFAS exposure via drinking water and diet in Parchment & Cooper Township

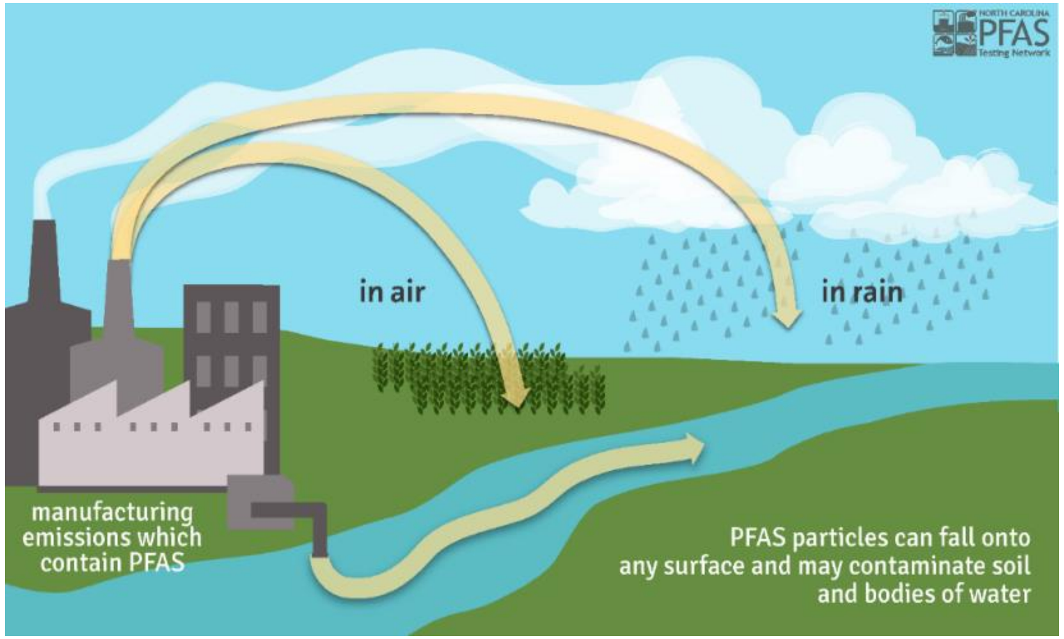
North Carolina: PFAS in **residential garden produce** in an impacted community in Fayetteville, NC

https://www.pfasunitedd.org/

Novel perfluoroalkyl ether acids in North Carolina

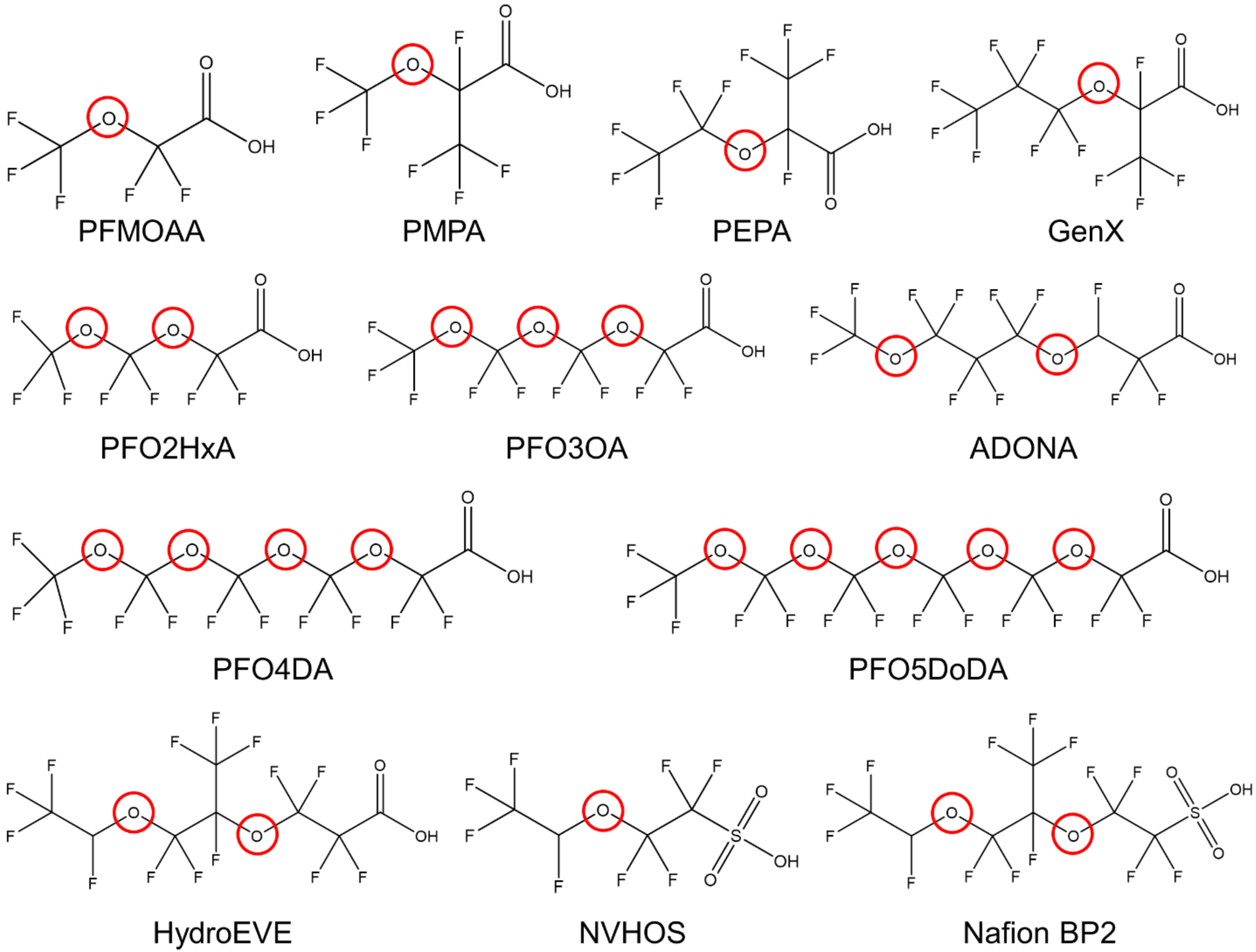
- In 2017, GenX was found in drinking water sources in the Cape Fear River basin of North Carolina.

- The Chemours facility in Fayetteville was identified as the source of GenX chemicals.

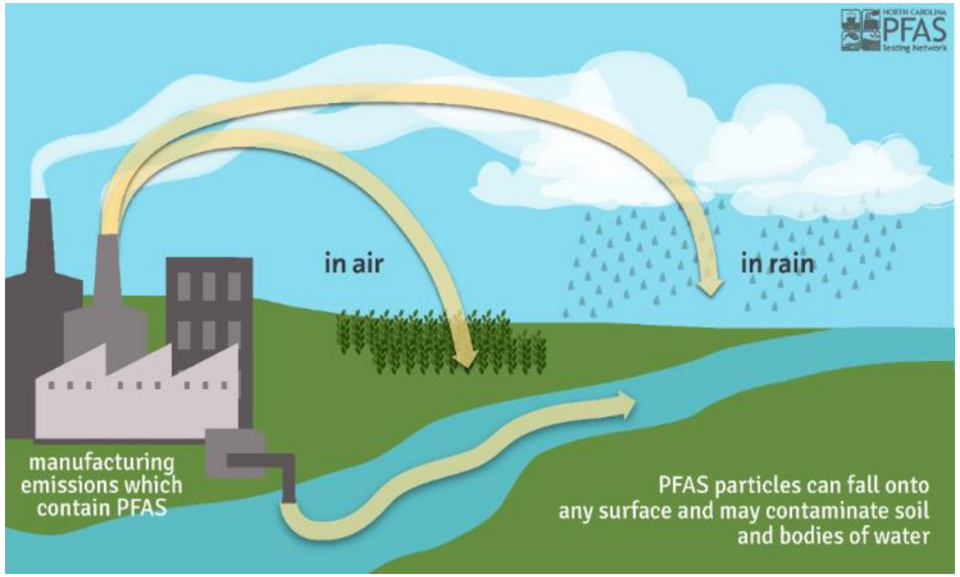


(From NC DHHS website)

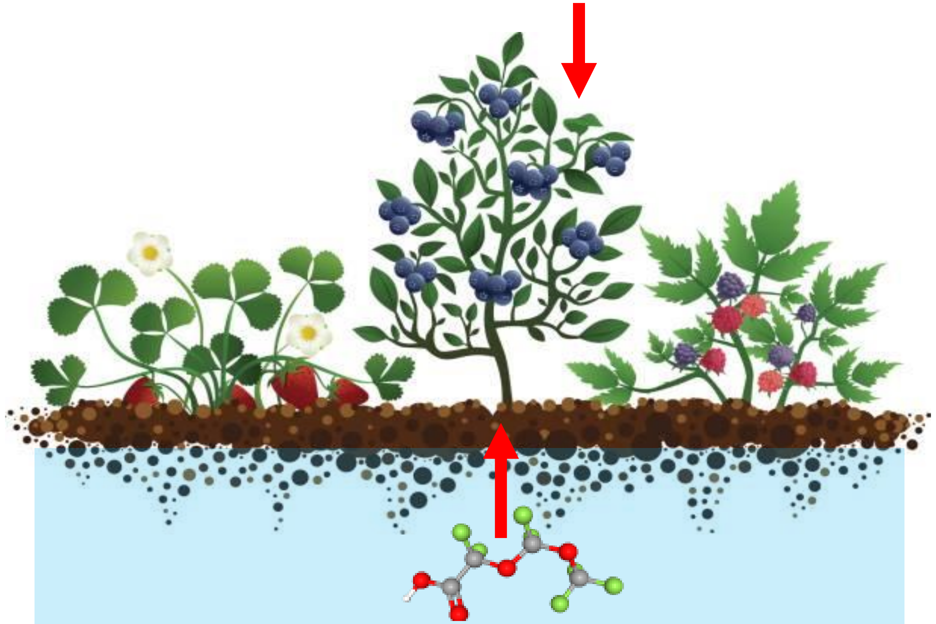
- Multiple novel PFEAs were detected in private drinking water wells near the Chemours facility.


PFMOAA
PMPA
PEPA
GenX
PFO2HxA
PFO3OA
ADONA
PFO4DA
PFO5DoDA
HydroEVE
NVHOS
Nafion BP2

Novel perfluoroalkyl ether acids in North Carolina

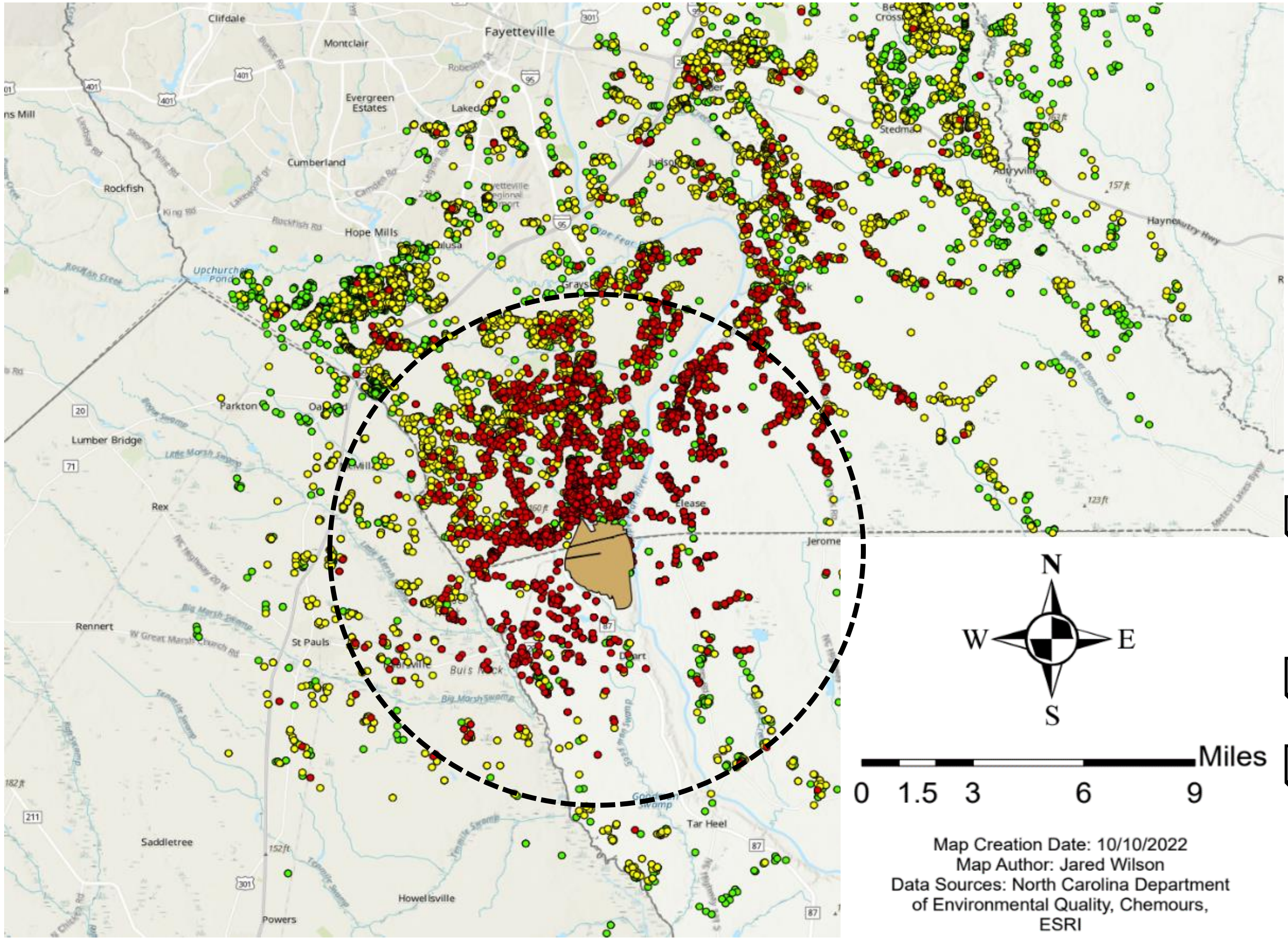


(From NC DHHS website)



Close to the fluorochemical manufacturer, many people harvested and consumed fruits and vegetables from their garden, but the uptake of fluoroethers into local produce remains unclear.

Five residential gardens were enrolled



- GenX ≥10ppt
- Any PFAS (except GenX) ≥ 10ppt or Total Sum PFAS ≥ 70ppt
- No Detections or No PFAS ≥ 10ppt
- Chemours property boundary

- ❑ All sites are within a 6-mile radius of the plant
- ❑ 53 samples
- ❑ Harvested in 2013-2019

(From NC DEQ website)

Produce inventory (n= 53)

Site A (n=21)

2014
- Pickled okra
- Pickled green beans

2015
- Pickles
- Pickled tomato
- Squash
- Pickled green beans

2016
- Pickled beans
- Okra
- Pickled okra
- Squash
- Pickled green beans

2017
- Blueberry
- Okra
- Corn
- Squash
- Potato

2018

2019
- Blueberry
- Grape
- Peach
- Tomato

Site B (n=23)

2013
- Pecan
- Tomato

2014

2015
- Blueberry
- Peas

2016
- Blackberry

2017
- Turnip
- Blackberry

2018
- Apple
- Corn
- Peach
- Pecan
- Sweat potato
- Blueberry
- Blackberry

2019
- Fig
- Apple
- Apple-unripe
- Grape
- Peach
- Peach-unripe
- Pear
- Blueberry
- Blackberry

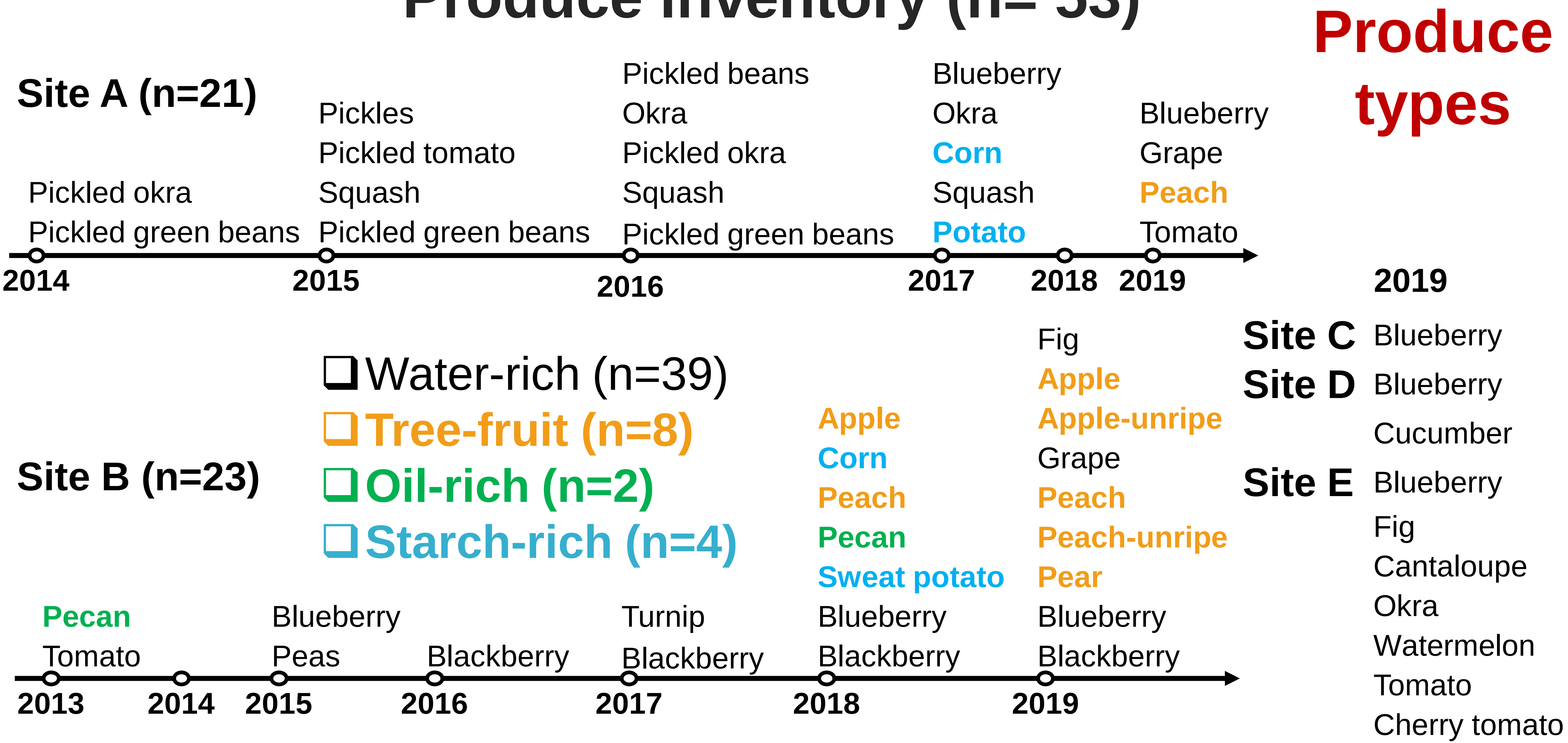
2019

Site C
- Blueberry

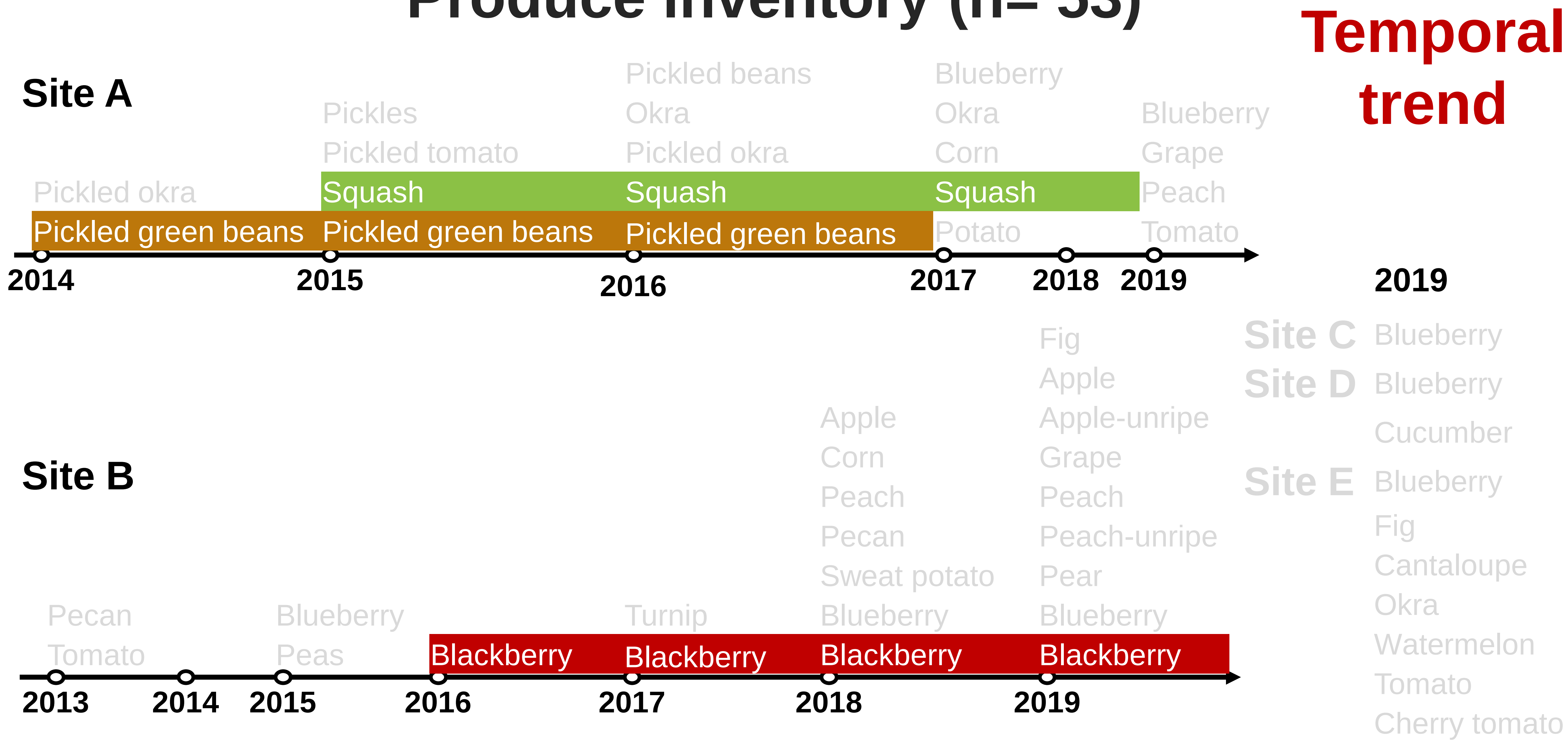
Site D
- Blueberry
- Cucumber

Site E
- Blueberry
- Fig
- Cantaloupe
- Okra
- Watermelon
- Tomato
- Cherry tomato

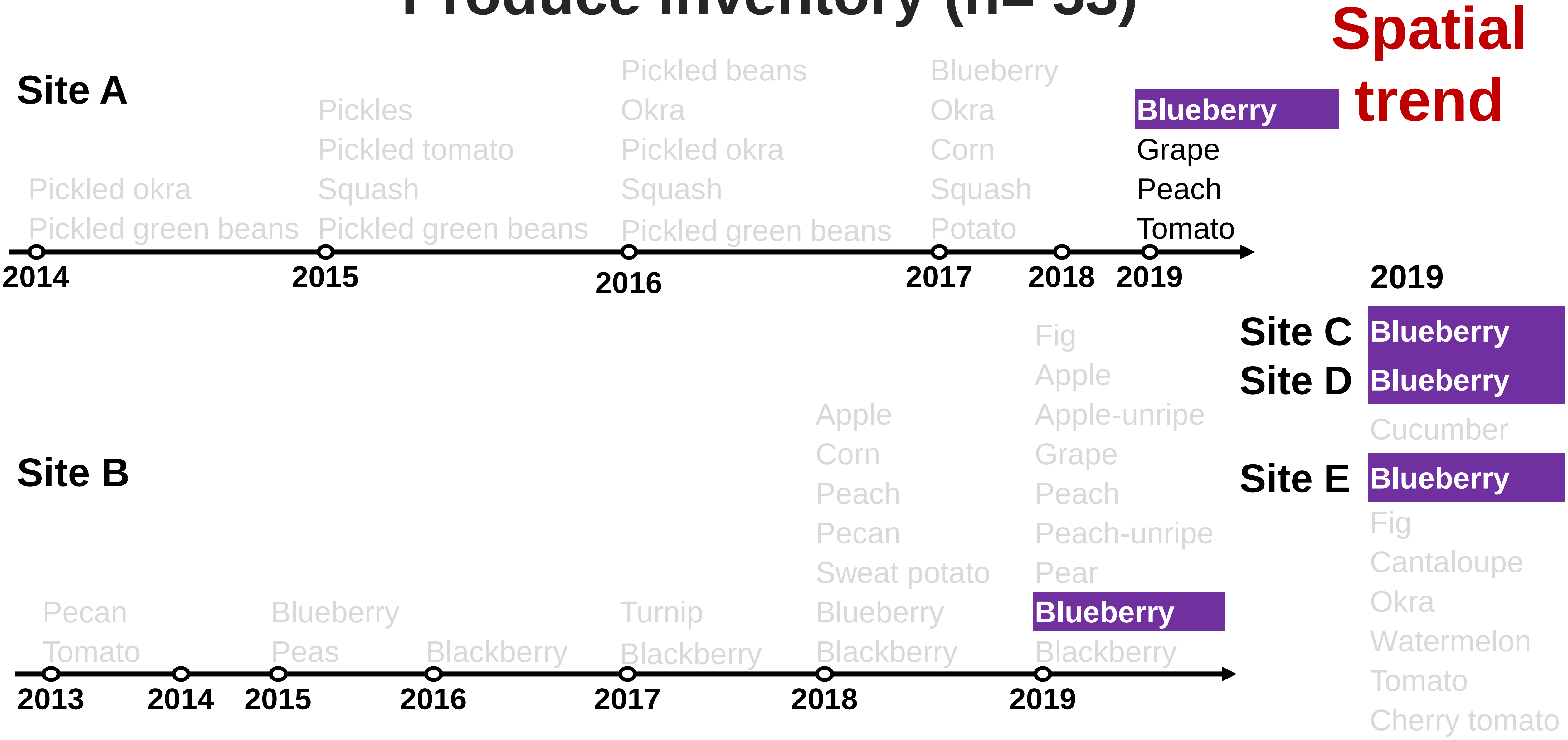
Produce inventory (n= 53)



Produce inventory (n= 53)

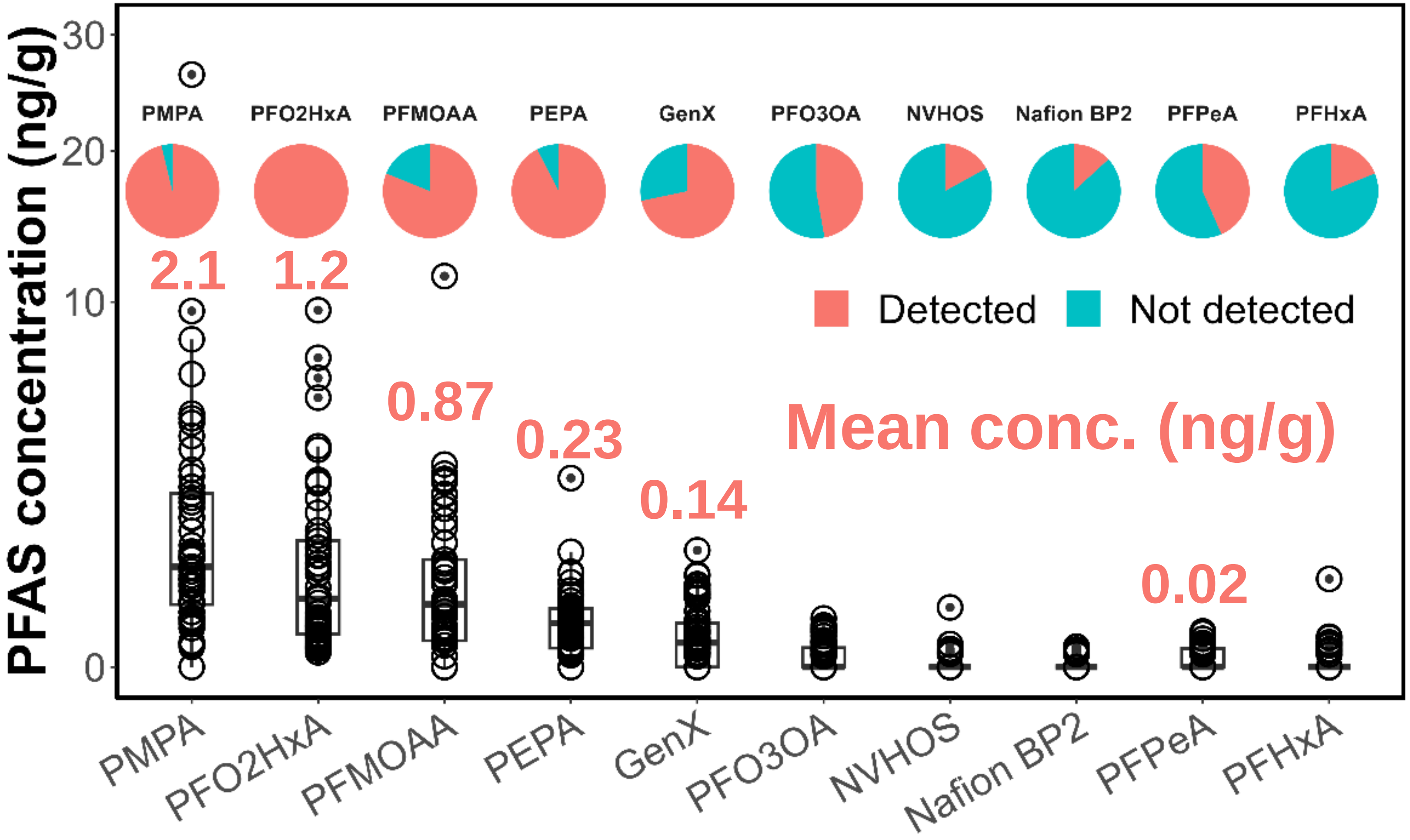


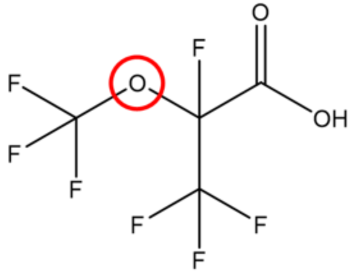
Produce inventory (n= 53)

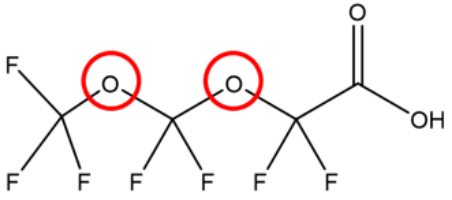


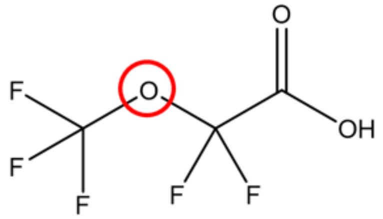
10 PFAS, including 8 PFEAs, were detected in at least 10% of the produce samples

Overview



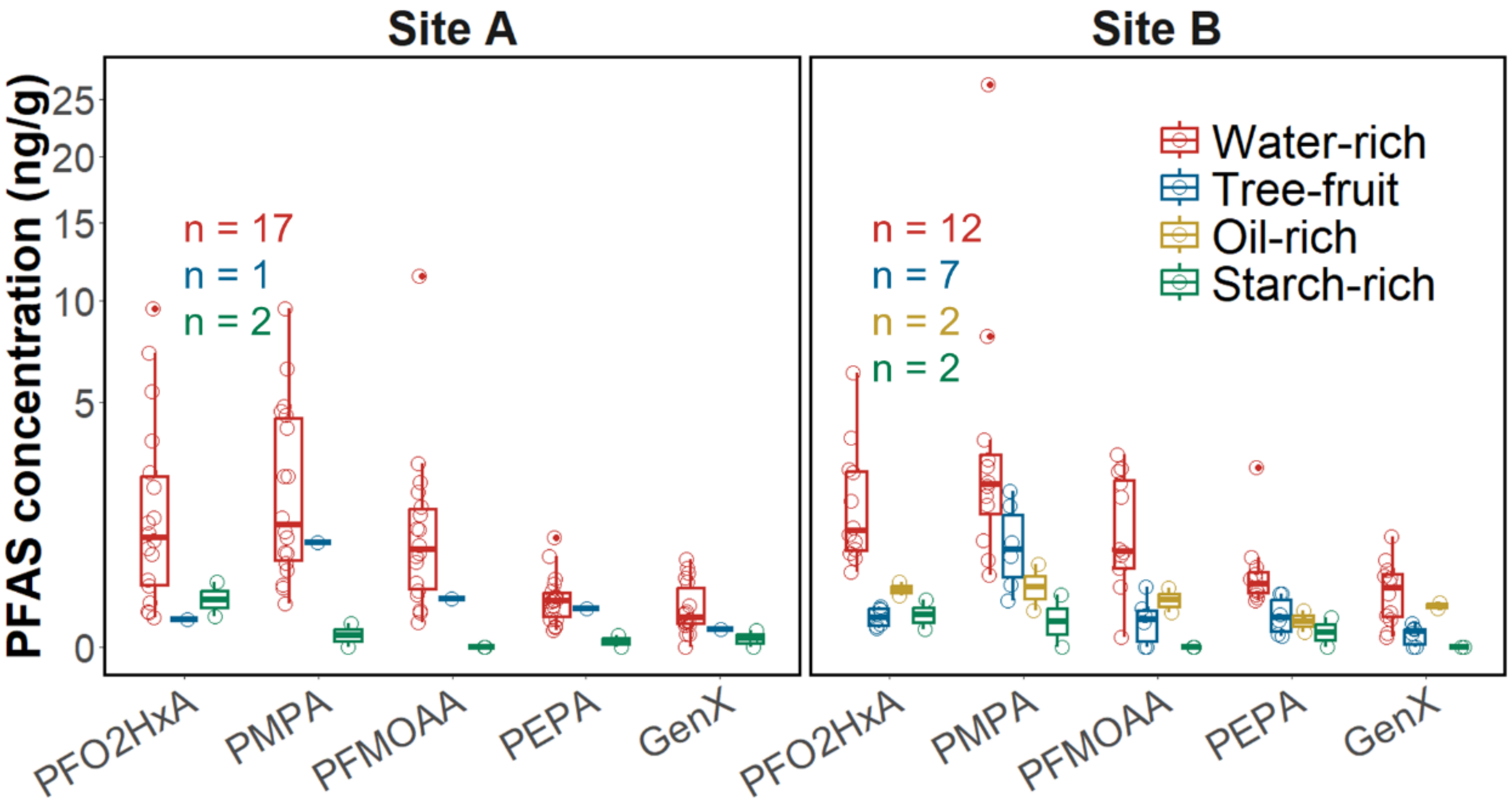






PFAS uptake efficiency and transport to edible parts varies with plant type

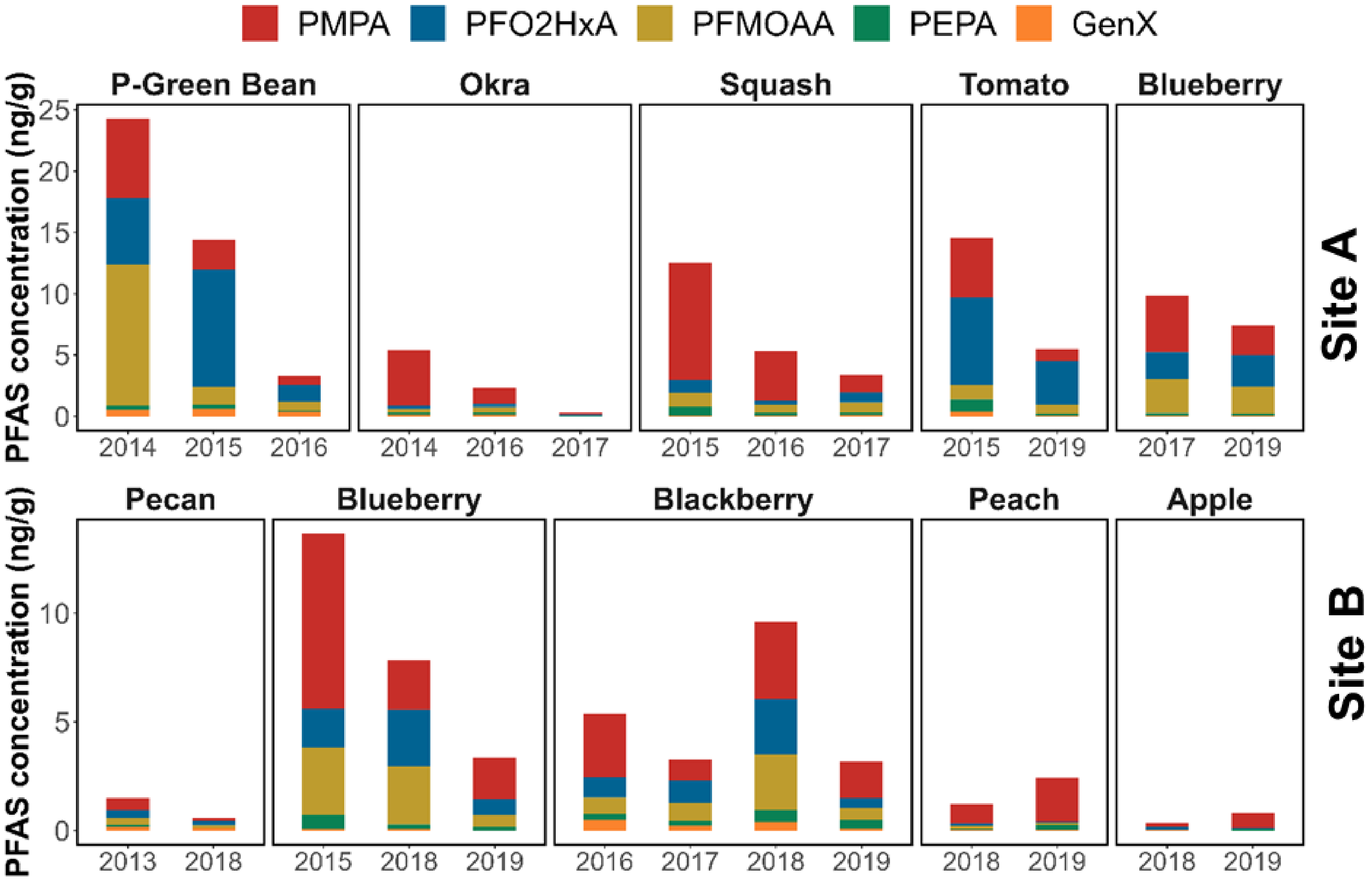
Produce type



Water-rich and starch-rich produce contained the highest and lowest PFAS levels, respectively.

It is unclear whether there is really a decreasing trend of PFAS plant uptake

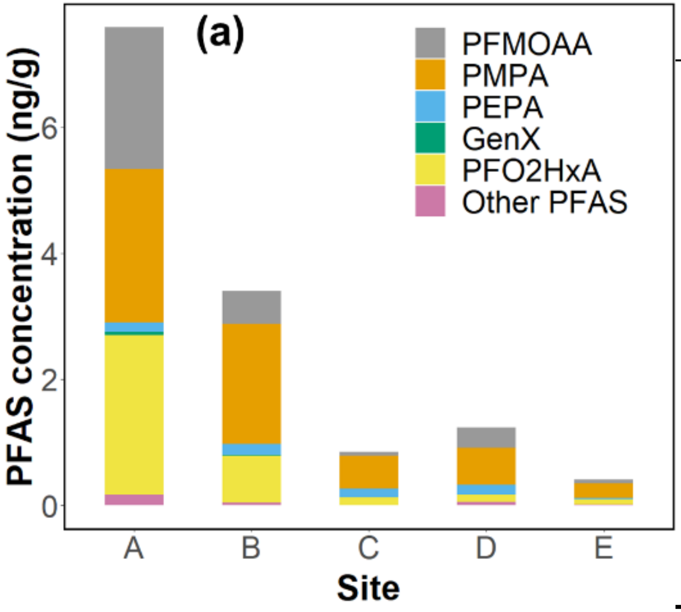
Temporal trend



In 2013, an air emission abatement technology was implemented.

Higher PFAS levels in groundwater generally corresponded to higher levels in blueberries, but…

Spatial trend



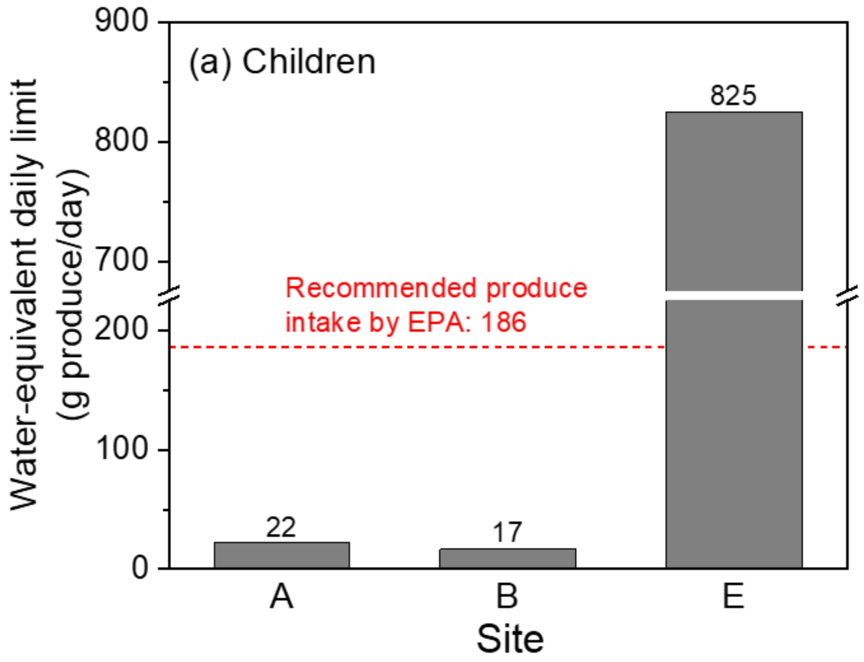
PFAS	MRL (ng/L)	PFAS conc. in groundwater (ng/L)				
		A	B	C	D	E
PFMOAA	5	50	4	<MRL	9	<MRL
PMPA	10	439	45	16	82	26
PEPA	2	159	10	2	16	4
GenX	0.5	304	24	3	23	<MRL
PFO2HxA	2	172	17	<MRL	24	12
Other PFASs	/	85	15	2	5	**65**
Sum	/	**1209**	115	**23**	159	106

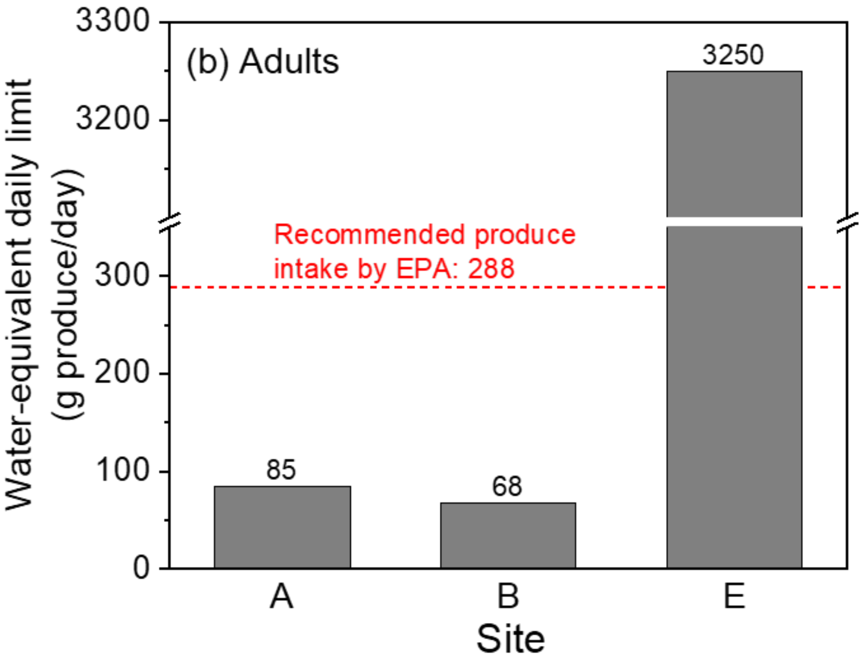
Groundwater is not an effective predictor of PFAS levels and signature in agricultural produce

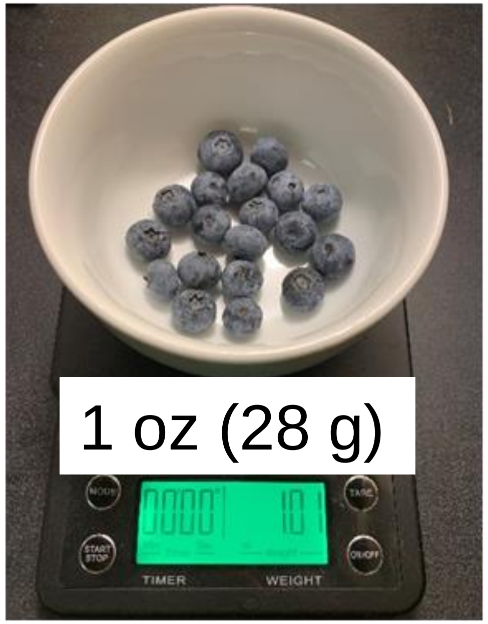
How important is dietary exposure compared to drinking water exposure?

Assumptions:

Water contains 10 ng/L GenX, an adult (21-50 yr.) drinks 1.3 L/d, a child (3-6 yr.) drinks 0.33 L/d.

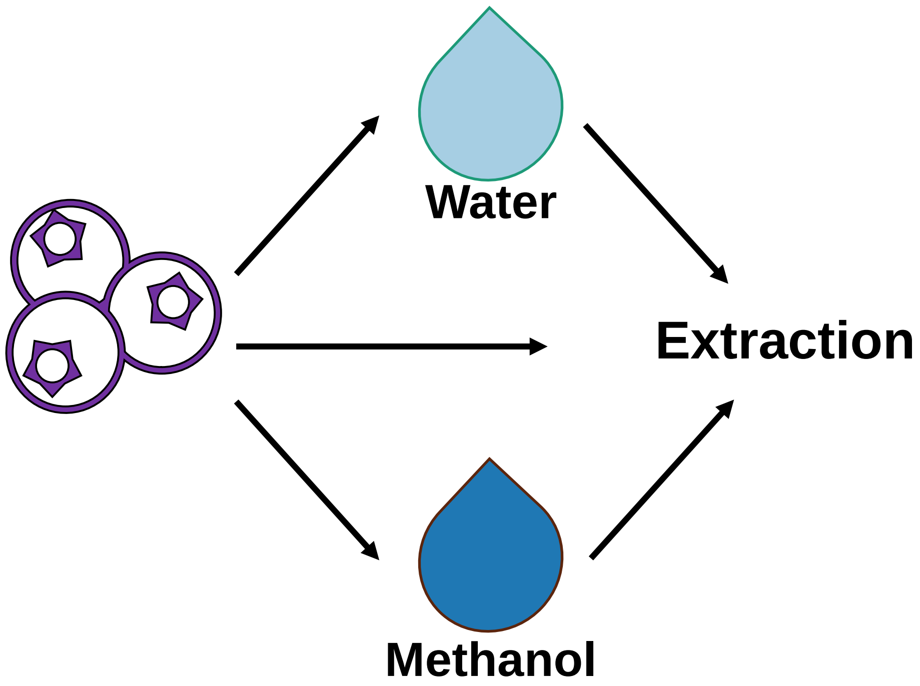


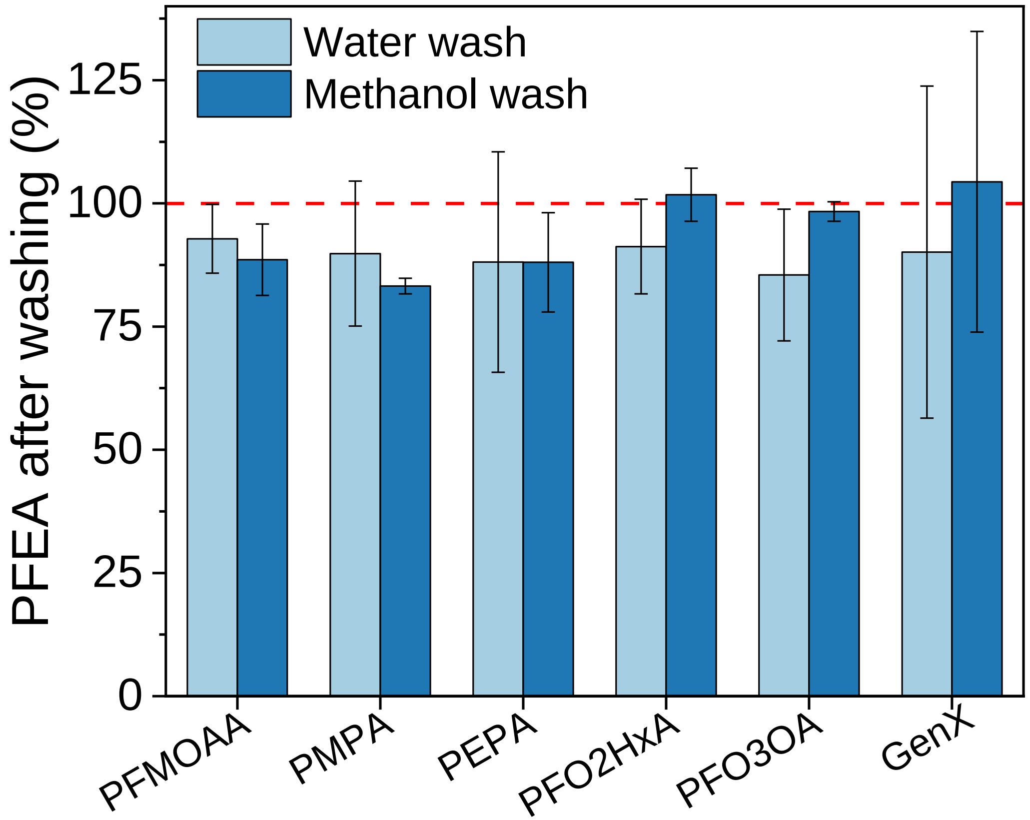




In frontline communities, uptake through residential garden produce could be an important route of PFAS exposure

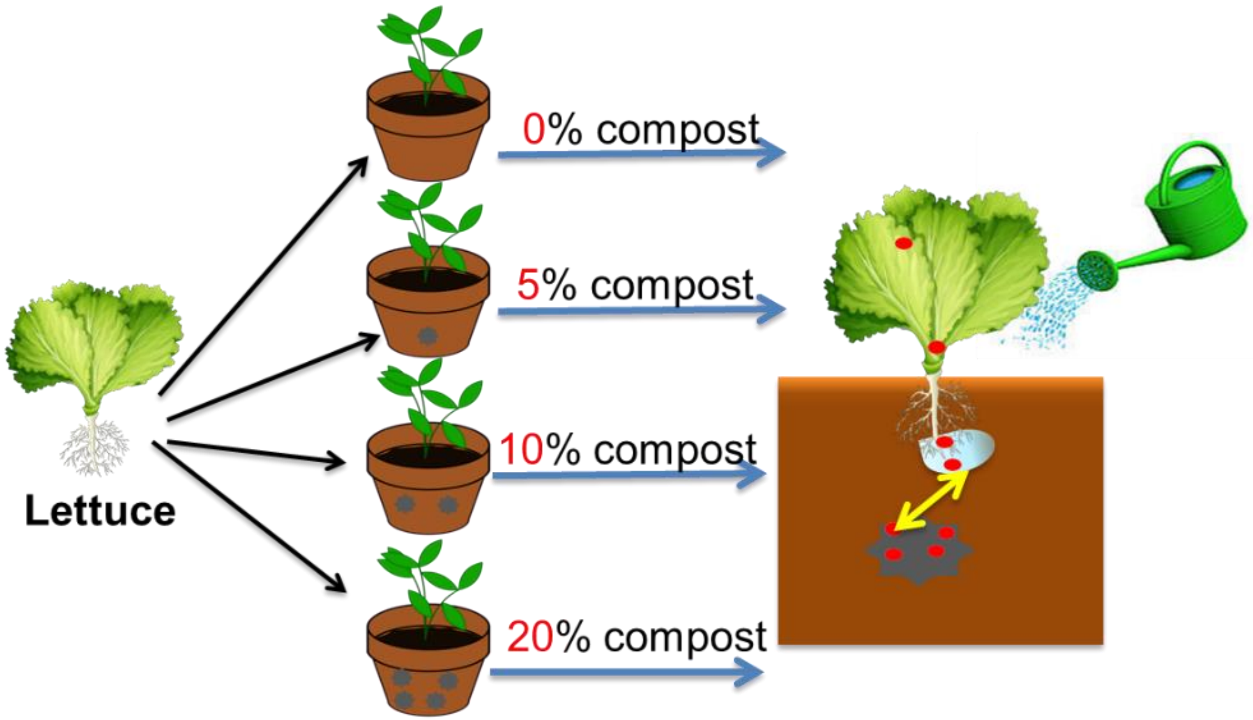
Can we clean the produce by washing?

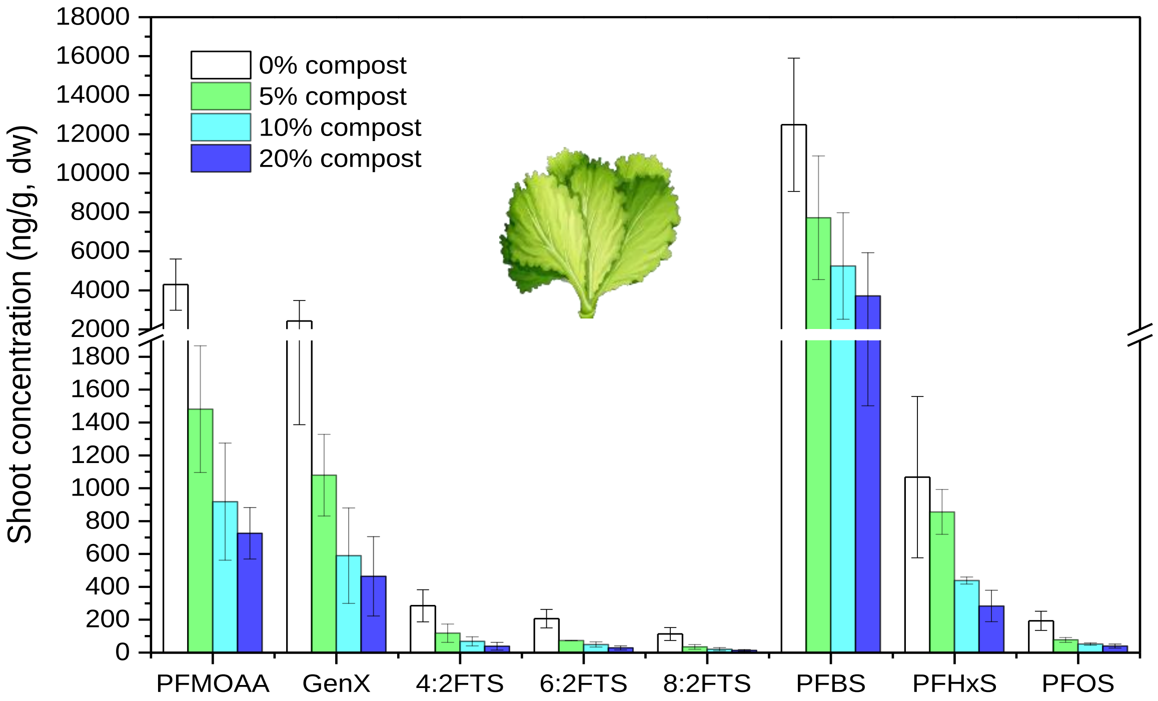




- ❑ **The majority (>90%) of fluoroethers detected were in the edible parts of blueberries**
- ❑ **Washing would not be effective for reducing human exposure**

Clean compost soil amendment reduced PFAS uptake by lettuce





Dr. Yuanbo Li

Dr. Yue Zhi

- ❑ **Greenhouse study with PFAS added to soil**
- ❑ **All studied PFAS were found in lettuce leaves**
- ❑ **Compost amendment lowered PFAS conc. in lettuce leaves**

Use with care!

How can we gain a better understanding of PFAS in agriculturally relevant crops and plants?

- ❑ Rapid PFAS screening and detection methods
- ❑ Compound-by-compound approach vs. class-approach
- ❑ Diversity in agricultural and exploring alternative land use strategies
- ❑ PFAS abatement by blocking PFAS mitigation pathways from groundwater/soil to edible parts

Questions?

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PFAS UNITEDD