

Tree shelter belts

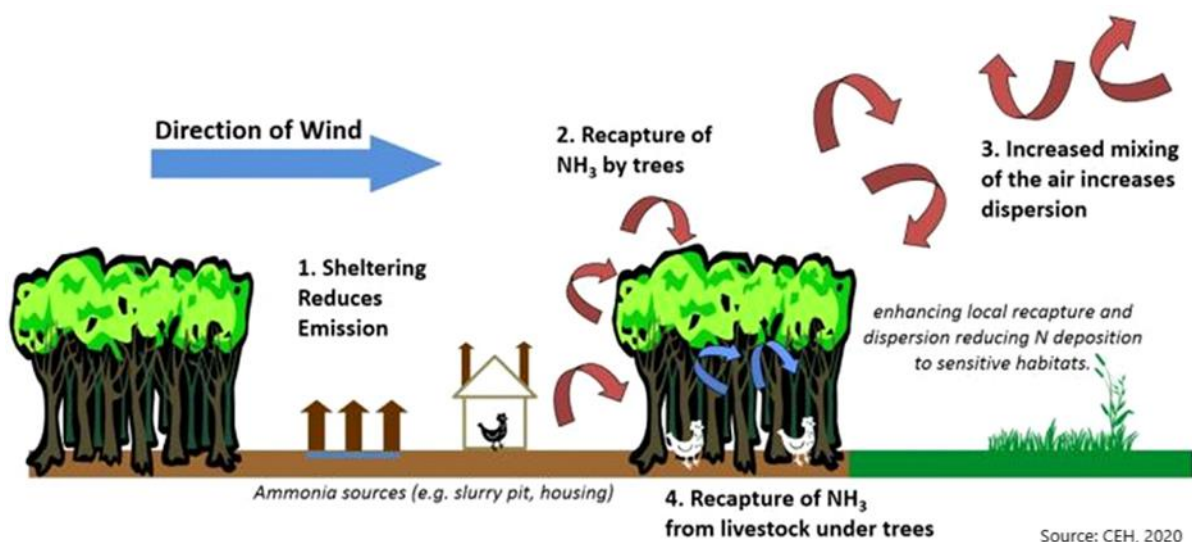
Background

Agriculture is responsible for 96% of ammonia emissions in Northern Ireland and does not show signs of reducing. Increasing levels of ammonia emissions are affecting air quality in Northern Ireland, which in turn affects all our natural habitats, our own health as well as what the future will hold for the next generation. Recent figures show that ammonia emissions in Northern Ireland increased by 22% from 2010, as opposed to the UK's international commitments to reduce ammonia emissions by 16% by 2030, based on 2005 levels. (National Atmospheric Emissions Inventory, 2020)

Trees and woodland can reduce the impact of ammonia emissions from animal housing. Trees and woodland have the ability to capture ammonia emissions from animal housing and from areas where animal roam. Trees and woodland also affect how emissions are dispersed, when planted close to the emission source and can affect the dispersal of nitrogen and deposition on nitrogen sensitive habitats. Trees and woodland also have a positive impact on biodiversity (both above and below ground: habitats, shelter & food), air quality (reducing critical ammonia emissions load exceedance on protected sites), carbon footprint (carbon and nitrogen capture by the trees (carbon dioxide, methane and nitrous oxide), national afforestation policies, Industrial Emissions Directive requirements etc.

Existing established woodland and the planting of new woodland (e.g. as farm tree shelterbelts) can therefore be used to reduce the impact of ammonia emissions on the environmental and reduce associated social impacts, (acidification, air pollution & ill-health effects).

With thousands of trees due to be planted across the country over the next three years, in Government-backed schemes, it is important to make sure that farmers understand the benefits of tree shelterbelts and consider this option for reducing the impact of ammonia emissions from their farm business.



Description of technology

Studies on the capture of ammonia by surrounding vegetation have shown lower ammonia concentrations when potted trees were present downwind of poultry houses (Patterson et al. 2008). Wind tunnel experiments (Famulari et al., 2015) indicated that significant ammonia was

recaptured using 2m tall *Picea Abies* (Norway spruce). The findings demonstrated in the wind tunnels, were further confirmed by field trials where two sites with agroforestry systems demonstrated reductions in atmospheric ammonia levels. Studies of the effects of Woodland edges in mature conifer and broadleaved woodland in UK suggested strong ammonia capture along 200m transects from point source of NH₃ emission into both woodlands. Bealey et al. (2014) modelled the tree-belts effect in capturing ammonia by altering the canopy length, leaf area index, leaf area density and height of the canopy in the model.

Ammonia capture ranged from 15-25% for housing emissions, 10-20% for slurry lagoons and up to 60% recapture for livestock ranging under the trees. The national potential for tree shelterbelts has been shown to be cost effective when taking into account the social costs of ammonia pollution, (Bealey et al., 2016).

A decision support tool, for the establishment of tree shelter belts, will provide a list of suitable species to plant at the site location. The species suitability index is predicted on the basis of six Ecological Site Classification (ESC) factors: The grid reference has four climatic factors:

1. Accumulated temperature,
2. Moisture deficit,
3. Windiness (by Detailed Aspect Method Scoring; DAMS)
4. Continentality (aspect, slope and continentality are derived from spatial data)

Soil quality factors (based on standard Forestry Commission Soil Classification and the Ecological Site Classification framework):

1. Soil moisture regime
2. Soil nutrient regime

The key processes by which trees can have a beneficial effect as landscape structures to mitigate NH₃ air pollution: capturing ammonia emissions carried by wind from animal housing by,

1. Capture ammonia by the trees themselves, through increased turbulence and deposition velocities. Ammonia particles settle on the canopy structure and tree leaves where they are absorbed by the tree through the stomata.
2. Increase ammonia dispersion above the canopy through increased disturbance of air flow. This reduces transport and deposition to nearby sensitive habitats; by increasing dry deposition of ammonia close to source.

Problem identified that technology will address

To reduce and disperse the emission of ammonia from livestock installations and its subsequent transport to sensitive sites. At sensitive sites, high levels of atmospheric ammonia and deposition of nitrogen (wet deposition) are high causing damage to nitrogen sensitive species.

Current / potential industry uptake

This method of ammonia capture is a promising method of reducing ammonia emissions for the agricultural industry, from an animal housing perspective. Currently ammonia emissions are having an impact on planning proposal screening. The effect of ammonia emissions from any

ammonia emitting proposal, is assessed on its potential impact on designated sites and priority habitats. Use of tree shelter belts may be considered a mitigation tool to allow agricultural development by reducing the potential impact on these habitats.

The use of tree shelter belts and the further development and validation of the support tool are very much ongoing research with trials still being completed. This validation is due to additional tree belt research and several factors, such as climate and growth rate, which are constantly changing. The updates of data, within the decision support tool, will continuously improve its validity.

The technology of using vegetation to improve air quality has been used worldwide for decades; urban environment with diesel, exhaust fumes etc. Public Park areas are often kept and protected (New York, Stockholm), bus stops with mosses and lichens (Amsterdam), indoor plant walls (London, Paris), moss walls in restrooms (Malaga) etc.

The world's forests absorb roughly a third of global emissions naturally every year. Particles, odours and pollutant gases such as nitrogen oxides, ammonia and sulphur dioxide settle on tree leaves. Trees absorb these toxic chemicals through their stomata, or 'pores', effectively filtering these chemicals from air and ground. (Harris et al., World Resources Institute, 2020)

The capture of ammonia by surrounding vegetation was studied by Patterson et al. (2008), who observed lower ammonia concentrations when potted trees were present downwind of poultry houses. Wind tunnel experiments by Famulari et al., (2015) indicated significant ammonia recapture (an average of 22% under dry conditions and up to 43% under wetter conditions) using 2m tall Picea Abies (Norway spruce) and case studies demonstrated the effect in the field.

Woodland edge effects studies in mature conifer and broadleaved woodland in UK suggested strong ammonia capture along 200m transects from point source of NH3 emission into both woodland, (Vanguelova and Pitman, 2009, 2011).

Bealey et al. (2014) modelled the effect of tree-belts in capturing ammonia by altering the canopy length, leaf area index, leaf area density and height of the canopy. Ammonia capture ranged from 15-25% for housing emissions, 10-20% for slurry lagoons and up 60% recapture for livestock ranging under the trees.

Example of estimated ammonia recapture when using the support tool.

The shelterbelt model is a main canopy planted with a surrounding (horseshoe like) dense backstop canopy. The following example is 60m main canopy Aspen and 10m deep backstop Scots Pine

Year	Main Canopy Height (m)	Backstop Height (m)	Main Canopy % Recapture	Backstop % Recapture	Total % Recapture
10	11.16	3.75	22.76	5.75	28.51
15	15.76	6.04	24.66	6.97	31.63
30	24.96	12.48	28.53	10.4	38.93
50	30.58	19.1	30.94	13.93	44.87

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