Fertilizer Association of Ireland

Summer Field Outing

Germany

17 – 19 June 2008

Background

As part of their activities, the Fertilizer Association of Ireland (www.fertilizer-assoc.ie) organise a one-day field meeting in June of each year. The content of these meetings is technical, and have often enjoyed input from Teagasc Staff and visits to various Teagasc facilities.

In 2008, on the invitation of Potash Ltd., (a subsidiary of K+S Kali GmbH, Germany), the association were invited to hold their summer field meeting in Germany, and to visit one of the seven Potash and salt mines that the company operates.

The three day trip included a visit to two farms (one arable and one dairy farm), and a visit to an active salt and potash mine. The trip also involved a considerable amount of time spent travelling by coach (approximately 600 km), and this provided an excellent opportunity to get a snapshot view of agricultural production systems in Germany.

A map showing the areas visited and indicating the journey and areas travelled is shown in Figure 1.

Figure 1. Map showing locations visited

Agriculture in Germany

Some statistics of German agricultural production compared with Ireland and UK are shown in Table 1. Compared to Ireland, Germany has a relatively low density of livestock, with double the total cattle numbers in a country with five times the land area. Germany is the largest pig producer in the EU, with 17% of the total EU pig herd. The areas and the proportion of the land area devoted to arable crops are higher in Germany than in Ireland. While the most common crops are spring barley and winter wheat, there is also a large area devoted to oilseed rape (OSR) and maize. Sugar beet production is also common. Crop yields in Germany differ from those experienced in Ireland. Barley and wheat yields are generally lower, and OSR and sugar beet yields are higher. There are many resaons which may contribute to the higher yield of OSR in Germany but key differences include

- K fertilisation is often applied rotationally at upto 150 kg K/ha. The Germans appreciate the huge quantity of K which is taken up during growth and which are required to partner N for maximum yields. The first wheat typically will then receive no K
- Appreciation of the importance of S for rape. 25-50 kg S/ha is standard for German rape crops
- Attention to detail in feeding with accompanying nutrients such as magnesium and also trace elements such as manganese and boron

Also of note regarding German OSR production is the fact that OSR is normally harvested directly, without the use of either chemical desiccants, or pre-cutting (swathing) that are essential in Ireland. This reflects the drier climate in Germany. The mean annual rainfall in the areas travelled range from 550 to 900 mm.

Driving through the countryside, there was a stark contrast in the farm structures and layout in the old West Germany compared with the former communist East Germany.

Table 1. Comparison of basic agricultural statistics of Germany with UK and Ireland

	Ireland	UK	Germany
Size km^2	70,000	250,000	357,000
Population	4.4 m	60.5 m	82 m
No. of Ag. Holdings	125,000	183,000	371,000
Area Cereals (ha)	275,000	3 m	5.75 m
Area OSR (ha)	5,000	680,000	1.54 m
% Ag. land in grass	86%	66 %	
Cattle (head)	6.2 m	10.1 m	13 m
Sheep (head)	4.8 m	24 m	2.6 m
Pigs (head)	1.6 m	4.6 m	27 m
Fertilizer consumption (t)	N – 352,000 P – 38,000 K – 100,000	N – 1,121,000 P – 259,000 K – 305,000	N – 2,014,000 P – 420,000 K – 599,000
Yield Winter wheat (t/ha)	9.2	7.3	6.9
Yield OSR (t/ha)	3.3	3.2	3.8

In the west, farm plots were relatively small, with parcels similar in size and appearance to Irish farms. Land parcels of two to three hectares were common. This is an artefact of the tradition of farm division among siblings for inheritance in the southern part of Germany. Immediately having crossed the former border to East Germany, field sizes were immediately larger, reflecting the large farm units that would have been in operation under the communist regime.

Much of the area seen on this tour was cultivated for arable crops, mainly spring barley, winter wheat, oilseed rape and maize. Of note were the vast majority of spring barley crops, particularly in the east, that had lodged. This was due to heavy storm events that had occurred in the weeks prior to the visit. Other crops seen were sugar beet, rye and triticale. Sugar beet crops looked particularly healthy.

The soils in the areas travelled are mainly wind blown (loess) sandy and loam soils. Soils developed from weathering rock in situ were also prevalent in some areas. Soils are generally more uniform and less stony than those of Ireland. The topography is gently rolling to undulating. Steep slopes occur in some areas, particularly in the Rhine valley. South facing slopes are often used for grape vine production for wine. Farm hedgerows are not common place, however large areas of land are forested, and pockets of high nature vale areas are also very common in the landscape.

Farm visits

Arable Farm

The arable farm visited was a 327 ha holding. Details of the farm are outlined in Table 2. This farm also operates a machinery contracting business to capitalise on spare capacity in the machinery fleet. The farm is not owned by the operator. 83 ha are leased, 124 ha are farmed as a stewardship contract, and the remaining 120 ha is farmed as a fully contracted service for all operations from drill to combining.

Fungicide use is lower compared with intensive Irish systems. Wheat crops would normally receive only two fungicide applications, and barley only one. The seed used for cereal crops on this farm are 90% home grown. Minimum cultivation techniques are used as much as possible for all crops, including sugar beet.

Fungicide applications are lower due to the semi-continental style climate with low relative humidity which does not favour disease proliferation

Fertilizer application rates are similar to those in Ireland. Environmental legislation restricts N application on winter wheat to 160 kg/ha. The application rate at any time cannot exceed 40 kg/ha. This is causing problems with crop yield, particularly since the optimal N application for maximum yield at the flag leaf stage would be higher than 40 kg/ha. Organic manures, as either FYM or cattle slurry, are also used on this farm, particularly on the winter OSR crops.

The average field size of 2.2 ha is typical of farms in the region, but creates problems for machinery operations in the fields. The farmer remarked on the usefulness of the GPS navigation systems that are fitted in the tractors to help drivers locate the correct fields for each operation.

Table 2. Summary of farm details for arable farm.

Farm Details	
Altitude	140-420 m
Annual rainfall	590 – 820 mm
Soil Quality	29-85 points (best soils = 100 points)
Soils	Loess Weathering basalt
Mean field size	2.2 ha

Crops grown	Area (ha)	Yield (t/ha)
Winter Wheat	161	8
OSR	79	4-5
Winter Barley	41	7
Spring Barley	21	4-5
Caraway (med.)	11	
Triticale	9	
Sugar Beet	6	75

Dairy Farm

A 160 cow dairy herd was located on an adjacent holding to the arable farm. This farm is typical of German dairy production systems in terms of scale and operation.

The cows are housed all year round, and fed a total mixed ration diet consisting of grass silage, maize silage, red clover silage, soyabean meal, rape meal, wheat, beet pulp, vitamins and minerals. Production performance is high, with mean yields of 9000 litres per cow, at 4.4% fat. The cow breeds used are German Simmental, Norwegian Red and Red Friesian calving. The mean calving interval is good at 370 days, but the average lactation number per cow is quite low at 3.5, leading in a higher replacement rate than that targeted for Irish systems. All bull calves are sold off of the farm.

The farm is limited to a stocking rate restriction of 170 kg/ha of organic N, but there is no restriction on the rate of chemical N fertilizer that can be applied to grassland. This farm produces a lot of slurry on account of the 365 day housing strategy. This slurry is recycled onto the grassland area, and also used for some of the cereal crops. When applying slurry, applications are targeted to early in the year. Application is performed using the splashplate application method. Typical N content of the slurry produced is approximately 4 g/kg of Total N, of which 2.2 g/kg is on the ammonium form. This ratio of ammonium to total N is higher than the 50% that is generally assumed in Ireland, but may be explained by the higher proportion of more digestible protein that would be contained in the TMR diet than the ad lib grass silage diets that are typical during the Irish winter housing period.

A typical fertiliser to accompany slurry in Germany is Magnesia-Kainit. This is a crude potash fertiliser containing salt, potash, magnesium and sulphur and which is used extensively for grassland in continental Europe. A derivative of this product was used for Irish sugar beet production and is still used in the UK in sugar beet blends. Because the potash is balanced with adequate sodium and water soluble magnesium, the risk of metabolic disorders sometimes associated with excess K use and poor Mg status can be reduced and applications of sufficient K can be safely applied in order to maximise N efficiency both from applied N and slurry. Magnesi-Kainit also has a positive effect on palatability due to the high salt content and dry matter intakes in trials are often seen to increase. Magnesia-Kainit could prove of interest for grassland in Ireland

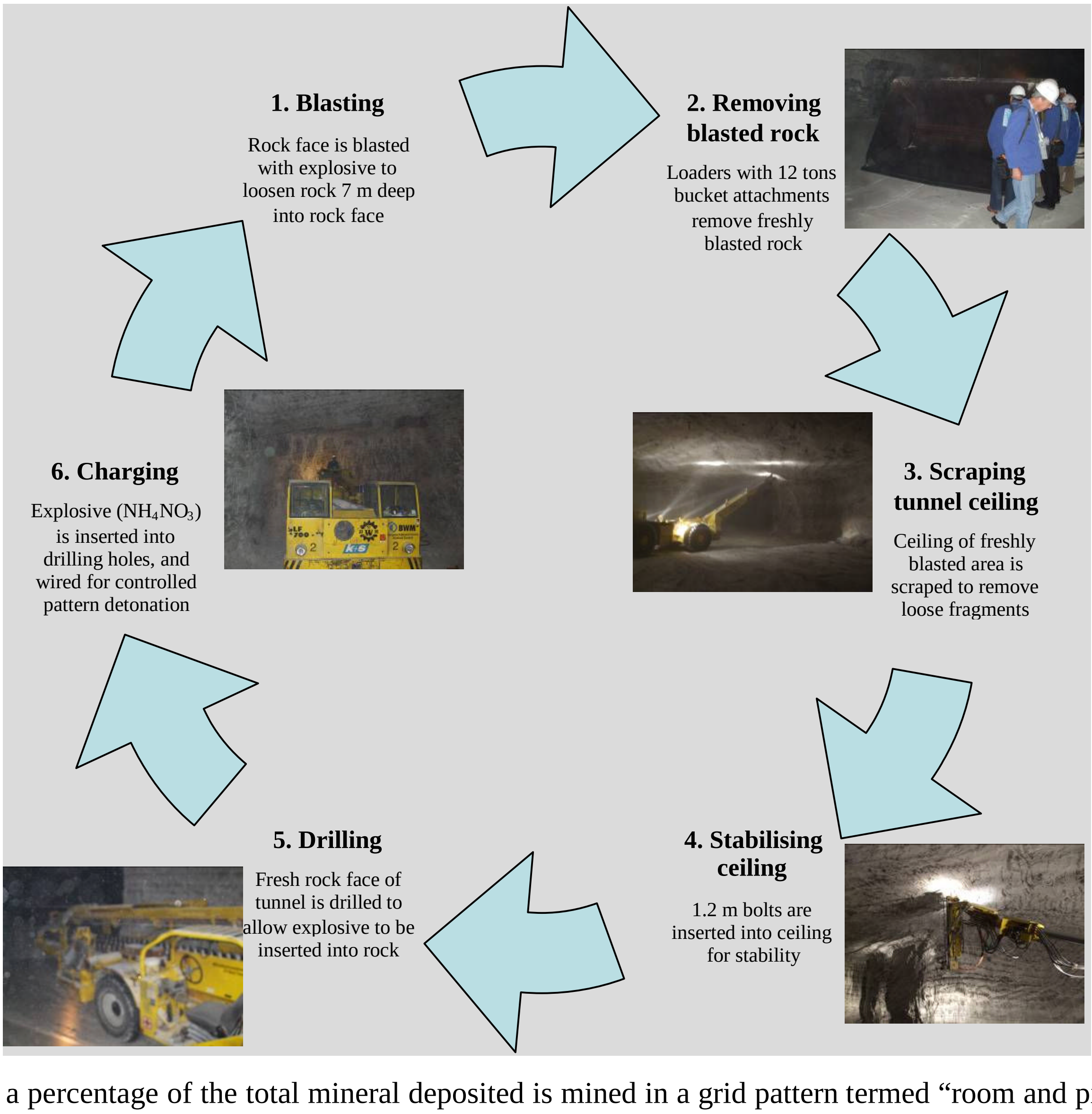
Potash Mining in Germany

Known for many years as 'Kali und Salz', literally 'Potash and salt' The K+S Group began mining Potash and salt in Germany in 1899, and K+S Kali GmbH, the potash and magnesium division currently supplies 11.8% of the world K fertilizer market. There are currently 6 active mines in Germany, one of which produces only muriate of potash (KCl), and the other five producing potash and kieserite (magnesium sulphate: $MgSO_4$). The mine visited on this trip is currently not in production, but mining activity is continuing in order to obtain material which is used to stabilise old mine tunnels by back-filling to prevent any possible subsidence to the land surface above

<u>The Mining Process</u>

The mining activity is confined to narrow horizontal seams of crude potash deposits (2-4m thick) that occur at various depths below the ground level. The rock minerals that contain the potash and kieserite salts are known as 'halite' minerals, and were deposited approximately 60 million years ago by the evaporation of warm tropical seas.

<u>6 Steps to mining rock salts</u>



Only a percentage of the total mineral deposited is mined in a grid pattern termed "room and pillar" design, the rooms being the mined out areas and the pillars being columns of salt left untouched to provide support for the whole structure. Depending on the depth of the seam, typically between 25% and 70% of the material is removed. One of the major safety concerns with potash mining is the risk of water ingress into the mine. Water in the mine would rapidly dissolve the salt columns and cause the stability of the mine to be compromised. This happened in 2007 in a potash mine in Russia.

The mines of K+S Kali GmbH operate at depths ranging from 400-1500 m below the ground level. The mine visited on this trip ranged in depth from 450-800m. The temperature of the mine increase with depth from approximately 20^{o}C at 500m, to over 50^{o}C at 1500m. The temperature in the mine is constant through the year, and is unaffected by season. Air-conditioned machinery cabs are required for working in the warmer extremities.

The total length of mine tunnels is very extensive. The mine visited had a total tunnel length of 4600 km. Our trip travelled more than 40 km within the mine. The mine shaft elevator went down to 500 m, and the trip within the mine ranged in depths between 450 m and 800 m deep the in journey by truck within the mine tunnels.

The blasting process only occurs between mine workers shifts. The mines are completely empty during the blasting, and detonations are controlled form the ground level. The cycle shown above takes on eight hour shift to complete. Multiple mine faces would be blasted at each shift change.

World Potash Markets

In 2007, 59 m tons of K fertilizers were consumed by the world market. Price of potash on the world market has increased in the last 12 months for a number of reasons including:

- Rising oil prices and increased production costs
- Inelastic supply capacity with no major new supply capacity in the pipeline (to commission a new mine takes at least 4-5 years and a minimum of several billion dollars)
- Some production problems in 2007 in a Canadian and a Russian mine
- The main reason is the strong increase in world demand for fertilizers driven by
    - Increasing world population
    - Static (or decreasing) area available for food production
    - Economic growth and improving standard of living in Chinese and Indian economies is increasing the demand for milk and meat food products, which are more fertilizer intensive to produce than grain foods
    - Increase fertilizer demand for production of non-food crops

Fertilizer prices have reached record highs in Europe, but further price increases are possible due to strong demand for high-priced fertilizers in Asia and South America.

Acknowledgements

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Appendix 1

Selection of Photographs of the trip

Oilseed Rape crop. OSR is harvested directly in Germany without using desiccants or swathing.

Winter Barley Crop. Cereal yields are generally lower in Germany than in Ireland. The crop shown is a '6-row' variety.

Animal housing on the dairy farm. The cows are housed all year round. This shed holds 160 cows. The cow breeds include German Simmental, Red Friesian, and Norwegian Red.

Potash Ore in mine. The reddish colour in this photograph is due to the high iron content in the mineral. The extracted potash (KCl) fertilizer is colourless.

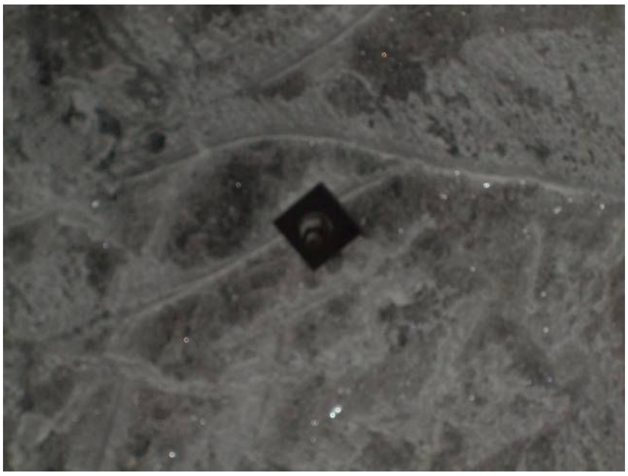
The original bucket used to begin mining in 1899. The bucket capacity is $0.8m^3$, and would have been lowered into the mine shaft with one or two workers.

Modern machinery for removing the freshly blasted rock. Each bucket full of the loader weighs approximately 12 tons. These loading shovels are used to move rock form the mine face to the conveyors and crushers that transport ore around the mine or to the mine shaft for lifting to the surface.

Crusher and conveyor for moving ore around the mine

After the freshly blasted ore is removed, the ceiling of the mine is scraped to remove any loose rock debris. This process ensures that no loose rocks will fall causing danger at a later stage.

After scraping, 1.2 m long bolts are inserted into the ceiling for stability.



An inserted bolt for ceiling stability. K+S Kali use over million such bolts each year as part of their safety procedures.

The rock face being drilled and charged with explosives for blasting. The blasting is carefully controlled to ensure the correct detonation pattern occurs to allow thorough loosening of the rock material.