Department for Environment Food & Rural Affairs

Consultation on reducing ammonia emissions from solid urea fertilisers

Government response

Date: March 2022

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Government response to the consultation on reducing ammonia emissions from urea fertilisers

Executive summary

The Clean Air Strategy[1] outlines our plans to tackle air pollution from several sources such as industrial processes, domestic heating and, via a range of measures, from agriculture. The government is determined to improve our air quality and natural environment, and reducing our ammonia emissions is crucial for both objectives. We are committed to reducing ammonia emissions levels every year (from the base year 2005) by 8% (19kt) by 2020, and 16% (48kt) by 2030[2]. Agriculture accounts for 88% of the ammonia emissions in the UK.

From 3 November 2020 to 26 January 2021, Defra consulted[3] on the following 3 (England-only) regulatory options to reduce ammonia emissions from solid urea fertilisers: 1) a ban; 2) a requirement to treat solid urea with urease inhibitors (UI); and 3) a restriction of solid urea use (allowable only from 15 January to 31 March). The consultation responses have been summarised and included in Annex I, below.

Global fertiliser shortages and price increases have led to significant concerns over the cost of food and, in turn, on the cost of living. We therefore consider a ban on solid urea fertilisers (Option 1) to be unfeasible. Furthermore, evidence submitted through the consultation indicated that the costs to farmers of banning solid urea would be substantially greater and ammonia emissions reduction less than previously expected. The timelines to implement a ban would be longer than previously estimated due to the changes needed to infrastructure to handle and store greater volumes of ammonium nitrate (AN).

An industry consortium including farming unions, research and advice bodies, accreditation/assurance schemes, and the fertiliser supply industry offered to set up and run a non-regulatory approach, which they have termed as “Option 4”. This would utilise farm assurance schemes such as Red Tractor, to reduce ammonia emissions from the use of fertilisers containing urea (both solid and liquid), in England from April 2023.

Our analysis indicates that the approach proposed by the industry consortium has the potential to deliver ammonia emissions reductions from 2023, more quickly than other

[1] https://www.gov.uk/government/publications/clean-air-strategy-2019
[2] National Emission Ceilings Regulations 2018, http://www.legislation.gov.uk/uksi/2018/129/schedule/3/made
[3] https://consult.defra.gov.uk/air-quality-and-industrial-emissions/reducing-ammonia-emissions-from-urea-fertilisers/

approaches. However, the analysis also indicated that a regulatory requirement to treat solid *and* liquid urea fertilisers with a urease inhibitor[4] (not consulted on previously) could achieve greater ammonia emissions reductions than Option 1 (a ban on solid urea fertilisers) and the approach put forward by industry.

In view of the results of the revised analysis and taking into account global supply and pricing of fertilisers, Defra is supportive of the industry consortium's proposed approach to be delivered from 2023, a year later than initially proposed. This approach is expected to deliver around 11kt of ammonia emissions reductions by 2024/25. The assurance scheme standard, coupled with advice and guidance on effective use of all fertilisers, have the potential to deliver greater protection for the environment in the longer term if they lead to improved crop nutrient management practices, such as increased nitrogen use efficiency. Defra will monitor the global supply of fertilisers and any impacts on food prices to determine whether any further postponement may be required. Once implemented, Defra will monitor the industry's scheme and its success in reducing ammonia emissions. Should the scheme not achieve sufficient ammonia emissions reductions and the global supply and pricing of fertilisers be more stable, government will consult on draft regulations from 2025/26.

Introduction

Taking action to manage the use of urea fertilisers will help to reduce pollution to air, land and water caused by:

- ammonia reacting with nitrogen oxides and sulphur dioxide, forming fine particulate matter ($PM_{2.5}$) which is harmful to cardiovascular and respiratory health
- nitrogen deposited on sensitive habitats such as peat bogs leading to excess nitrogen in soils that encourages the growth of nitrogen-loving plant species which changes plant species balance, leading to biodiversity loss
- nitrogen leaching through the soil and surface run-off which pollutes water courses, causing harm to plants and animals and impacting on water quality

Agriculture contributes 88% of the UK's ammonia emissions[5]. Most agricultural ammonia emissions come from livestock manures in animal housing and stores, and when manures and inorganic fertilisers are applied to land. Around 17% of agriculture-derived ammonia

[4] Urease inhibitors are chemicals that inhibit the action of enzymes in naturally-occurring soil bacteria that convert urea to ammonium, allowing more time for rain to disperse the urea into the soil and for plant uptake thus limiting ammonia emissions.

[5] Emissions of air pollutants in the UK – Ammonia (NH3), https://www.gov.uk/government/statistics/emissions-of-air-pollutants/emissions-of-air-pollutants-in-the-uk-ammonia-nh3

emissions are from inorganic fertiliser application[6]. Solid urea and urea ammonium nitrate (UAN) fertilisers' use in England, represented 5.2% and 2.7%, respectively, of total UK emissions.

As a result of these negative impacts of ammonia, government committed to legally binding targets to reduce ammonia through the National Emissions Ceilings Regulations (2018). The Clean Air Strategy, published in 2019, set out the actions that will be taken to achieve these reductions, including the plan to consult on reducing ammonia emissions.

In November 2020, Defra consulted on 3 cost-effective regulatory options for the use or sale of solid urea fertilisers. A brief overview of these responses is included below and are summarised in more detail in the Annex. This government response is a culmination of the following:

- collating and analysing all the consultation responses and evidence received through workshops with ports, hauliers and Defra's Nutrient Management Expert Group
- investigating issues raised through the consultation with independent market analysts, the Health and Safety Executive and the Food Standards Agency
- re-analysing consultation policy options using new evidence and updated NAEI data
- re-drawing and analysing Option 2 to include liquid urea fertilisers (along with solid urea fertilisers) in the requirement for them to be treated with a urease inhibitor
- assessing a farming and fertiliser industry consortium's proposed approach to drive ammonia emissions reductions from fertilisers containing urea (both solid and liquid) through assurance scheme standards coupled with advice ("Option 4")
- developing a system to collect data to monitor uptake of the industry approach
- monitoring the impacts on the stability of global fertiliser supply and pricing

The consultation responses and input from industry bodies such as Agricultural Industries Confederation (AIC), Associated British Ports (APB), UK Major Ports Group (UKMPG), and Road Haulage Association (RHA), gave Defra a strong indication that the 3 regulatory options consulted on could potentially be implemented in the following years:

1. Option 1, a ban on the sale or use of solid urea fertilisers by 2025 (at the earliest) to allow for planning consents and construction for additional secure storage facilities at ports or inland facilities for anticipated increases in imports of AN fertilisers (assumed to be the main substitute for solid urea fertilisers). This has been remodelled to take into account revised assumptions based on evidence that more

[6] https://uk-air.defra.gov.uk/assets/documents/reports/cat07/2103191000_UK_Agriculture_Ammonia_Emission_Report_1990-2019.pdf

users than previously anticipated were likely to use liquid urea ammonium nitrate (UAN), as well as AN, as a substitute for urea.

2. Option 2, a requirement to treat solid urea fertilisers with a urease inhibitor (UI) by 2024 (at the earliest) to allow for stores of untreated solid urea to be used and UI products to be regulated and in sufficient supply.
3. Option 3, a restriction on use of solid urea fertilisers (allowable only from 15 January to 31 March) by 2023/24 (at the earliest). Increased volumes of AN fertiliser (as the expected substitute for urea in the closed period) would need to be imported so lead-in time would be required to allow for additional AN storage provision.

Input from stakeholders such as individual agronomists and fertiliser manufacturers and suppliers indicated that Option 2, a requirement for solid urea fertilisers to be treated with a UI, could be extended to require the addition of a UI to liquid fertilisers containing urea. The inclusion of liquid fertilisers containing urea would not be impracticable for farmers' operations as originally assumed in the Impact Assessment accompanying the consultation.

A consortium of agricultural industry organisations[7] proposed using the Red Tractor farm assurance scheme to limit ammonia emissions from fertilisers containing urea (solid and liquid) ("Option 4"). The proposed new Red Tractor standard will require the spreading/spraying of uninhibited/unprotected fertilisers containing urea (solid and liquid) only between 15 January and 31 March, and only spreading/spraying inhibited/protected solid and liquid fertilisers containing urea throughout the rest of the year (1 April to 14 January). Liquid urea would be exempt for uses such as a foliar application or if approved by a FACTS Qualified Adviser/farmer.

Option 4, and the 3 consultation policy options have been modelled for both economic and pollutant emissions. In addition, a further option was modelled: Option 2a – a requirement for solid urea and urea AN to be treated with a UI.

Summary of consultation responses and industry input

We received 405 responses to the consultation, 76% of which came from respondents with a clear role in the agriculture sector. There were responses from 12 farming and fertiliser industry bodies (including National Farmers Union, Agricultural Industries Confederation) and 10 environmental NGOs (including Plantlife, ClientEarth). 71% of respondents opposed Option 1, predominantly citing the adverse effects banning solid urea would have on the choice of available fertilisers, the price of AN (as it will have more

[7] Comprising National Farmers Union (NFU), Agricultural Industries Confederation (AIC), Association of Independent Crop Consultants (AICC), BASIS Scheme for crop nutrition advisers (FACTS), Country Land and Business Association (CLA), National Institute of Agricultural Botany (NIAB), and Red Tractor.

of a market share), and the added burden of safely storing increased amounts of AN (for both farmers and seaports), as the main reasons for the opposition.

Most of those who disagreed with Option 1 indicated a preference for either Options 2 or 3 and some indicated a preference for Option 4, the industry-led approach led by the NFU/AIC. Modelling results produced by industry (and verified by Defra) indicate Option 4 could achieve ammonia emissions abatement amounting to around 11kt by 2024 and be implemented by April 2022 as a mandatory Red Tractor farm assurance standard[8]. Should there be an indication that behaviour has not changed and that ammonia reductions have not been achieved then the industry will acknowledge the need for a regulatory approach (probably along the lines of Options 2 or 3).

Some environmental Non-Governmental Organisations agreed that Option 1 was their preferred choice because they thought it would provide the greatest reduction in ammonia emissions and would be the easiest option to enforce. However, they also expressed concern with the risks of increasing GHG emissions and nitrate leaching from increased use of AN (as a substitute for urea) and advocated reducing the overall use of nitrogen fertilisers.

A workshop held with port authorities, along with many consultation responses, confirmed that England would not be ready for Option 1 until 2025, primarily for ports to be ready to safely store increased amounts of AN (as a substitute for the banned urea). Responses from the consultation and views from the NFU and AIC workshops indicated that England would not be ready to implement Option 2 until 2024, in order for farmers to use up their existing stores of untreated urea and for there to be adequate supply of UI products.

Other key points that have come to light though the consultation are as follows:

- There is a broad consensus that the price of AN will increase substantially in the event that use of untreated urea fertiliser is banned. Market insiders monitoring the sales and prices of nitrogen fertilisers indicate that the market for AN, in contrast to the market for urea, is not very liquid and therefore price increases are more likely if urea, as the main alternative to AN, is banned.
- AN imports to the UK have to be shipped in to ports in shallow vessels and the contents must be loaded in to bags at storage facilities that comply with COMAH (Control of Major Hazards) requirements or transported by hauliers that are licenced to carry dangerous goods to inland COMAH-compliant storage sites. By contrast, urea imports to the UK can be shipped in bulk in deep vessels. Additional loading infrastructure and storage facilities for AN at ports and possibly at inland storage points are likely to be required if urea is banned. This is likely to increase the costs and delay the implementation of Option 1 by 3 to 5 years.

[8] Note that the Option 4 dates referred to here and in Annex I were the dates originally planned before the onset of the current fertiliser supply and pricing instability.

- More hauliers with licenses to transport AN would be needed to transport the increased volume of imported AN in England.
- Respondents identified that while most urea would be replaced by AN in the event of a ban on solid urea, some farmers are likely to shift towards the liquid fertiliser UAN. This would reduce the abatement potential of Option 1.
- There are several products available on the market that claim to reduce ammonia emissions from urea to a similar extent to UIs.
- Farming industry responses generally indicated that it is practical to use a UI with UAN, however other responses question the experimental data demonstrating the extent of emissions from UAN and the efficacy of UI when used with UAN which, they claimed, is not robust. Several responses highlighted that UIs should not be used alongside sulphur which is included in many compound fertilisers and may also be added to liquid spray applications.
- The Nutrient Management Expert Group stated that there is a lack of evidence on the effects of widespread use of UIs on soil microbiology and biogeochemical cycling or on drinking water and freshwater. The group noted a potential for negative impacts from UIs which may lead to elevated urea concentrations (as it would retain its integrity longer in the soil for plant uptake) in freshwater, estuarine and marine environments resulting in eutrophication effects.

Re-modelling and analysis of consultation policy options and modelling of alternative options

The consultation outputs (qualitative and quantitative) and updated data from the NAEI and the British Survey of Fertiliser Practice required Defra to not only re-model and re-analyse the consultation regulatory options but also to model alternative options that came to light. Table 1 provides an outline of the economic and environmental impacts of these options.

It is assumed that banning solid urea (option 1) would lead to an increased demand for AN as the predominant substitute (with consequent GHG emissions increases of around 69kt per year). However, it is more likely that there could be a more significant shift to UAN as a substitute (Option 1a) in which case, the ammonia abatement potential is reduced to around 11kt per year. It is considered that a ban on solid urea could not be introduced until 2025, due to a 3 to 5 year lead-in time required to install suitable safe storage capacity at ports or at inland facilities. Market analysts have advised that AN prices in the UK would increase by at least 20% if solid urea were to be banned in England. This option also received the most opposition in the consultation responses where respondents highlighted significant concerns from a consequent over-reliance on AN that comes from a reduction in fertiliser choice.

Table 1: ammonia abatement, greenhouse gas emissions and cost-effectiveness of Option 1-3, augmented Option 2 (2a) and Option 4.

Options, England only	Assumptions	Abatement Ammonia (kt) start/2030	GHG Emissions CO2e (kt) Start/2030	Present value benefits (£m) start-2030	Present value costs (£m) start-2030	Present value net benefits (£m) start-2030	Benefit cost ratio	Average Annual Cost (£m)
Option 1: Ban of solid urea **Start Date: 2025**	**100% AN substitute; 20% increase in AN price**	**13.8 / 13.9**	+69.3 / +69.5	587.0	153.7	433.3	3.8	25.4
Option 1a: Ban of solid urea **Start Date: 2025**	**50% AN substitute and 50% UAN substitute; 20% increase in AN price**	**10.7 / 10.8**	+20.8 / +20.7	499.2	111.0	388.3	4.5	18.3
Option 2: Solid Urea + UI **Start Date: 2024**	**Only solid urea to be treated with UI. No price uplift in AN and no substitute assumptions.**	**11.1 / 11.2**	-42.7 / -42.9	705.5	48.2	657.3	14.6	6.2
Option 2a: Solid and liquid (UAN) urea used with UI **Start date: 2024**	**Including UAN to be required to be used with UI (as well as solid urea). No price uplift in AN and no subsitution assumptions.**	**13.9 / 14.1**	-53.9/ -54.4	892.5	87.4	805.1	10.2	11.8
Option 3: Restrict solid urea use to Jan- March rest using AN **Start Date: 2023**	**50% of the substiute fertilisers used in the closed period to be AN and 50% UAN. 20% increase in AN price.**	**8.8 / 9.7**	-8.9 / -8.8	671.4	150.1	521.2	4.5	17.9
Option 4: Industry Option **Start Date Apr 2023**	**Solid untreated urea used during Jan – March, thereafter urea and UAN used with UI, unless otherwise directed by FACTS adviser or farmer has received FACTS training. 20% increase in AN price.**	**11.1 / 11.2**	-43.8 / -44.3	926.6	83.1	820.0	11.2	8.3

The greatest ammonia abatement (of around 14kt per year) can be achieved by requiring the use of a UI with solid urea and liquid urea (Option 2a). This could also reduce GHG emissions (by around 54kt per year) and may help reduce nitrate leaching to water due to an assumed reduced reliance on AN as a substitute fertiliser. It is considered that this option could be introduced by 2024 to allow farmers to use their existing stores of untreated urea and enough time for industry to provide the required increased supply of UI products.

Restricting solid urea use (from 15 January to 31 March), Option 3, has the lowest ammonia abatement potential (around 9kt pa). Winter months provide the optimal soil and ambient conditions (damp and cold) to prevent volatilisation and release of ammonia into the air. Untreated urea would be available for farmers to use all year round and so the approach could be difficult to enforce. It is considered that this option could be introduced by 2023/24 to allow farmers to use their existing stores of untreated urea and enough time for industry to provide the required increased supply and storage requirements of substitute AN.

Industry's "Option 4", to use farm assurance schemes to reduce ammonia emissions, would reduce emissions by around 11kt per year by 2024/25. This assumes 100% compliance by all farmers who are members of the Red Tractor assurance scheme (that covers at least 95% of urea fertilisers use) and does not account for some exemptions to the use of untreated liquid urea proposed by industry, such as when heavy rainfall is forecast or for use as a foliar spray. On the other hand, the analysis for Option 4 does not account for the possibility of farmers shifting to UI-treated urea or AN in the open period (15 January to 31 March), which could provide further ammonia emissions abatement.

Industry "Option 4" approach

An agricultural industry partnership offered its commitment to deliver substantial ammonia emissions reductions from the use of both solid and liquid fertilisers containing urea from April 2023. The new Red Tractor farm assurance standard proposed is:

- Fertiliser containing Urea must only be applied where the following requirements are met:
    - protected/inhibited fertilisers containing solid urea can be applied within any product use-by/best before dates
    - protected/inhibited fertilisers containing liquid urea can be applied with the prescribed rate of protector/inhibitor for the application, and within any product use by/best before dates
    - in England, unprotected/uninhibited solid fertiliser containing urea can only be applied between 15th January and 31st March
    - in England, unprotected/uninhibited liquid fertiliser containing urea can be applied between 15th January and 31st March
    - in England, unprotected/uninhibited liquid fertiliser containing urea can be applied between 1st April and last application in autumn[9] only if agronomic justification is provided by
        - FACTS-qualified farm personnel[10] or
        - advice specific for the crop has been provided by a FACTS- Qualified Adviser and been followed (see EC 9.1)
    - in Northern Ireland, Scotland and Wales fertiliser containing urea (solid and liquid) can be applied as per relevant legislation

Uptake will be monitored through fertiliser sales and treatment data, Red Tractor monitoring data, and the British Survey of Fertiliser Practice. This will establish whether the ammonia abatement expected is achieved. In addition, Defra will gather relevant data to monitor and assess the level of ammonia abatement achieved by the scheme.

[9] All applications should be made before the end of October in accordance with RB209
[10] A member of the FACTS professional register

Under the industry-led scheme the consortium and fertiliser suppliers will:

- adapt to anticipated change in demand for protected/inhibited fertilisers and AN containing fertiliser, after 1 April 2023
- advise farmers, through their FACTS Qualified Advisers, of the best ammonia mitigation strategy (product choice, rate, timing) level of improvement considering the need for continuous improvement in nitrogen use efficiency to enhance crop performance and reduce overall nitrogen losses to reducing nitrous oxide to air and nitrate to water
- require fertiliser suppliers selling fertilisers without advice, to signpost farmers (via invoices, QR codes etc) to further generic guidance on ammonia reduction and FACTS Training module
- require all fertiliser suppliers to clearly state on invoices the inclusion of inhibitor (as relevant for all materials in scope). Hearing this from the voice of Defra would ensure consistency across the board (making sure everyone involved knows that there is a requirement for the audit trail)
- provide supporting guidance to Red Tractor auditors on the new standards, what information the farmer needs to provide to demonstrate compliance with the new standards, and provide farmers with clarity on how to comply. All mineral fertilisers, for agricultural use, containing 1% ureic nitrogen or more are in scope with the exception of urea solution for late-season foliar application
- assess and register any non-conformance from October 2023 and report back with early interim results to all Industry Partners and Defra by July 2024 and full results by the end of 2024 and each subsequent year. Detailed guidance on conformance will be issued along with the publication of the standard in April 2023
- issue a sanction for non-conformance – where farmers are to take a FACTS Training module (and on-line assessment) covering best practice for managing ammonia loss from fertilisers containing urea as well as from organic fertilisers
- develop training for reducing ammonia losses from mineral and organic fertiliser applications (including guidance on mitigation on days before April 1st based on soil temperature etc and considering the opportunities for financial savings).
- develop (with the Health & Safety Executive) and disseminate a manual for the safe handling of urease inhibited/protected products and materials sold for on-farm inclusion
- run a communications campaign to disseminate the new Red Tractor standards and requirements in England, including a campaign on nitrogen use efficiency

Roll-out will be tracked from October 2023 with an expectation of significant ammonia emissions abatement by the end of 2023. This would inform government of the potential part this approach will play in meeting its national air quality obligations and therefore assess the need for any regulatory intervention.

The industry consortium will not be limiting their ambition to 11.2kt aiming to close the gap between 11.2Kt and 14.1Kt (Defra's alternative regulatory Option 2a mandating the use of UIs/protected fertilisers containing urea, all year round). This will be done with the support of the wider ambitions of the consortium's nutrient management campaign to 2030. The

concept of improving nitrogen use efficiency by improving farm nutrient balance, is well embedded in Option 4 and co-benefits for ammonia mitigation are expected as a result.

Discussion

The proposed industry approach through a farm assurance scheme, coupled with advice and guidance (on improving overall farm nutrient balance and nitrogen use efficiency), should deliver ammonia emissions abatement earlier than a regulatory approach. This could improve nutrient management, which is essential for improving water and air quality, habitats condition and preventing greenhouse gas emissions. Full compliance with Option 4 is expected in 2024/25. If Option 4 does not achieve sufficient ammonia reductions, Defra will consult on and implement legislation to reduce ammonia emissions from fertilisers containing urea. The decision on implementing the scheme in April 2023 will be reviewed in the autumn of 2022 to allow government to respond to developments in fertiliser supply and costs. Once the scheme is implemented, the decision on whether to pursue regulation will likely be made in 2025/26 but will be kept under review based on a range of data, including data from sales of protected/inhibited fertilisers containing urea as well as products for inclusion on farm (for example, in concentrate form). A regulatory approach would likely require farmers to only spread UI-treated/protected solid and liquid urea and they would be banned from using untreated solid and liquid urea throughout the year.

Urease inhibitor (UI) products are used in relatively small quantities in the UK, although they have been used widely in the US for many years and have also been mandated in Germany since 2019. The Food Standards Agency has reviewed the evidence on the UIs currently marketed in the EU on safety for the food chain and has concluded that sufficient information exists to conclude that 2 of the 3 UI products currently licensed for use in the UK can be used safely. These are N-(n-butyl) thiophosphoric triamide (NBPT) and N-propyl-thiophosphoric triamide (NPPT). The FSA has requested for more safety data on N-(2-nitrophenyl) phosphoric triamide (2-NPT), at the time of writing this response.

Safe handling of UIs is essential to mitigate risks associated with occupational exposure. The industry consortium is preparing guidance in collaboration with HSE to mitigate this risk. With regards to ascertaining the efficacy of UIs on ammonia abatement (i.e. how much they reduce ammonia emissions in urea fertilisers), a new European Committee for Standardization (CEN, of which the UK is a member along with EU member states) methodology to test UIs is currently under development and will be published this year. Regulatory controls on the efficacy of UIs and other modes of protection will be considered in developing the new regulatory regime for fertilisers due to be in place by 2023, although we intend to request data on their efficacy as part of the monitoring plan for Option 4.

The impact of increased use of UIs on soil quality is uncertain due to a lack of evidence. There is some evidence that UI-treated urea, as it retains integrity longer in the soil for plant uptake, can lead to increased concentrations of ureic nitrogen in connected watercourses. Studies on freshwater, estuarine and marine environments indicate eutrophication effects from elevated urea concentrations as well as from other species of

nitrogen, and it might be expected that use of UIs could increase the opportunity for urea to enter watercourses. Further evidence would be needed to ascertain and quantify these effects and compare them with the effects of reduced ammonia deposition on catchments. Defra will investigate these impacts in more detail through reviews and experimental monitoring as the Red Tractor measures are implemented and ahead of implementing any regulatory approach.

There is currently a shortage of AN fertiliser in both GB and across Europe. All fertiliser types have increased in price, and AHDB quoted October (2021[11]) an imported AN delivery price of £587 per tonne and a granular urea price of £678/t. Translated into price per kg of nitrogen, the price for AN was £1.70/kg N and the price for urea was £1.50/kg N both representing increases from the same month last year of 142% and 149%, respectively. Urea is the next favoured product farmers turn to when AN is not available. Therefore, there is a risk that any legislation or industry scheme that takes away the choice of use of fertiliser type (i.e. untreated solid urea) under current circumstances would present significant operational and economic difficulties for farmers. At the time of this publication (March 2022), nitrogen fertilisers are trading at around £900 - £1000 per tonne (source AIC).

Conclusion

Ammonia emissions must be reduced to improve air quality and restore our natural environment. Taking action on urea fertilisers in England will help reduce a significant amount of ammonia emissions by 2030.

Banning the sale or use of solid urea fertilisers before 2025 is currently unfeasible, due to the time it would take to implement, and the unintended consequences for farming, particularly if there were to be a short supply and/or increase in cost of alternative fertilisers (namely AN). An industry-led approach has advantages – the emission savings achievable could be substantial and delivered sooner than possible through a regulatory approach. Industry is confident in take-up and compliance, assuming farmers can purchase the fertilisers they require. Red Tractor covers around 90% of urea users and around 95% of all urea use and industry believes that Red Tractor members will comply with their scheme to continue to use untreated solid urea. Sanctions available include the need to sit a FACTS training course and assessment on ammonia emissions reductions.

Pending the stability of the fertiliser industry and once implemented (currently planned for April 2023), if the industry-led approach does not shift fertiliser use sufficiently, we will consult on regulation to control emissions from fertilisers containing urea from 2025/26.

[11] https://ahdb.org.uk/GB-fertiliser-prices

This would likely be to mandate the use of urease inhibitors/treatments with fertilisers containing urea (solid and liquid) throughout the year.

Annex I: Summary of responses to the consultation on reducing ammonia emissions from urea fertilisers

Introduction

This document summarises the responses received to the consultation on reducing ammonia emissions from solid urea fertilisers in England. The consultation ran for 12 weeks from 3 November 2020 to 26 January 2021 to seek views on 3 policy options for reducing ammonia emissions from solid urea fertilisers:

1. A ban on solid urea fertilisers (“ban”). Preferred option: provides the most ammonia emission reductions (abatement) of the 3 options.
2. A requirement to stabilise solid urea fertilisers with the addition of a urease inhibitor (“urease inhibitor”). Achieves less ammonia reductions than Option 1.
3. A requirement to restrict the spreading of solid urea fertilisers to 15 January to 31 March (“restricted period”). Achieves less ammonia reductions than Options 1 and 2.

In total, we received 405 responses, 346 responses were received through Citizen Space and 59 by email. We held 5 stakeholder workshops including one with the Nutrient Management Expert Group (NMEG).

The majority of respondents indicated that they had an agricultural interest (309 respondents altogether, including 207 arable farmers, 49 livestock farmers and 53 farm advisors). There were 25 responses from the fertiliser industry (9 fertiliser distributors or retailers and 16 fertiliser manufacturers). There were 12 responses from industry bodies, including agricultural bodies such as the National Farmers Union (NFU) and the Agricultural Industries Confederation (AIC), and the transport body, the Road Haulage Association (RHA). There were 10 responses from NGOs, including Plantlife and ClientEarth. Other categories of respondent included academics (6 respondents) and the general public (13 respondents). There was one response from a local authority. 29 respondents identified as ‘Other’, including the organisations Associated British Ports (ABP), Affinity Water and Natural England, as well as individuals from a range of backgrounds.

About the analysis of responses

It is important to keep in mind that public consultations are not necessarily representative of the wider population. Since anyone can submit their views, individuals and organisations who are more able and willing to respond are more likely to participate.

Because of this self-selection, the emphasis of this analysis has been qualitative rather than quantitative, aiming to understand the key issues raised and underlying reasoning.

In presenting the results, we have aimed to provide a broad picture of the views and comments made. Therefore, a range of qualitative terms is used, including ‘many’ ‘some’, ‘most’, and ‘a few’. Interpretation must take into account the context of the question, as not every respondent answered all questions, and not every respondent who provided an answer provided additional detail.

In this respect, qualitative terms are only indicative of relative opinions to questions on the basis of who responded. Therefore, they cannot be assumed to relate numerically back to the total number of people and organisations. However, in general the following definitions of these qualitative terms were used:

Alternative: The views expressed by a small number of respondents, or within limited subgroups that are important to acknowledge.

Mixed / range of views: a lack of clear consensus, or expressive of a wide diversity of views.

Majority: a significant amount, more than half who commented at any question.

Many: a significant amount, but less than half who commented at any question.

A small number of respondents / a few / several / some / others: a small amount of respondents, or a limited subgroup

The majority of questions required a response. However, where a response was voluntary, the number of respondents is included to indicate how many responses were received.

Some respondents misunderstood one or more questions, for example answering ‘No’ to a question when their written explanation suggested they meant yes. This issue was discussed within the consultation team and a decision was made to adjust closed option responses so they aligned with written statements. Such confusion was noted in some responses to 4 different questions. The number and direction of changes made are noted in the summary of responses of the relevant questions.

Responses to consultation questions

General urea fertilisers policy questions

Q1a. Should the use of liquid fertilisers (such as UAN) containing urea remain unrestricted? Yes/ No/ No view. Q1b. If No, why?

Table 1	Views given by respondents to Q1a (%)[12]
Yes	63
No	24
No view	13

The majority of respondents, including most of those who identified as farmers, agreed that liquid fertilisers such as Urea Ammonium Nitrate (UAN) should remain unrestricted. A few of these respondents suggested that liquid fertilisers such as UAN are spread more accurately than solid urea fertilisers, leading to better uptake rates by crops and lower levels of ammonia volatilisation. The National Farmers Union (NFU) also argued that if liquid fertilisers were to be banned, there would be significant cost impacts for those farmers who have already invested in a liquid fertiliser system. However, the NFU did advocate treating UAN (for example, with a urease inhibitor) in the closed period as part of their Option 4 proposal, a form of restriction.

Other respondents who felt the use of liquid fertilisers needed to be restricted but not be banned completely, similarly suggested that liquid fertilisers should only be used when an inhibitor has been added. Others suggested that its use should be restricted but with exceptions in place, for example restrictions should not apply for milling wheat or in certain weather conditions or seasons. Restricting the quantity of liquid fertiliser applied was also suggested by a few respondents.

However, a minority of respondents, a number of whom were environmental NGOs, thought that liquid fertilisers containing urea should be banned alongside solid urea fertilisers. They were largely concerned that if UAN was not banned alongside solid urea, there would be a risk that farmers would move from solid urea to UAN. Plantlife asserted UAN is a fast-growing source of ammonia, as well as nitrous oxide emissions. The negative impact of liquid fertilisers on water quality compared to solid urea fertilisers through leaching or run-off was also raised by a few respondents, such as South East Water (which supplies drinking water to 2.2 million customers in the south east of England).

Several of these respondents, such as the environmental NGOs Plantlife and ClientEarth, which both called for more research into UAN, had alternative views to other respondents who claimed that UAN should not be restricted because it is required for milling wheat. Another respondent who identified as an arable farmer suggested there are better fertiliser alternatives than UAN, for instance AN, and this included for milling wheat.

[12] 16 responses to Q1a were adjusted to align with the written explanation provided by respondents for Q1b. This included 14 responses changed from ‘No’ to ‘Yes’, 1 response changed from ‘Yes’ to ‘No’ and 1 response changed from ‘No’ to ‘No view’. These changes are reflected in Table 1 above.

Q2a. Should the policy (all policy options) applied relate to solid compound fertilisers (as well as solid straight urea fertilisers)? Yes/ No/ No view. Q2b. If No, what solid compound fertilisers should/ should not be restricted and why?

Table 2	Views given by respondents to Q2a (%)
Yes	41
No	41
No view	18

An equal proportion of respondents answered 'Yes' and 'No' to this question on whether the policies applied should relate to solid compound fertilisers, as well as solid straight urea fertilisers. Of those respondents who disagreed with applying a ban to solid compound fertilisers, some farmers and farm advisors suggested that compound fertilisers contain very small amounts of urea. Some also argued that their usage could be made more efficient and less polluting if farmers were educated on best practice, for example on which weather conditions to apply urea fertilisers in. Other respondents suggested that expanding the policies to include solid compound fertilisers would further reduce the fertiliser options available to farmers, and therefore reduce competition in the fertiliser market. This, they argued, would likely lead to increases in fertiliser costs, and therefore increase production costs for farmers.

Responses to Q2b, largely from the agriculture industry, focused on recommendations of solid compound fertilisers that should not be restricted. Whilst some said that no solid compound fertilisers should be restricted, others specifically mentioned urea sulphur compound fertilisers, including urea ammonium sulphate, because it was felt that they are less polluting but as efficient as AN. The fertiliser manufacturer, BASF, suggested that coated fertilisers and products containing condensed urea (slow and controlled release fertilisers) should not be restricted as they are already equipped with technology that curbs ammonia emissions.

The fertiliser company Yara International suggested that the ban should apply to a blended product that uses straight urea as the nitrogen source. However most, if not all, compound fertilisers would be AN-based and therefore do not contain urea. They pointed out that research has demonstrated that the active ingredients (for example, urease inhibitors) that 'chemically protect' the urea are unstable and degrade with time in the presence of other nutrients (most notably sulphur and phosphate). The question that they said this posed is how to ensure these products such as urease inhibitors maintain their effectiveness in reducing ammonia emissions in compound fertilisers?

A few respondents pointed out that the consultation had not considered farmers who mix their own liquid fertiliser using solid urea.

Q2c. If you agree, should the policy (all policy options) applied relate to solid compound fertilisers (as well as solid straight urea fertilisers)? Yes / No / Don't know. Q2d. If you disagree, what should be the threshold of carbamide nitrogen content in order for the policy to reduce ammonia emissions to be effective?

Table 3	Views given by respondents to Q2c (%)
Yes	34
No	33
Don't know	33

Of the respondents who agreed that a ban on solid fuel urea should include solid compound fertilisers, opinion was virtually split equally between 'Yes', 'No' and 'Don't know' over whether it should apply to all compound fertilisers containing greater than 1% carbamide (ureic) nitrogen. Many NGOs, including Plantlife, and most respondents who identified themselves as members of the general public, answered 'Yes' to this question.

Many of those respondents who disagreed that it should apply to all compound fertilisers containing greater than 1% carbamide (ureic) nitrogen, most of whom identified as farmers, provided alternative thresholds of carbamide nitrogen content. These suggestions varied from 5 to 40% and were not supported by submitted evidence. One arable farmer suggested it should be 5 to 10% to start with, and this could then be adjusted if needed.

A few respondents said there should be no threshold, with several arguing that it is the rate and timing of application that is important rather than the percentage of ureic content.

Q3a. Do you agree or disagree with the Impact Assessment results for each of the policy options presented? Agree / Disagree / Don't know. Q3b. If you disagree please specify which of the results you disagree with and provide additional evidence to support your response.

Table 4	Views given by respondents to Q3a (%)[13]
Agree	23
Disagree	38
Don't know	39

More respondents who gave an opinion in response to this question (many of whom were farmers) disagreed with the Impact Assessment results than agreed with them. Those who agreed with the Impact Assessment results mostly included farmers and a few NGOs, such as the Soil Association. Fertiliser companies who gave an opinion were divided between those that agreed and those that disagreed.

Some of those respondents who disagreed with the results raised concerns that the environmental impacts of solid urea fertilisers had been overestimated in the Impact Assessment, particularly in relation to the ammonia abatement associated with a ban. Several respondents called for further independent field trials, suggesting that Defra

[13] One response to Q3a was adjusted from 'Don't know' to 'Disagree' to align with the written explanation provided by the respondent for Q3b. This is reflected in Table 4 above.

evidence (NT26 trials) on volatilisation levels was not representative of the majority of UK farming due to the climatic conditions under which the studies were conducted.

Some respondents also suggested that, particularly when used correctly, solid urea fertilisers are better for the environment than the main alternative, AN, which was said to negatively impact water quality and greenhouse gas emissions. Additional evidence was provided by respondents, including references to volatilisation trials and data on solid urea usage, which we will consider further. A few respondents also suggested that inhibitors could negatively impact on soil health. They called for more research to investigate the difference between emissions from solid urea and from urease inhibited urea fertilisers. In addition, one arable farmer argued that carbon sequestration from crops that are fertilised is higher and this should be considered in the Impact Assessment.

Another issue particularly in farmer responses, was the estimated cost to industry of the policy changes that was presented in the Impact Assessment. A number provided estimates that were much higher, including the NFU. These respondents claimed that if solid urea fertilisers were to be removed from the market, fertiliser competition will be reduced and this will lead to increases in the prices of the main alternative, AN.

Q4a. Would these policy options (on an England only basis) have a significant impact on the UK internal market and ensure a level playing field for users? Yes / No / No view. Q4b. If yes, please indicate how.

Table 5	Views given by respondents to Q4a (%)[14]
Yes	69
No	29
No view	2

The majority of respondents, including most respondents who identified themselves as being involved in the farming and fertiliser industries, such as the NFU, the AIC, and UK Major Ports Group (UKMPG), felt that the policy options presented would have a significant impact on the UK internal market. Many of these respondents suggested that if the quantity and quality of yield were to be maintained, the policy options would lead to a steep increase in production costs. Some respondents felt that the removal of solid urea fertilisers from the market would result in a monopoly being created for AN producers, which in turn would result in price increases. Several respondents also said that a switch to AN would incur additional storage, transport and plastic bagging costs.

[14] This question appears to have caused some confusion among respondents. Therefore, the approach taken has been to analyse responses based on the first part of the question looking at the impact of the policy options on the internal market. 11 responses to Q4a were adjusted to align with this approach and with the written explanation provided by respondents for Q4b. This included 1 response which was adjusted from 'Yes' to 'No' and 10 responses adjusted from 'No to Yes'. This is reflected in Table 5 above.

Many respondents, mostly farmers and fertiliser companies, said that this might raise prices, making English farmers less competitive in the global and UK markets. NFU Scotland stated that the measures in the consultation document could impact the rest of the UK market. Some respondents were also concerned that the proposals would increase food imports because prices would be more competitive as a result of not having to abide by the same regulations. They argued that an increase in food imports would result in more transportation emissions and the exporting of England's emissions problem to other countries, as providing additional crops that England would want would require more fertiliser use.

In addition, a few respondents raised concerns that the proposed policy approaches might disadvantage some types of farming more than others, for example some proposed that milling wheat, quince and cereals would likely be adversely affected. Smaller businesses were also highlighted as an area that could be negatively impacted.

Option 1 (A ban on solid urea fertilisers) questions

Q5a. The Impact Assessment suggests that this option (Option 1: A ban on solid urea fertilisers) provides the greatest reduction of ammonia emissions. Do you agree or disagree with this being the preferred option? Agree / Disagree / No view.
Q5b. If you disagree, please state why and what your preferred policy option would be.

Table 6	Views given by respondents to Q5a (%)[15]
Agree	20
Disagree	71
No view	9

The majority of respondents, mostly farming and fertiliser businesses, disagreed with a ban on solid urea fertilisers (Option 1). Some preferred Option 2 (urease inhibitors) and some preferred Option 3 (a restricted application period). Moreover, some respondents, including NGOs, said the ban was their preferred option, and a minority made no choice.

Farmers who disagreed with Option 1 mainly raised concerns about the potential economic impacts of a urea ban, such as increased costs and/or reduced competition in the fertiliser market. Concerns were raised that the environmental benefits of a ban had been overestimated, with some respondents questioning the reduction in ammonia emissions that would be gained. Some respondents, mostly farmers, also outlined a range of potential issues with using AN as an alternative fertiliser, including concerns around its safety and environmental credentials.

[15] 6 responses to Q5a were adjusted to align with the written explanation provided by respondents for Q5b, including 3 responses which were changed from 'Agree' to 'Disagree' and 3 responses which were changed from 'No View' to 'Disagree'. This is reflected in Table 6 above.

Most respondents who identified themselves as a member of the general public or an NGO supported a ban because they thought it would provide the greatest reduction in ammonia emissions and would be the easiest option to enforce (although noting the increase in GHG emissions). Plantlife argued that the 'voluntary approach', such as Defra's guidance on urea usage in the Code of Agricultural Practice, is 'not working' as a means of reducing ammonia emissions.

Some respondents preferred Option 2, which would require solid urea fertilisers to be stabilised with the addition of a urease inhibitor; others, including many farmers, preferred Option 3, which would restrict the spreading of solid urea fertilisers to the period of 15 January to 31 March. Where rationale was provided they tended to centre on the fact these two policy options would mean solid urea fertilisers remained in the market, which according to respondents, could help maintain competition and eliminate the need to switch to using AN, seen as the main alternative. A few respondents indicated that they would prefer an alternative option to those outlined in the consultation document, such as an industry-led approach or one that focused more on organic fertilisers or other sources of ammonia emissions. More detail on these approaches is included in the summary for Q25.

Q6a. Do you agree or disagree with the assumption that there will be a shift to the use of ammonium nitrate as a result of a ban? Agree / Disagree / No view. Q6b. If you disagree, what alternatives might be used?

Table 7	Views given by respondents to Q6a (%)
Agree	82
Disagree	7
No view	11

The majority of respondents agreed with the assumption that there would be a shift to the use of AN as a result of a ban. This included industry bodies such as the NFU and the Agriculture and Horticulture Development Board (AHDB). A small number of respondents, mainly from the farming industry, said alternative fertilisers, such as liquid Urea Ammonium Nitrate (UAN), solid compound fertilisers, calcium ammonium nitrate (CAN) and organic fertilisers, would be increasingly used as a result of a ban.

Origin Fertilisers suggested there is already a trend for both urea and AN users in the UK switching to UAN, a move which they say is forecast to continue as the supply of AN is already constrained. They said this is occurring due to domestic demand for AN in countries where it is produced, aging European production plants, and the lack of attractiveness of exporting to the UK, where the fertiliser market is significantly more competitively priced than elsewhere in Europe. Therefore, they questioned whether any increase in demand for UAN could be met, should solid urea fertilisers be banned. They pointed to new regulations in Germany to treat solid urea with urease inhibitor, which they said have led to a switch to CAN and UAN.

Several other respondents mentioned the possibility of a shift to alternative land management strategies were a urea ban introduced.

Q7a. Would storage and transportation of ammonium nitrate be a challenge to farmers and/or industry? Yes / No / No view. Please delete appropriately: I am a farmer / an industry representative / other (please specify). Q7b. If yes, how? Please list the potential challenges and ways these might be mitigated. Q7c. If you have suggested ways to mitigate potential challenges, what do you estimate the financial costs of these would be?

Table 8	Views given by respondents to Q7a (%)
Yes	66
No	31
No view	3

Though some respondents (mostly members of the farming industry, as well as most NGOs and members of the general public) did not agree that storage and transportation of AN would be a challenge to farmers and industry, the majority did. Furthermore, many farmers and fertiliser companies also raised concerns about the potential costs they would incur in meeting these challenges.

Challenges around health and safety, security, and the risk of theft for purposes of terrorism because AN has explosive properties, were raised by many farmers and fertiliser companies. Respondents felt that this would mean greater security measures would be needed at storage facilities and insurance costs could increase. The fertiliser manufacturer and supplier OMEX advocated limiting the tonnage of AN stored on-farm.

Additional storage, transportation trips, and plastic bagging for AN stocks were raised. AN has a lower nitrogen content than solid urea and so is needed in greater volumes but it can only be stored in bulk in line with the requirements of the Health and Safety Executive (HSE). A few respondents wondered whether planning permission or notification of local authorities would be needed for additional storage.

Associated British Ports (ABP) emphasised the limited capacity for AN storage at ports and flagged concerns about HSE approval for additional capacity. It added that increased storage meant significant and costly security enhancements.

Some respondents, particularly those in the fertiliser industry, raised haulier capacity to transport AN as they need to be licensed under the Fertiliser Industry Assurance Scheme (FIAS), the Control of Major Accident Hazards (COMAH) regulations, and the International Carriage of Dangerous Goods by Road (ADR) regulations. The Road Haulage Association (RHA) suggested that the haulage industry is already experiencing critical shortages of Heavy Goods Vehicle drivers, while the limited number of ADR qualified drivers has been further reduced due to Covid-19 impacts.

Several respondents suggested that financial support would be needed to meet these additional expenses, with a few providing estimates of the financial costs that would be incurred to mitigate the potential challenges identified. These estimates varied widely, from a small number of farmers saying that there would be no additional costs, to others giving estimates that ranged from £5,000 per farm to as high as £250,000 per farm. This was

mostly attributed to the cost of building new storage, although a few highlighted transport costs. Other respondents provided a similarly wide range of estimates of the cost of AN, from £4.00 to £80.00 per tonne. The fertiliser manufacturer, GreenBest, commented that for many distributors, stockists, and transport companies it would be a £2,000 to £5,000 per annum increase and could be much higher if security fencing is not yet in place and staff are not fully trained. An alternative suggestion made was to increase the product's nitrogen content so that smaller quantities would be needed, therefore reducing transportation and storage requirements.

A few respondents, particularly industry bodies and environmental NGOs, suggested that training, awareness-raising and advice would be necessary to ensure that the AN is applied correctly. The NFU stated that the regulations on handling AN can be confusing for farmers, and this would be exacerbated by the increase in AN use that Option 1 (ban) may bring. It suggested an awareness-raising campaign for farmers on changes needed to remain compliant with these regulations.

Additional challenges mentioned in response to this question included the environmental impacts of AN, such as an increased risk of nitrate leaching and GHGs, as well as lengthier application times, in comparison with solid urea fertilisers. A few respondents also suggested there was a risk that handling and spreading equipment could be corroded by AN, meaning that equipment may need to be washed down thoroughly after use. Measures to mitigate these challenges were not suggested.

Q8. If a ban is the agreed approach, how quickly following confirmation of this do you think this option could be introduced without impacting on the availability of suitable alternative fertilisers?

a. 0 to 6 months

b. 7 to 12 months

c. 1 to 2 years

d. More than 2 years

Table 9	Views given by respondents to Q8 (%)
0-6 months	4
7-12 months	7
1-2 years	30
More than 2 years	59

The majority of respondents (mostly from the farming or fertiliser industries, and haulage and ports representatives, RHA and UKMPG) said that it could take more than 2 years – the longest lead-in time proposed in the consultation – before introducing a ban on solid urea fertilisers to ensure the availability of suitable alternative fertilisers. However, almost a third of respondents, mostly from the farming and fertiliser industries, felt that 1 to 2siz years was feasible. A minority of respondents, including a few from the farming and fertiliser industries, and most members of the general public, thought that the ban could be introduced within a year.

Q9a. Would this policy option (Option 1: A ban on solid urea fertilisers) impact any other specific sectors such as horticulture or other small-scale end-users? Yes / No / Don't know. Q9b. If yes, please indicate who. Q9c. If yes, please provide further details including whether alternatives can be used.

Table 10	Views given by respondents to Q9a (%)
Yes	23
No	9
Don't know	68

The majority of respondents did not know whether a ban on solid urea fertilisers would impact on any other sectors. However, some – mostly from the farming or fertiliser industries – agreed that it would and only a few disagreed.

Of the small number of respondents who indicated which other sectors would be impacted, the horticulture sector was most frequently referenced. In particular, SBM Life Science, which manufactures care and protection products for crops, plants and the home, argued this option would have a significant impact on the home and garden sector. They said that this sector sells small quantities of compound fertilisers for domestic garden use that contain low concentrations of urea; this is mostly applied after mixing with water to ornamentals and home-grown edibles. AN was considered not to be a feasible alternative by SBM Life Science, since many suppliers prevent the sale of fertiliser containing even small amounts following the Beirut (AN explosion) incident in 2020.

Fertilisers Efficiency Enhancers, the fertilisers stabilisers industry body representing 6 members, claimed that foliar, controlled-release, and slow-release fertilisers are used for very specific applications for which there are no reasonable alternatives available, and this would impact the horticultural and public green sectors.

A few respondents said the amenity turf sector would be impacted – some said liquid urea or AN could be used as alternatives.

Feed grade urea and urea used in vehicles were also suggested by a small number of respondents as products that could be affected by a ban on solid urea fertilisers. Yara International suggested that as feed grade urea is a similar product to solid urea fertilisers, assurance schemes would be needed to ensure farmers do not spread this product onto crops as an alternative, so legislation should cover use as well as sale. They also mentioned the use of urea in the glue manufacturing process, which they also felt needed consideration.

Q10a. If it is necessary to ban the use rather than the sale (and use) of solid urea fertilisers, do you agree or disagree that farmers should be required to hold and present records of fertilisers purchased, such as receipts or invoices, when required? Agree / Disagree / No view. Q10b. If you disagree, what other enforcement options would you suggest? Please specify.

Table 11	Views given by respondents to Q10a (%)
Agree	52

Disagree	26
No view	22

The majority of respondents, mostly from the farming and fertiliser industries as well as most members of the public, agreed with the proposal that farmers should be required to hold and present records of fertilisers purchased when required if there were to be a ban on the use, rather than the sale, of solid urea fertilisers. However, some respondents, mostly farmers, disagreed. A few farmers said that they are already required to keep records of fertiliser stocks through farm assurance schemes such as Red Tractor. Other suggestions for enforcement included checking with fertiliser producers and carrying out random spot checks.

Q11a. Do you agree or disagree with the analysis of the environmental impacts of this measure (Option 1 to ban solid urea fertilisers)? Agree / Disagree / No view. Do you have evidence of environmental impacts which have not been considered? Yes/no. Q11b. If yes, please provide links or references.

Table 12	Views given by respondents to Q11a (%)
Agree	25
Disagree	43
No view	32

Many respondents, mainly from the farming and fertiliser industries, disagreed with the analysis of the environmental impacts of the ban on solid urea fertilisers (Option 1). However, some respondents from across all categories agreed, including the NFU and the Soil Association.

Of those who disagreed, some respondents felt that the impacts of a solid urea fertiliser ban on transport emissions needed to be taken into greater consideration. One argument made was that a solid urea fertiliser ban would result in more food being imported into England due to reduced competitiveness of UK farming markets, which in turn could result in greater food miles. Another was that the need for AN fertilisers resulting from a ban would require more road haulage journeys and shipping than solid urea fertilisers, as it has a lower nitrogen content than solid urea fertilisers and cannot be stored in bulk form on farms.

A few respondents also said that plastic waste would increase due to the increased number of plastic bags that would be required to hold additional, smaller quantities of AN. One arable farmer claimed that replacing solid urea fertilisers with AN would lead to microplastics being spread to the land.

Other respondents raised concerns over the impact of AN on soil health and water quality, due to an increased risk of nitrate leaching in comparison with solid urea fertilisers. This included the NFU and Anglican Water Services. An arable farmer also asked that the

environmental benefits of fertiliser use on the capture of carbon dioxide as a result of improved pastures and higher biomass crops be considered.

A number of respondents, mostly environmental NGOs (such as Wildlife & Countryside Link, Plantlife, WWF, and ClientEarth) and an arms-length body (Natural England) all highlighted the potential negative impact a ban on solid urea fertilisers could have on greenhouse gas emissions (via increased usage of AN) and that there was a greater need for nutrient management across the industry to prevent the potential for pollution swapping. Many of these respondents recommended the establishment of a UK nitrogen balance sheet that integrated all sectors of the economy and environment that interact with and have an impact on nitrogen flows.

Some respondents provided evidence of further fertiliser trials and reports on emissions reductions, on some of the environmental concerns raised. An academic report on the use of humic substances with liquid and solid fertilisers was also provided.

Option 2 (urease inhibitor (UI)) questions

Q12a. Would farmers use solid urea stabilised with urease inhibitor (UI)? Yes / No / No view. Q12b. If not, why? What alternatives might farmers use?

Table 13	Views given by respondents to Q12a (%)[16]
Yes	64
No	13
No view	23

The majority of respondents, mostly from the farming and fertiliser industries, answered 'Yes' to this question. Although no explanation was required, a few farmers added the caveat that this decision would depend on cost. Fertiliser manufacturers made claims about the benefits of UI and why some farmers choose to use it, including reductions in ammonia emissions and improvements in nitrogen use efficiency. Most of the 13% of respondents who disagreed were from the farming industry. The main reason they gave for their response was the cost of UI, which many felt would make solid urea fertilisers less competitive when compared to the price of AN fertilisers.

However, some also questioned the efficacy of UI, and were concerned that it would not be effective in certain weather conditions (for example, higher temperatures). One farmer also pointed out that UI-treated solid urea fertilisers have a shelf life of less than 12 months, while another stated that 'they slow down an already slow product'. Tenant Farmers Association (TFA) called for more research into the use of UI.

[16] One response to Q12a was adjusted from 'No' to 'Yes' to align with the written explanation provided by the respondent to Q12b. This is reflected in Table 13 above.

Environmental concerns of UI were also raised, many of which centred around the unknown impact of UI on soil health. One arable farmer stated ‘Farmers are looking to reduce chemicals applied to their fields. Stabilised urea has not been proven safe for all soil biology.’

A minority of respondents who questioned whether farmers would use UI-stabilised solid urea suggested alternative fertilisers they saw as more likely to be used. Of these respondents, many pointed to AN, while a few suggested UAN. This included the NFU who suggested that farmers are more likely to switch to AN, or potentially liquid urea, rather than inhibited solid urea because of cost. Other alternatives mentioned included stabilised foliar N fertilisation, AN inhibitor (DMPP) and a mix of liquid urea with liquid ammonium sulphate and liquid carbon.

Q13. At what concentrations should UI be applied to solid urea in order for there to be good efficacy? Please support your answer with evidence.

216 respondents answered this question, mostly from the farming or fertiliser industries. The majority of respondents said that they were unable to suggest concentrations and, where they did, most provided no supporting evidence. Several respondents referenced reports and efficacy studies on UIs. A few said that concentrations needed to be product specific and should be set by fertiliser manufacturers based on scientific evidence. Others commented that concentrations should be linked to other factors, such as the weather, soil conditions, and application timings.

The fertiliser manufacturers -- BASF, Origin Fertilisers, and Yara International -- suggested there was a need for the development of a new UK fertiliser standard or new regulations to define what constitutes an effective UI that could cover the minimum and maximum concentrations of UI at the point of sale. BASF suggested this could be based on a target to reduce ammonia emissions by over 70% compared to untreated urea. Yara International argued that concentrations should be in line with the EU regulations of 414ppm minimum for NBPT. However, Origin Fertilisers felt that concentrations were not adequately represented in the EU fertiliser regulation EC2003/20037.

Q14a. With regards to the efficacy of UI in solid urea when blended/coated with other minerals (for example, sulphur), do you have further evidence that might support this consideration? Yes/No. Q14b. If Yes, please submit your further evidence

21 respondents submitted further evidence in response to this question to this question but some respondents, including fertiliser manufacturers and Natural England, provided links to evidence such as trial data. Several suggested that UI is already being used and so has been proven to be effective.

Q15a. As a supplier, when would sufficient volumes of treated urea be available to the UK market if there was a requirement to include UI in the melt?

a. 0 to 6 months

b. 7 to 12 months

c. 1 to 2 years

d. More than 2 years

Table 14	Views given by respondents to Q15a (%)
0-6 months	8
7-12 months	8
1-2 years	30
More than 2 years	54

The majority of respondents across all professions/ organisations said 'More than 2 years' would be needed to ensure sufficient volumes of treated urea would be available if there were a requirement to include UI in the melt. This included many respondents from the fertiliser industry, as well as the industry bodies the AIC, the NFU, RHA, and UKMPG. Some respondents said 1 to 2 years would be feasible, including most respondents identifying as fertiliser distributors or retailers, while only a small number of respondents (including members of the general public) suggested less than a year

Q15b. Would a requirement to include UI in the melt (as opposed to a coating) increase the price of UI treated urea? Yes / no / no view. Q15c. If yes, by how much?

Most respondents answered 'no view' to this question or said that they were not qualified to provide an answer. Of the relatively few respondents who did provide a 'Yes'/'No' answer, the majority from the farming industry said that a requirement to include UI in in the melt would increase the price of UI-treated urea.

Of those respondents who estimated how much the price of UI-treated urea would increase by, responses ranged from a 10 to 25% increase, or a rise of £15 to £40 per tonne. COFCO International, China's largest food and agriculture company and a key importer of fertilisers in the UK, suggested £10 to £20 per tonne.

BASF suggested that the costs of coating urea with an inhibitor are low and if volumes increased, these would reduce further. They argued that major urea producers would be encouraged by increased sale volumes to invest in technology to add urease inhibitors to the melt, removing the cost associated with coating urea at port. Similarly, the fertiliser manufacturer, Koch Fertilisers, said that if UI treated urea demand increased, investments in technology to add UI to the urea melt would become economic and the costs of UI treatment may therefore reduce. In contrast, Yara International suggested that manufacturing factories are not set up to do this, and so a significant investment would be needed, and that there would be a decrease in productivity.

Q16a. Would this policy option (Option 2: a requirement to stabilise solid urea fertilisers with the addition of a urease inhibitor) impact any other specific sectors such as horticulture or other small-scale end-users? Yes / No / Don't know. Q16b. If yes, please indicate who. Q16c. If yes, please provide further details including whether alternatives can be used.

Table 15	Views given by respondents to Q16a (%)
Yes	13
No	9
Don't know	78

Most respondents answered 'don't know' to this question. Of the small number of respondents who responded that there would be impacts of requiring use of UI-treated solid urea fertiliser on other sectors, most – including the NFU – identified horticulture. A few pointed to the amenity turf sector, although Collier Turf Care – a fertiliser supplier to the sports and amenity market – said that UI-treated solid urea fertiliser is already widely used in the sector, and therefore this option would have limited impact on it. A small number of respondents also mentioned fruit growers and milling wheat farmers.

Views on alternative fertilisers that might be used varied. Suggestions included AN, UAN, the use of more legume cropping (that leaves residual nitrogen) and injecting anhydrous ammonia. One arable farmer suggested that while organic fertilisers could be used as an alternative, there are restrictions on the amount that may be used.

Q17a. If it is necessary to ban use rather than sale (and use) of uninhibited solid urea fertilisers, should farmers be required to hold and present when required, records of fertilisers purchased, such as receipts or invoices? Yes / No / No view.

Table 16	Views given by respondents to Q17a (%)
Yes	51
No	22
No view	27

The majority of respondents – including most fertiliser companies and farmers – said they felt farmers should be required to hold, and present when required, records of fertilisers purchased if a ban on the use of solid urea fertilisers is introduced. Some respondents, again mostly from the farming industry, disagreed, whilst a similar percentage gave no view.

Q17b. Can invoices / receipts contain details of the name of the specific fertiliser product bought? Yes / no / don't know.

91 respondents, mostly those from the farming industry and some fertiliser companies, answered this question. Most respondents thought that invoices or receipts can contain details of the name of a specific fertiliser product that is bought. Some respondents also pointed out that farmers already keep records of fertiliser purchases and usage as part of existing farm assurance schemes and in line with other regulations.

Q17c. What other option(s) might be more effective for monitoring and enforcing the measure (Option 2: A requirement to stabilise solid urea fertilisers with the addition of a urease inhibitor)?

93 respondents (mostly from the farming industry, as well as the AIC and some fertiliser companies) answered this question. A number mentioned farm assurance checks as a potentially more effective means for monitoring and enforcing the use of UI-treated solid urea fertilisers. Several suggested field application records could be implemented.

A small number of respondents suggested that rather than focusing on farmers, fertiliser sellers should be better regulated. This included an academic who recommended that fertiliser sellers record sales, including the date, product and address of the farmer applying the fertiliser, as is done in Denmark.

A different option was suggested by Fertilisers Efficiency Enhancers and BASF, that inhibited urea should be coloured so that it can be easily distinguished from white feed urea. A few suggested that the easiest option would be to ban urea altogether.

Q18a. Do you agree or disagree that UI-treated solid urea would be a better option to use than ammonium nitrate, should this policy option be chosen? Agree / Disagree / No view. Q18b. If you disagree, why?

Table 17	Views given by respondents to Q18a (%)
Agree	41
Disagree	25
No view	34

More respondents agreed than disagreed that UI-treated solid urea would be a better option than AN. Most on both sides were from the farming and fertiliser industries. Some expressed no view, including many of the respondents from NGOs or industry bodies, such as the AHDB and the AIC.

Of those who agreed, a number suggested that UI-treated solid urea would be better for the environment than AN. For example, NFU Scotland suggested that UI-treated solid urea would lead to a decrease in nitrous oxide, and thereby carbon emissions, in comparison with a shift to AN, and provided statistics the Department for Business, Energy and Industrial Strategy published on 2019 GHG emissions to support this. Anglican Water also raised concerns about the impacts of AN on GHG emissions, but also pointed to issues of water quality.

UKMPG, a trade association representing most of the larger commercial ports in the UK, also preferred UI-treated solid urea over AN as they felt it presented fewer logistical challenges, while still delivering significant ammonia emissions reductions. UKMPG said that they are aware of one major operator which has indicated that it could offer facilities to apply UI in port, and ABP claimed that several ports already have suitable facilities for coating. They also suggested that the installation requirements for inhibitor machines is modest, and that UI benefits from not needing the additional secure storage required for AN. Another respondent also said farmers would be able to buy and store UI-treated solid urea fertiliser in bulk, unlike AN.

Of those who disagreed that UI-treated solid urea would be better than AN, one reason mentioned by some was its cost. Several farmers also commented that the effects of inhibitors on soil biology are unknown and needed further study.

Yara International claimed that UI-treated urea has higher ammonia emissions than AN. They also raised safety concerns in relation to UI application and handling, and suggested that there is the potential of overloading the inhibitor, and reduced efficacy after storage or when combined with sulphur, phosphate or potash.

Q19a. Are you aware of any evidence of negative health or other environmental impacts from use of UIs that are licensed for use in the EU or UK? Yes / No. Q19b. If yes, please provide evidence / references.

Table 18	Views given by respondents to Q19a (%)
Yes	11
No	89

The majority of respondents answered 'No' to this question.

A small proportion (mostly from farming and fertiliser industries and including the industry bodies the NFU and AHDB) answered 'yes'. Most of their concerns focused on the potential negative environmental impacts, specifically the effects of UIs on soil health and microbes, as well as on water quality. However, most respondents did not provide evidence related to these impacts. Natural England pointed out the limited evidence in relation to long-term environmental impacts available and several other respondents felt more independent research was required in this area.

Anecdotal evidence was provided from a few respondents relating to UI traces found in milk in New Zealand. The NFU were concerned that, while this may not be a safety issue, if there were similar reports in England this could lead to potentially negative perceptions from the public and therefore affect demand for milk.

Some fertiliser manufacturers claimed that there was no evidence of negative impacts of UI, with registration requirements, provision of clear safety instructions for operators, and a strong international safety record provided as evidence in support of this. Other fertiliser manufacturers, as well as the AHDB, cited a lack of evidence on environmental effects, including on soil health, or on the health of operators. The AHDB called for more research in this area. Yara International listed specific human health hazards from the use and handling of the UI, N-butyl-phosphorotriamide (NBPT) listed on the product's Safety Data Sheet and used the Glyphosate lawsuits as an example of where the full impacts of continued exposure had not been understood. Yara International also said that the cleaning of fertiliser spreading equipment could be a route for secondary exposure to UI.

Another respondent called for research to be undertaken into alternative nitrogen inhibitor options such as DMPP, which is already available and is claimed to be kinder to soil health.

Option 3 ("restricted period") questions

Q20. In your opinion, are farmers likely to apply more solid urea than needed during the open application window? Yes / No / No view.

Table 19	Views given by respondents to Q20 (%)
Yes	23
No	58
No view	19

The majority of respondents, including most farmers, thought that farmers were not likely to apply more solid urea during the open application window. However, some respondents, including most NGOs, felt this was likely. Opinions of respondents from the fertiliser industry were evenly split on this question.

Q21a. Do you think this policy (Option 3: requirement to restrict the spreading of solid urea fertilisers, allowable only from 15 January to 31 March) aligns with Farming Rules for Water and the Code of Good Agricultural Practice in terms of nutrient management? Yes / No / Don't know. Q21b. If no, please explain why and note any potential conflicts.

Table 20	Views given by respondents to Q21a (%)
Yes	46
No	29
Don't know	25

Many respondents, including most farmers, thought that there was alignment between the proposed policy option of restricting the spread of solid urea fertilisers to the period of 15 January to 31 March each year, and the Farming Rules for Water and the Code of Good Agricultural Practice in terms of nutrient management. However, whilst some said they did not know, others said they disagreed.

Of those farmers who disagreed, most explained that this was because they felt that farming decisions should depend on the conditions prevailing at the time, such as weather, soil or crop requirements, rather than be predetermined by fixed calendar dates. Some respondents pointed out that weather and soil conditions vary each year, as well as across the country, and that climate change will only make these differences more acute. One arable farmer commented, "you can't farm by calendar date". The NFU said that, in their view, all the options put forward in the consultation document contradicted the Code of Good Agricultural Practice in terms of nutrient management as they removed the agronomic flexibility which enables the use of the right product at the right time.

Additional reasons for disagreement included a farm advisor who argued that ground conditions are seldom fit for tractor access between these times and therefore Option 3 would break Good Agriculture and Environmental Conditions (GAEC) standards on damage to fields. Some respondents, including South East Water, also raised concerns about the risk of leaching if urea is not applied correctly, for example to wet, cold

soil. Meanwhile, Yara International implicitly questioned the dates of the open period by claiming that there is still potential for volatilisation of urea in February or March if temperatures are higher than average. Another respondent pointed to potential compliance issues by arguing that there were already too many rules and farmers were likely therefore to end up ignoring any new regulations and instead apply solid urea fertilisers according to their needs.

Q22. (To farmers currently using solid urea between April and December) What fertiliser(s) might you use to substitute solid urea from April to December under this option? Q23. (To fertiliser suppliers) What fertiliser(s) might be in more demand to substitute solid urea from April to December under this option?

223 respondents answered Q22, including 164 farmers. Only responses by farmers have been analysed, as this is what the question focused on.

The majority of farmers who answered Q22 said that AN would be the fertiliser they would use from April to January when solid urea fertiliser use would be restricted, under this option. Several farmers suggested they would use UAN or UI-treated urea. CAN, compounds, ammonium sulphate and organic options such as slurry and manure were also mentioned by a few as alternatives. A small number of farmers did not identify a specific type of fertiliser they would use as they suggested that they would choose the one best suited to the conditions they faced at a particular time, while others said they do not normally use fertiliser during these dates.

80 respondents answered Q23, including 20 fertiliser companies. Only responses by fertiliser companies have been analysed, as this is what the question focused on. AN was the most common answer provided by fertiliser companies, while UI-treated urea, UAN, CAN, ammonium sulphate, organic options, nitrogen and sulphur compounds such as 27N 9SO3, NPK (nitrogen, phosphorous, and potassium) compounds and liquid sulphur were mentioned as alternatives. OMEX suggested that solid AN would be preferred due to the additional machinery and storage needed for liquid nitrogen. Koch fertilisers commented that while farmers may want to use more UAN or AN, UI-treated urea fertilisers are the easiest and most cost-effective solution, as switching to UAN necessitates changing (and investing in) other storage capacities, as well as application technologies, for example other nozzles and dragging hose.

Q24a. Do you have suggestions for more effective or less burdensome approaches to enforce this requirement? (Option 3: a requirement to restrict the spreading of solid urea fertilisers, allowable only from 15 January to 31 March) Yes / No. Q24b. If yes, please provide details here.

Table 21	Views given by respondents to Q24a (%)
Yes	40
No	60

The majority of respondents said they did not have suggestions for more effective or less burdensome approaches to enforce the requirement to restrict the spreading of solid urea

fertilisers. Of those who did (40%), many (mostly farmers) suggested that it would be better if Option 3 (“restricted period”) were voluntary rather than legislated, with farmers provided best practice guidance from FACTS advisors or agronomists.

Several arable farmers said that it is not in their interest to waste money by not applying fertiliser correctly. It was suggested the advice offered would need to be based on the weather, soil conditions and temperatures, specific to a farm’s location. The NFU also suggested that a restricted period for application would be better enforced through a standard in a farm assurance scheme, particularly Red Tractor and/or FACTS. A few respondents suggested that adoption of such a voluntary approach could be incentivised through financial payments.

Some respondents pointed out that farmers already keep records of when they apply fertiliser, including through assurance schemes such as Red Tractor and as part of Nitrate Vulnerable Zones regulations. Recording temperature and weather conditions at application was a new suggestion. One agronomist suggested all invoices should be sent to Defra. Other suggestions included reviewing farm records with random on farm inspections; an online annual declaration; and adding colour to the product. Yara International suggested FACTS Qualified Advisors verifying data on the date of application and being held responsible for the farmer, or potentially using track and trace via GPS, such as AtFarm. However, they contended that it would be very difficult to enforce the restricted period and would rely on trusting farmers to adhere to the dates.

Another suggestion from a few respondents was limiting the use of nitrogen. A farm advisor suggested it would be better to lower the rate of solid urea that can be used to 20Kg per Ha at any one time. A livestock farmer suggested that farmers should only be allowed to order a pre-agreed tonnage and an arable farmer called for limits on imports.

A small number of respondents suggested a derogation could be included for adverse weather conditions to provide more flexibility. Several respondents suggested that the period when solid urea fertiliser could be spread should be extended: the end of April was proposed as after that, it was claimed, urea is rarely used anyway. In contrast, a few respondents advocated banning untreated urea.

Q25. Are there any other suggestions you would like to make that are not covered in this consultation document, or not covered by the previous questions?

235 respondents answered this question, providing a range of other suggestions, including alternative approaches to those covered in the consultation document.

The AIC and the NFU issued a joint response representing a range of industry bodies, farmers and fertilisers manufacturers/suppliers, proposing an alternative industry-led “Option 4” approach. Signatories to the response are Red Tractor, BASIS (an independent standards setting and auditing organisation for the pesticide, fertiliser and allied industries), the Country Land and Business Association (CLA), the Association of Independent Crop Consultants (AICC), and the National Institute of Agricultural Botany (NIAB). The NFU is the largest agri-organisation in England and Wales representing

55,000 farmers and growers, while the AIC represents the UK agri-fertiliser supply industry. Option 4, similar to a combination of Option 2 and 3, would allow farmers to use untreated solid urea fertilisers from 15 January to 31 March, followed by using only inhibited solid *and* liquid urea (UAN) for the rest of the year, via mandatory Red Tractor standards. The scheme would be accompanied by a communications campaign and FACTS advice. They believe this could result in 11.2kt of ammonia reductions by 2024 and could be ready to implement by January 2022. They have contended that if they do not see the reductions predicted by 2024, they would be content with a regulatory approach.

Several respondents, mainly farmers as well as the fertiliser manufacturer CF Fertilisers, and the industry body the CLA supported this “Option 4” approach suggested by the AIC and the NFU. A few respondents also mentioned an unspecified "industry-led approach" which probably refers to this AIC/NFU proposal.

Some NGOs argued that a more integrated approach with other relevant Clean Air Strategy measures would be preferable, with a view to reducing all ammonia emissions from farming and moving towards reducing artificial fertiliser use overall. The Soil Association, a UK membership charity that campaigns for sustainable food, farming and land use, suggested that the government establish a UK-wide nitrogen balance sheet integrating all sectors of the economy and environment that interact with and have an impact on nitrogen flows. It also suggested tasking the Agriculture and Horticulture Development Board (AHDB) to deliver a targeted farm-led innovation programme to improve nitrogen use efficiency.

A few respondents suggested there was a need for the regulations to tie in with the Environmental Land Management scheme, so that financial incentives were provided to farmers in order to counterbalance any financial losses that would be incurred by banning solid urea fertilisers. Several respondents also suggested that making restrictions part of a voluntary scheme with financial incentives to encourage the necessary behaviour change would be more effective.

A few respondents felt advice, guidance, education and training should be provided to farmers, including on improving nitrogen use efficiency and the environmental impacts of urea, using FACTS qualified advisors. OMEX also suggested product labelling to highlight negative environmental impacts of the use of urea.

Other suggestions included that:

- exemptions for the horticulture sector were made in any regulations which they claimed uses only small amounts of solid urea
- a suggestion for a higher tax rate on solid urea fertilisers to bring their price into alignment with AN.

A few respondents argued that Defra should be focusing on other sources of emissions rather than urea fertilisers. This included other sources of ammonia emissions within the agricultural sector such as from livestock, or ammonia emissions from other sectors such as transport, including diesel cars treated with AdBlue. Other respondents felt that the

focus should be on other types of pollutants which they feel are more damaging, again referencing emissions from the transport sector, as well as carbon emissions.