Nitrates toxicity

UW Extension
University of Wisconsin–Extension

Nitrate Issues

- Nitrate Poisoning in Animals
- Silo Gas Poisoning in Man

Cause of High Nitrates in Plants

- Nitrate to plant cycle influenced by:
  - Adequate water
  - Energy from sunlight
  - Temperature conducive to rapid chemical reaction
- Nitrate to protein cycle disruption causes:
  - Nitrate absorption by roots continues
  - Nitrates accumulate in roots, lower stalk and leaves

Most Susceptible Plants

Crops	Weeds
Corn	Pigweed
Small Grains	Lambsquarter
Sudangrass	Field Bindweed
Sorghum	

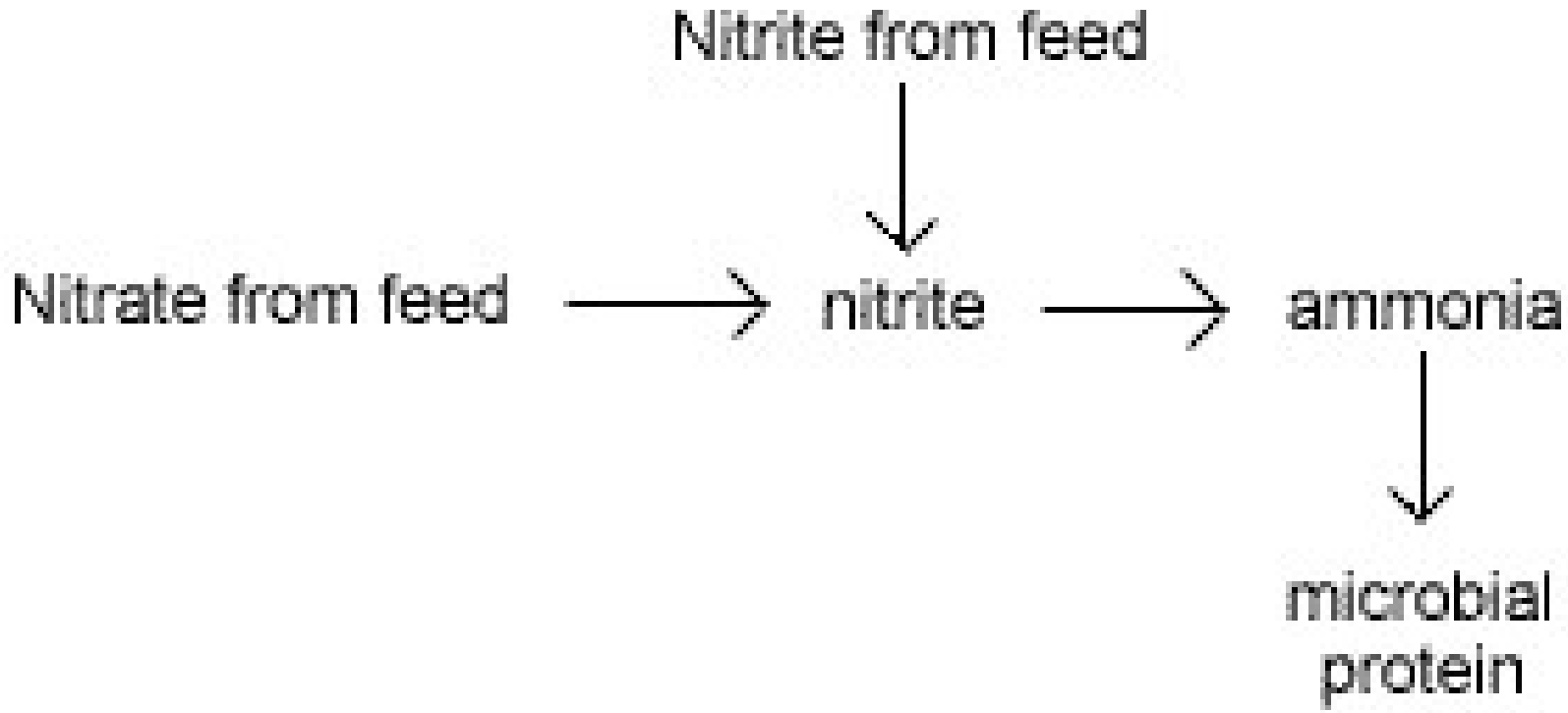
Causes of High Nitrates In Plants

- Rain after period of drought
- Frost
- Hot or cool weather
- Extended cloudy weather
- Excessive nitrogen fertilization

Nitrate Poisoning in Animals

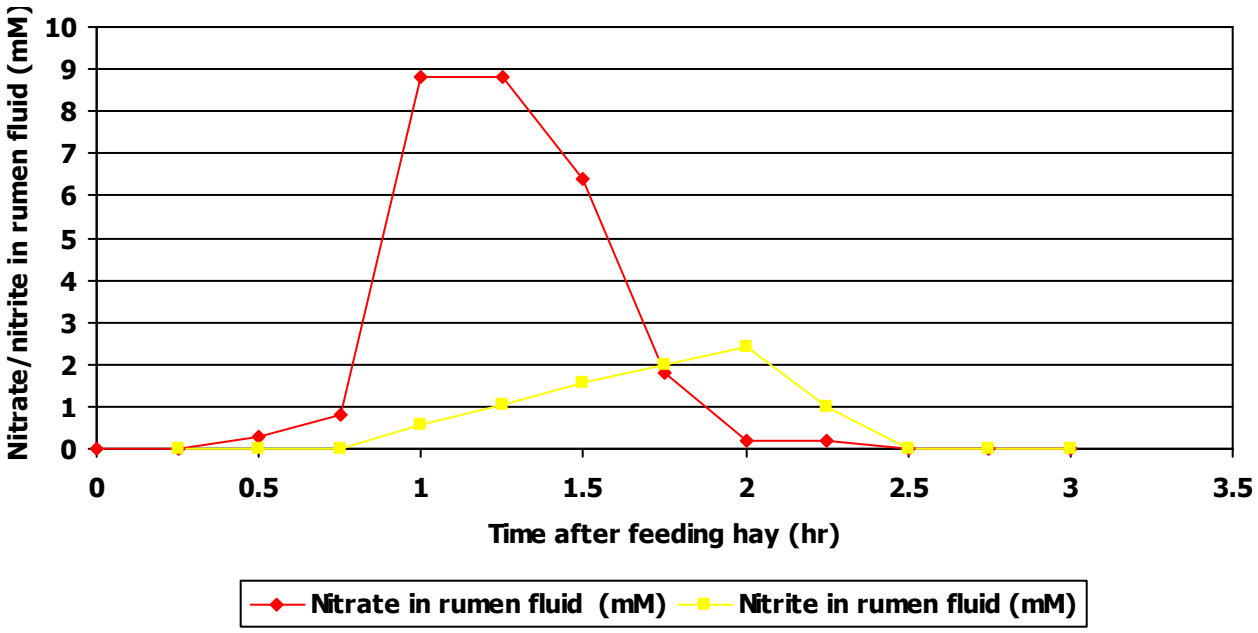
- Nitrite absorbed into bloodstream
- Hemoglobin converted to methemoglobin
- Methemoglobin reduces oxygen carrying capacity of blood

RUMINANT:

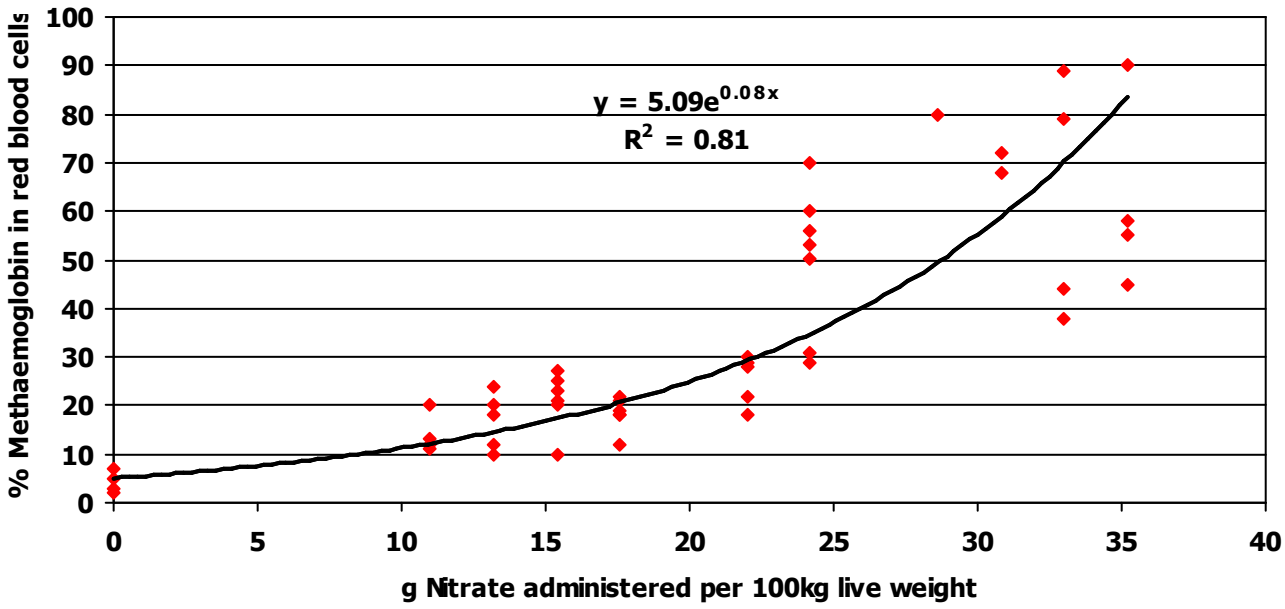


NON-RUMINANT:

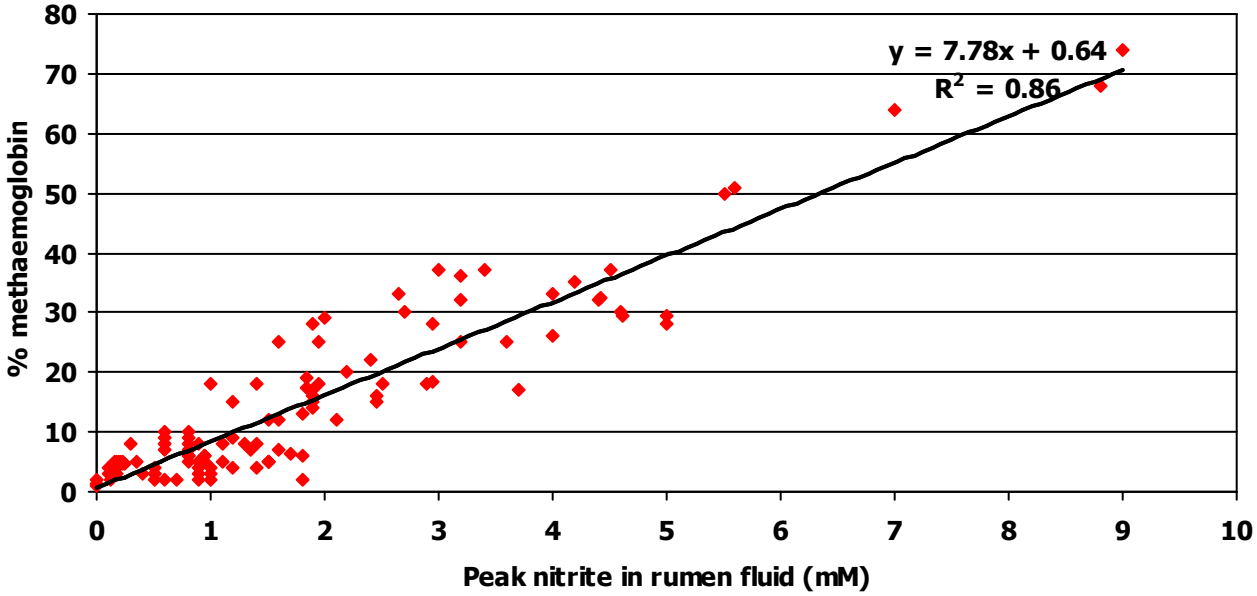
Changes in nitrate and nitrite in rumen fluid of a cow after ingesting hay over 45 minutes, containing 82 g of nitrate (Kemp et al 1977)



The changes in methaemoglobin in blood of cattle with increasing amounts of nitrate entering the rumen (after Crawford et al 1965).



Relationship between the peak concentration of nitrite in rumen fluid and methaemoglobin in the blood of cows (Kemp et al 1977)



Symptoms of Animal Nitrate Poisoning

- Poor appetite
- Weak calves
- Abortions
- Poor growth
- Unthrifty animals

Nitrate Management Strategies

- Drought Do not green chop or pasture 10 to 14 days after rain on stressed crops.
- Test suspected high nitrate feedstuffs.
- Provide adequate energy, minerals and vitamins in total ration.
- Consider raising cutter bar when chopping known or suspected high nitrate feedstuffs.
- Ensiling forage reduces nitrate levels approximately 50% during the 30-60 day fermentation process.

Oklahoma Research

- A study conducted at three Oklahoma agronomy research field stations (near Haskell, Chickasha, and Tipton)
- found that when hot weather stress occurred, pearl millet contained greater concentrations of nitrate than did sudan x sudan, sorgo x sudan, or sorghum x sudan hybrids

Table 2. Average nitrate concentrations in ppm for four forage types at three locations grown in two years.

Forage Type	Location Haskell	Chickasha	Tipton
SMXSU*	7795	3302	7049
SOXSU	7291	3255	6673
SUXSU	8079	3461	7190
PM	14122	6572	10534

*SMXSU=sorghum-sudangrass; SOXSU=sorgo-sudangrass; SUXSU=sudan-sudan; PM=pearl millet

Table 3. Average nitrate concentrations (ppm) of hybrid sudangrass hay grown under different nitrogen fertilizer schemes.

Treatment				
0 lb. N	* 50 lb.	100 lb. N	150 lb. N	200 lb. N
3631	6282	6098	7083	8432

*Applied at planting and after each harvest.

Table 1. Generalized rating of some forage grasses and forbs in their nitrate accumulation potential.

High Potential		Low Potential
Grasses	Forbs	
Barley	Horsenettle	Bermudagrass
Bromegrass	Kochia	Bluestem
Corn	Lambsquarter	Buffalograss
Fescue	Morningglory	Gramagrass
Johnsongrass	Pigweeds	Weeping lovegrass
Oats	Puncturevine	
Rescuegrass	Russianthistle	
Rye	Sunflower	
Sorghum		
Sudangrass		
Wheat		
Pearl millet		

Additional Feeding Guidelines

“Dilution is the Solution”

- Introduce high nitrate feeds slowly in ration.
- Ruminants will become conditioned to high nitrate feeds.
- Provide adequate grain (carbohydrate source) in ration.
- Feed only to healthy animals.
- Carefully monitor feeding to dry cows/heifers.
  - Low energy, high forage diets
- Monitor nitrate levels in all feeds and water.

Sampling for Nitrates

- Certified labs will analyze for nitrates.
- Follow sampling directions carefully.
- Cost
  - University of Wisconsin Labs – Marshfield
    - $9.00/sample

Feeding Guidelines with Known Nitrate Content

Nitrate N Content	Feeding Guideline (DM Basis)
Below 1000 ppm	Safe
1000 ppm – 2000 ppm	Limit to 1/2 total ration
2000 ppm – 3000 ppm	Limit to 1/3 total ration
3000 ppm – 4000 ppm	Limit to 1/4 total ration
Over 4000 ppm	Use Extreme Caution - (Ensile)

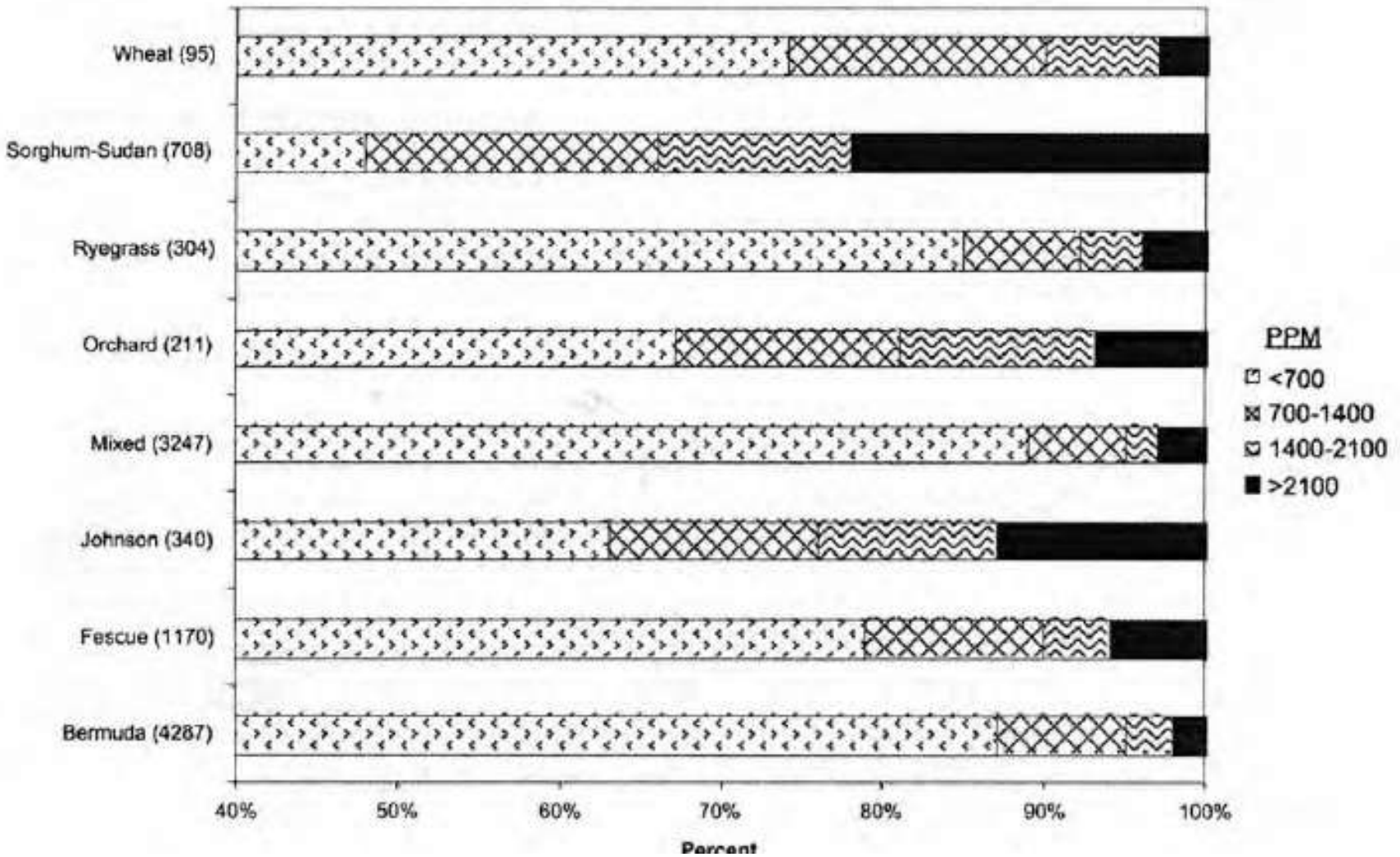
Guidelines for Use of Feeds With Known Nitrate Content[a]

Level (ppm, dm basis)[b]	Animal Response	Comments and Recommendations
Below 700 NO_3-N 3080 NO_3 5040 KNO_3	Normal if on an adequate ration.	Safe to feed.
700-1400 NO_3-N 3080-6160 NO_3 5040-10,080 KNO_3	May be hazardous to pregnant and very young animals.	Generally safe when fed balanced rations but best to limit the feed to half of the total dry ration for pregnant animals. Also be sure water is low in nitrate.
1400-2100 NO_3-N 6160-9240 NO_3 10,080-15,120 KNO_3	May result in poor appetite, slow growth, abortions, vitamin A deficiency symptoms in the sixth to eighth week and a decrease in milk production (slow at first, increasing after six to eight weeks).	Limit the feed to less than half of the total dry ration. Be sure water is safe. Be sure ration is well fortified with energy, minerals and vitamin A.
Above 2100 NO_3-N 9240 NO_3 15,120 KNO_3	Potentially lethal. Poor appetite, vitamin A deficiency, abortions, general production lowered.	Hazardous intake level for all animals.

[a] In most situations feed would refer to forages.
[b] Move decimal four places to left to convert ppm to percent (i.e., 700 ppm equals .07 percent).

NO_3 = nitrate
NO_3N = nitrate nitrogen (value reported by UofA Diagnostic Lab)
KNO_3= potassium nitrate

Figure 1. Percentage of hay samples for various species that fell within four different tolerance levels for nitrate-nitrogen in the diet of beef cattle



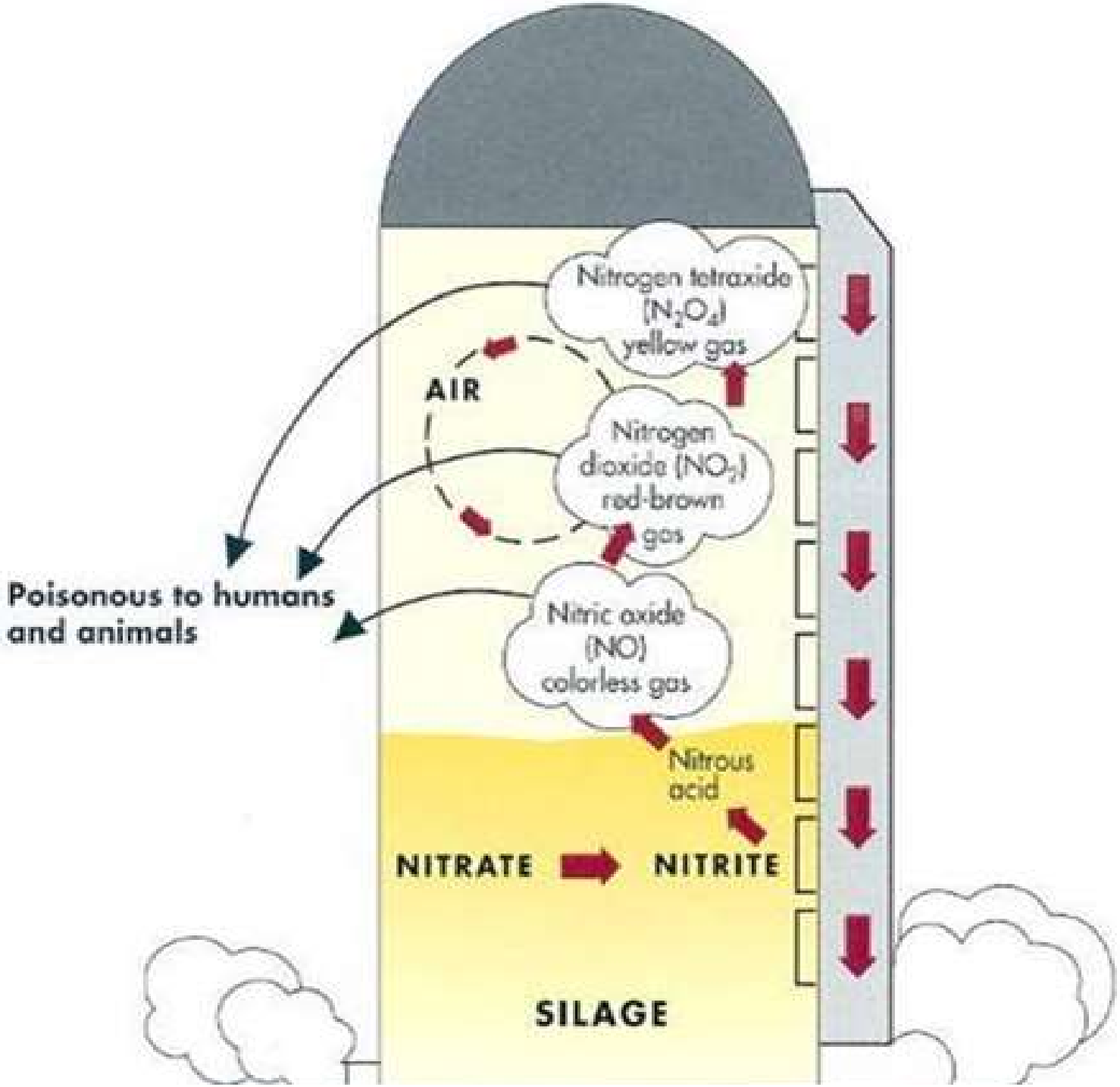
Other Nitrate Issues

- Silo Gasses.
  - Brownish-yellow gas with bleach odor
  - Accumulates in low areas:
    - Silo room
    - Silo chute
    - Below silo door opening

Silo Gas Issue.

  - Do not leave silo room door open to barn!
  - Ventilate silo with blower for 30 minutes before entry.

- Silo gas, a combination of nitrogen dioxide and carbon dioxide, is heavier than air and hovers close to the ground.
- Farmers harvesting and storing silage are advised to use extreme caution


Nitrogen tetraxide
(N_2O_4)
yellow gas
AIR
Nitrogen
dioxide (NO_2)
red-brown
gas
Poisonous to humans
and animals
Nitric oxide
(NO)
colorless gas
Nitrous
acid
NITRATE
NITRITE
SILAGE

- Nitrogen dioxide (NO2) is heavier than air and toxic to humans and animals.
- The gas may be colorless, yellow, or reddish brown with an acrid, bleach-like smell.
- Unfortunately, gas odor is not a reliable indicator of the presence of nitrogen oxides.

- Symptoms of silo gas poisoning range from mild to severe and include
- severe irritation of the nose and throat, coughing, shortness of breath and vomiting.
- Exposure may lead to lethal fluid buildup in the lungs. Many victims may suffer relapses with pneumonia-like symptoms up to six weeks after exposure.
- Anyone exposed to silo gas must seek immediate medical attention.

Summary

- Nitrates may be an issue in drought stressed crops after a rain.
- Ensiling reduces nitrate levels 30 - 50%.
- Dilution is the solution when feeding high nitrate feeds.
- Follow sampling directions.
- Watch out for silo gas.