Presenza di prioritari di emergenti nei reflui di allevamento

(*Emerging and priority pollutants in manure*)

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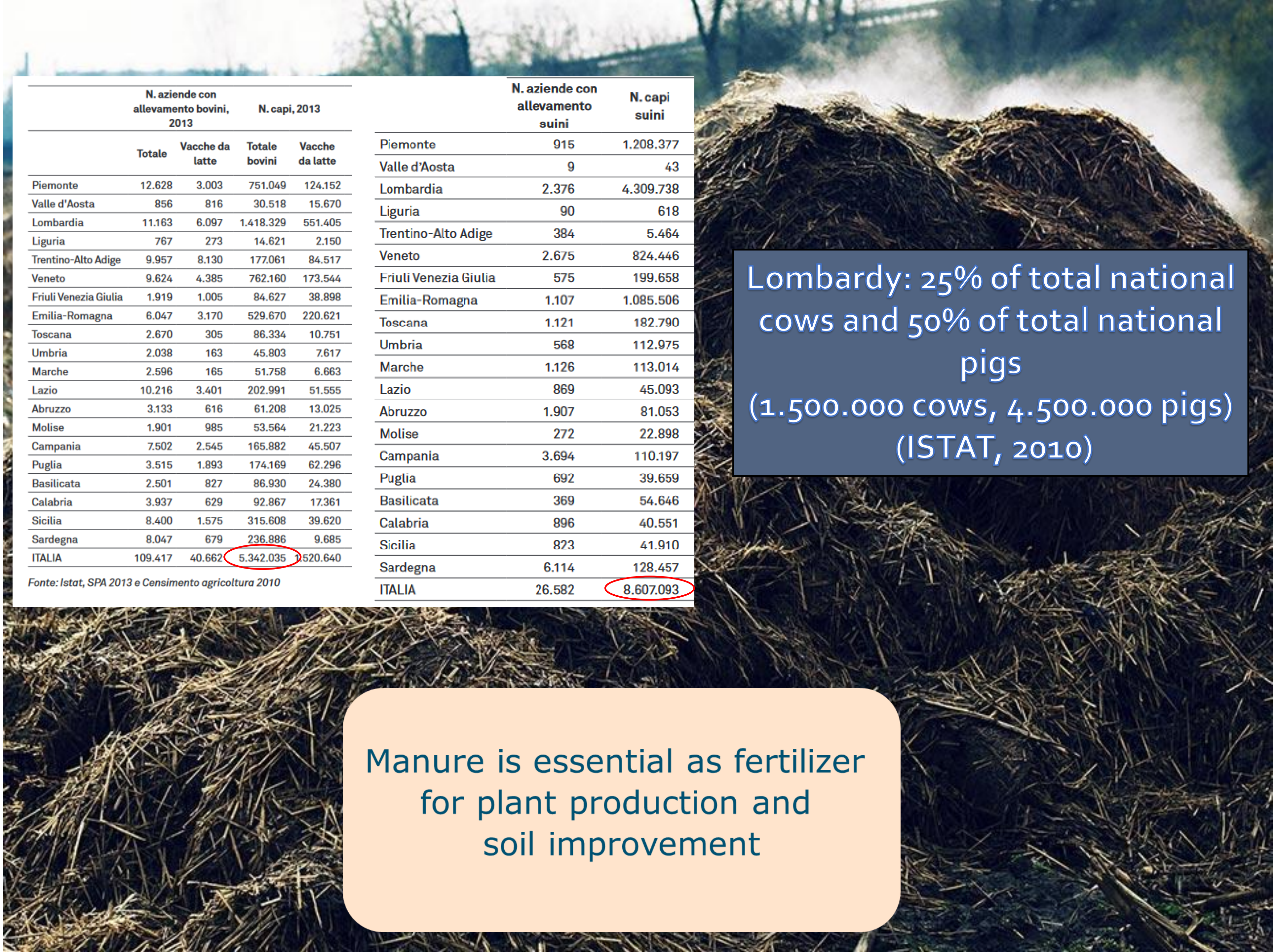


	N. aziende con allevamento bovini, 2013		N. capi, 2013	
	Totale	Vacche da latte	Totale bovini	Vacche da latte
Piemonte	12.628	3.003	751.049	124.152
Valle d'Aosta	856	816	30.518	15.670
Lombardia	11.163	6.097	1.418.329	551.405
Liguria	767	273	14.621	2.150
Trentino-Alto Adige	9.957	8.130	177.061	84.517
Veneto	9.624	4.385	762.160	173.544
Friuli Venezia Giulia	1.919	1.005	84.627	38.898
Emilia-Romagna	6.047	3.170	529.670	220.621
Toscana	2.670	305	86.334	10.751
Umbria	2.038	163	45.803	7.617
Marche	2.596	165	51.758	6.663
Lazio	10.216	3.401	202.991	51.555
Abruzzo	3.133	616	61.208	13.025
Molise	1.901	985	53.564	21.223
Campania	7.502	2.545	165.882	45.507
Puglia	3.515	1.893	174.169	62.296
Basilicata	2.501	827	86.930	24.380
Calabria	3.937	629	92.867	17.361
Sicilia	8.400	1.575	315.608	39.620
Sardegna	8.047	679	236.886	9.685
ITALIA	109.417	40.662	5.342.035	1.520.640

Fonte: Istat, SPA 2013 e Censimento agricoltura 2010

	N. aziende con allevamento suini	N. capi suini
Piemonte	915	1.208.377
Valle d'Aosta	9	43
Lombardia	2.376	4.309.738
Liguria	90	618
Trentino-Alto Adige	384	5.464
Veneto	2.675	824.446
Friuli Venezia Giulia	575	199.658
Emilia-Romagna	1.107	1.085.506
Toscana	1.121	182.790
Umbria	568	112.975
Marche	1.126	113.014
Lazio	869	45.093
Abruzzo	1.907	81.053
Molise	272	22.898
Campania	3.694	110.197
Puglia	692	39.659
Basilicata	369	54.646
Calabria	896	40.551
Sicilia	823	41.910
Sardegna	6.114	128.457
ITALIA	26.582	8.607.093

Lombardy: 25% of total national cows and 50% of total national pigs
(1.500.000 cows, 4.500.000 pigs)
(ISTAT, 2010)

Manure is essential as fertilizer for plant production and soil improvement

VMPs Categories

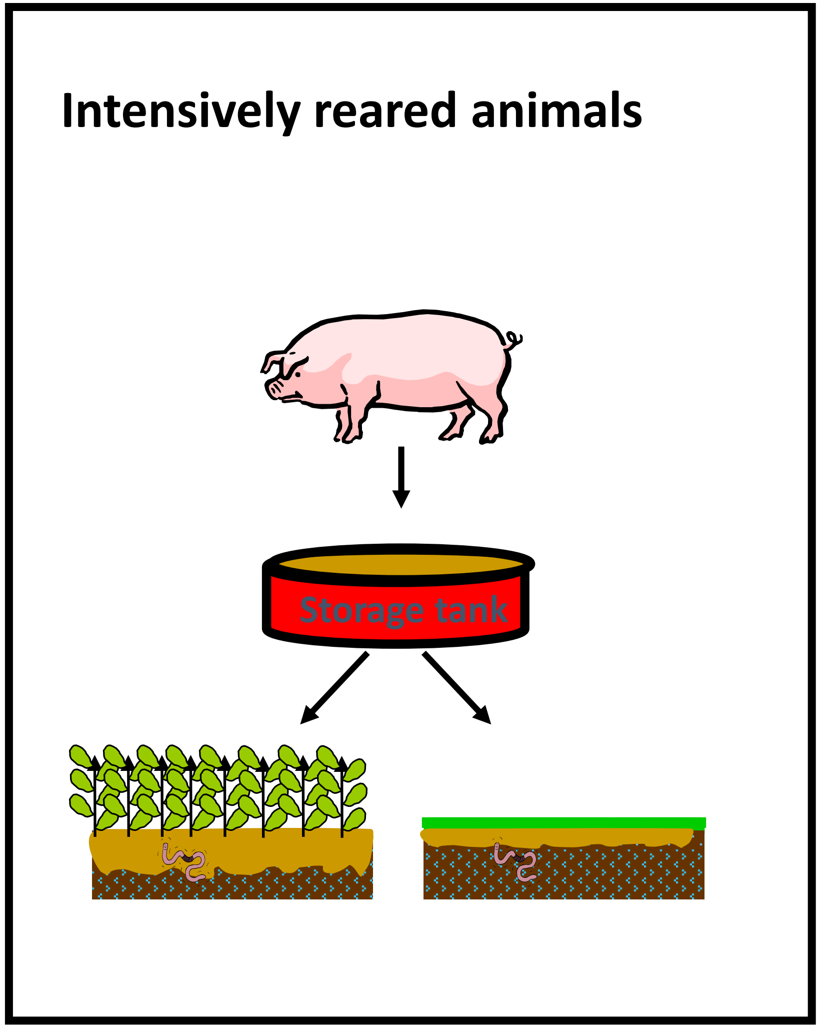
Group	Chemical class	Major active ingredients
Antibacterials	Tetracyclines	Oxytetracycline, chlortetracycline, tetracycline
	Sulphonamides	Sulfadiazine, sulfamethazine, sulfathiazole
	β-lactams	Amoxicillin, ampicillin, penicillin G, benzylpenicillin
	Aminoglycosides	Dihydrostreptomycin, neomycin, apramycin
	Macrolides	Tylosin, spiramycin, erythromycin, lincomycin
	Fluoroquinolones	Enrofloxacin
	2,4-diaminopyrimidines	Trimethoprim
	Pleuromutilins	Tiamulin
Parasiticides	Macrolide endectins	Ivermectin, doramectin, eprinomectin
	Pyrethroids	Cypermethrin, deltamethrin
	Organophosphates	Diazinon
	Pyrimidines	Pyrantel, morantel
	Benzimidazoles	Triclabendazole, fenbendazole
	Others	Levamisole
Hormones		Altrenogest, progesterone, medroxyprogesterone, methyltestosterone, estradiol benzoate

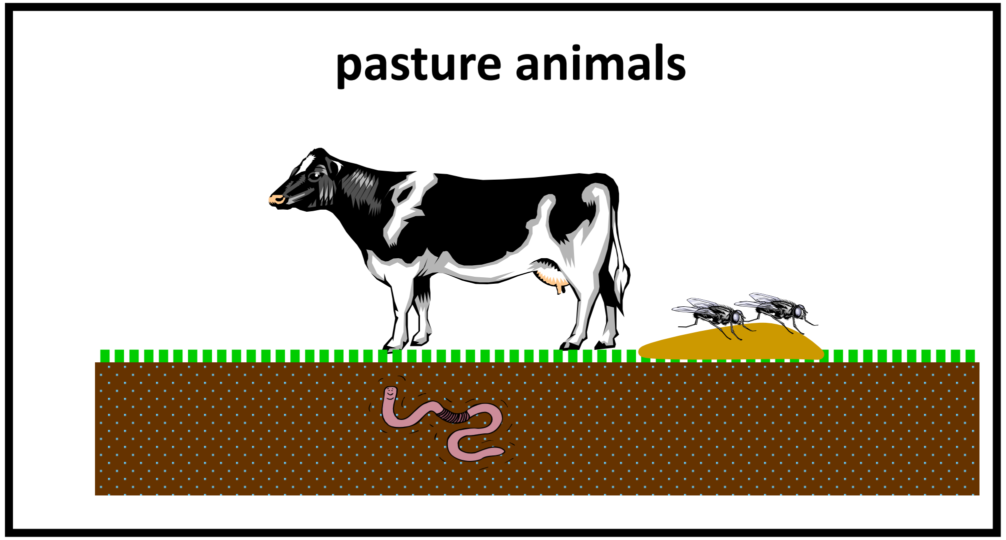
Group	Chemical class	Major active ingredients
Antifungals	Biguanide/gluconate	Chlorhexidine
	Azole	Miconazole
	Other	Griseofulvin
Coccidiostats/ antiprotozoals		Amprolium, clopidol, lasalocid, maduramicin, narasin, nicarbazin, robenidine, toltrazuril, diclazuril
Growth promoters		Monensin, salinomycin, flavophospholipol
Aquaculture treatments		Oxytetracycline, amoxicillin, florfenicol, emamectin benzoate, cypermethrin, teflubenzuron, hydrogen peroxide
Anaesthetics		Isoflurane, halothane, procaine, lido/ lignocaine
Euthanasia products		Pentobarbitone
Analgesics		Metamyzole
Tranquilizers		Phenobarbitone
Nonsteroidal anti-inflammatory drugs (NSAIDs)		Phenylbutazone, caprofen
Enteric bloat preps		Dimethicone, poloxalene

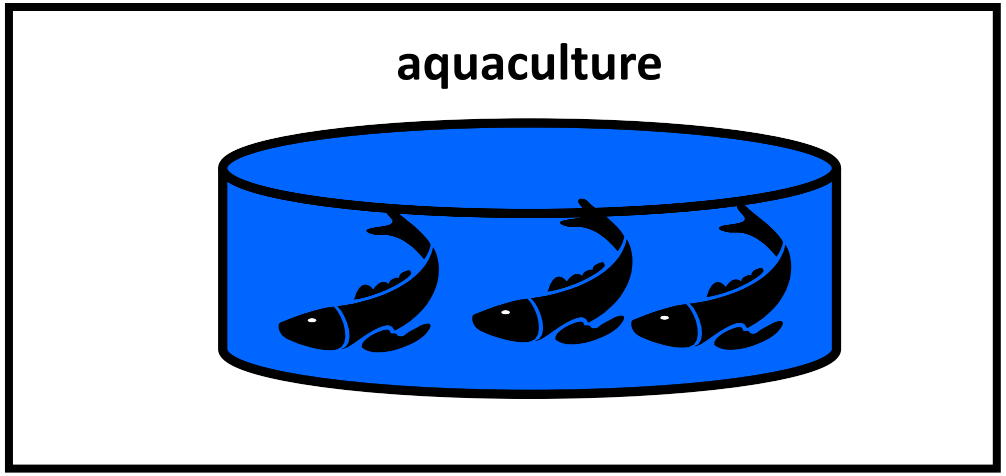
Table 3. Distribution of overall sales, in tonnes of active ingredient, split into tablets (used in companion animals) and all other pharmaceutical forms (used mainly in food-producing animals), by country, in 2015

Country	Tablets		All other pharmaceutical forms		Total tonnes
	Tonnes	% of overall sales	Tonnes	% of overall sales	
Austria	0.3	0.6%	48.5	99.4%	48.8
Belgium	1.9	0.7%	258.1	99.3%	260.1
Bulgaria	0.5	1.0%	46.3	99.0%	46.8
Croatia	0.3	1.2%	27.9	98.8%	28.2
Cyprus	0.1	0.1%	46.9	99.9%	46.9
Czech Republic	1.1	2.2%	47.5	97.8%	48.6
Denmark	0.8	0.8%	101.9	99.2%	102.8
Estonia	0.1	1.6%	8.1	98.4%	8.2
Finland	1.7	13.6%	10.6	86.4%	12.3
France	12.3	2.4%	501.5	97.6%	513.8
Germany	7.1	0.8%	851.1	99.2%	858.2
Greece	0.5	0.7%	72.6	99.3%	73.1
Hungary	0.3	0.2%	176.0	99.8%	176.3
Iceland	0.03	5.2%	0.6	94.8%	0.6
Ireland	0.6	0.6%	96.4	99.4%	97.0
Italy	9.7	0.7%	1,300.0	99.3%	1,309.7
Latvia	0.1	1.3%	6.8	98.7%	6.9
Lithuania	0.04	0.3%	11.9	99.7%	11.9
Luxembourg	0.1	6.2%	1.8	93.8%	1.9
Netherlands	2.8	1.3%	213.7	98.7%	216.5
Norway	0.5	8.8%	5.6	91.2%	6.1
Poland	2.3	0.4%	582.5	99.6%	584.8
Portugal	0.7	0.5%	134.0	99.5%	134.6
Romania	2.3	0.9%	257.2	99.1%	259.6
Slovakia	0.2	1.4%	13.3	98.6%	13.4
Slovenia	0.4	8.1%	4.6	91.9%	5.0
Spain	1.9	0.1%	3,027.8	99.9%	3,029.8
Sweden	0.9	8.8%	9.6	91.2%	10.5
Switzerland	0.1	0.2%	41.2	99.8%	41.3
United Kingdom	12.8	3.1%	394.9	96.9%	407.7
Total 30 countries	**62.4**	**0.7%**	**8,298.9**	**99.3%**	**8,361.3**

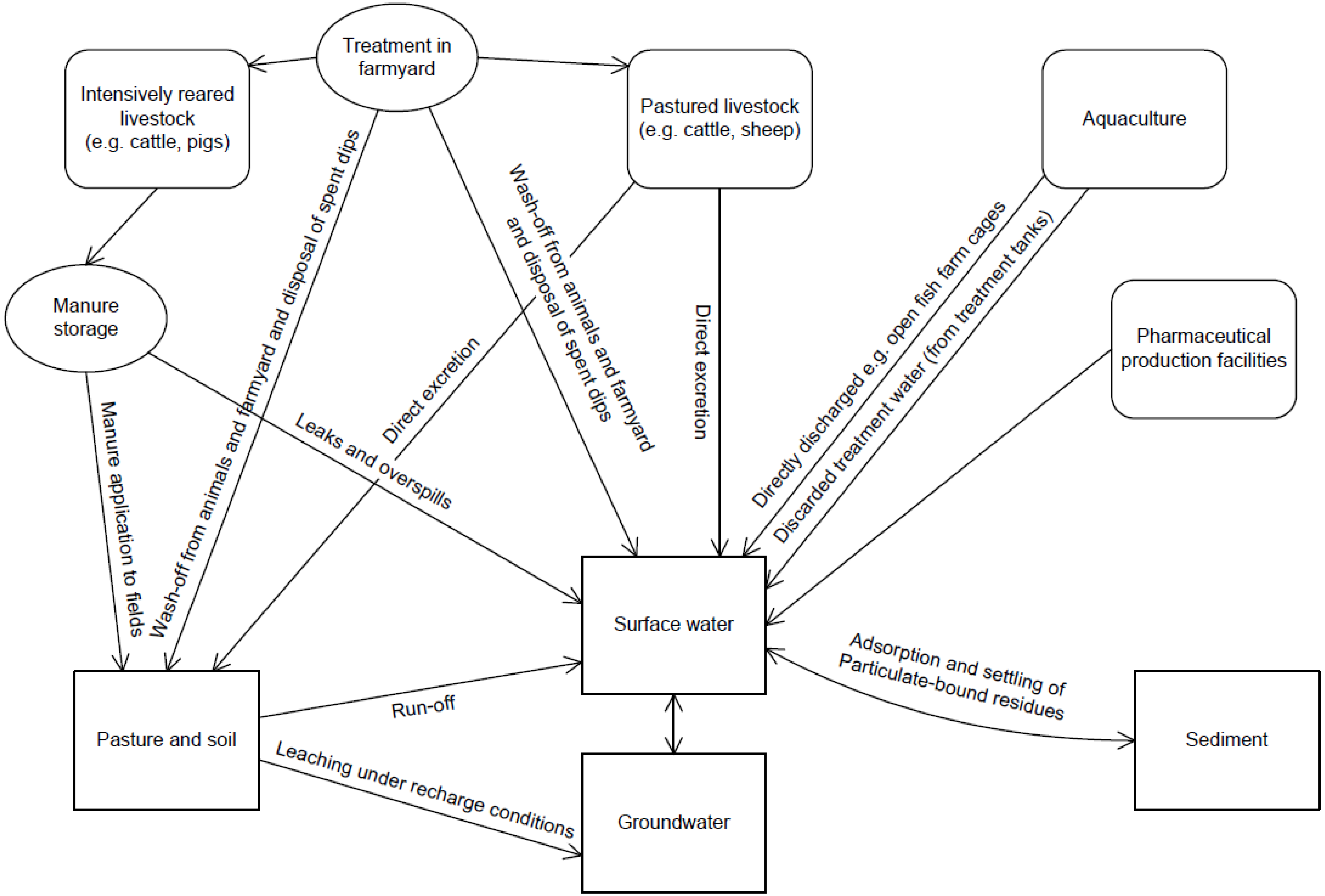
VMPs: where and how



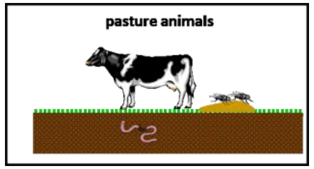




Routes of Environmental Exposure for VMPs



VMPs: Pasture Animals

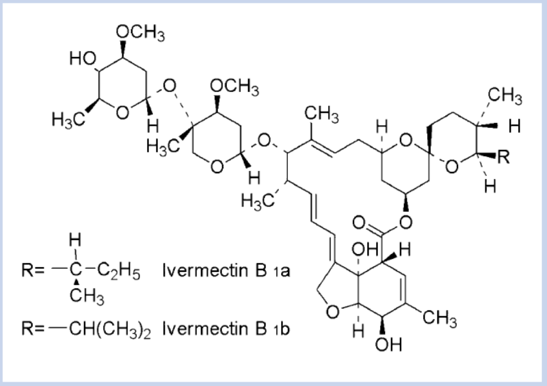


The development of anthelmintics, and latterly endectocides with a broad range of target pathogens, has provided more efficient and economic options for the treatment and control of parasitic disease both in ruminant and monogastric animals

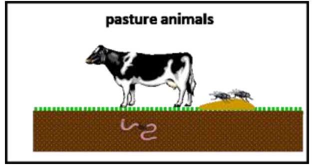
BUT

Concerns have been increasingly expressed by the scientific community regarding:

the possible unintended side effects of chemicals used in veterinary and agricultural practices and, more particularly, in the widespread **use of anthelmintics to control gastrointestinal parasites of grazing livestock** and companion animals



VMPs: Pasture Animals

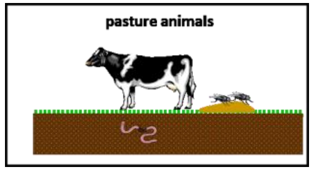


In pastures, most antiparasitics are excreted in the faeces of animals, creating a concern for their effect on the organisms that feed and/or breed in animal dejections. As the spectrum of activity of antiparasitics has enlarged, the potential for affecting non-target organisms has increased equally.

Possible impacts:
- dung degradation;
- grassland insect communities;
- ecosystem stability and on the sustainability of pasture fertility

Many of the non-target organisms play a vital role in the processes of dung dispersal. They are crucial for maintaining pasture hygiene, nutrient cycling, soil aeration, humus content, water percolation and pasture productivity.

VMPs: Ivermectin Effects on NTA



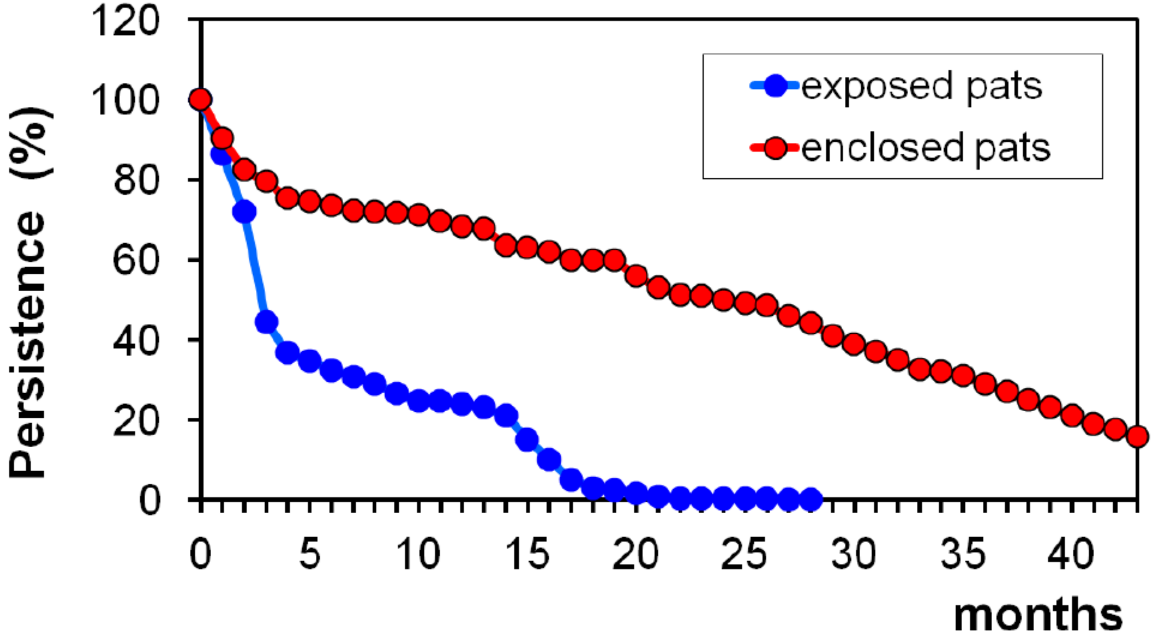
Iglesias et al., 2006. Environmental impact of ivermectin excreted by cattle treated in autumn on dung fauna and degradation of faeces on pasture

Arthropods	Control	Treated	p value
Adult insects			
Diptera: Nematocera	150	111	*
Diptera: Brachycera	85	48	*
Coleoptera: Polyphaga	191	181	
Collembola	7743	5833	
Other adults	67	37	
Total	8,236	6,210	*
Larvae insects			
Diptera: Nematocera	317	41	**
Diptera: Brachycera	523	62	**
Coleoptera	127	106	
Other larvae	25	4	
Total	992	213	**
Arachnida			
Acari: Oribatida	390	164	
Acari: Gamasida	639	314	**
Acari: Actinedida	28	6	*
Acari: Acaridita	24	6	*
Other Acari	14	3	
Miscellaneous (spiders)	5	6	
Total	1,100	499	**
Total arthropods	10,328	6,922	**

*$p<0.05$; **$p<0.01$

Importance of Dung Fauna

Impact on degradation



MANURE AND SLURRY: NOT ONLY EMERGING CONTAMINANTS

Denmark: 44.000 km^2 ; 5 million people; reared pigs > 30 million per year

The consumption of copper and zinc in modern farming is linked to their documented benefit as growth promoting agents and usefulness for controlling diarrhoea.

Denmark has restricted the use of veterinary antimicrobials since January 2000

↓

The farmers have subsequently turned their attention to alternatives like copper and zinc (inert and non-degradable in the slurry and the environment)

Zn: EFSA conclusions (EFSA, 2014): *"Elevated zinc is an environmental issue.* ***There are many regions in Europe where zinc levels are far above background****. Leaching from galvanized steel is the largest source of zinc input into the environment, contributing about 30% of all zinc emissions in the EU. Industrial point sources add another 10%, but the remaining* ***60% comes from a variety of minor diffuse sources, one of which is farming****.*

Cu: EFSA conclusions (EFSA, 2013): "***Potential risks to soil organisms have been identified as a result of the application of piglet manure****. Levels of copper in other types of manure are too low to create a potential risk within the timescale considered.* ***There might also be a potential environmental concern related to the contamination of sediment resulting from drainage and the run-off of copper to surface water***".

Sources of Copper and Zinc on Arable Land

Primary sources use of manure, slurry and sewage sludge as organic fertilisers.
However: Hansen et al., 2014 in Denmark → feed additives (365 ton Cu y^{-1}) 10 times more than used for fertilizer (32 tons Cu y^{-1}). Consumption of Cu for feeds fairly constant (1992-2012), whereas other sources (wood preservation, fertilizers and pigments) decreased.

Copper and zinc may reach relative high concentrations in manure, especially pig slurry.

Concentrations (mg kg^{-1} dry weight) of Cu and Zn in Denmark soils

	1986		1992		1998		2014	
	Cu	**Zn**	**Cu**	**Zn**	**Cu**	**Zn**	**Cu**	**Zn**
0–25 cm								
Mean	7.9	36.7	8.6	33.9	9.2	32.3	11.7	47.7
Std.	2.5	19.6	2.4	13.4	3.0	15.7	3.9	14.2
n	103	105	45	45	105	105	70	70
25–50 cm								
Mean	6.1	31.2	–	–	7.5	28.6	9.4	41.5
Std.	3.6	20.4	–	–	3.3	15.5	4.4	17.8
n	103	105	–	–	105	105	67	67

Table 2. The annual increase of Cu and Zn over the period of 1998–2014. Data in mg kg^{-1} y^{-1} and % of the 1998 soil concentrations at two different soil layers collected at farms within the national grid-net. Data from 1998 originates from Gräber et al., 2005, whereas data from 2014 is the current study.

	Cu		**Zn**	
	(mg kg^{-1} y^{-1})	**%**	**(mg kg^{-1} y^{-1})**	**%**
Top soil (0–25 cm)	0.16	1.7	0.96	3.0
Below ploughing zone (25–50 cm)	0.12	1.6	0.81	2.8

Metabolism of VMPs

The degree of metabolism varies across chemical class and within classes.

It varies also among species.
The amount absorbed can range from a small proportion to 100%

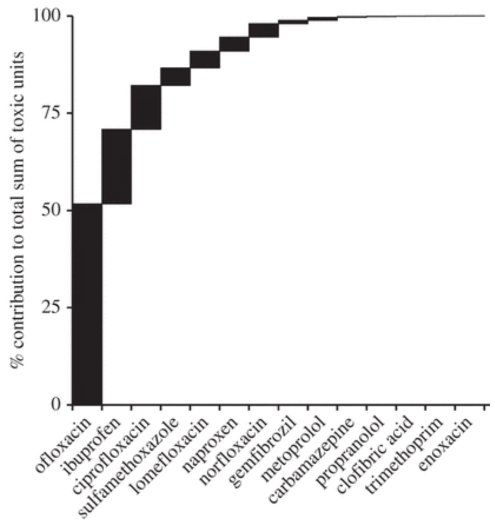
Phase I and Phase II metabolism produce polar metabolites that are excreted.

If a compound is not metabolized, then it may be excreted unchanged

Chemical group	Metabolism
Tetracyclines	Minimal
Sulfonamides	High
Macrolides	Minimal
Aminoglycosides	Minimal to high
Azoles	Moderate
Macrolide endectins	Minimal to moderate
Lincosamides	Moderate
Fluoroquinolones	Moderate to high

Minimal: less than 20% metabolism; *Moderate*: 20 to 80% metabolism; *High*: more than 80% metabolism.

Consequently, animal excreta may contain a mixture of the parent compound and metabolites



Persistence of VMPs in Manure, Slurry and Soil

Manure and slurry

Chemical group	Compound	Matrix	DT50 (d)	Reference
Macrolides	Tylosin	Pig slurry	<2	Loke et al. (2000)
	Eryhromycin	Liquid manure	41	Schlusener et al. (2006)
	Roxithromycin	Liquid manure	130	Schlusener et al. (2006)
Macrolide endectins	Ivermectin	Cattle dung	>45	Sommer et al. (1992)
Sulfonamides	Sulphachloro-pyridazine	Broiler faeces	<8	Van Dijk and Keukens (2000)
	Sulphachloro-pyridazine	Laying hen faeces	<90	Van Dijk and Keukens (2000)
	Sulphachloro-pyridazine	Pig slurry	>8	Boxall et al. (2003b)
Tetracyclines	Chlortetracycline	Chicken manure (+ soil)	>30	Gavalchin and Katz (1994)
	Oxytetracycline	Cattle manure	<30	Di Liguoro et al. (2004)
Others	Amprolium	Laying hen faeces	>8	Van Dijk and Keukens (2000)
	Amprolium	Broiler faeces	>90	Van Dijk and Keukens (2000)
	Nicarbazin	Broiler faeces	>8	Van Dijk and Keukens (2000)
	Salinomycin	Liquid manure	6	Schlusener et al. (2006)
	Tiamulin	Liquid manure	>180	Schlusener et al. (2006)

- Mainly aerobic

- Half-lives ranging from days to months (env. conditions, soil type, soil-organic carbon, specific degrading bacteria)

Soil

Compound	$t_{1/2}$ (d)	Reference
Amoxicillin	<1	Boxall et al. (2006)
Ceftiofam	22.2–49	Boxall et al. (2004)
Chlorfenvinphos	<35–<120	Boxall et al. (2004)
Coumaphos	200–300	Boxall et al. (2004)
Danofloxacin	87–143	Boxall et al. (2004)
Deltamethrin	14–36	Boxall et al. (2004)
Enrofloxacin	>152	Boxall et al. (2006)
Erythromycin	20	Schlusener et al. (2006)
Florfenicol	<103	Boxall et al. (2006)
Ivermectin	14–56	Boxall et al. (2004)
Levamisole	<103	Boxall et al. (2006)
Metronidazole	9.7–26.9	Boxall et al. (2004)
Olaquindox	5.8–8.8	Boxall et al. (2004)
Oleandomycin	27	Schlusener et al. (2006)
Oxytetracycline	16–18	Blackwell et al. (2005)
Phenylbutazone	<103	Boxall et al. (2006)
Salinomycin	5	Schlusener et al. (2006)
Sarafloxicin	>65	Boxall et al. (2004)
Sulfachloropyridazine	2.8–3.5	Blackwell et al. (2005)
Sulfachloropyridine	21.3	Accinelli et al. (2007)
Sulfamethazine	18.6	Accinelli et al. (2007)
Tiamulin	16	Schlusener et al. (2006)
Trimethoprim	<103	Boxall et al. (2006)
Tylosin	4.1–4.2	Boxall et al. (2004)
Tylosin A	7	Hu and Coats (2007)
Tylosin D	8	Hu and Coats (2007
Virginamycin	>64	Boxall et al. (2004)

Antimicrobial Occurrence in Manure

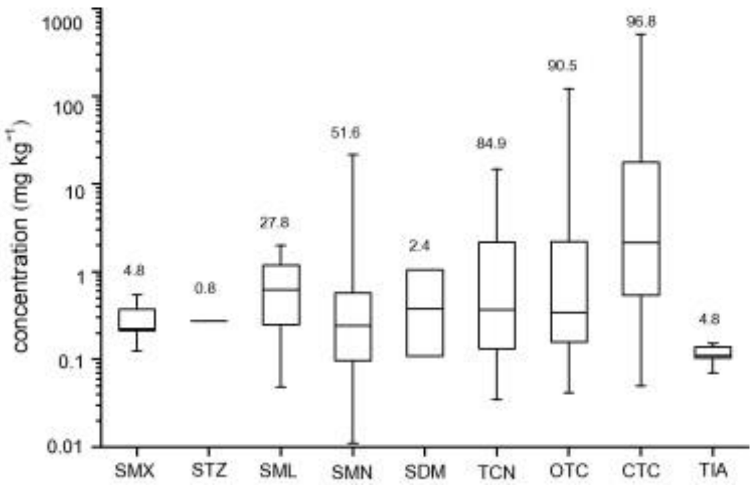
Du Liu, 2012:

Table 1 The reports on antibiotic content in animal excreta

Sites	Antibiotics species	Sample description	Average concentration	Reference
Germany	TC, CTC	Liquid pig manure	0.1–4 mg/kg	Hamscher et al. (2002)
Germany	TYL, TC, SMZ, CAP	10–15 Dust samples each year during 1981–2000 from piggery	Detected in 90% samples, 0.19–12.5	Hamscher et al. (2003)
Seven provinces, China	OTC, TC, CTC	32 Pig and 23 chicken manure samples	Pig manure: 9.09 for OTC, 5.22 for TC, 3.57 for CTC; chicken manure: 5.97 for OTC, 2.63 for TC, 1.39 for CTC	Zhang et al. (2005a, b)
Tianjin, China	OTC, TC, CTC, Doxycycline, SDZ, SDM, SCP, SMZ, SDO, Furazolidone, CIP, Pefloxacin, CAP	9 Pig manures and 11chicken manures	0.3–173 μg/kg	Hu et al. (2008)
Zhejiang province, China	OTC, TC, CTC	93 Pig, cow and chicken manure samples	3.1 for OTC, 1.57 for TC,1.8 for CTC	Zhang et al. (2008a, b, c)
Jiangsu, China	SG, SA, SD, SMR, SMD, SMM, SCP, SMZ	178 Manure samples	0.08–7,105 μg/kg	Chen et al. (2008)
Tianjin, China	OTC, CIP, CTC, SMZ, SDO, SCP, CAP, OFL, PEF, CIP, LIN	Winter manures and summer manures	Winter manures: 0.1–183.5; summer manures: n.d.–29.3	Hu et al. (2010)
Eight provinces, China	FQ, SDM,TC	61 Pig, 54 chicken and 28 cow dung samples	Pig and cow dung: up to 34 and 30 CIP, 33 and 47 EFL, 59 and 60 OTC, 21 and 28 CTC; chicken dung: up to 99 fleroxacin, 225 norfloxacin, 46 CIP, 1,421 EFL	Zhao et al. (2010)

AMX amoxicillin, *AOC* aureomycin, *CAP* chloramphenicol, *CTC* chlortetracycline, *CIP* ciprofloxacin, *EFL* enrofloxacin, *FQ* fluoroquinolones, *LIN* lincomycin, *LSM* lincosamides, *OFL* ofloxacin, *OTC* oxytetracycline, *PEF* pefloxacin, *SMD* sulfonamides, *SMZ* sulfamethazine, *SMX* sulfamethoxazole, *SDO* sulfadoxine, *SCP* sulfachloropyridazine, *SG* sulfagidine, *SA* sulfanilamide, *SDZ* sulfadiazine, *SDM* sulfadimidine, *SMM* sulfamonomethoxine, *SCP* sulfachloropyridazine, *SMR* sulfamerazine, *SMT* sulfameter, *SDM* sulfadimethoxine, *TC* tetracycline, *TYL* tylosin; *n.d.* not detected

Xun Pan et al., 2012:
Nine veterinary antibiotics were simultaneously detected in swine manure



Concentrations of test antibiotics in 126 swine manure samples. (legend: sulfathiazole (STZ), sulfamethoxazole (SMX), sulfamethizole (SML), sulfadimethoxine (SDM), tetracycline hydrochloride (TCN), oxytetracycline (OTC), sulfamethazine (SMN), chlorotetracycline (CTC), tiamulin fumarate (TIA)

Occurrence of Contaminants in Manure-based Fertilizers (Mingrong Qian et al., 2016)

	SMZ	SDZ	SMM	SMX	SCP	TMP	ENR
Chicken	**70.7–4184 (956)**	**ND**	**3.9–2571 (488)**	**72.9**	**ND**	**85.0**	**8.4–1356 (299)**
	90–6040 (430)	30–3120 (150)	80–900 (300)	120–2800 (780)	200–710 (460)	-	330–1,420,760 (4650)
	5.9–22.7 (9.7)	5.5–1845 (28.2)	2.1–3.9 (2.8)	4.1–28.8 (6.7)	NA	NA	10.6–8575 (102.8
Pig	**3.1–613 (93.8)**	**ND**	**5.0–910 (248)**	**ND**	**161**	**41.2–57.6 (49.4)**	**6.4–4091 (310)**
	60–1730 (210)	90–800 (210)	70–4080 (200)	230–840 (510)	90–3510 (820)	NA	480–33,260 (209(
	5.7–33.7 (11.7)	5.1–6792 (119.5)	2.1–20.3 (4.8)	4.1–14.3 (6.5)	NA	NA	12.5–89.0(38.8)
Cattle	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**6.8–2908(363)**
	100–180(140)	ND	60–60(60)	ND	360–360(360)	NA	1720–46,700(679
	4.7–34.0 (10.6)	5.2–65.0 (12.5)	2.0–2.2 (2.2)	4.2–7.85 (5.2)	NA	NA	10.1–740 (56.1)

Type	Hg	As	Cu	Pb	Zn
Chicken	**0.1–1.4 (0.3)**	**1.5–49.3(9.6)**	**26.3–653(116)**	**0.6–29.7 (10.0)**	**165–2377 (482)**
	< 0.0002–0.08(0.02)	< 0.004–0.6(0.05)	20.7–570(89.1)	2.9–20.3(11.1)	175–965(417)
	NA	0.6–10.4	1.5–488	ND-22.1	15.4–1063
	ND-83.9(17.3)	ND-41.2(4.8)	17.9–1726(142)	0.5–57.2(6.1)	73.0–1827(432)
	NA	NA	25–36(30)	0.03–1.1(0.6)	234–241(238)
Pig	**0.1–4.3 (0.5)**	**0.8–200 (19.4)**	**0.6–2030(464)**	**0.2–232(19)**	**4.6–5720(1165)**
	< 0.0002–0.2(0.03)	< 0.004–0.08(0.01)	35.7–1726.3(399)	4.2–82.9(12.8)	113.6–1506(506)
	NA	0.6–33.5	77.6–1521	ND-5.1	63.4–1623
	0.1–505(28.9)	ND-73.9(5.2)	8.4–1712(300)	0.7–194(7.3)	39.5–11,379(599
Cattle	**0.1–2.5(0.5)**	**1.2–24.2(5.6)**	**19.0–941(147)**	**3.2–39.4 (12.4)**	**74.3–2230 (402)**
	< 0.0002–0.07(0.04)	< 0.004–0.042(0.01)	22.7–91.0 (46.0)	5.3–12.9(9.7)	98.9–306(186)
	NA	0.5–19.4	10.3–113	0.5–5.5	17.0–377
	0.1–77.3(29.1)	ND-8.3(1.5)	20.7–342(56.1)	2.4–11.7(8.1)	68.1–535 (213)
	NA	NA	5.6–180(44)	0.1–2.4(0.8)	22–443(130)

Antimicrobial Occurrence in the Environment

The occurrence of antimicrobials in soils, sediment, surface water, and groundwater well documented in close proximity to livestock and poultry operations.

Campagnolo et al. (2002): **antimicrobial** compounds (lincomycin, chlortetracycline, and sulfadimethoxine) present **in 67% of groundwater and surface water samples collected near poultry operations** and 31% of ground water and surface water samples collected near swine operations;
Batt et al. (2006): two types of **sulfonamides**, which are approved only for veterinary use, in **private drinking water wells** near a large beef cattle livestock production facility;
Harden 2009: lincomycin measured in a groundwater well near a swine lagoon in North Carolina

Environmental concentrations ranging from non-detectable concentrations **to levels of mg/L**. Concentrations in soil tend to be much higher than in water because most antimicrobials bind well to soil (Lee et al. 2007). However, antimicrobials can be transported in aquatic systems (Chee-Sanford et al. 2009, Zounková et al. 2011).

Note that our understanding of the occurrence of antimicrobials in the environment is limited by the fact that **research tends to focus on the most commonly used antimicrobials (e.g., tetracyclines, sulfonamides)**, rather than degradates and less commonly used compounds. Numerous antimicrobial agents have been approved for livestock use, though many have not yet been researched in terms of their prevalence in the environment.

Hormones in Manure

Hormones are endocrine disruptors that are naturally produced by, and **in some cases artificially administered** to, livestock and poultry. **Livestock and poultry excrete hormones in their waste**, which has the potential to enter water resources through runoff and discharges from animal production facilities and fertilized cropland.

Hormone	Select Hormone Metabolites	Purpose
Estrogens	Estrone, 17β-estradiol, and estriol	• Natural reproductive hormone • Stimulates and maintains female characteristics
Androgens	Testosterone, 5α-dihydrotestosterone, 5α-androstane-3β, 17β-diol, 4-androstenedione, dehyroepiandrosterone, and androsterone	• Natural reproductive hormone • Stimulates and maintains male characteristics
Progestogens	Progesterone	• Natural reproductive hormone • Produced during the estrous cycle • A metabolic precursor to estrogens

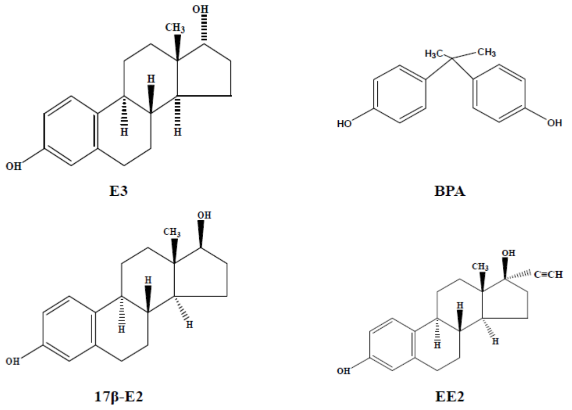


Figure 1. Molecular structures of estriol (E3), 17β-estradiol (17β-E2), bisphenol A (BPA), and 17α-ethinyloestradiol (EE2).

Synthetic Hormone	Mimics the Behavior of Which Natural Hormone Metabolite?	Purpose
Zeranol	17β-estradiol	• Administered as an implant (typically without other hormones) • Used to improve feed efficiency and animal growth
Trenbolone acetate	Testosterone	• Administered as an implant either alone or with 17β-estradiol • Used to improve feed efficiency and animal growth
Melengestrol acetate	Progesterone	• Administered as a feed additive • Used for estrous synchronization and to induce lactation • Used to improve feed efficiency and animal growth

✓Livestock excreted an estimated 722,852 pounds of endogenous hormones in 2000.

✓Beef cattle feedlot operations may administer synthetic hormones as implants and feed additives to promote animal growth.

Hormones in Manure (Andaluri et al., 2012)

Table 3 Concentration of estrogen hormones in solid waste matrices (ng/g DS)

Analyte	Municipal biosolids	Poultry manure	Cow manure
17α-estradiol	462.6	92.7	6.2
17β-estradiol	229.7	149.8	16.6
17α-dihydroequilin	152.1	nd	27.4
Estrone	98.5	44.2	16.1
Total estrogen	942.9	286.7	66.3

nd not detected

Table 4 Annual generation of solid waste and estimated estrogen content in the US

Solid waste	Amount of solid waste generated (tons)	Estimated estrogen content (tons)
Municipal biosolids	6,900,000	6.5
Poultry manure	12,000,000	3.4
Cow manure	980,000,000	64.9
Mushroom compost	324,000	0.012
Swine manure[a]	15,500,000	1.2
Total	1,014,724,000	76

[a]Cromwell et al. (1993)

Hormones in the Environment

- **Half-lives of natural and synthetic hormones** vary considerably, ranging **from several hours to over 260 days** depending on the type of hormone and media. Manure storage may facilitate the degradation of natural and synthetic hormones. However, research suggests that **synthetic hormones may persist at low concentrations even after months of storage and land application**. Trenbolone acetate and melengestrol acetate were detected in the solid manure after excretion and also after 4.5 months of storage. **Trenbolone** was still detected in the soil up to two months after the liquid manure was applied to corn fields and had an estimated **half-life of 267 days during storage**;

- Bartelt-Hunt et al., 2012. Natural and synthetic hormones and their metabolites have been measured in runoff from livestock and poultry operations (**testosterone up to 420 ng/L, 17α-estradiol up to 720 ng/L, and estrone up to 1050 ng/L**).

- Shore et al., 1995: concentrations of up to 5 ng/L of estrogen and 28 ng/L of testosterone in small streams draining fields which had recently been fertilized with poultry litter.

- Kolodziej and Sedlak (2007): steroid hormones in 86% of samples from rangeland creeks where cattle had access to the creeks.

- Arnon et al., 2008 and Harden et al. 2009: Hormones in groundwater impacted by dairy farms and swine.


VLADIMIR I. LENIN
CHE FARE?
Seguito dagli atti delle sedute del secondo congresso del Partito operaio socialdemocratico russo (1903) e dagli scritti di V. Akimov, P. Aksel'rod, A. Bogdanov, V. Lenin, L. Martov, D. Rjazanov, G. Plechanov, L. Trockij, V. Vorovskij sul concetto di partito.
A cura di Vittorio Strada
122
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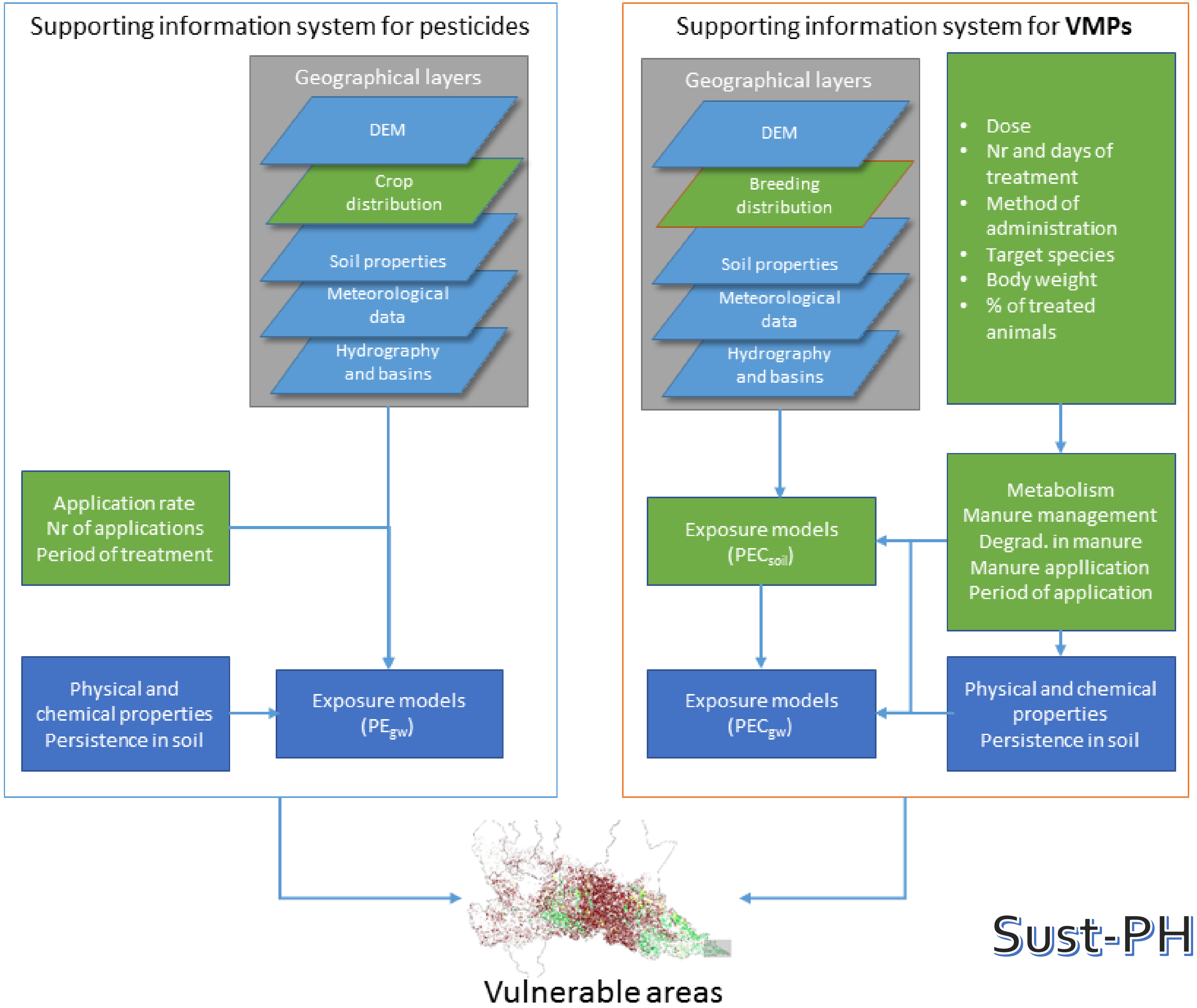
Supporting information system for pesticides
Geographical layers
DEM
Crop distribution
Soil properties
Meteorological data
Hydrography and basins
Application rate
Nr of applications
Period of treatment
Physical and chemical properties
Persistence in soil
Exposure models (PE_{gw})
Supporting information system for **VMPs**
Geographical layers
DEM
Breeding distribution
Soil properties
Meteorological data
Hydrography and basins
Dose
Nr and days of treatment
Method of administration
Target species
Body weight
% of treated animals
Metabolism
Manure management
Degrad. in manure
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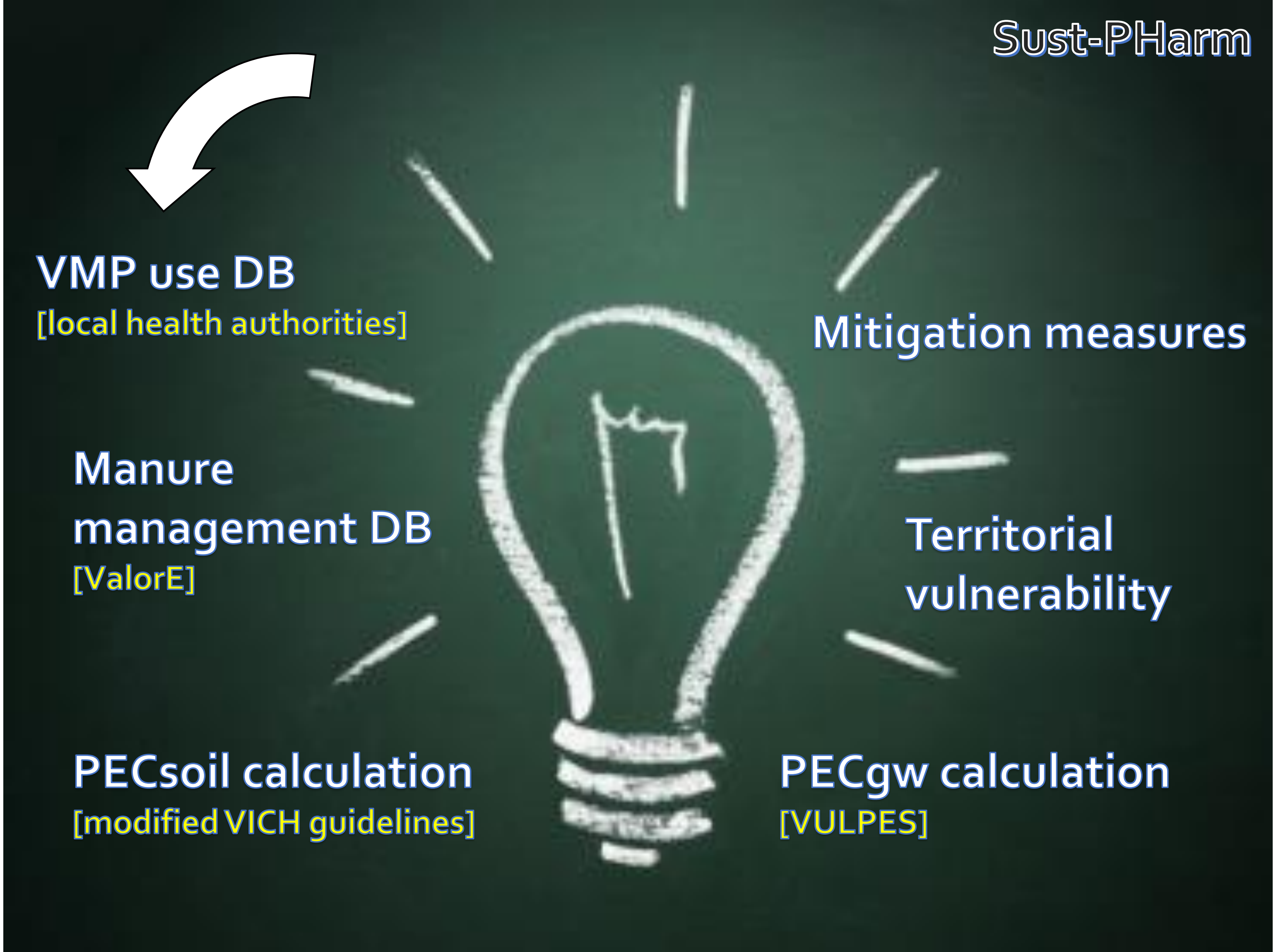
Exposure models (PEC_{gw})
Physical and chemical properties
Persistence in soil
Vulnerable areas

Sust-PHarm


Sust-PHarm
VMP use DB
[local health authorities]
Mitigation measures
Manure
management DB
[ValorE]
Territorial
vulnerability
PECsoil calculation
[modified VICH guidelines]
PECgw calculation
[VULPES]

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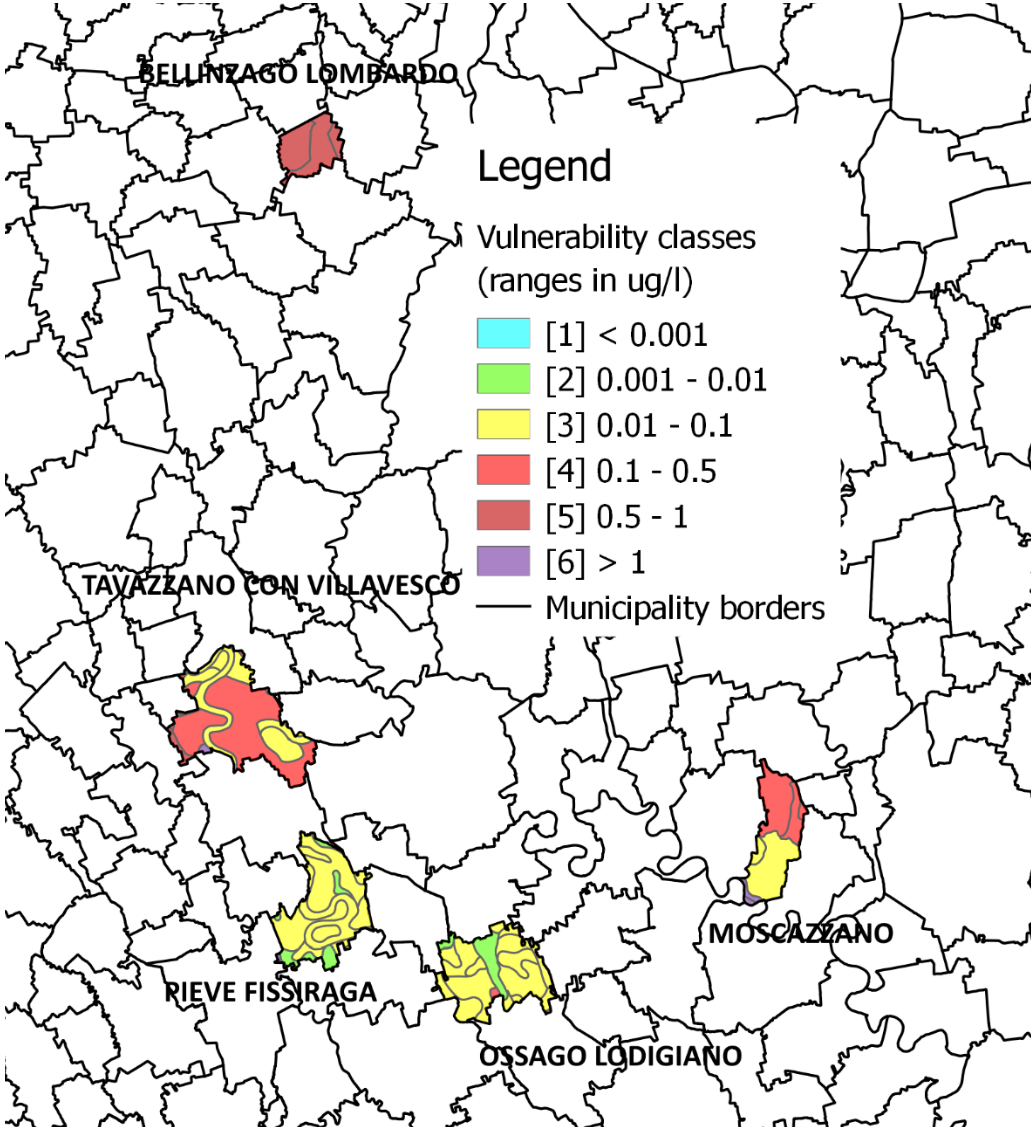
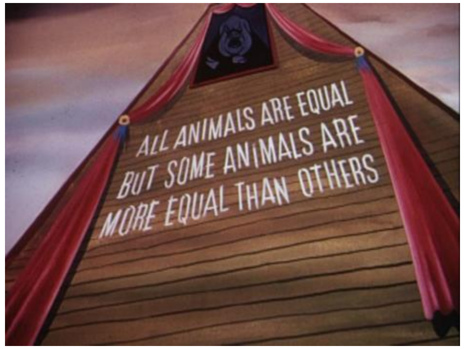
Sustainable use of veterinary pharmaceuticals on the territory (Sust-PHarm): Linking available database of manure management and environmental fate models

Andrea Di Guardo [a,b,*], Antonio Finizio [a]

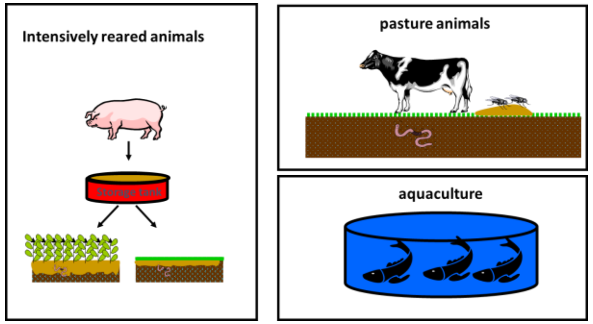


Sust-Pharm: Vulnerability map to flumequin (antibiotic) in Lombardy Region

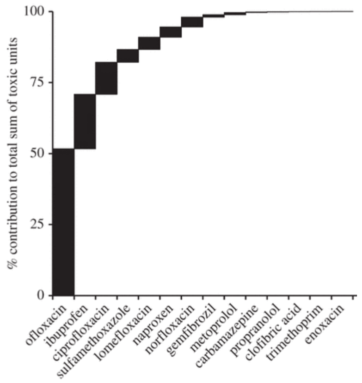
Conclusions



- ✓ Lombardy: 25% of total national cows and 50% of total national pigs



- ✓ Different routes of environmental exposure for VMPs



- ✓ Presence of different pollutants in manure and environmental compartments (antibiotics, hormones)

- ✓ How to deal with? Learn lesson from pesticides……