

Tier 3 methods for ammonia emission from fertilizers

- Ammonia emissions from synthetic fertilisers is calculated from
 - The mass of nitrogen (N) applied
 - An emission factor
- The Guidebook Tier 2 emission factors depend on
 - The chemical composition of the fertiliser
 - The pH of the soil onto which it is applied
- Fertilisers are grouped into 4 classes
 - Solid fertilisers based on urea
 - Urea ammonium nitrate (a liquid)
 - Ammonium+2 fertilisers (low mission such as ammonium nitrate)
 - Ammonium+2 fertilisers (all other ammonium-based fertilisers)



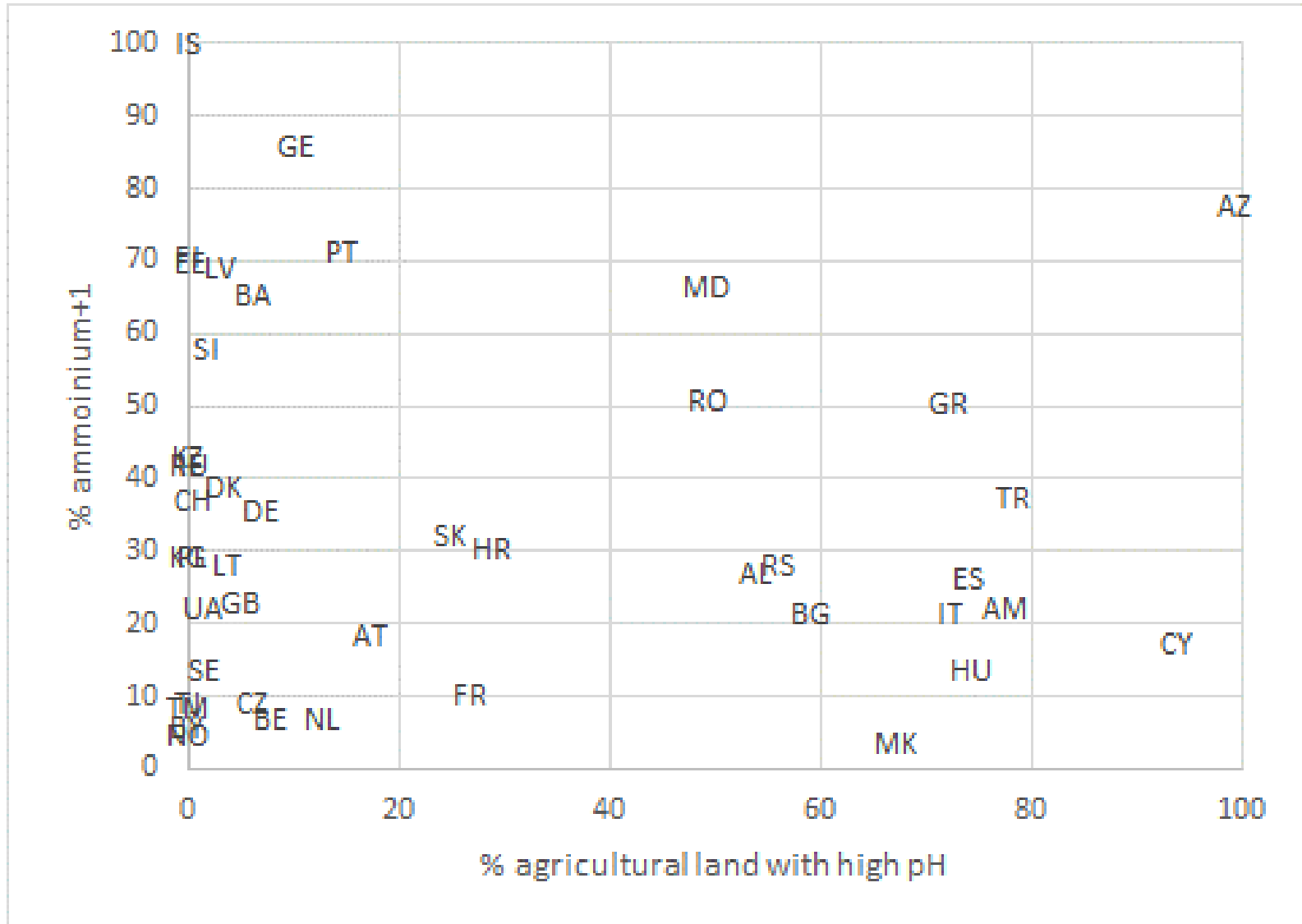
Tier 3 methodologies

- Tier 3 methodologies allow more factors to be taken into account
 - Potentially more accurate estimates of emission
 - Ability to target abatement strategies
- Tier 3 methodologies require more activity data
- Accuracy achieved depends on
 - How well the relationships capture the factors driving emissions i.e. which factors are included and how well they are parameterised
 - The quality of the activity data used as input
- Moving to a Tier 3 methodology does not guarantee greater accuracy



Tier 3 methodologies

- Tier 3 methodologies = any methodology more detailed than Tier 2
 - Potentially many methodologies
- Choose the Tier 3 methodology that will give the most accurate estimate
 - Availability (or additional cost) of obtaining additional activity data
 - The range of the factors in your country
- Example using the Tier 2 methodology
 - High emission factor for Ammonia+1 fertilisers on high pH soils
 - Investigate scope for reducing ammonia emissions by switching from Ammonia+1 to Ammonia+2 fertilisers on these soils



Explanatory variables

- Collate data from indoor and outdoor experiments
 - Global scope, all years
 - Methodological information (indoor/outdoor, measurement technique)
 - Categorical variables (e.g. application method)
 - Continuous variables (e.g. air temperature, soil clay content)
- Similar to method used to revise Tier 2 emission factors
 - Additional measurements found and included
- Investigate statistical relationships between ammonia emissions and single or multiple variables
- More variables = fewer data for analysis

Variable	All data				Outdoor only				
	Model								
	A12	A13	A15	A16	LO12	LO13	LO14	LO15	LO16
Fertilizer category	***	***	***	***	***	***	***	***	***
Application technique	***	***	***	***	***	***	**	***	***
Measurement method	***	***	***	***	***	***	**	***	***
Indoor/outdoor	***	***	***	***	NR	NR	NR	NR	NR
Application rate								***	***
Soil pH	***	***	***	***	***	***	***	***	***
Soil pH x Fertilizer category	***	***	***	***	***	***	***	***	***
Clay content	***	***							
Air temperature	***		***		***		***		***
Non-linear rainfall							*		

Choice of variables in Tier 3 methodologies

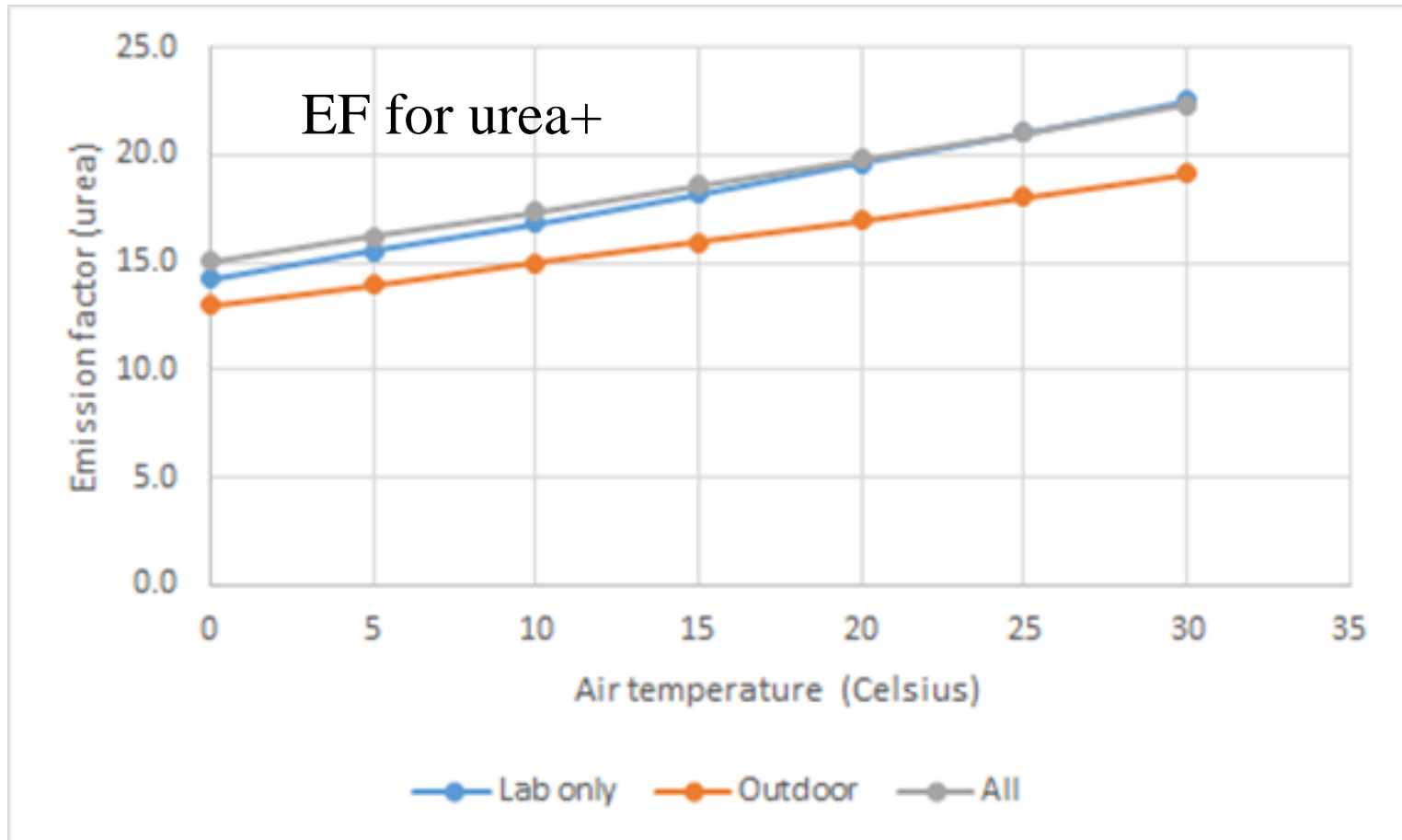
	All data				Outdoor only		
Fertilizer category	***	***	***	***	***	***	Core variables
Soil pH	***	***	***	***	***	***	
Soil pH x Fertilizer category	***	***	***	***	***	***	
Application technique	***	***	***	***	***	***	Optional variables
Application rate					***	***	
Clay content	***	***					
Air temperature	***		***			***	



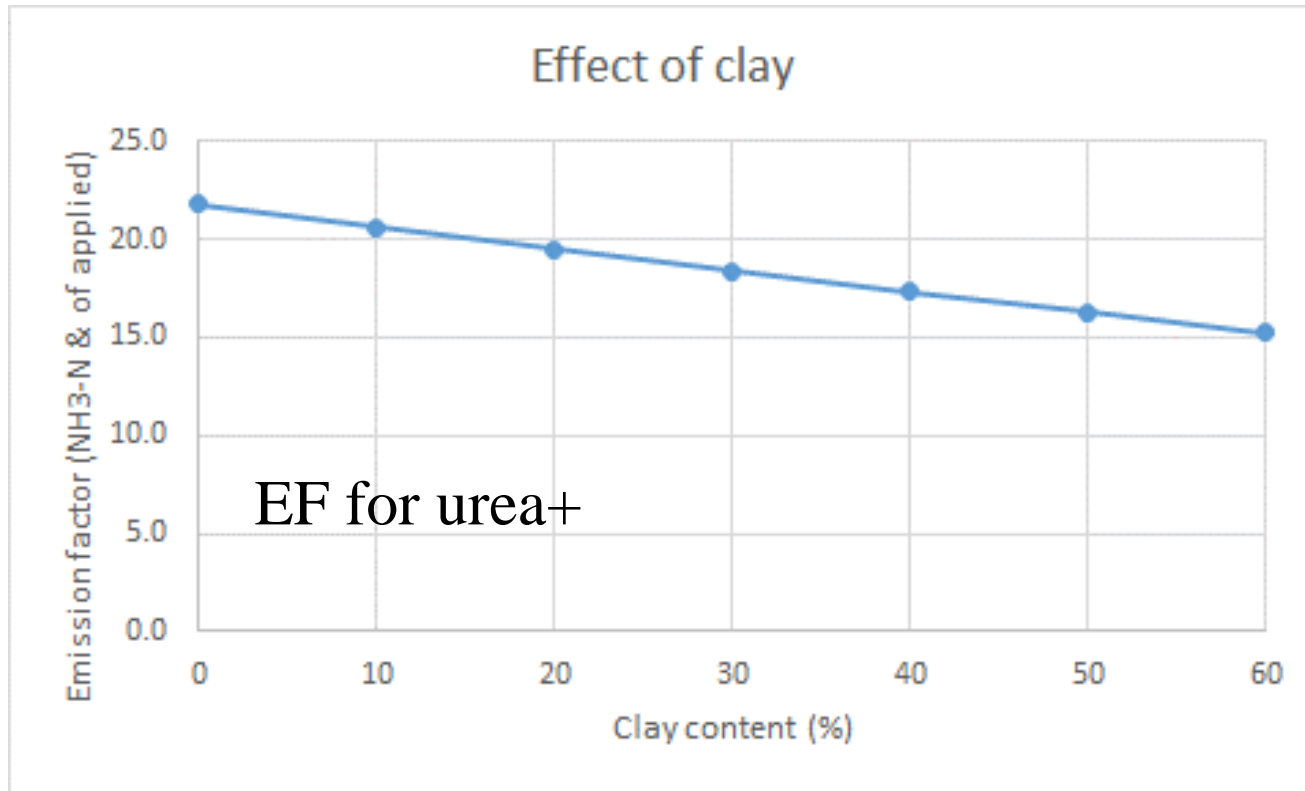
New for this analysis

- Emission factors are generally higher than the results used to develop the Guidebook 2023 Tier 2 emission factors
 - Particularly for UAN
 - Greater effect of soil pH
- Positive correlation between air temperature and rainfall
 - But only in the outdoor data
 - Relationship between emission and air temperature quite similar when using outdoor, indoor and all data

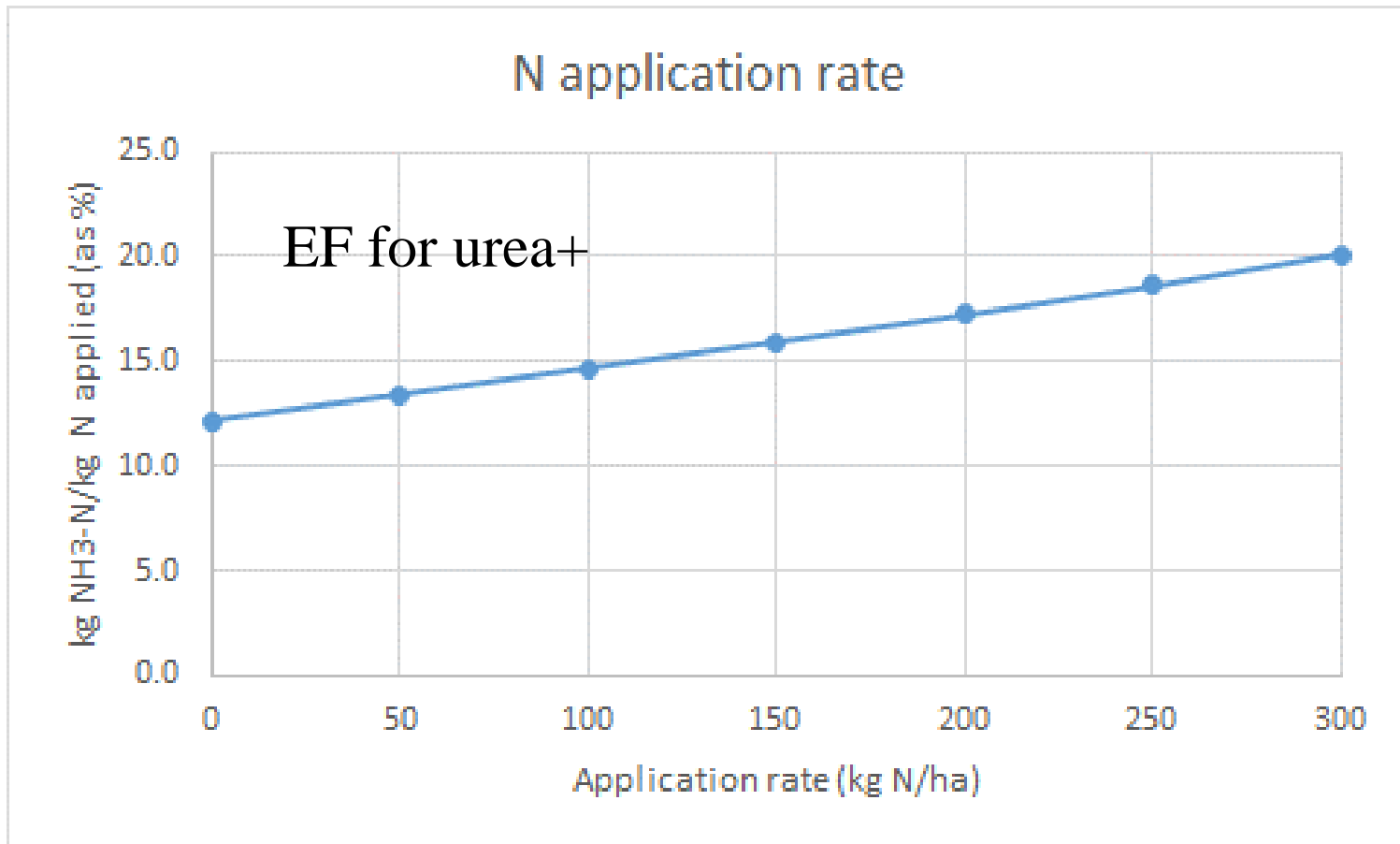
Effect of single variables – air temperature



Effect of single variables – clay content



Effect of single variables – application rate



Why no really low emission factors?

- Low emission factors (<10%) sometimes measured in practice cannot be explained with the factors sound significant here.
- A large effect of rainfall not seen in the data
 - However, we only considered mean rainfall (or water input) during the measurement period
- Significant rainfall or irrigation immediately after application has been shown to substantially reduce emissions
 - Worth re-examining the data to extract more detailed time series



Is it worth moving to a Tier 3 methodology?

- Would the range of any of the explanatory variables result in a significant variation in the emission factor?
- Do you have the activity data or can you get it?
 - How is each fertiliser applied (broadcast, injected, incorporated)?
 - At what rate is it applied (application rate)
 - Where is it applied (soil pH, clay content)
 - When is it applied (air temperature)
- Would a more detailed understanding of ammonia emissions from this source assist with abatement policy?