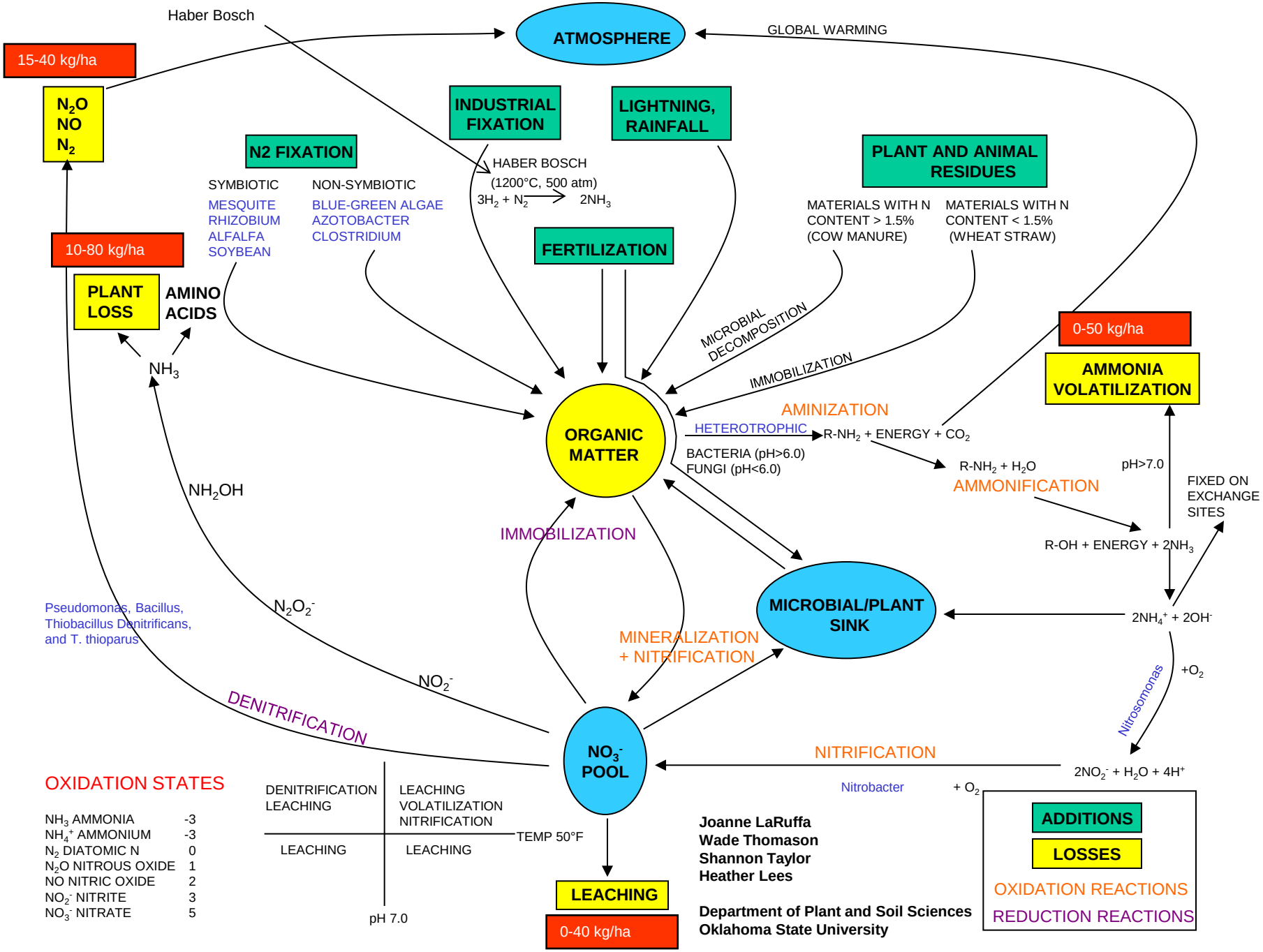
Haber Bosch
ATMOSPHERE
GLOBAL WARMING
15-40 kg/ha
N_2O
NO
N_2
INDUSTRIAL FIXATION
LIGHTNING, RAINFALL
N2 FIXATION
HABER BOSCH
(1200°C, 500 atm)
$3H_2 + N_2 \rightarrow 2NH_3$
PLANT AND ANIMAL RESIDUES
SYMBIOTIC
MESQUITE
RHIZOBIUM
ALFALFA
SOYBEAN
NON-SYMBIOTIC
BLUE-GREEN ALGAE
AZOTOBACTER
CLOSTRIDIUM
MATERIALS WITH N CONTENT > 1.5% (COW MANURE)
MATERIALS WITH N CONTENT < 1.5% (WHEAT STRAW)
10-80 kg/ha
FERTILIZATION
PLANT LOSS
AMINO ACIDS
NH_3
MICROBIAL DECOMPOSITION
IMMOBILIZATION
0-50 kg/ha
AMMONIA VOLATILIZATION
ORGANIC MATTER
AMINIZATION
HETEROTROPHIC
$R\text{-}NH_2$ + ENERGY + CO_2
BACTERIA (pH>6.0)
FUNGI (pH<6.0)
$R\text{-}NH_2 + H_2O$
AMMONIFICATION
pH>7.0
FIXED ON EXCHANGE SITES
NH_2OH
IMMOBILIZATION
R-OH + ENERGY + $2NH_3$
Pseudomonas, Bacillus, Thiobacillus Denitrificans, and T. thioparus
$N_2O_2^-$
MICROBIAL/PLANT SINK
$2NH_4^+ + 2OH^-$
MINERALIZATION + NITRIFICATION
$+O_2$
Nitrosomonas
NO_2^-
DENITRIFICATION
NO_3^- POOL
NITRIFICATION
$2NO_2^- + H_2O + 4H^+$
Nitrobacter
$+ O_2$
OXIDATION STATES
NH_3 AMMONIA -3
NH_4^+ AMMONIUM -3
N_2 DIATOMIC N 0
N_2O NITROUS OXIDE 1
NO NITRIC OXIDE 2
NO_2^- NITRITE 3
NO_3^- NITRATE 5
DENITRIFICATION
LEACHING
LEACHING
VOLATILIZATION
NITRIFICATION
TEMP 50°F
LEACHING
LEACHING
pH 7.0
LEACHING
0-40 kg/ha
Joanne LaRuffa
Wade Thomason
Shannon Taylor
Heather Lees
Department of Plant and Soil Sciences
Oklahoma State University
ADDITIONS
LOSSES
OXIDATION REACTIONS
REDUCTION REACTIONS