The Introduction of Granulated Lime to the UK & Republic of Ireland
Contents

• UK & Irish Lime Market

• How the application rates of Granulated Lime was developed

• Use of Granulated Lime

• The Next Step In Assessment

• Conclusion
Granulated lime developed in Germany for application to Forest areas & Lakes to counteract acid rain by helicopter application
Existing lime market

- Granulated Liming material had a place in UK & ROI Agricultural Market.

- UK Lime Market 2.5-3 million tonnes per year

- Ireland Lime Market 1-1.5million tonnes per year
Lime specifications

- UK The fertilizer Regulation 1991 govern required standards of Lime sold

- 20 different types of materials specified

- All require a NV% (a declaration of how many Kg of pure CaO would equal a 100kg of Lime)

- sieve size minimum % requirements
Screened Limestone:

- 95% passing 3.35mm / 20% passing 150um

Ground Limestone:

- 95% passing 3.35mm / 40% passing 150um
Republic of Ireland:

- NV% a declaration of how many Kg of pure CaCo$_3$ would equal a 100kg of Lime with a minimum level of 90%

- Sieve size minimum % requirements to meet. Ground Limestone: - 100% passing 3.35mm / 35% passing 150um

- Moisture max 3%

Lime specifications
No consideration given to efficiency factor of particle size within these required sizes.
• Comparison of Limes based only on NV%

• Importance of small particle size acknowledged in UK & ROI but no assessment applied.
How the application rates of Granulated Lime was developed

- importance of particle size
- efficiency assessment systems & how they were applied
True value of Granulated Lime is in the uniform size of its small particle size

- There was a needed to find a system that recognised the importance of the size of Lime in a Liming agent.
Looked to USA

How the application rates of Granulated Lime was developed
There has long been recognition that smaller particles are more effective.

“The fineness of limestone is as important as chemical composition.”

(Brady; 1974)
“Limestone must be finely ground to be effective. The finer it is, the more quickly it reacts with the soil. Limestone pebbles over ¼” in diameter will persist for so many years in the soil that they are ineffective for practical liming.”

(Thompson and Troeh 1973)
Historical USA work

How the application rates of Granulated Lime was developed
Iowa Agriculture Limestone Act 1967:

- required the determination of the amounts of the material that will pass through a number of declared sieve sizes.
- 4-mesh, (5mm)
- 8-mesh (2mm)
- 60-mesh (0.25mm)
“at this time, it was assumed that material passing through a 60-mesh sieve was 100% effective during the first three years.”

(Thompson & Troeh, 1973)
Iowa Agriculture Limestone Act 1967

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarser than 4 mesh (&gt; 5mm)</td>
<td>0% effective</td>
</tr>
<tr>
<td>4 - 8 mesh (2 - 5 mm)</td>
<td>10% effective</td>
</tr>
<tr>
<td>8 - 60 mesh (0.25 - 2 mm)</td>
<td>40% effective</td>
</tr>
<tr>
<td>Finer than 60 mesh (&lt;0.25 mm)</td>
<td>100% effective</td>
</tr>
</tbody>
</table>

Table 1. Effectiveness of lime depending upon diameter of particle. Thompson & Troeh.

How the application rates of Granulated Lime was developed
Mississippi State University Method:

60 mesh sieve < 0.25mm 100% effective

0.25mm- 2mm - 50% effective

10 mesh sieve > 2mm - 0% effective

How the application rates of Granulated Lime was developed
• the view that limestone particles <0.25 mm were fully effective was not consistent with the data such as that found by University of Nebraska- Lincoln in 1984

• making this assumption in their calculations, they experimented with material ground at the 0.075 - 0.15 mm level
• The finer material (0.075 – 0.15 mm) produced a far more rapid and effective result.

• And was far more effective than the 0.25-0.5 mm material.

• previously assumed to have been 100% effective.
Australia go further in 1992

Scott, Conyers, Fisher and Lill challenged the idea.

experimented with six particle sizes:
3mm – 0.075mm
### Results of trials

<table>
<thead>
<tr>
<th>Size in millimetres</th>
<th>Physical Effectiveness %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.075</td>
<td>100</td>
</tr>
<tr>
<td>0.075 - 0.15</td>
<td>58</td>
</tr>
<tr>
<td>0.15 - 0.25</td>
<td>52</td>
</tr>
<tr>
<td>0.25 - 0.5</td>
<td>47</td>
</tr>
<tr>
<td>0.5 - 1.0</td>
<td>34</td>
</tr>
<tr>
<td>1.0 - 2.0</td>
<td>9</td>
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</table>

How the application rates of Granulated Lime was developed
Scotts et al Trial work also demonstrated that the continued reaction of coarse particles beyond six months after liming was slight.

This suggested that slow breakdown over a long period did not occur significantly.
Field trials in Australia 2001 tested the theory of Scott et al at a practical level

- By the Department of Agriculture in Western Australia.

- Confirmed Scotts previous findings.
Lime particle action in soil

How the application rates of Granulated Lime was developed
Lime particle action in soil

How the application rates of Granulated Lime was developed
How the application rates of Granulated Lime was developed
Using Physical Effectiveness % figures, calculations were made to determine granulated lime application rates.

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</table>
Effective value per tonne

<table>
<thead>
<tr>
<th>Granulated %</th>
<th>Eng Bulk Lime %</th>
</tr>
</thead>
<tbody>
<tr>
<td>52%NV x 91.57 = 47.61</td>
<td>45%NV x 27.20 = 12.24</td>
</tr>
</tbody>
</table>

How the application rates of Granulated Lime was developed
Effective value Comparison

<table>
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<th>Effective value per ha</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Granulated Lime</td>
<td>Bulk Lime</td>
</tr>
<tr>
<td>61.20</td>
<td>61.20</td>
</tr>
<tr>
<td>1.28 tonne/ha</td>
<td>5 tonne/ha</td>
</tr>
</tbody>
</table>

How the application rates of Granulated Lime was developed
it would have been impossible to carry out sieve tests on all the limes available in UK & ROI therefore based on the same principles

Granulated : Bulk
1 : 5

How the application rates of Granulated Lime was developed
Factors that influence the decline of soil pH

- **LEACHING**
- **CROPPING**
- **FERTILISING**
- **POLLUTION**
Factors that influence the decline in the pH of a soil is the consumption of Calcium

- Leaching 500kg /ha/yr
- Crop off take 100kg/ha/yr
- Fertilizer 400-1000kg/ha/yr
- Pollution ??????
- Annual loss total approximately 1tonne 1.6tonne/ha/yr

Use of Granulated Lime
• Common practice to promote the minimum pH a crop will grow at.

• Effect and cost on other inputs?

• Greater importance as inputs increase.
pH Crop Range

Use of Granulated Lime
How pH level affects the availability of other soil elements

Use of Granulated Lime
# pH EFFECT ON NUTRIENTS

<table>
<thead>
<tr>
<th>FERTILISER</th>
<th>pH4.5</th>
<th>pH5.0</th>
<th>pH5.5</th>
<th>pH6.0</th>
<th>pH7.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>NITROGEN</td>
<td>30%</td>
<td>43%</td>
<td>77%</td>
<td>89%</td>
<td>100%</td>
</tr>
<tr>
<td>PHOSPHATE</td>
<td>23%</td>
<td>31%</td>
<td>48%</td>
<td>52%</td>
<td>100%</td>
</tr>
<tr>
<td>POTASH</td>
<td>33%</td>
<td>52%</td>
<td>77%</td>
<td>100%</td>
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</tbody>
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*Use of Granulated Lime*
It is now possible to present a cost per/ha for different crops at a range of pH levels.
pH effect on annual fertilizer spend

Total annual loss

pH 5.0-6.0 for wheat land
58%-13% $ Dollar

pH 5.0-6.0 for grazing season
57%-12% $ Dollar

pH 5.0-6.0 for 2 cuts of silage
58%-13% $ Dollar

Use of Granulated Lime
• Regular small applications
  – Relationship with N
  – Treat Ca like N P K
• Costs - smooth cash flow
• pH maintenance rather than fire fighting
Having established a soil testing rotation
Corrected any very low pH levels

Use of Granulated Lime annually or bi-annually will maintain the soil pH level

Avoiding major movement in pH will maintain the availability of major input fertilizers
Ideal pH Management

Use of Granulated Lime
• Simple guide would be to apply 1kg granulated Lime per 1kg Nitrogen per year

• Assess impact of other factors that influence pH decline with rotational soil tests
UK arable farmers grow:

• 10 tonnes/ha of wheat applying 220kg/ha N

• 4.5 tonnes/ha of OSR applying 250kg/ha N
Why use Granulated?

• Less dust
• More even spread pattern
• Flexibility and timeliness of application
• Use own equipment
• Eliminate heavy machinery. Season long application
• Maintain soil condition
• Available
• Use as necessary on small area
Farm Examples of Granulated Lime use

Example 1:

**Manor Farm**  Size (Ha) 486.36

- area requiring Lime (Ha) 225.44
- Arable crops WW/WB/OSR/SpB
Farm Examples of Granulated Lime use

- Annual average bulk Lime use/yr/tonnes **525.25**
- Bulk Lime application rates tonnes/ha 2.5/5.0/7.5
- Annual Number of bulk delivery Trucks coming to Farm **26**
- Contractor Terragator applied
- Annual Number of bulk Lime Terragator loads to
- spread Lime at 12m to Fields **44**
• Annual Number of Bagged Granulated delivery Trucks coming to Farm 3

• Annual average Granulated Lime use/yr/tonnes 74.79

• Granulated Lime application rates kg/ha 377/754/1132

• Contractor Terragator applied

• Annual Number of Granulated Lime Terragator loads to spread Lime at 24m to Fields 7
• Reasons for change Bulk Lime to Granulated Lime
• Farm access
• Reduced field compaction / Traffic management
• use of existing tramlines in fields

Farm Examples of Granulated Lime use
Example 2  Vicarage Farm

- Size (Ha) 401.48
- Area requiring Lime (Ha) 276.53
- Arable crops  WW/WB/OSR
- Potatoes Ha 30
- Asparagus Ha 30
- Fruit Pick your own Ha 30

Farm Examples of Granulated Lime use
Farm Examples of Granulated Lime use

- Annual average bulk Lime use/yr/tonnes **459.66**
- Bulk Lime application rates tonnes/ha 2.5/5.0/7.5
- Annual average Granulated Lime use/yr/tonnes **27.6**
- Granulated Lime application rates kg/ha 377/754/1132
Farm Examples of Granulated Lime use

- Reasons for application of Granulated Lime
- Access to PYO
- Access to Asparagus beds
Example 3  Dairy farm

- Size (Ha) 292.59
- area requiring Lime (Ha) 292.59
- Crops  Grass-Grazing/silage, Arable Maize silage
- Historic Annual average bulk Lime use/yr/tonnes 530.33
- Bulk Lime application rates tonnes/ha 5.0/7.5

Farm Examples of Granulated Lime use
Example 3  Dairy farm

- 500 milking cows
- 500 young stock
• Now Annual average Granulated Lime use/yr/tonnes 55.2

• Granulated Lime application rates kg/ha 377/754/1132

• present Bulk Lime application use in Maize fields 30ha 150

Farm Examples of Granulated Lime use
• Reasons for application of Granulated Lime

• Access to Grass Paddocks

• Time application with grazing

• Move to annual small application to match N fertilizer & FYM application

• counter stock compaction in conjunction with pasture spiking
Next step to assess the quality of Granulated Lime.

established successful granulated Liming Material imitation was going to follow
• How to assess

• Products have similar NV%

• Similar particle size

• Different origin

Look at physical structure of material by assessing the reactivity of a material.

*Next step to assess the quality of Granulated Lime.*
What is Reactivity?

Next step to assess the quality of Granulated Lime.
Reactivity

Technical Information

The effectiveness and speed of reaction of a liming material can be quantified in the laboratory using the "Reactivity Test". Sauerbeck/Rietz test

The results obtained from this test may be used to estimate the behaviour of a liming material in the soil. These results bear a good correlation with results obtained from long term pot trials.

Source: Agricultural Lime association UK
• The Reactivity Test involves the decomposition of the liming material in hydrochloric acid under stable pH conditions.
• The acid consumption during a given time is a direct measure for the reaction time of the liming material being tested.
• The results of the test are expressed as a percentage, and they compare the speed and effectiveness of the sample with pure precipitated calcium carbonate.

Source: Agricultural Lime association UK
• Granucal formed from pure Chalk with 86% reactivity
• Other granulated materials made from Mg Limestone with 22% reactivity
• Direct link to particle structure
Particle Structure

Chalk particle

Lime Particle

Reactivity
500Kg/ha
Pure CaCO₃

570Kg/ha
86% reactive

890Kg/ha
22% reactive

Reactivity
570 Kg/ha
86% reactive

890 Kg/ha
22% reactive

56% Extra

Reactivity
We need to consider 3 quality /value factors when looking At Liming materials:

With these all assessed then the true value of a Liming material can be found.
Conclusion

• The quality of Lime applied should always be the best it can be. Lime can be shown to be a very important input for profitable Farming and should not be over looked.

• It can greatly help with the utilisation of Fertilizer and Farm Waste as sources of cost effective plant food.

• There is no place & no need for poor quality material or inaccurate application.
• Granulated Lime has been successfully introduced to the UK & ROI and I hope will have long standing benefit to healthy & profitable farming in these countries

• In these difficult times Lime needs to be in the thoughts of all those making a living from Farming.

Conclusion
The latest research has shown that a little fine material can go a long way.

Thank you for listening.