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Ammonia and dust emissions from broiler production under modern systems

M.E.E. Ball, C.M. Mulvenna and R. Olave

Elizabeth.Ball@afbini.gov.uk

Broiler Farming in the Next Decade
10 and 11 October 2022
afbini.gov.uk

Background

- Ammonia gas an environmental pollutant – nitrogen deposition
- Reduction in biodiversity and carbon sequestration ability in sensitive sites, source of nitrous oxide - GHG
- Northern Ireland (NI) 6% of the UK land area & 3% of the population, responsible for 12% of UK ammonia emissions (~25% NI agricultural emissions is from pigs and poultry)
- 98% of Special Areas of Conservation and 83% of Special Protection Areas are at risk from ammonia's harmful effects
- Agreed 16% reduction in ammonia emissions from 2005 levels by end of 2030
- Legislation (Gothenburg Protocol, Habitats Directive, Birds directive, Nitrates directive and IPPC)

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Quantifying the emissions from broiler production

- Current standard for broilers = UK Ammonia Inventory
- Based on historic values (~work conducted in 1990s)
- Overall nitrogen (N) excretion has reduced due to advances in nutrition, management and genetics
- Current emission factors need to be updated in addition to mitigation strategies to reduce emissions….a need to know the baseline and understand the impact of strategies already implemented and of potential future strategies

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Objective

Establish an up-to-date emission factor for broilers housed under modern production systems

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Materials and Methods

- Verification of Environmental Technologies for Agricultural Production (VERA) Test Protocol for Livestock Housing and Management 2.0.
- Ammonia analyser – 10 point tunable diode laser absorption spectroscopy (TDLAS)
- Cascade Impactor (Dekati) for PM mass size distribution
- Two broiler units each with two identical houses – four houses

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Site	1	2
Building Design	1 building: two houses separated by a service passage. Common control room	1 building: two houses separated by a service passage. Common control room
House dimensions (m)	85m L, 19.6m W, 6m H	73m L, 21m W, 5.5m H
Ventilation system	Roof extract & side inlet	Roof extract & side inlet
Ventilation controller	Fancom	Fancom
Fan diameter	800mm	800mm
Number of inlets (per house)	74	70
Number of fans (per house)	16	12
Inlet size	850mm W X 300mm H	850mm W X 300mm H
Space allowance per bird (number/kg/m^2)	17 birds/m^2 (max stocking density of 30kg/m^2)	17 birds/m^2 (max stocking density of 30kg/m^2)
No. birds entering building	28000	24900

Materials and Methods

- Ammonia (NH_3) measured - over six production cycles at each site
  - continuously every 15 minutes for at least 24hrs
  - over the six measurement periods per site
- Sampling points at inlet and fan outlets
- Measured in **ppm** and converted to **g/bird/d** using ventilation rate and bird numbers
- PM_{10}, $PM_{2.5}$ and PM_1 airborne particles measured and converted to mg/m^3.
- NH_3 in **g/bird/d** converted to ammonia **g/d/LU** using weight of birds
- Final value expressed as NH_3 **g/d/LU** or **g/bird place/year**
- Corresponding weather data from near-by weather stations collected
- Average emission factor calculated; site and house differences statistically tested for
- Relationships between emissions and bird age and weather conditions determined

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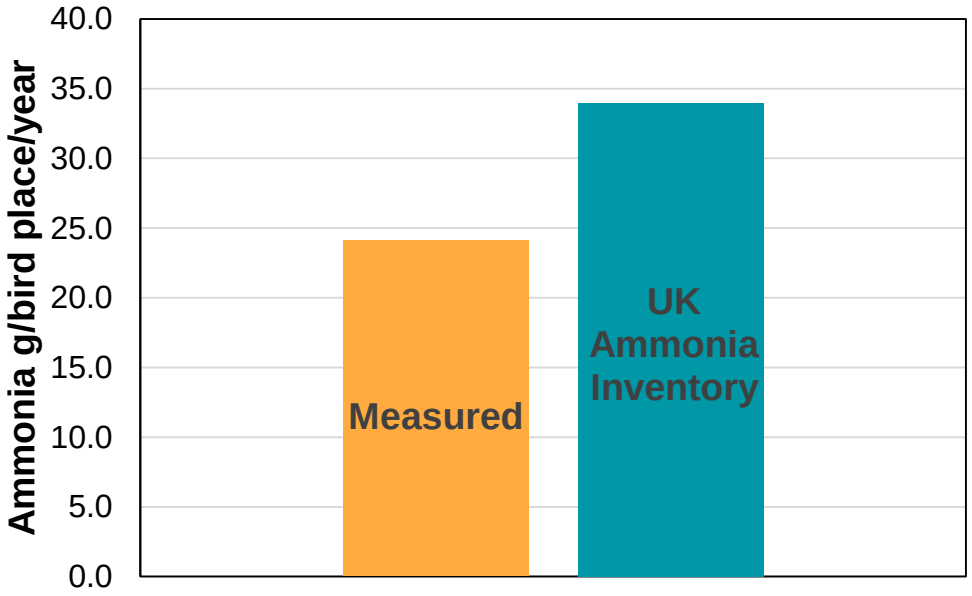
Average Emission Factor

- Ammonia emissions from broilers = **24.1 g/bird place/year**
- 29% lower than the value used in current regulations (34.0 g/bird place/year)



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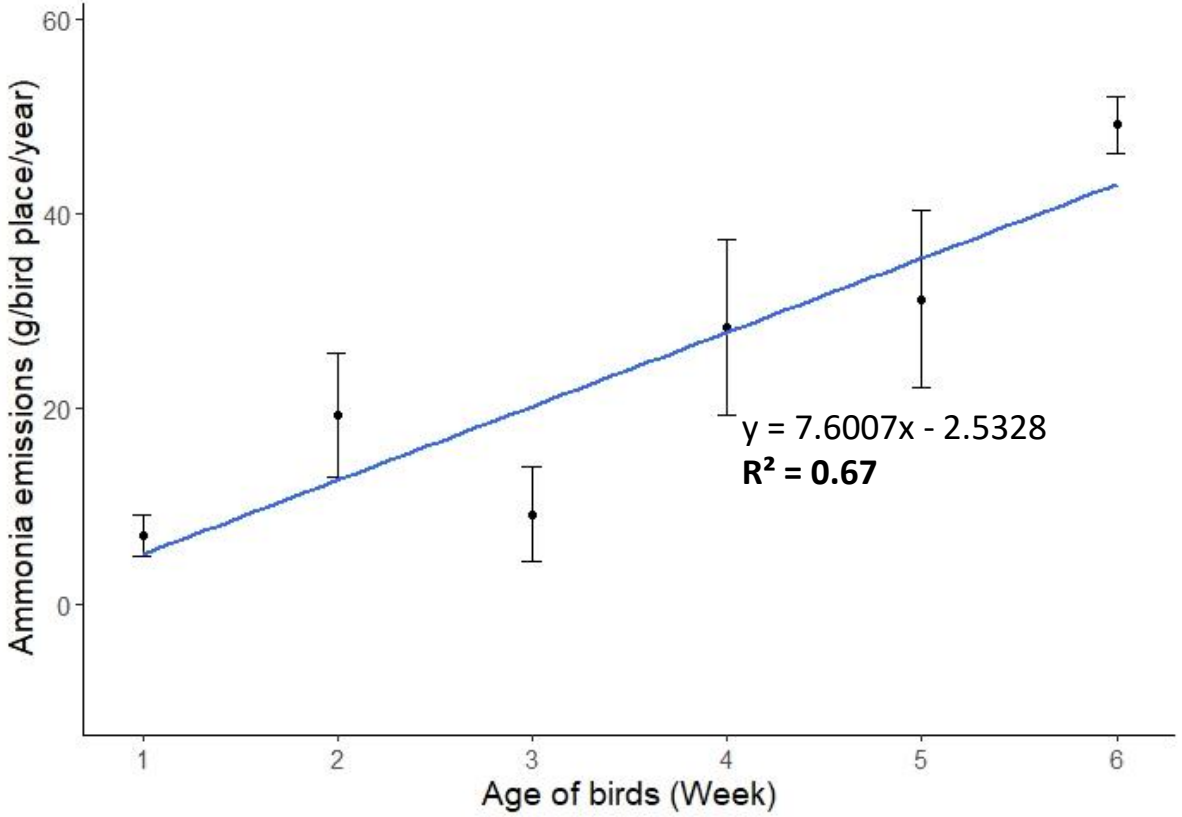
Relationship between ammonia emissions and stage of production



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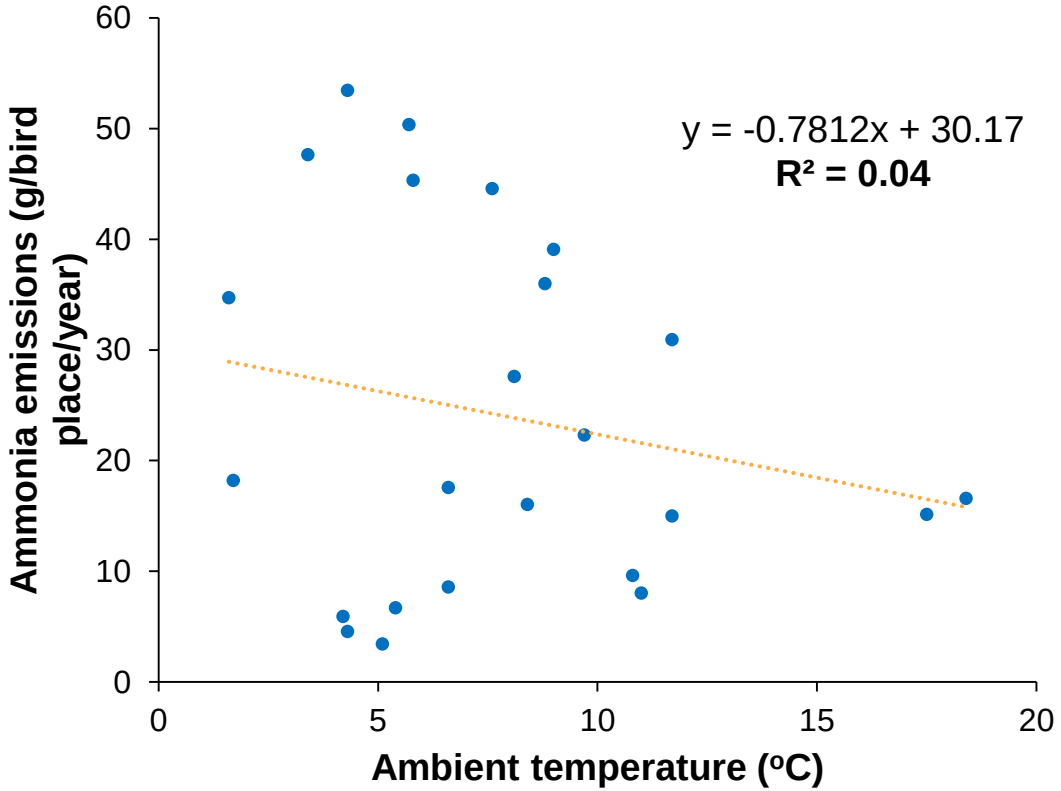
Relationship between ammonia emissions and temperature



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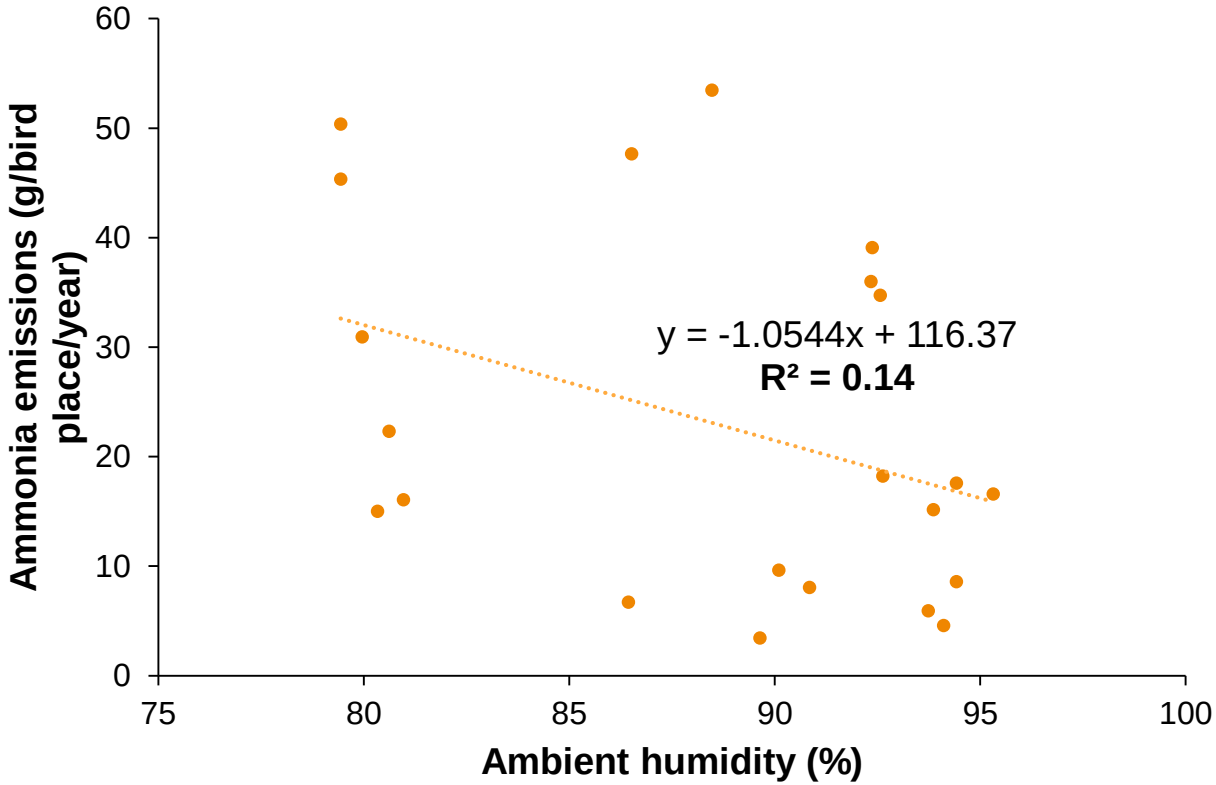
Relationship between ammonia emissions and humidity



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Conclusions

- NH_3 emissions in g/bird/place/year is 24.1g
- **29% lower than current standard**
- Modern heating systems (i.e. indirect heating which increases litter DM)
- Advancements in genetics and nutrition leading to improved feed efficiency and N efficiency resulting in less N excretion/bird place
- Representative of broiler units across Northern Ireland – no significant difference between sites/houses (followed VERA principles)
- Will support changes to UK Ammonia Inventory
- Provides an accurate baseline to model the effect of mitigation strategies and inform planning decisions

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Measurements of particulate matter (PM)

R. Olave

- What is PM – not just dust!
- $PM_{10,}$ $PM_{2.5,}$ PM_{1}
- Environmental and health concern
- Relationship with ammonia emissions?

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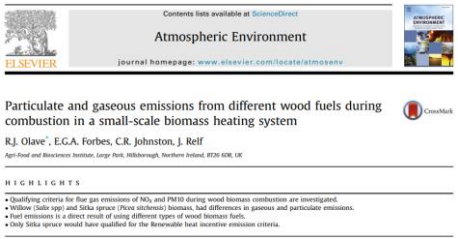
What we measured.....

PM and distribution of particles sizes were determined gravimetrically according to Olave *et al*., (2017)



Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Particulate and gaseous emissions from different wood fuels during combustion in a small-scale biomass heating system

R.J. Olave*, E.G.A. Forbes, C.R. Johnston, J. Relf

Agri-Food and Biosciences Institute, Large Park, Hillsborough, Northern Ireland, BT26 6DR, UK

HIGHLIGHTS

- Qualifying criteria for flue gas emissions of NO_x and PM10 during wood biomass combustion are investigated.
- Willow (Salix spp) and Sitka spruce (Picea sitchensis) biomass, had differences in gaseous and particulate emissions.
- Fuel emissions is a direct result of using different types of wood biomass fuels.
- Only Sitka spruce would have qualified for the Renewable heat incentive emission criteria.

PM measured in 2 houses over the crop (two locations)

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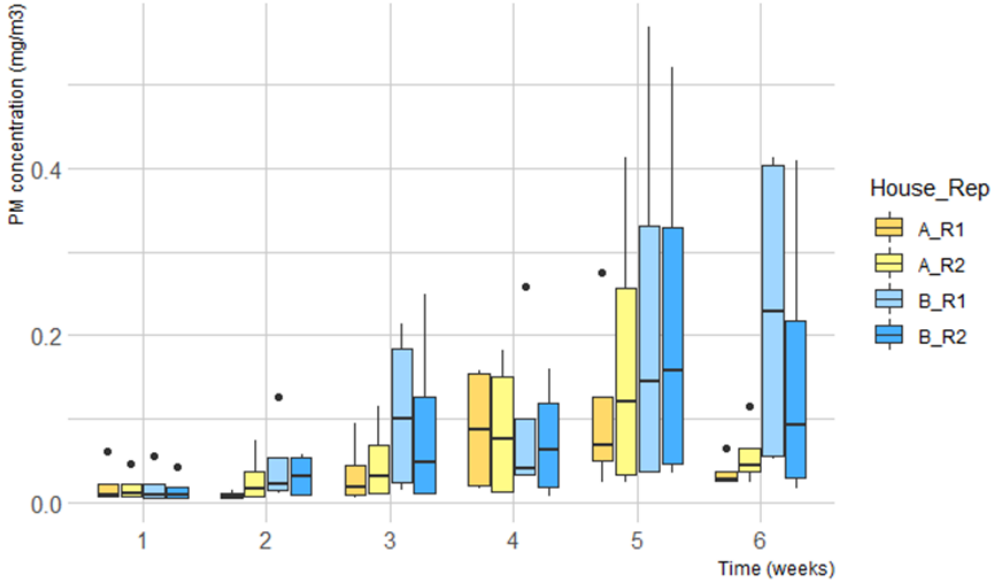
PM_{10}, $PM_{2.5}$ and PM_1 airborne particles captured by a fine particle analyser for chemical characterisation

Comparison of PM concentrations in different locations and broiler houses

All particulate sizes increased considerably over time with an average overall PM total of 0.07 mg/m^3 in week 1 to 0.47 mg/m^3 in week 6

No significant differences in PM between houses or locations when birds are same age but high variability in PM levels within houses



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Next steps

- Correlate with ammonia emissions
- Relationship with weather conditions
- Emission Factor?

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Acknowledgements

- Department of Agriculture, Environment and Rural Development for Northern Ireland
- Moy Park Ltd.
- Mrs Lavinia Wright
- John Kearns
- JF McKenna and Fancom

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