



Norwegian Centre for Organic Agriculture

# Circular handling of nutrients and risk for accumulation of heavy metals in urban farm soil

URBANFARMS final conference

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# Outline

- Soil sampling on 10 out of 11 case farms, April 2020
- Mean concentrations of potentially toxic elements (PTEs = heavy metals) in soil
- Types of fertilisers produced from urban organic waste; e.g. green waste compost soil (photos below: ROAF)
- Concentrations of PTEs in these fertilisers
- Unbalanced content of nutrients in urban waste-based fertiliser
- Theoretical accumulation of PTEs over time
- Need for better fertilises, and assessment of regulations



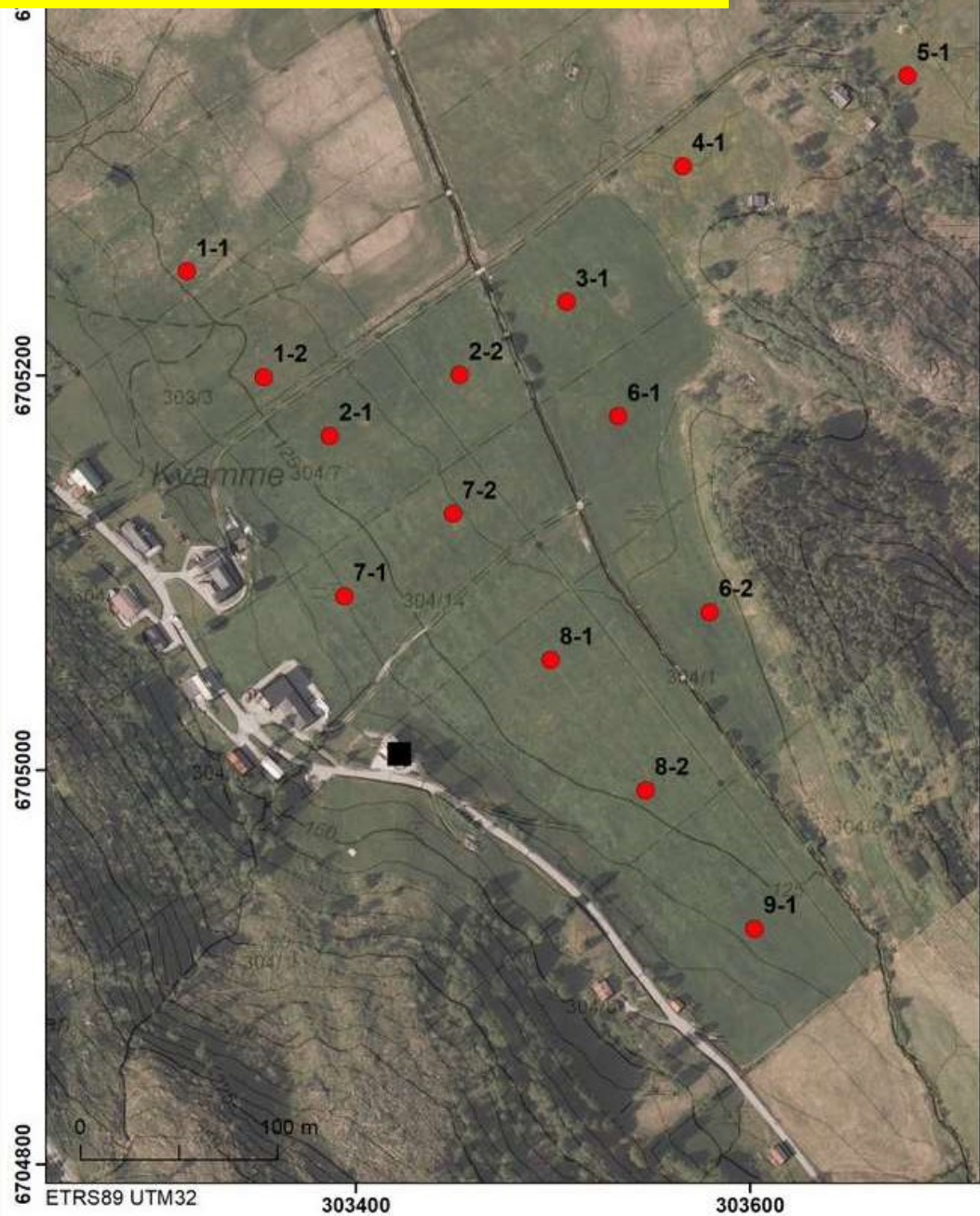




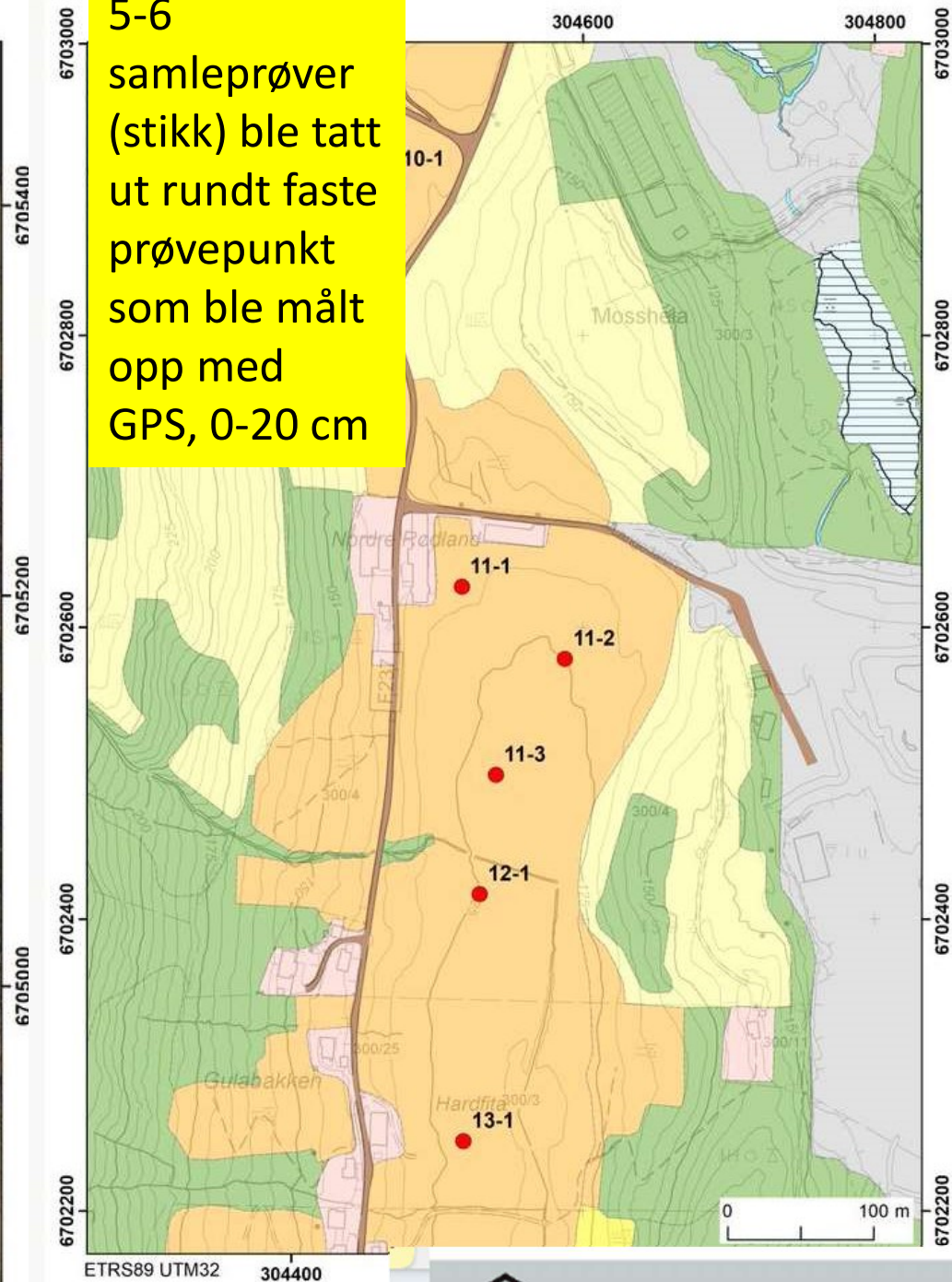
Soil sampling, Kvamme farm near Bergen,  
20.4.2020



På kilden.nibio.no kan man få ut kart av gårder når man har gårds- og bruksnummer, og legge inn prøvepunkt. Flyfoto eller kart.



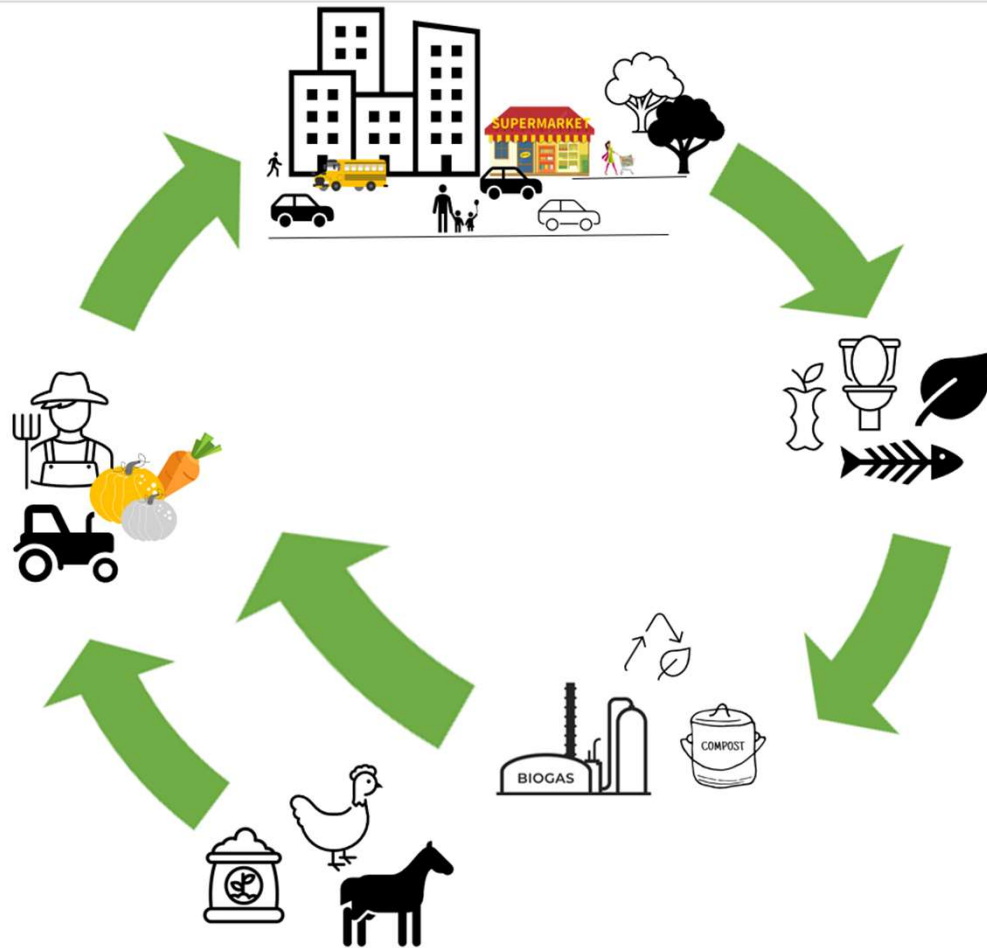
5-6 samleprøver (stikk) ble tatt ut rundt faste prøvepunkt som ble målt opp med GPS, 0-20 cm



Region	Farm, (samples)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Bergen	1 (1)	5	0.6	15	47	0.05	8	36	60
Bergen	2 (3)	4.7	0.5	27	33	0.17	29	31	59
Bergen	3 (4)	< 2.0	0.7	40	35	0.07	27	19	90
Bergen	4 (3)	4	0.5	56	17	0.05	26	28	78
Bergen	5 (1)	5	0.4	14	39	0.26	6	19	53
Bergen	6 (2)	5.5	0.6	24	28	0.05	17	21	97
Oslo	8 (3)	5.7	0.5	31	18	0.09	26	18	90
Oslo	9 (2)	4.5	0.3	27	13	0.07	14	20	95
Oslo	10 (1)	4	0.6	25	9	0.04	17	16	53
Oslo	11 (5)	2.3	0.3	16	7	0.04	9	16	53
<b>Mean, region Bergen</b>		<b>4.8</b>	<b>0.6</b>	<b>29</b>	<b>33</b>	<b>0.11</b>	<b>19</b>	<b>26</b>	<b>73</b>
<b>Mean, region Oslo</b>		<b>4.1</b>	<b>0.4</b>	<b>25</b>	<b>12</b>	<b>0.06</b>	<b>17</b>	<b>17</b>	<b>73</b>
<b>Threshold soil quality</b>		-	1	100	50	1	30	50	150
<b>Threshold pollution</b>		8	1.5	50	100	1	60	60	200
<b>EU range</b>		10-200	0.5-20	30-1000	40-1000	0.5-80	30-300	40-750	60-2500

«Heavy metals» (potentially toxic elements): Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead and Zinc

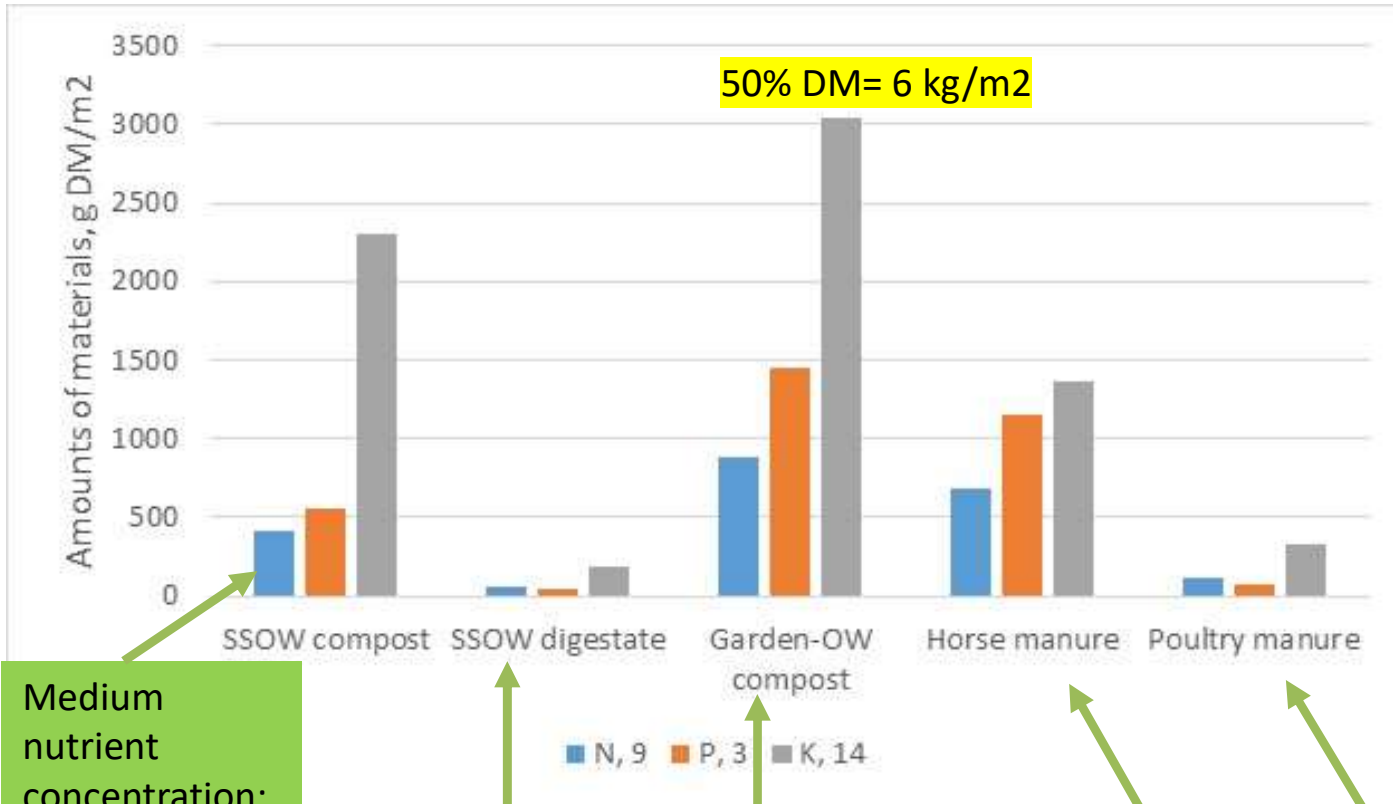
# Urban waste-based fertilisers



- Compost from source-separated organic waste, mainly from households, catering and retail (SSOW)
  - Digestate from SSOW
  - Composted organic waste from gardens and recreational areas
  - Horse manure
  - Poultry manure
- 
- Sewage products not considered here



# Nutrients in urban waste-based fertilisers



1 g per m<sup>2</sup> = 1 kg per daa  
 1 dekar (daa) = 1000 m<sup>2</sup>  
 1 hectare = 10 daa

Nutrient demand of carrots =

9 g N  
 3 g P  
 14 g K  
 per m<sup>2</sup>



Medium nutrient concentration; low in K

Very high nutrient concentration in DM, but very low in DM! (liquid)

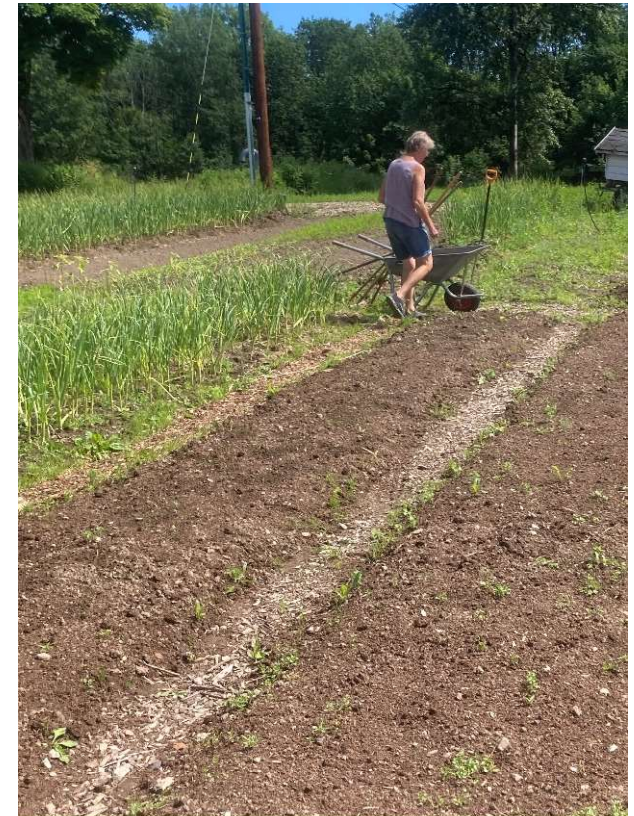
Low nutrient concentration, especially for K

Less concentrated

Concentrated (dry)

How much material (in DM) do we have to apply to cover the demand for N, P and K?

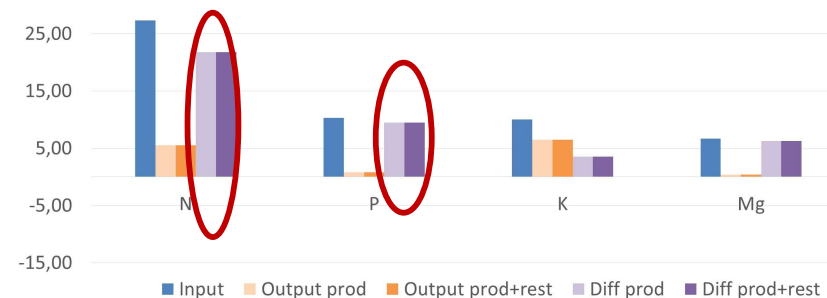
# Compost applied as mulch – often $> 5 \text{ kg/m}^2$ (= 1 cm)



## Market garden philosophy and practice:

- No turning of the soil!
- Weeds must be controlled
- Very poor utilisation of applied N; additional poultry manure is applied

Næringsstoffbalanse i g/m<sup>2</sup>



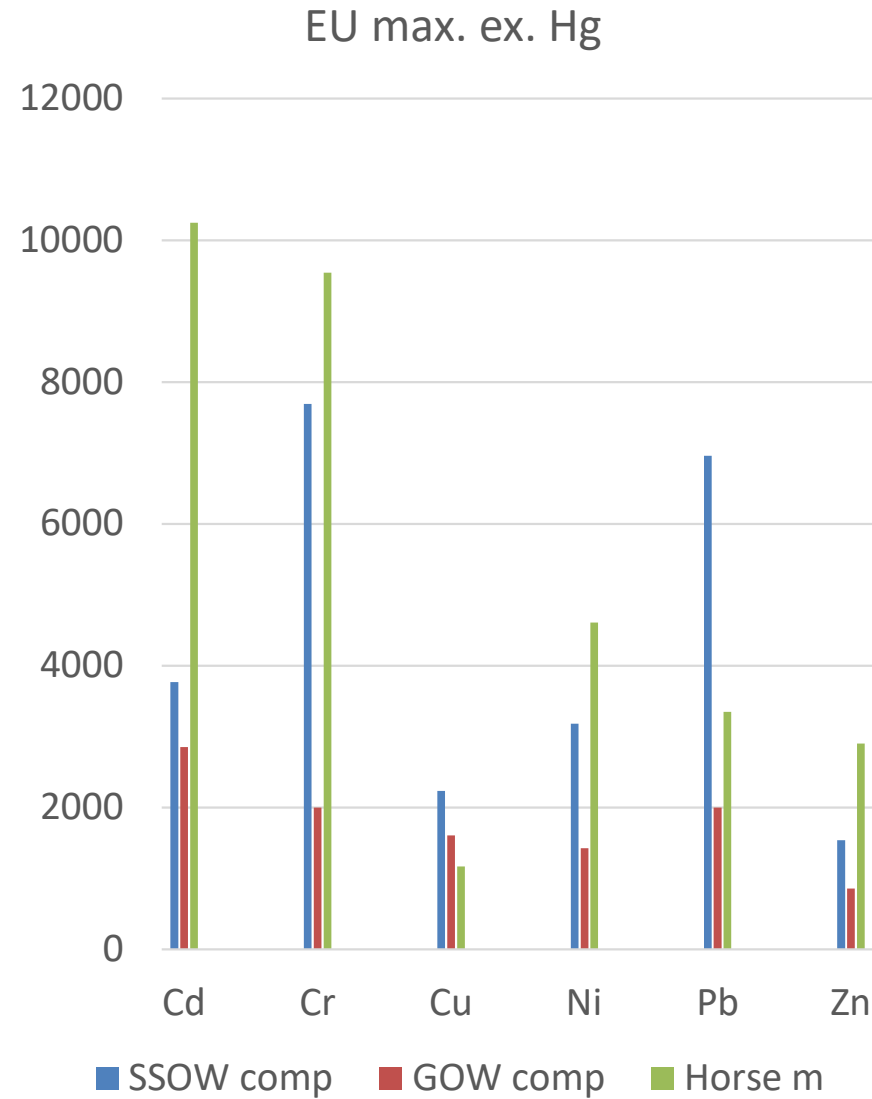
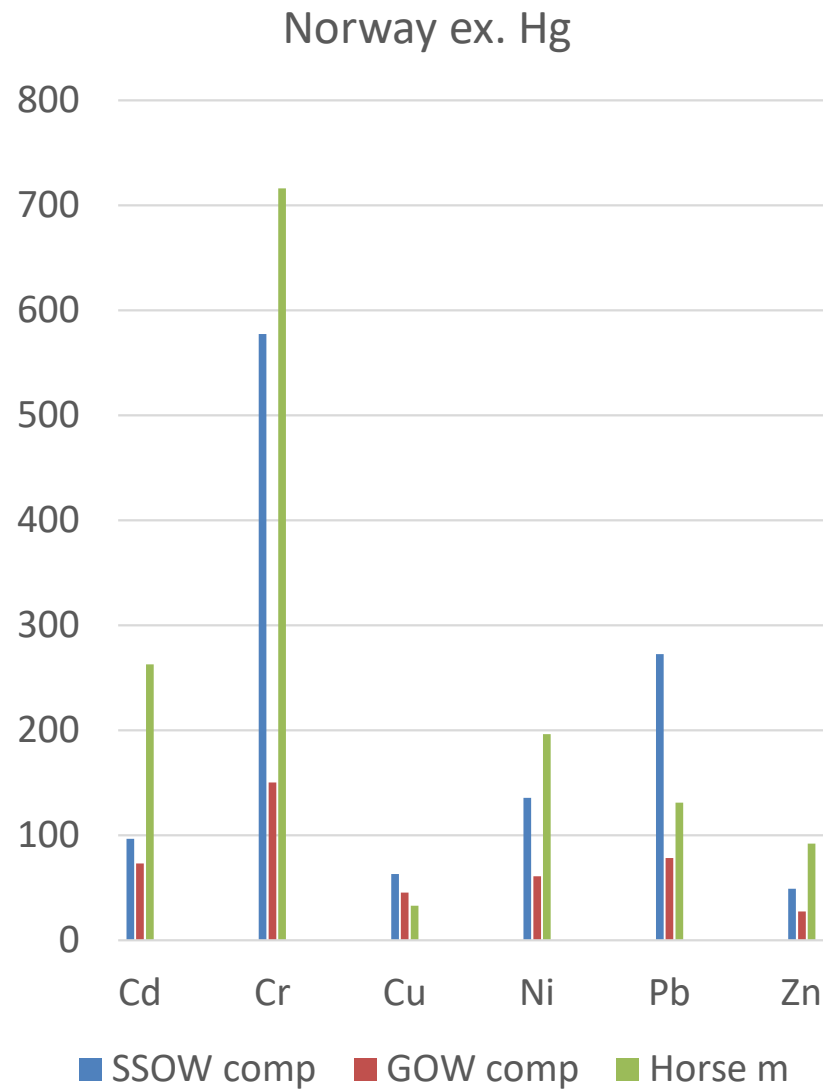


# Theoretical accumulation of PTEs over time

			1-50	50-100	100-500	500-1000	>1000	YEARS			
	SSOW comp	SSOW cor	SSOWdig	SSOWdig	GOW cor	GOW cor	Horse m	Horse m	Poultry	Poultry	
	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y	Time to reach max, y
	Bergen	Oslo	Bergen	Oslo	Bergen	Oslo	Bergen	Oslo	Bergen	Oslo	Bergen
Cd	77	116	1032	1549	59	88	210	315	2446	3670	
Cr	562	593	10889	11502	146	154	697	736	13570	14335	
Cu	39	87	391	874	28	63	20	45	274	612	
Hg	1290	1363	31393	33157	733	774	4366	4611	54434	57492	
Ni	124	147	2707	3199	56	66	180	213	3738	4417	
Pb	229	315	4096	5632	66	91	110	152	20675	28427	
Zn	49	49	198	198	27	27	92	92	255	255	



# Theoretical accumulation of PTEs over time





# Need for better fertilisers; and assessment of regulations

To foster recycling  
of nutrients and  
organic matter!

- PTE values in Norwegian urban waste-based (UWB) fertilisers were all below the upper EU-limit for organic fertilisers, but still classified as Class I or II by Norwegian regulations
- UWB fertilisers are low in K
- Need for additional K (seaweeds?) and covering of compost windrows
- Applications required for K supply of carrots imply much higher N application of N than recommended
- Such high applications are not rare in small-scale growing, and the materials are often not incorporated in the soil
- Current soil quality limits will be reached relatively fast (20-50 years) if such high amounts of materials are applied.
- Limits are first reached for Zn and Cu, which are essential nutrients for plants, animals and humans.
- Growers using UWB fertilisers should monitor their soil regularly with fixed sampling points and include analyses of PTEs
- Norwegian authorities should assess the soil quality limits and the limits for classification of soil amendments and rates of application. Current levels do not support a recycling of valuable nutrients and organic matter.









[www.norsok.no](http://www.norsok.no)