Department of Agriculture, Fisheries and Food
An Roinn Talmhaíochta, Iascaigh agus Bia

NDP National Development Plan Transforming Ireland

UCD DUBLIN

Ammonia and nitrous oxide emissions following land application of high and low nitrogen pig manures to winter wheat at three growth stages

EAAP Conference Barcelona, Spain

August 2009

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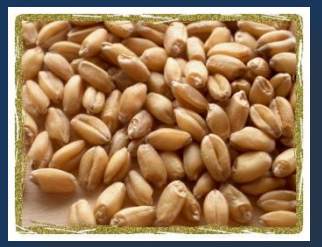
Background

- Agriculture in Ireland - 26.8% of GHG emissions
  - GHG almost transparent to solar radiation but absorb & emit infrared radiation. Thus, GHG trap heat within the surface-troposphere system causing global warming
  - N_2O, CH_4, CO_2, sulphur hexafluoride, HFC's, PFC's
- Kyoto Protocol - reduction of GHG emissions
  - Europe has chosen to reduce emissions by 8%
  - Ireland has to be within +13% of 1990 levels by 2012
  - Beyond 2012, 20% reduction of GHG on 1990 levels by 2020
- Agriculture in Ireland - 98% of ammonia emissions
  - Atmospheric deposition causing eutrophication & acidification of sensitive eco-systems
  - Gothenburg Protocol to reduce NH_3 by 8% based on 1990 levels for 2010

Background to this Project

Manure Disposal

Wheat Production



Animal Feed

Pig Production

Introduction

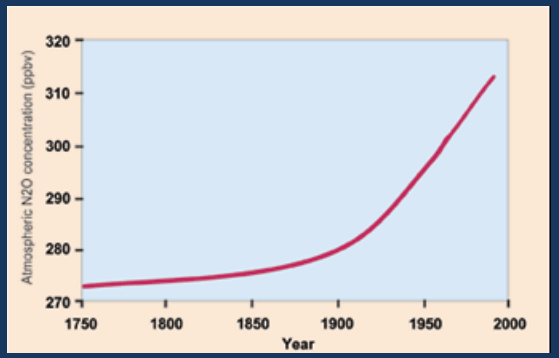
- Pig manure can be a valuable nutrient source in tillage crop production
    - Benefits include:
        - Increased soil organic matter content
        - Reduced N, P, K costs
        - Reduced trace element deficiency problems

- Significant loss through leaching, denitrification and volatilisation can reduce beneficial effects
- Need to quantify the losses of nitrogen as ammonia and nitrous oxide for meeting Kyoto & Gothenburg targets but also to quantify N losses for farmers

Nitrous Oxide & Ammonia Emissions

- Denitrification: Microbial reduction of nitrate to di-nitrogen gas
  - Anaerobic conditions - Denitrifying bacteria (e.g *Pseudomonas*)
- Nitrification: Oxidation of ammonium to nitrate
  - Aerobic conditions - Nitrifying bacteria (e.g *Nitrosomonas, Nitrobacter)*

- Current nitrous oxide content in the air is **319 ppb**
- Increasing at a rate of 0.25% per year
- 300 times greater global warming potential than CO_2
- Estimated 16.8kg N/ha/yr lost as N_2O in Ireland



- With ammonia the key issue is the loss of NH_3 to the air after manure application
- Rate of ammonia volatilisation depends on:
  - Weather conditions, Soil characteristics, Mode of application, Manure characteristics

Hypothesis

Pigs fed low CP diet

Low Urea Pig Manure

Applied by band spreader

Applied to wheat at later growth stages

Canopy more dense/ increased N requirement

Ammonia/Nitrous Oxide emissions reduced

Reduced global warming

Environmental Benefits

Diets for Manure Production

- Ideal protein concept
  - Feed that yields all of the essential A.A in proper proportions for growth & maintenance after digestion
- 2 pig diets 16% vs. 23% CP
  - HCP = 65% wheat, 31% soya
  - LCP = 83% wheat, 12% soya
- Low protein diet – meeting protein requirements
  - Added synthetic A.A to prevent deficiency (1%)
- High protein diet – supplying excess protein
  - Nitrogen excreted in urine – more N available for volatilisation

Manure Production & Crop Growth

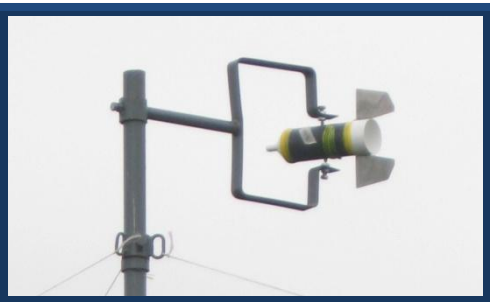
- 2 groups of 85 pigs were housed in a grower/finisher house with 2 separate manure storage tanks
- Pigs entered the house at 35kg and were fed for approximately 12 weeks

- Manure applied at 3 spread dates (SD)
  - **SD 1** - Mid tillering – GS 25
  - **SD 2** - Stem extension – GS 31-32
  - **SD 3** - Flag Leaf – GS 37-39

- Manure was applied by use of band spreading equipment
- ↑ Crop canopy as G.S increases
- Micro-climate created
- Increased requirement for N

Micrometeorological Technique

- Use of passive flux samplers to measure the ammonia concentration in air
- Manure spread & mast immediately erected in the centre of plot
- Shuttles place at 5 heights 0.2m 0.4m, 0.8m, 1.5m and 3.0m
- 7 sampling times 1, 3, 6, 24, 48, 96 & 168 hours post spreading
- Background mast for measuring the background levels of ammonia in the area surrounding the trial plots

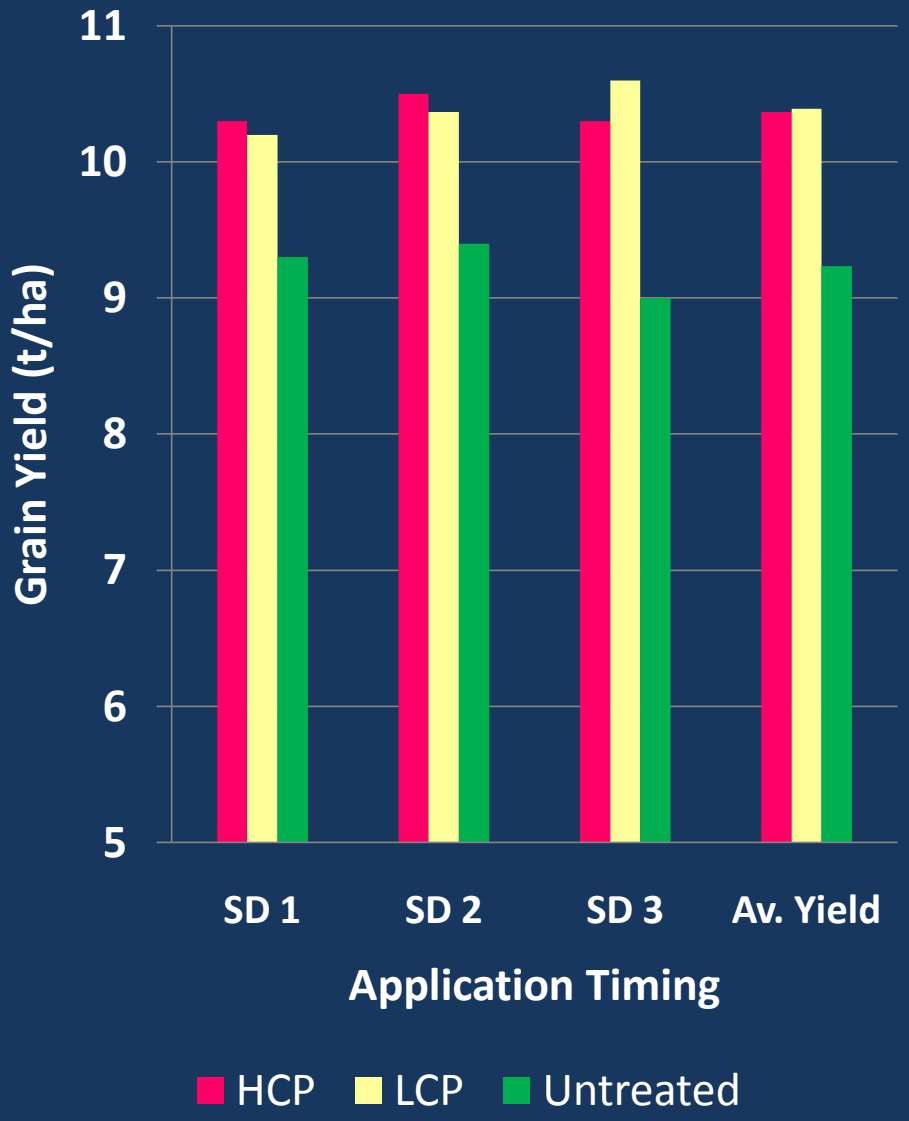


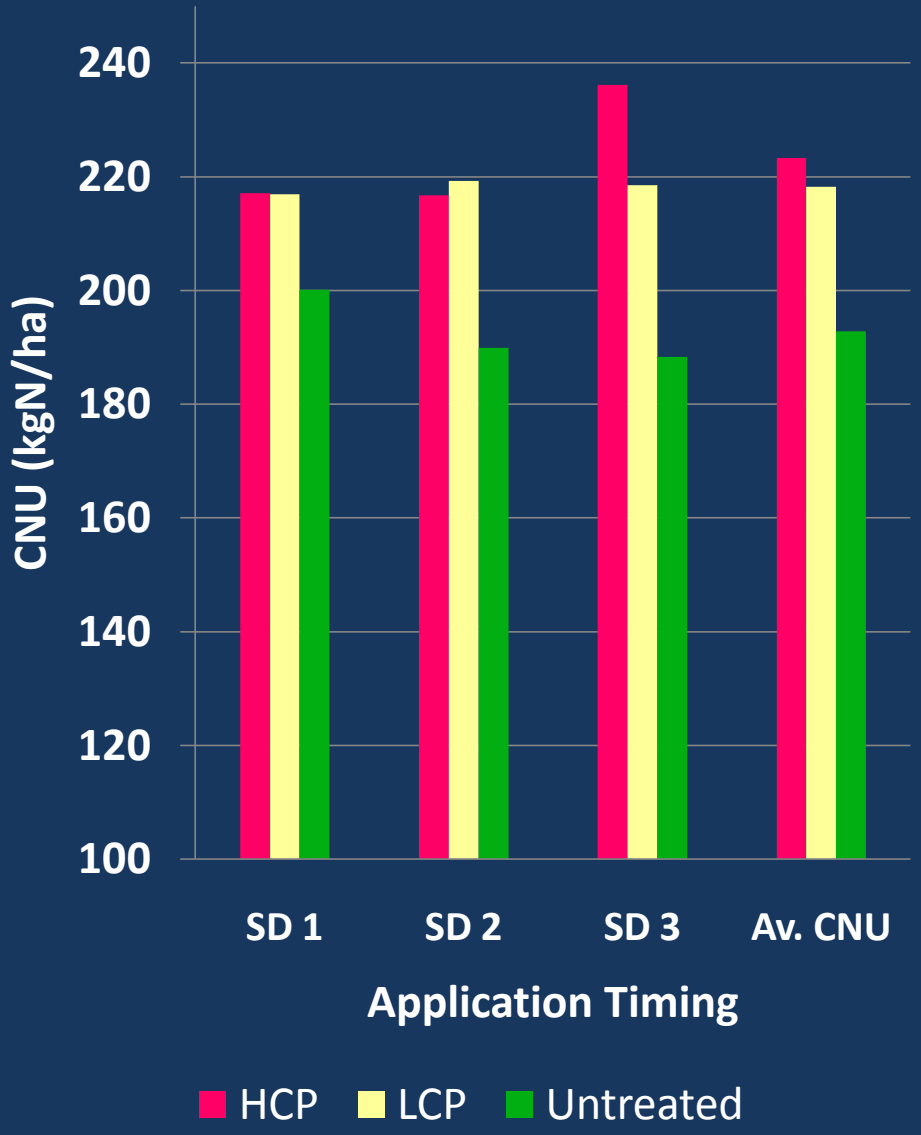
Nitrous Oxide Measurement

- Static chamber technique
- Stainless steel chambers 0.41m*0.41m
- Measure flux of N_2O over a given time period
- Sampled at 0, 15 & 30mins

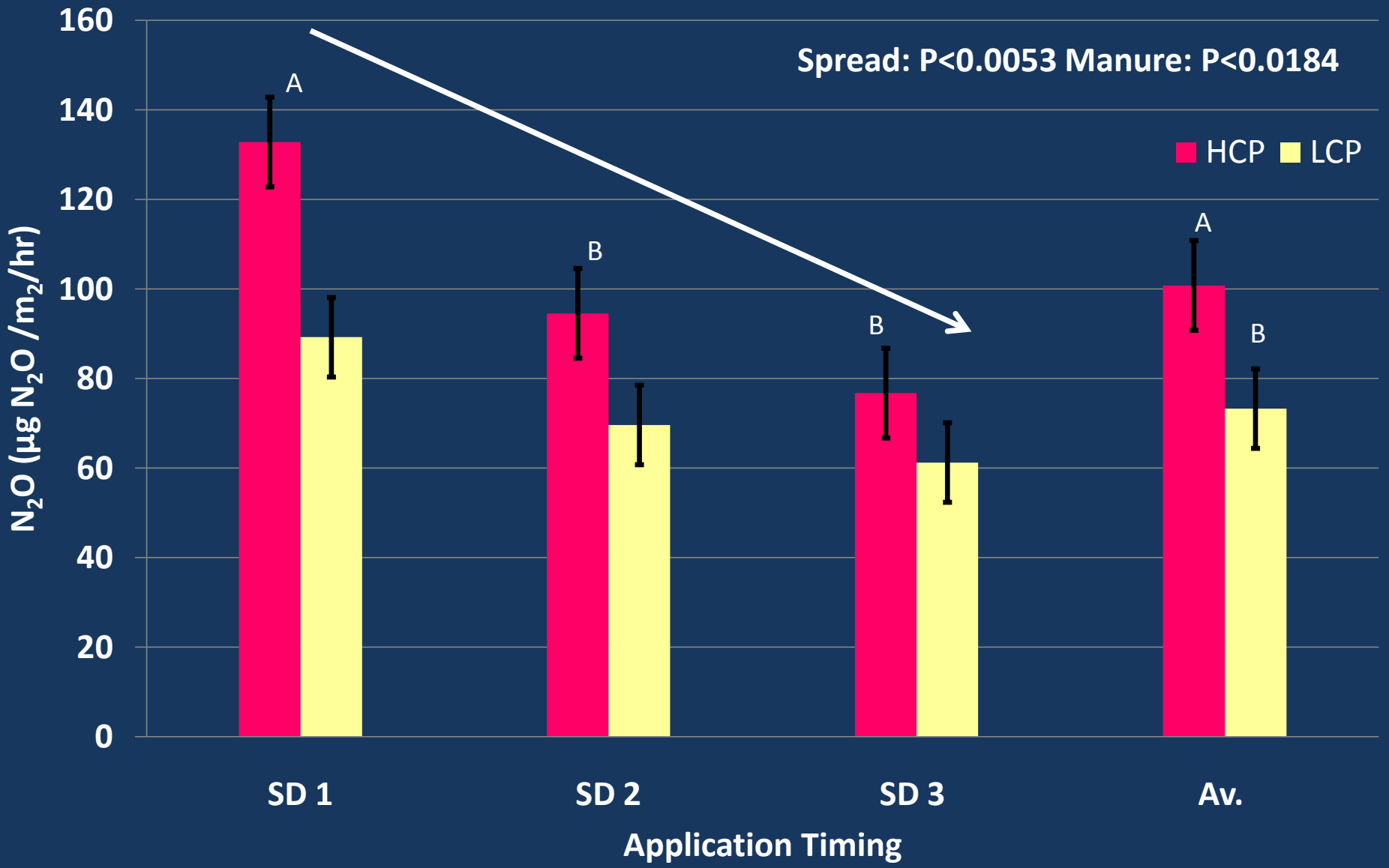
Results

Grain Yield & Crop N Uptake

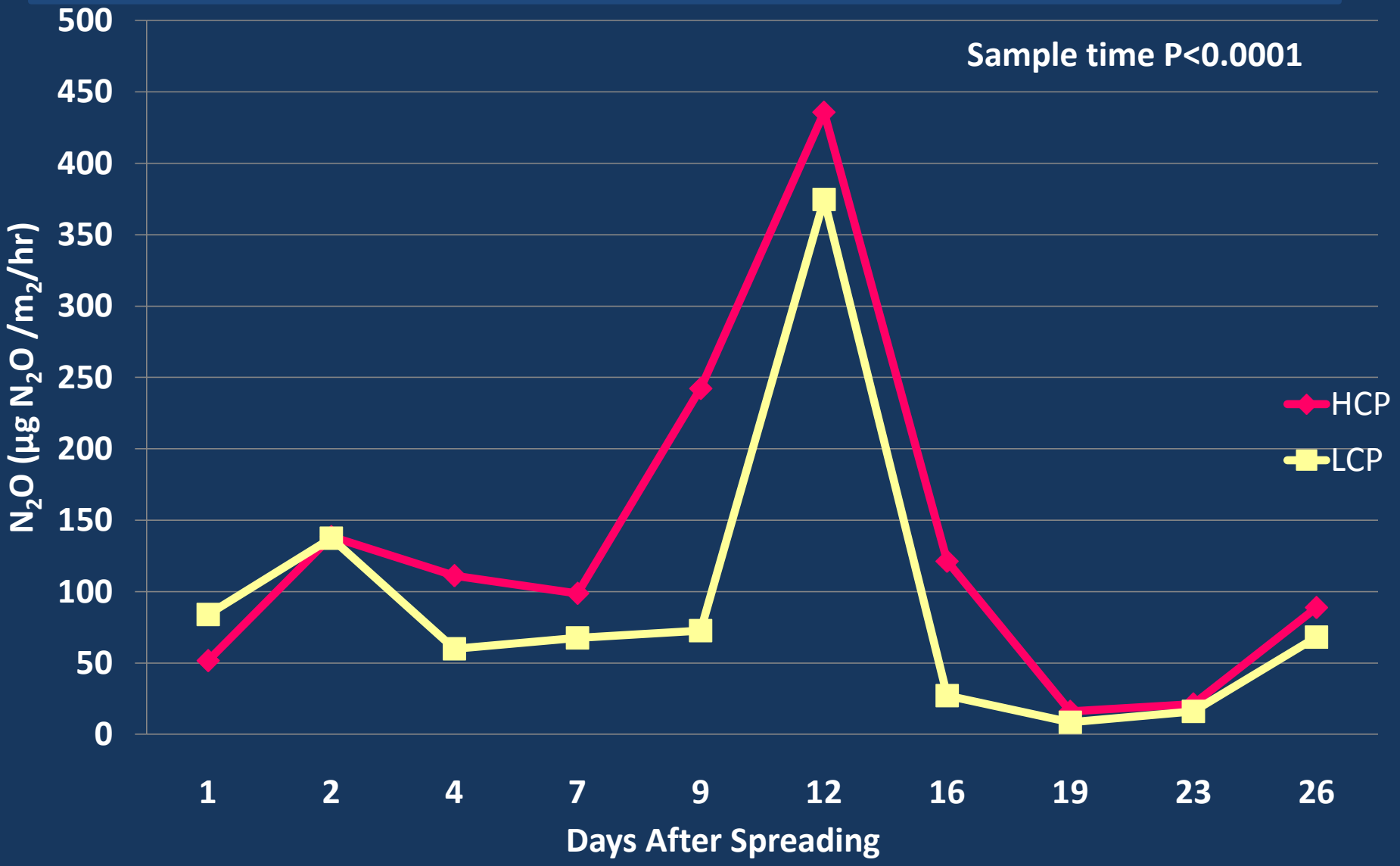




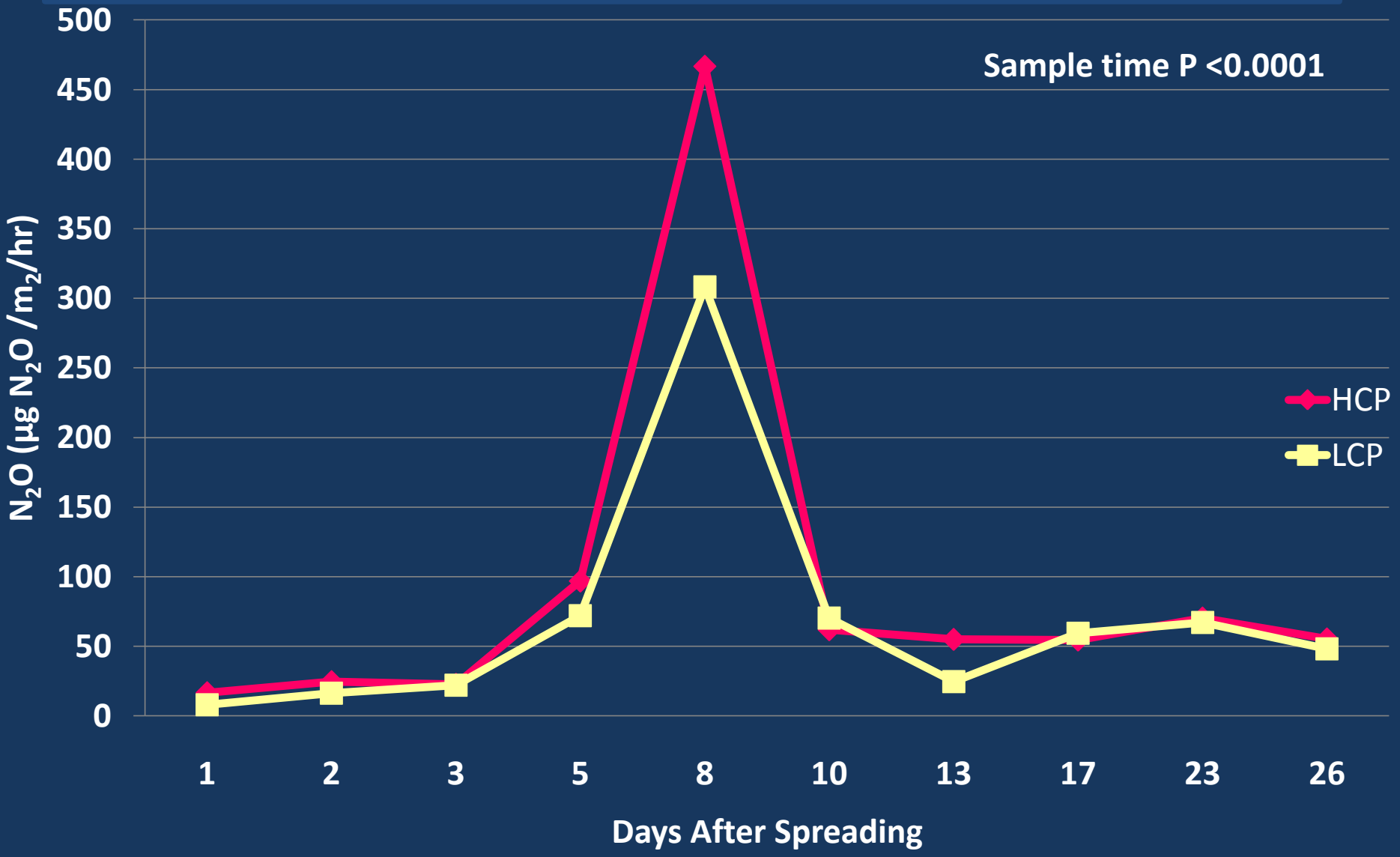
Results – Nitrous Oxide



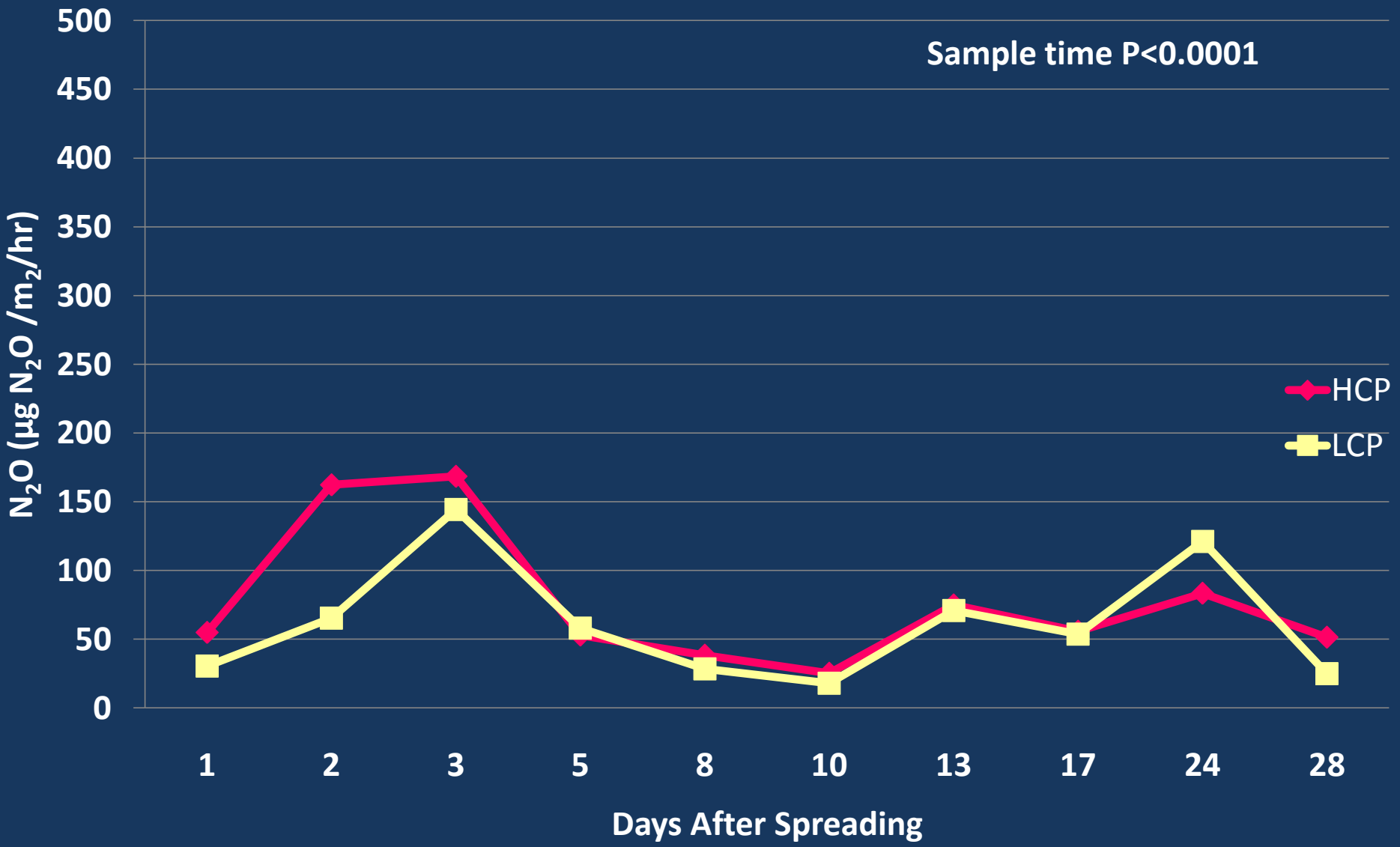
Nitrous Oxide - SD 1



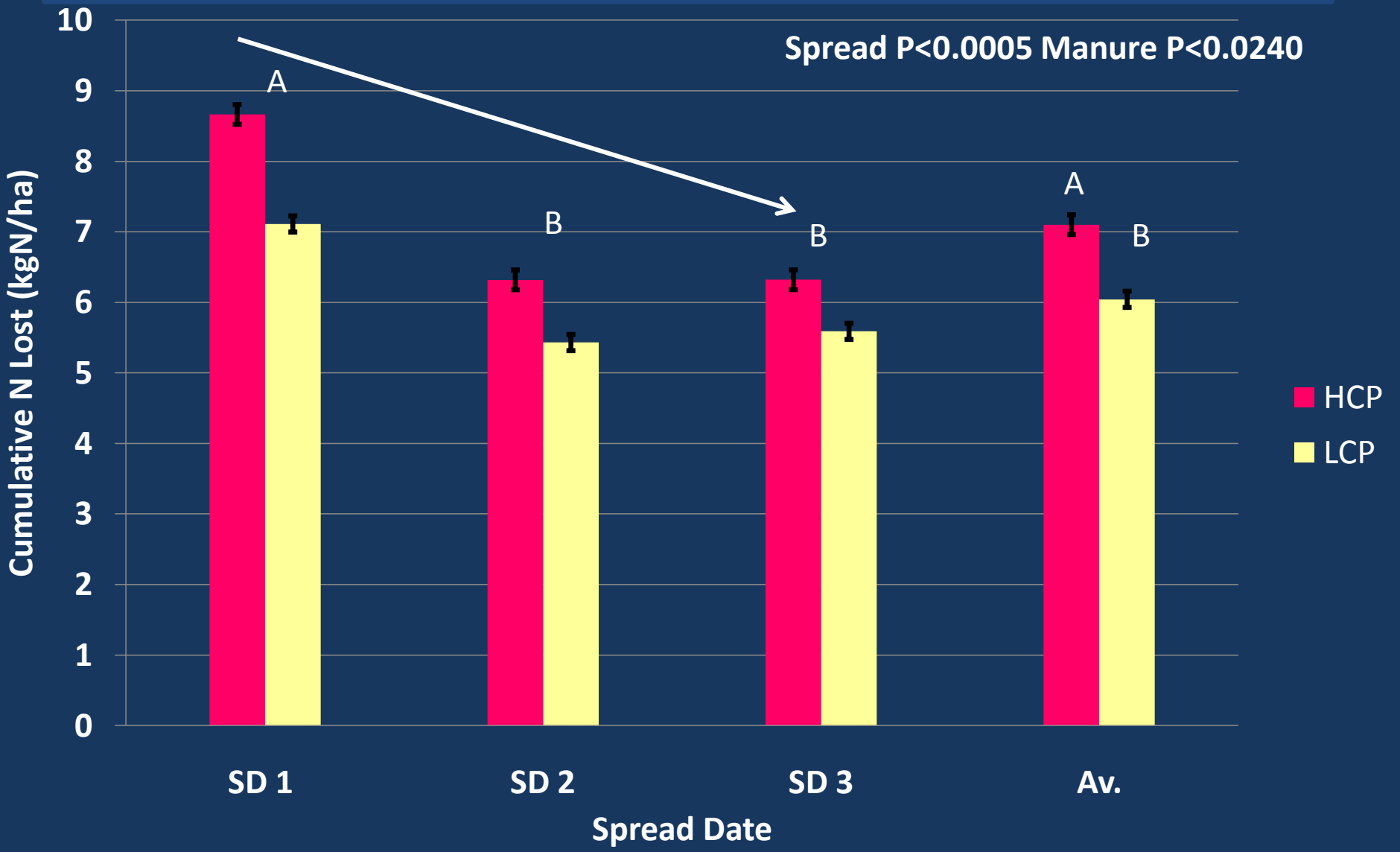
Nitrous Oxide - SD 2



Nitrous Oxide - SD 3



Ammonia Volatilisation



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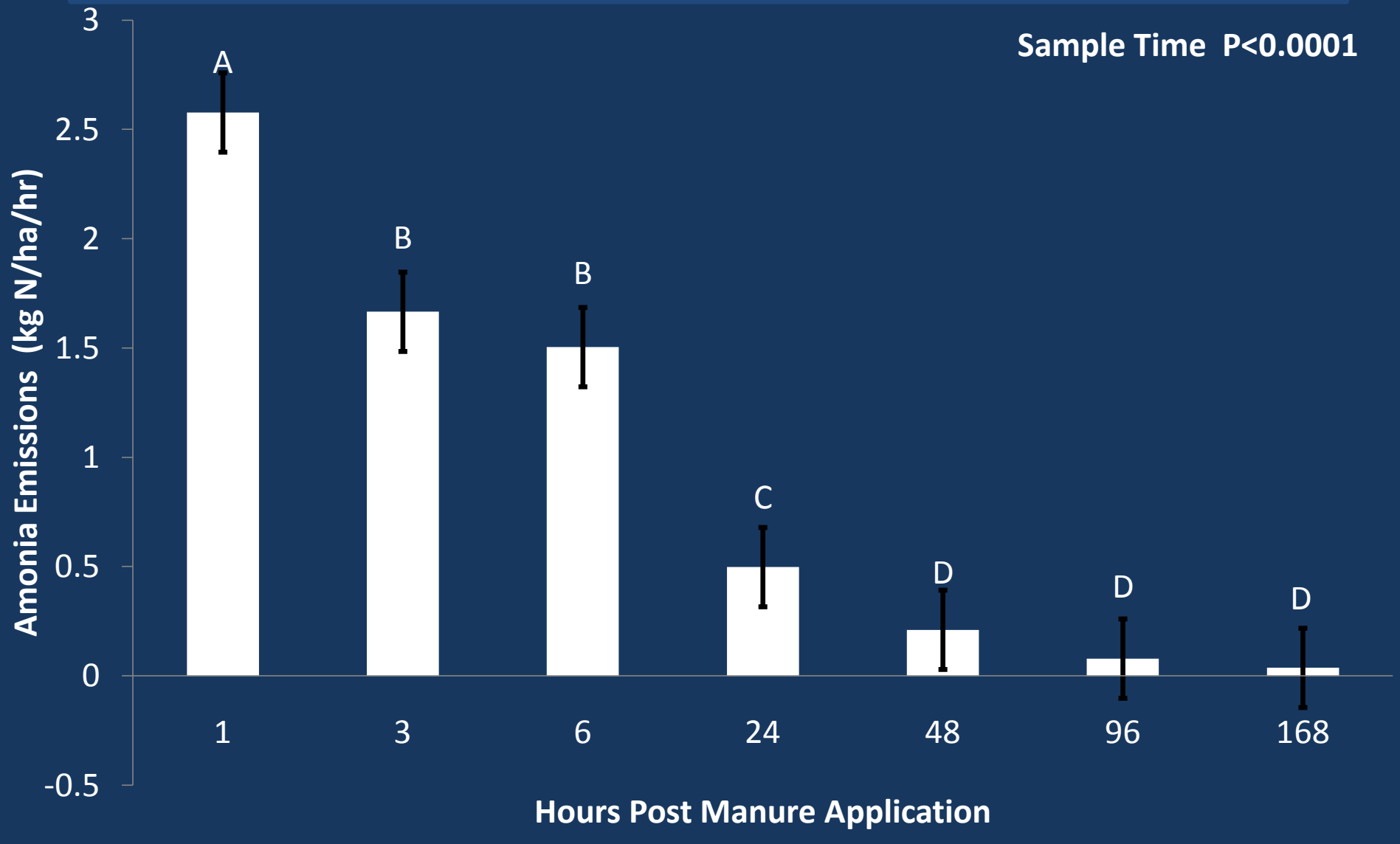

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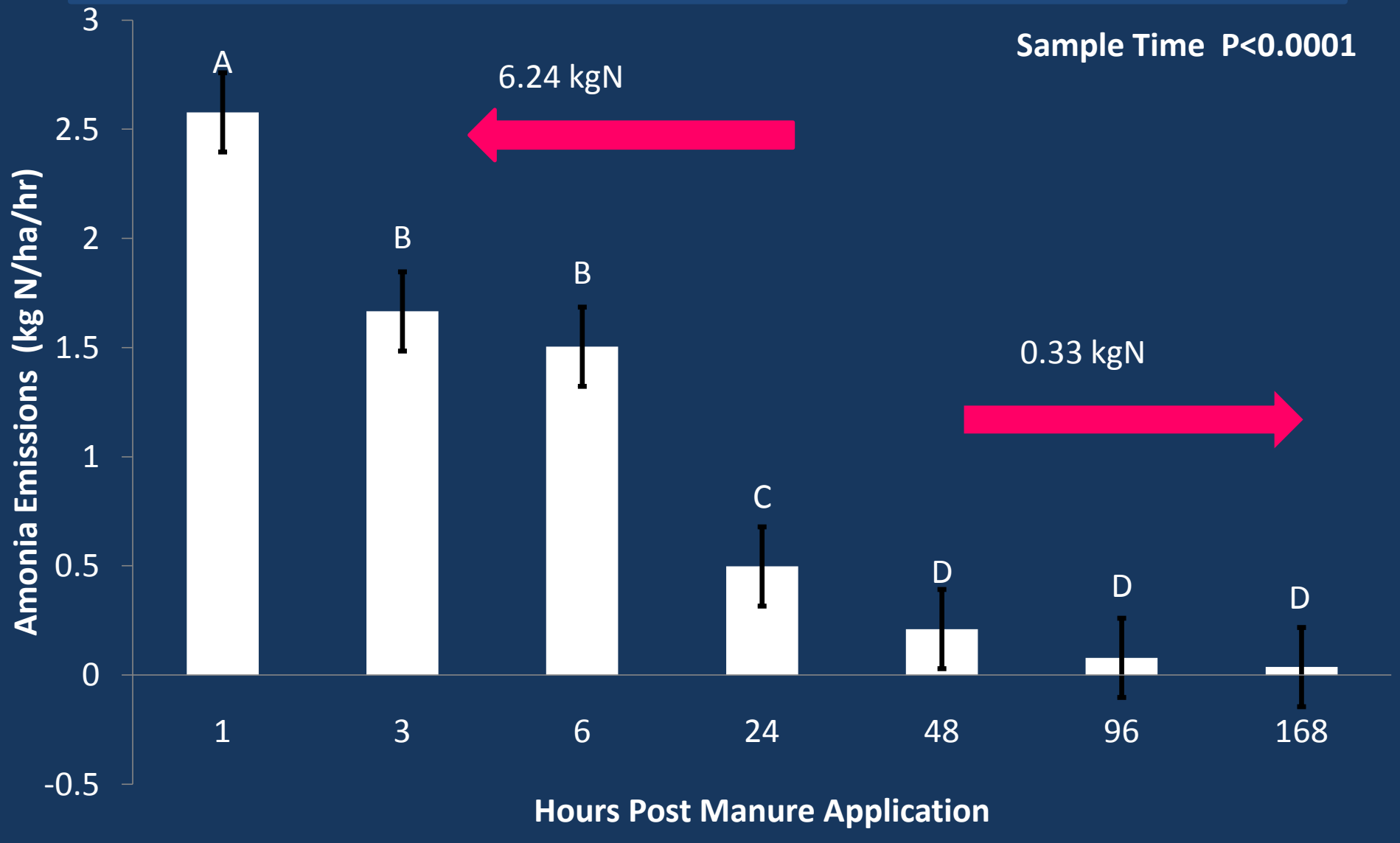
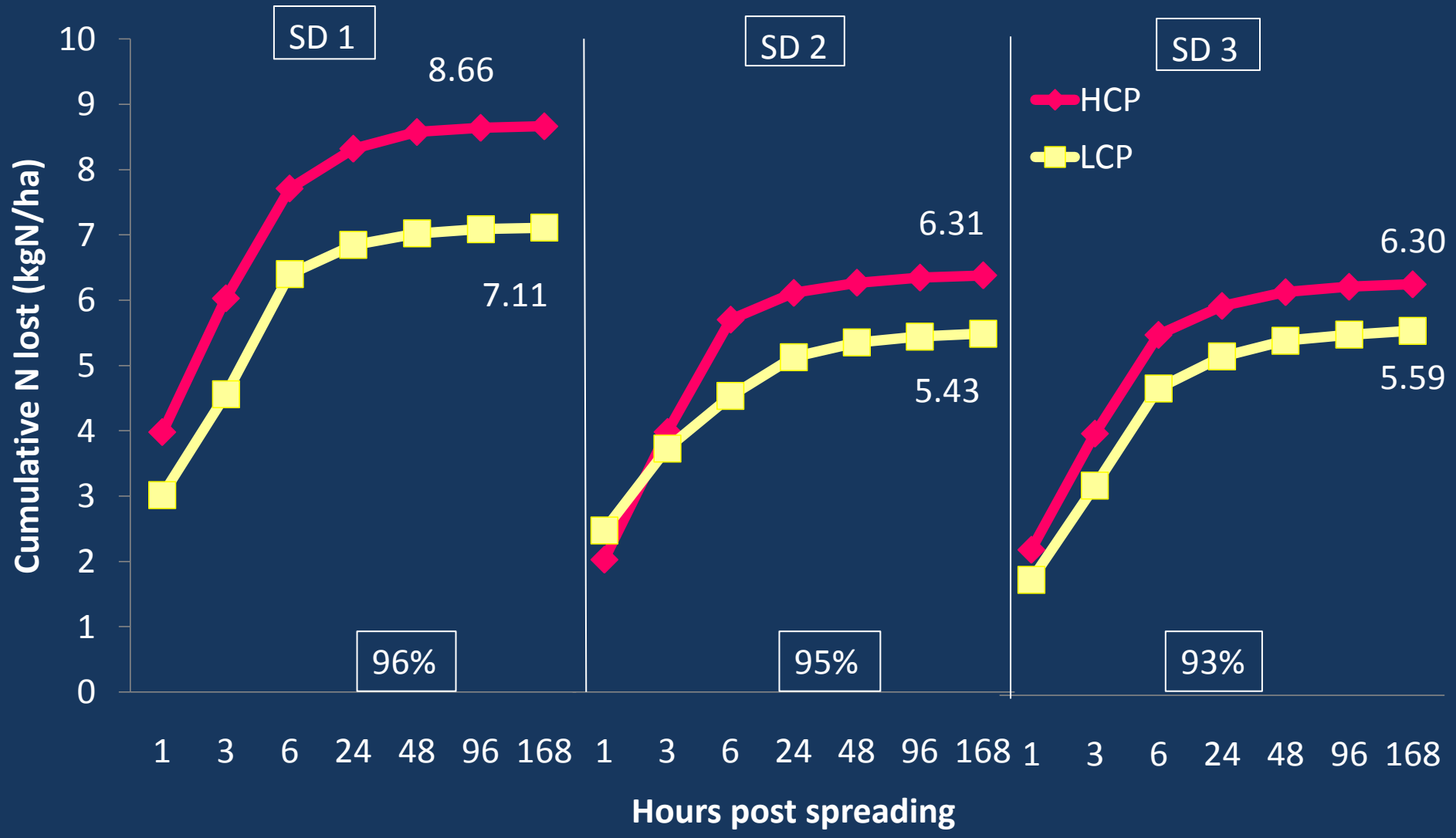


Ammonia SD 1-3



Overview –Results

- Manure application increased crop yield & crop nitrogen uptake
- HCP manure had consistently higher emissions than the LCP manure
- Ammonia and nitrous oxide emissions decreased as the crop advanced
- 93-96% of ammonia emissions occurred in the first 24hrs
- Total nitrogen lost as ammonia ~6.5kgN/ha over the 1 week measurement period
- Total nitrogen lost as nitrous oxide ~0.626kgN/ha in 30 days