

# Nitrates toxicity

# 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

Corn

Small Grains

Sudangrass

Sorghum

## Weeds

Pigweed

Lambsquarter

Field Bindweed

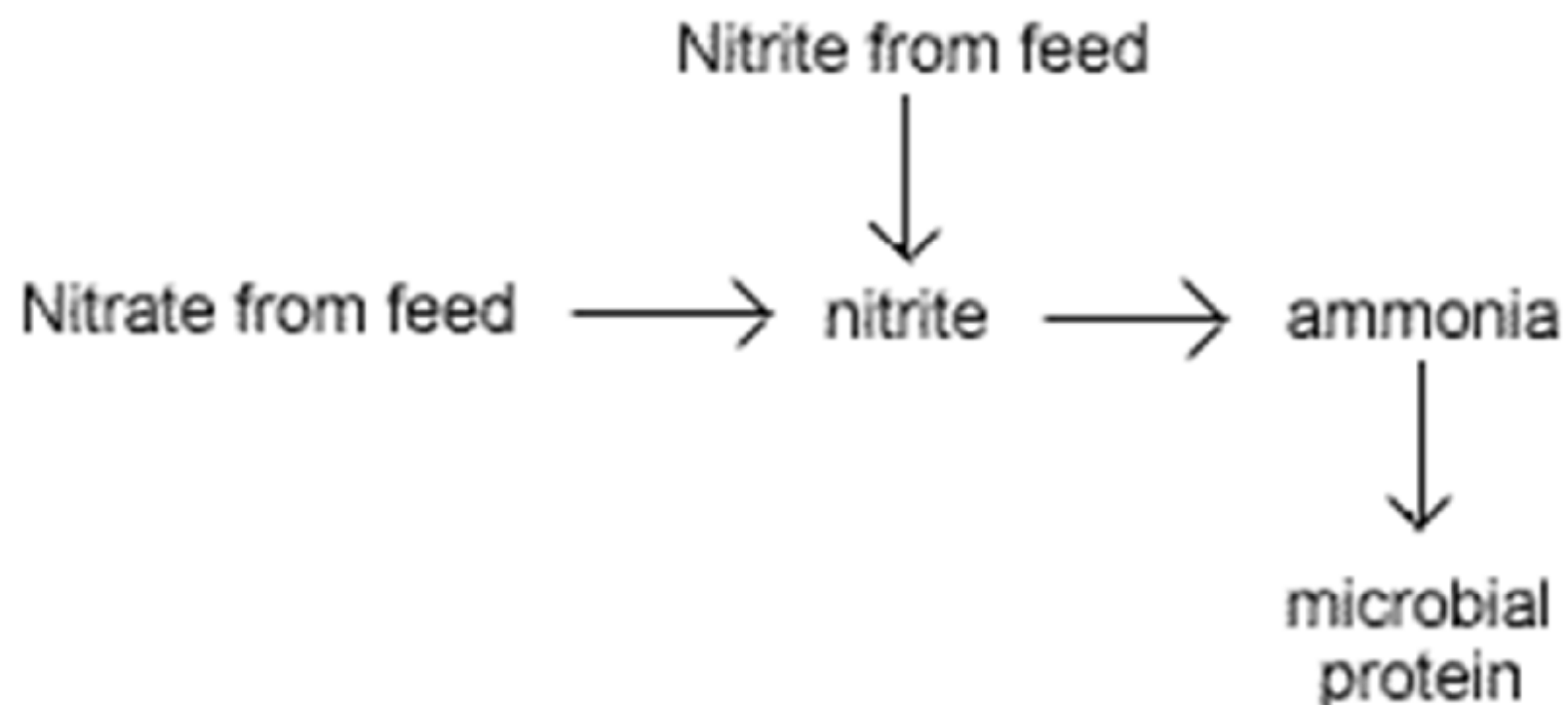
# Causes of High Nitrates In Plants

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

# Nitrate Poisoning in Animals

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

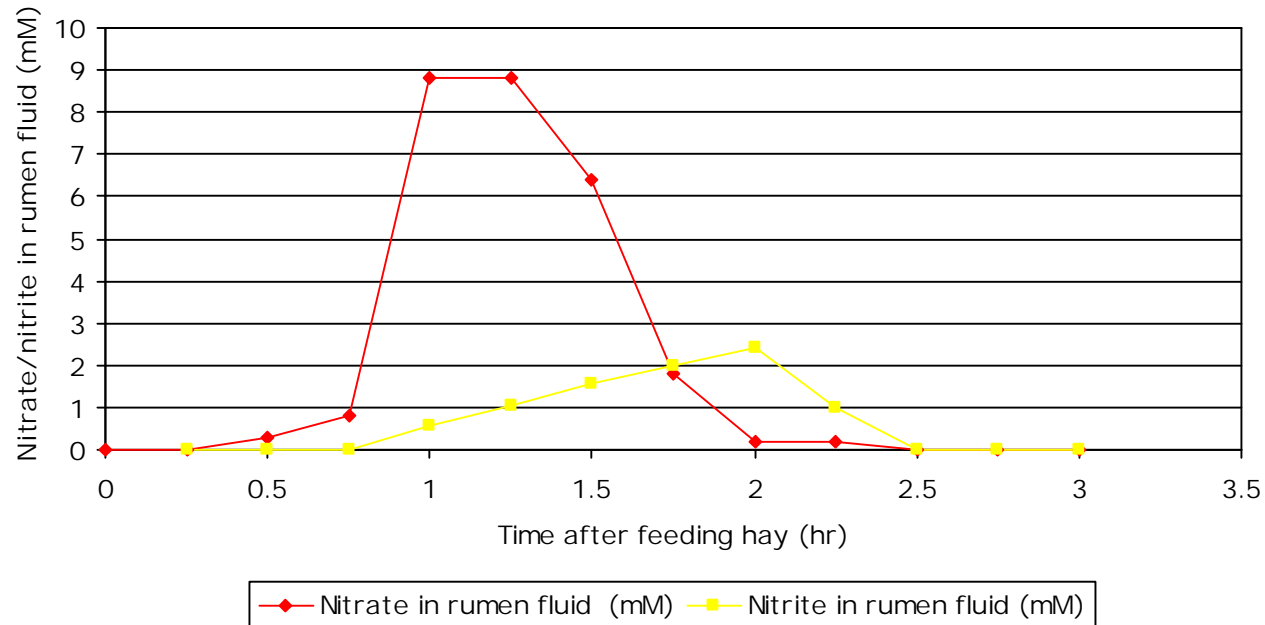
## RUMINANT:



## NON-RUMINANT:

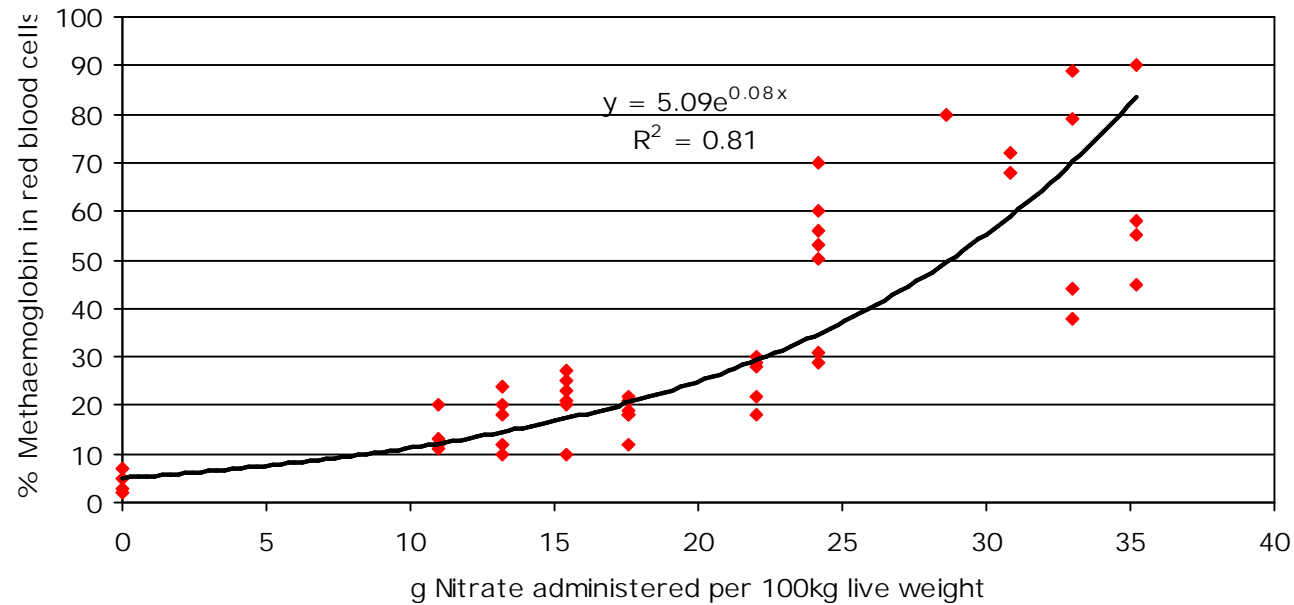


# Changes in nitrate and nitrite in rumen fluid of a cow after ingesting hay over 45 minutes, containing 82 g of nitrate (Kemp et al 1977)

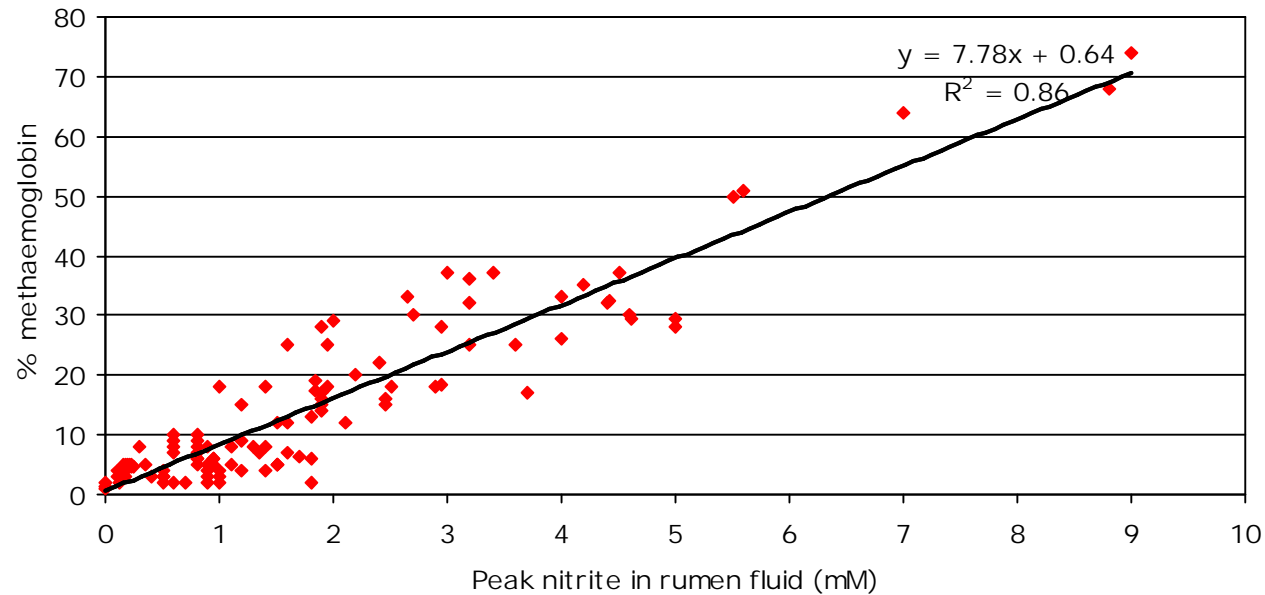




# The changes in methaemoglobin in blood of cattle with increasing amounts of nitrate entering the rumen (after Crawford et al 1965).



# 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 | Haskell | Location  |        |
|-------------|---------|-----------|--------|
|             |         | 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.**

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

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\*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 -  
(Ensilage)

### Guidelines for Use of Feeds With Known Nitrate Content<sup>a</sup>

| Level<br>(ppm, dm basis) <sup>b</sup>                                                       | Animal Response                                                                                                                                                                                        | Comments and Recommendations                                                                                                                                    |
|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Below</u><br>700 NO <sub>3</sub> -N<br>3080 NO <sub>3</sub><br>5040 KNO <sub>3</sub>     | Normal if on an adequate ration.                                                                                                                                                                       | Safe to feed.                                                                                                                                                   |
| 700-1400 NO <sub>3</sub> -N<br>3080-6160 NO <sub>3</sub><br>5040-10,080 KNO <sub>3</sub>    | 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 <sub>3</sub> -N<br>6160-9240 NO <sub>3</sub><br>10,080-15,120 KNO <sub>3</sub> | 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.          |
| <u>Above</u><br>2100 NO <sub>3</sub> -N<br>9240 NO <sub>3</sub><br>15,120 KNO <sub>3</sub>  | Potentially lethal. Poor appetite, vitamin A deficiency, abortions, general production lowered.                                                                                                        | Hazardous intake level for all animals.                                                                                                                         |

<sup>a</sup>In most situations feed would refer to forages.

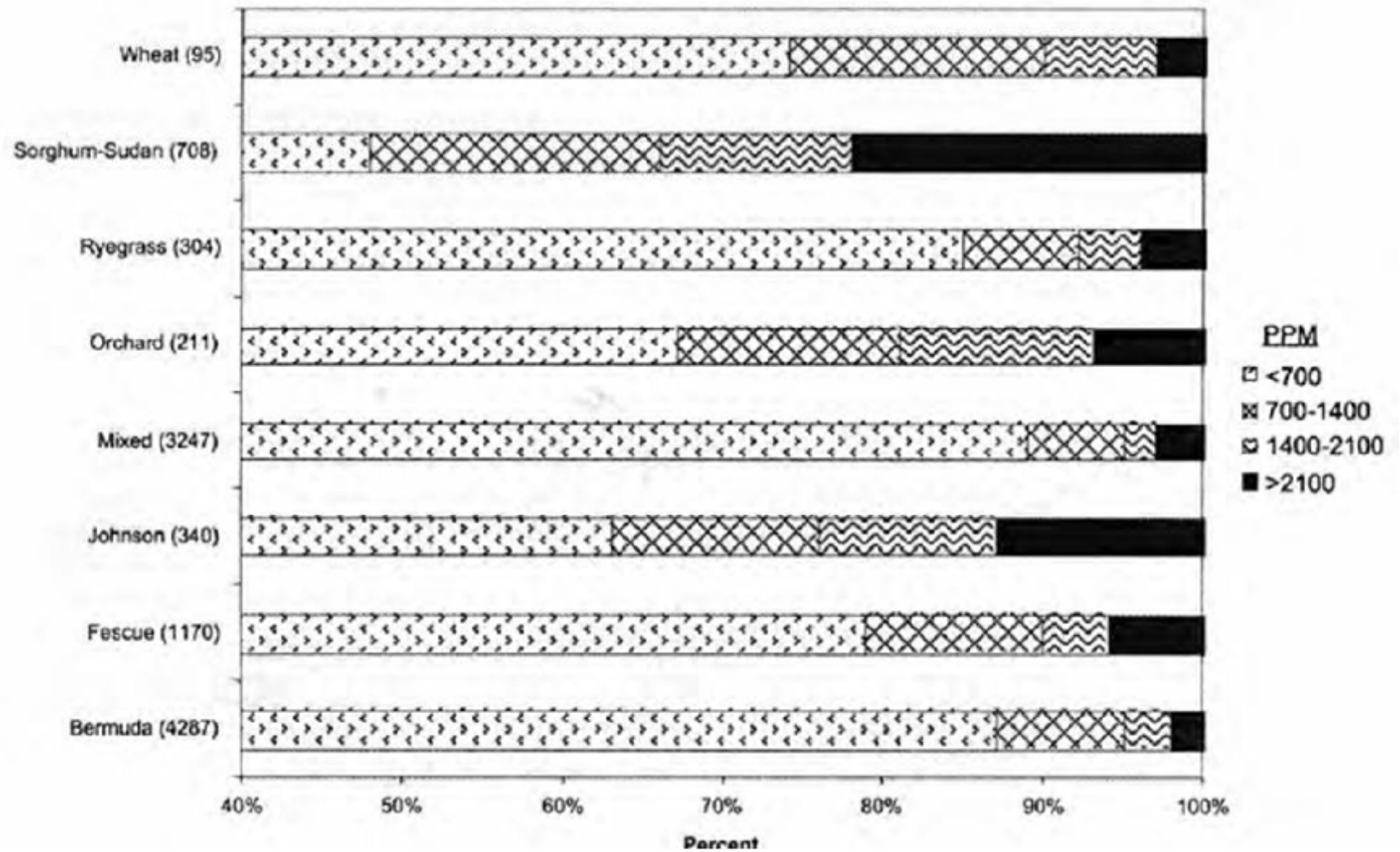
<sup>b</sup>Move decimal four places to left to convert ppm to percent (i.e., 700 ppm equals .07 percent).

NO<sub>3</sub> = nitrate

NO<sub>3</sub>N = nitrate nitrogen (value reported by UofA Diagnostic Lab)

KNO<sub>3</sub> = 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



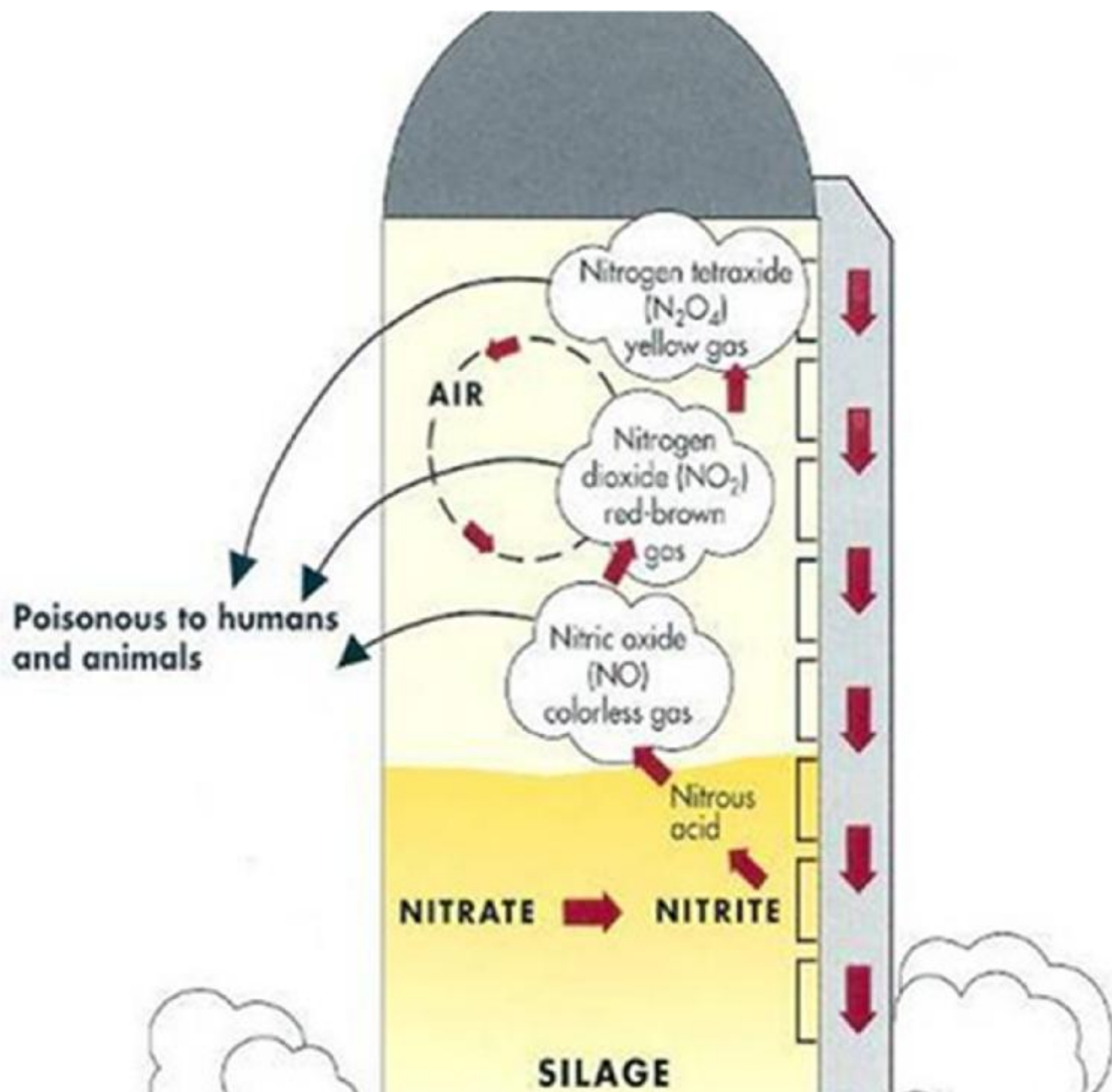
# Other Nitrate Issues

- 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 dioxide (NO<sub>2</sub>) 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.