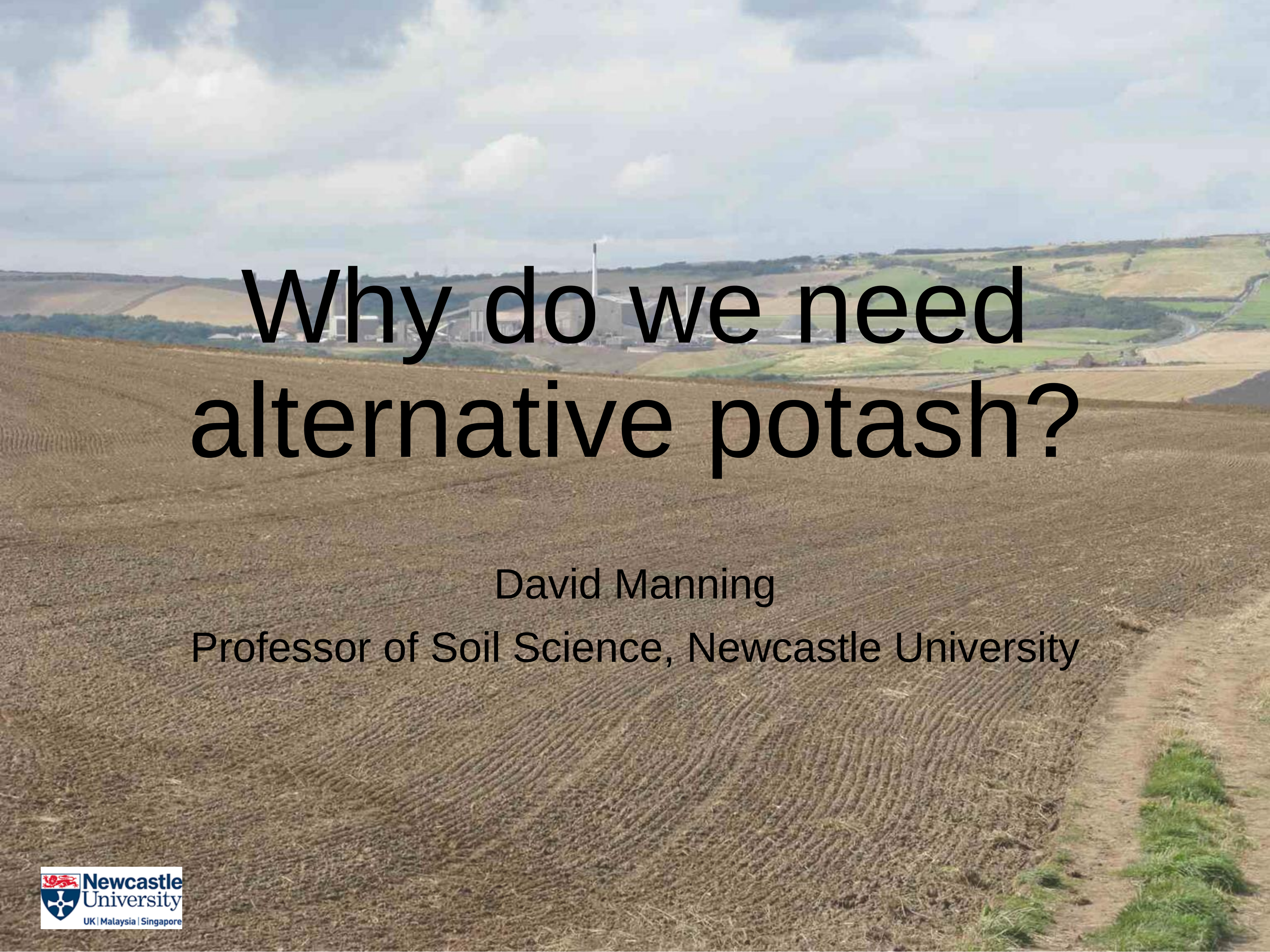


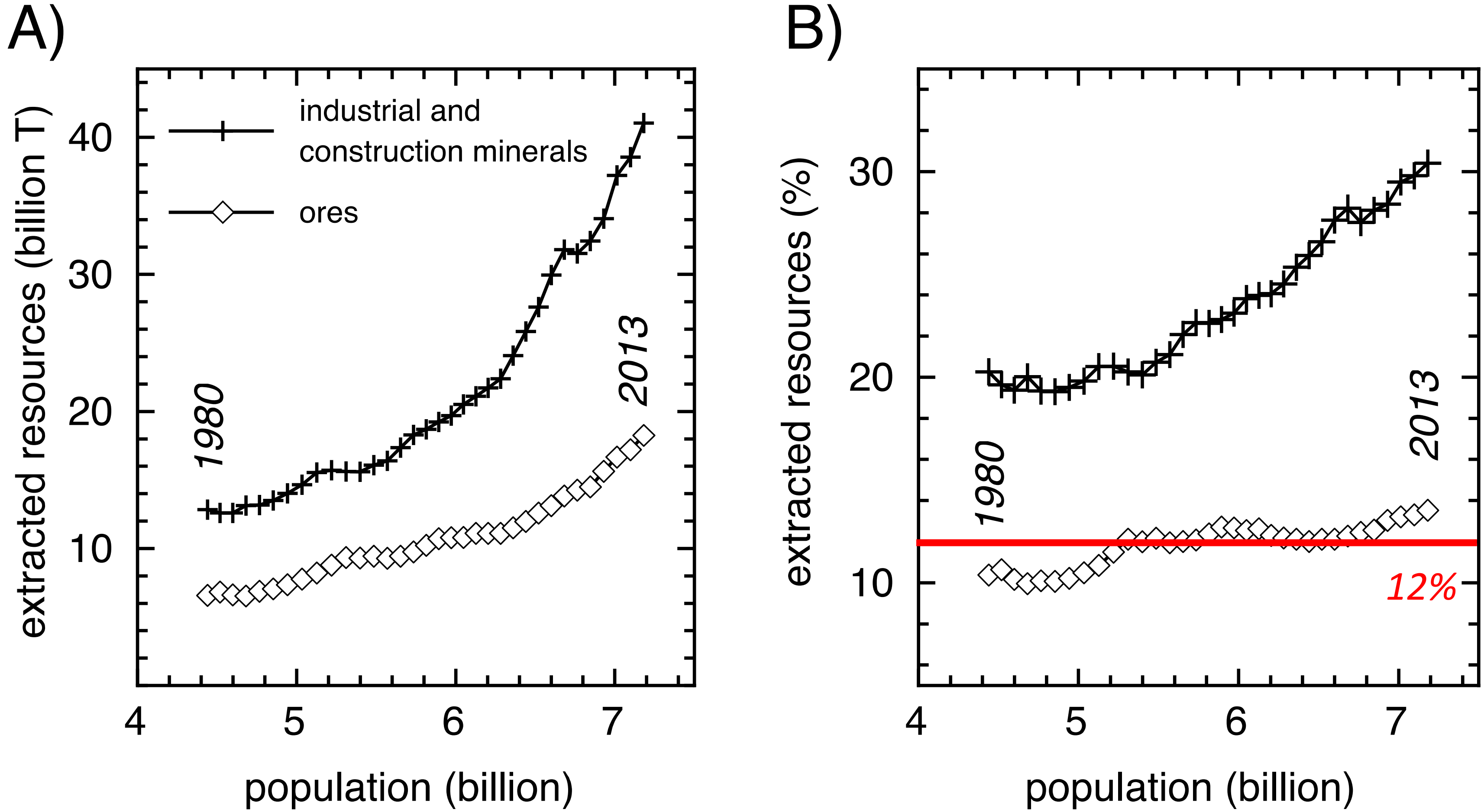
Why do we need alternative potash?

David Manning

Professor of Soil Science, Newcastle University

Newcastle University
UK | Malaysia | Singapore

To feed the world's population



The global potash industry is well established

- 38.8 million tonnes produced in 2015
- Demand expected to rise from 35.5 (2015) to 39.5 million tonnes in 2019
- Mainly from evaporite deposits or brines
- US produced 770k tonnes, total fob value $680m
- Corresponding world production value: $34 billion
- Grade: up to 63% K_2O equivalent

Jasinski: USGS Mineral Commodity Summary ‘No substitutes exist for potassium as an essential plant nutrient and as an essential nutritional requirement for animals and humans. Manure and glauconite (greensand) are low-potassium-content sources that can be profitably transported only short distances to the crop fields.’

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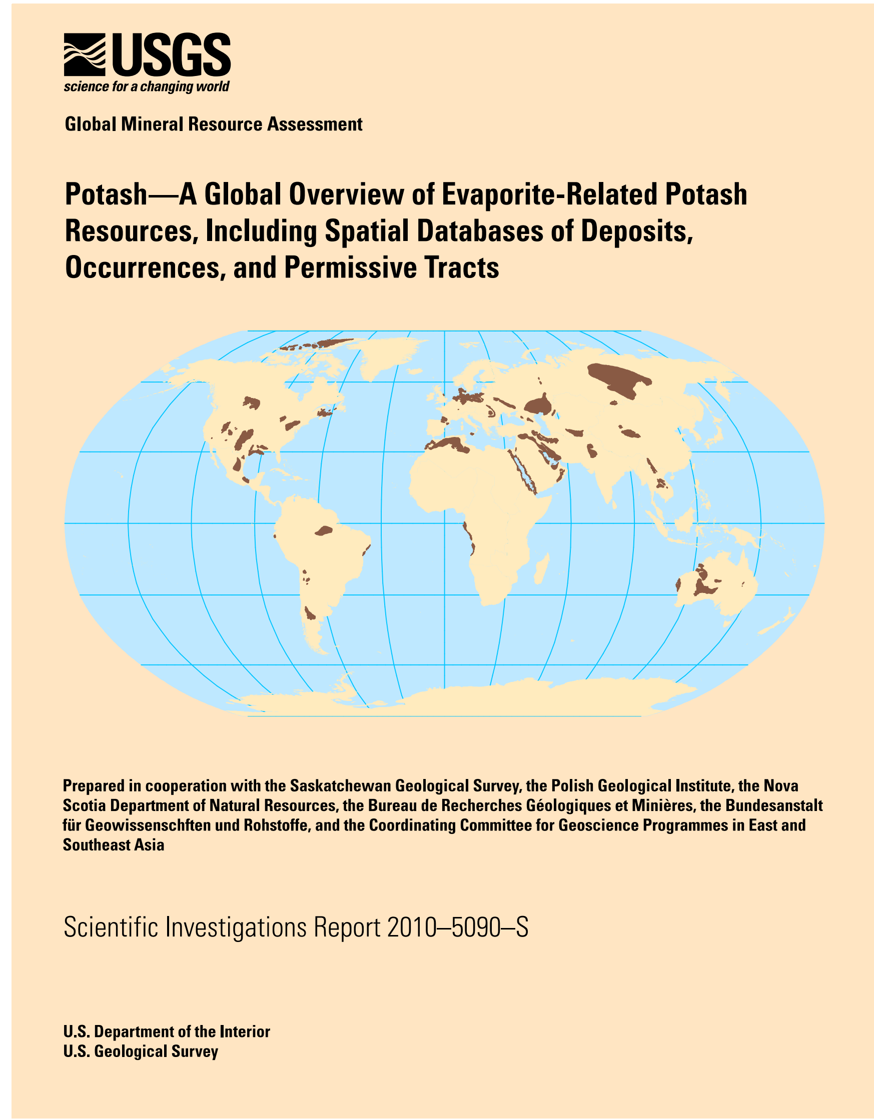
Why do we need alternative potash?

Where does potash come from?

- USGS has produced a major report
- Potash deposits most commonly occur in the northern hemisphere
- They occur much less widely in the southern hemisphere
- They are notably lacking in Africa


USGS
science for a changing world

Global Mineral Resource Assessment

Potash—A Global Overview of Evaporite-Related Potash Resources, Including Spatial Databases of Deposits, Occurrences, and Permissive Tracts

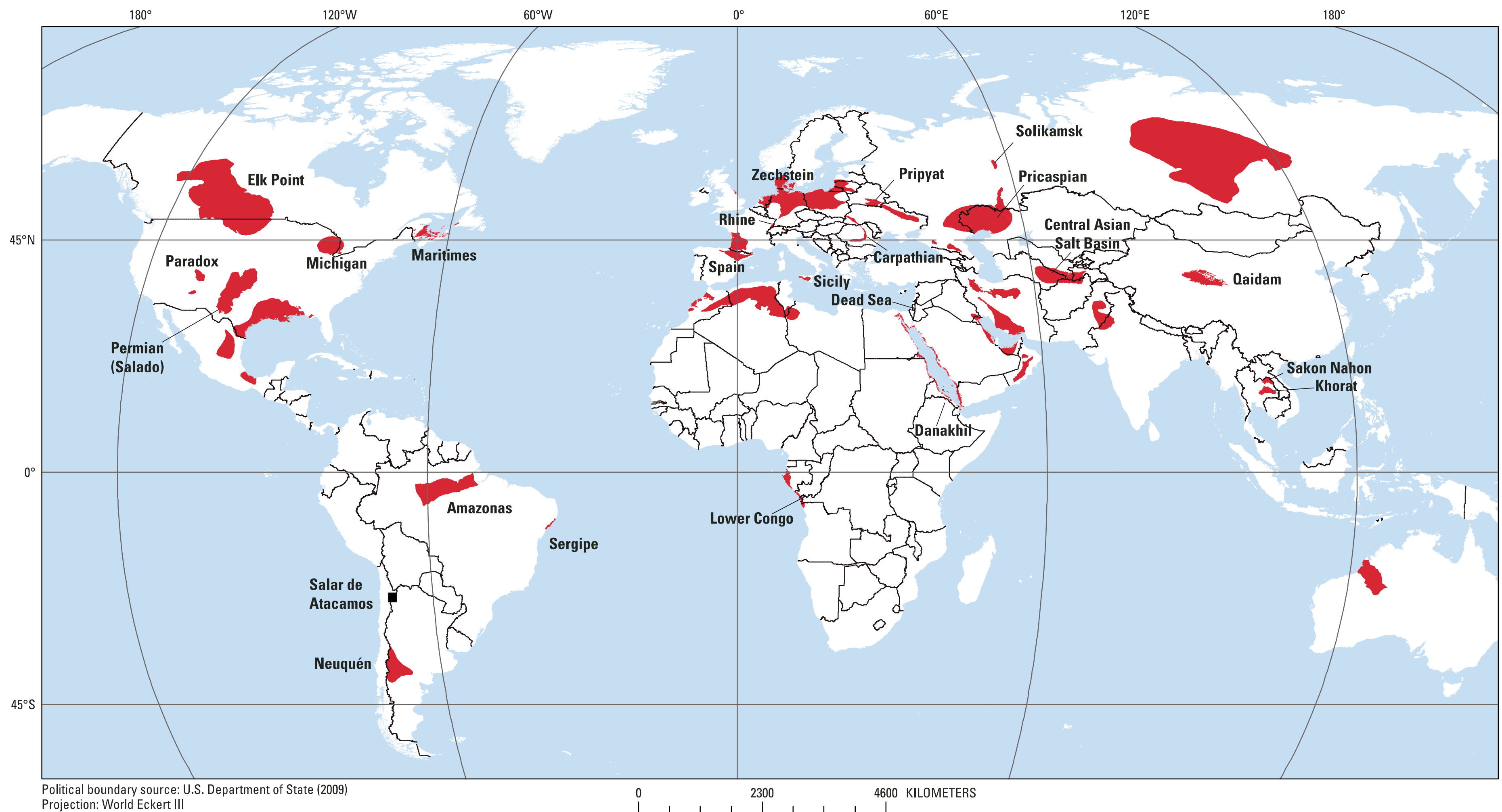
Prepared in cooperation with the Saskatchewan Geological Survey, the Polish Geological Institute, the Nova Scotia Department of Natural Resources, the Bureau de Recherches Géologiques et Minières, the Bundesanstalt für Geowissenschften und Rohstoffe, and the Coordinating Committee for Geoscience Programmes in East and Southeast Asia

Scientific Investigations Report 2010–5090–S

U.S. Department of the Interior
U.S. Geological Survey

Where does potash come from?

- Potash basins – not all are mined

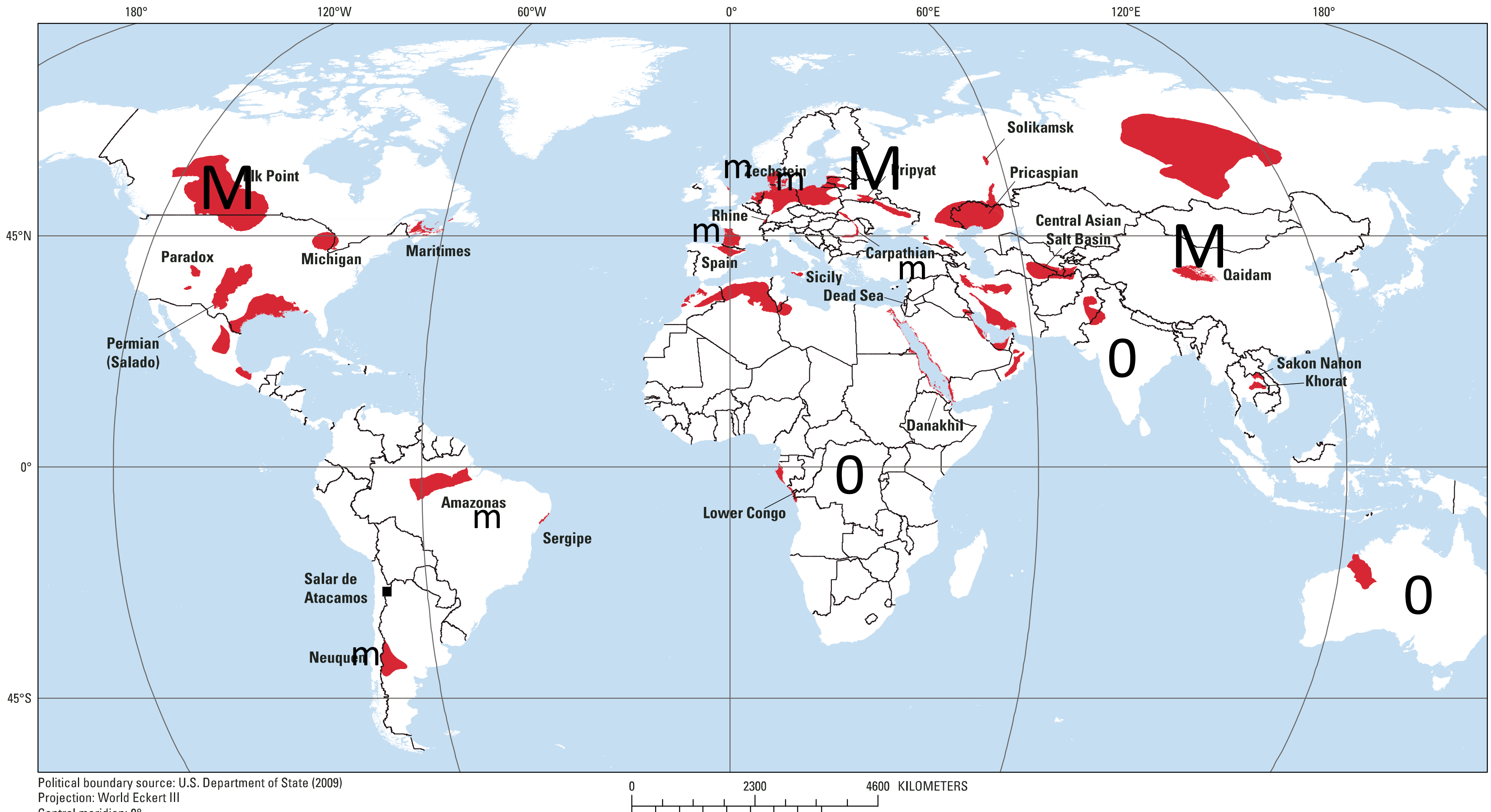


Where does potash come from?

M: 3 producers, 75% of global production

m: 9 producers, 25% of global production

0: <<1% production



Where is potash needed?

Nutrient audits indicate demand

ELSEVIER

Food Policy 29 (2004) 61–98

FOOD POLICY

www.elsevier.com/locate/foodpol

The use of nutrient audits to determine nutrient balances in Africa

William F. Sheldrick *, John Lingard

School of Agriculture, Food and Rural Development, University of Newcastle, Newcastle upon Tyne NE1 7RU, UK

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Nutrient Cycling in Agroecosystems **62:** 61–72, 2002.

A conceptual model for conducting nutrient audits at national, regional, and global scales

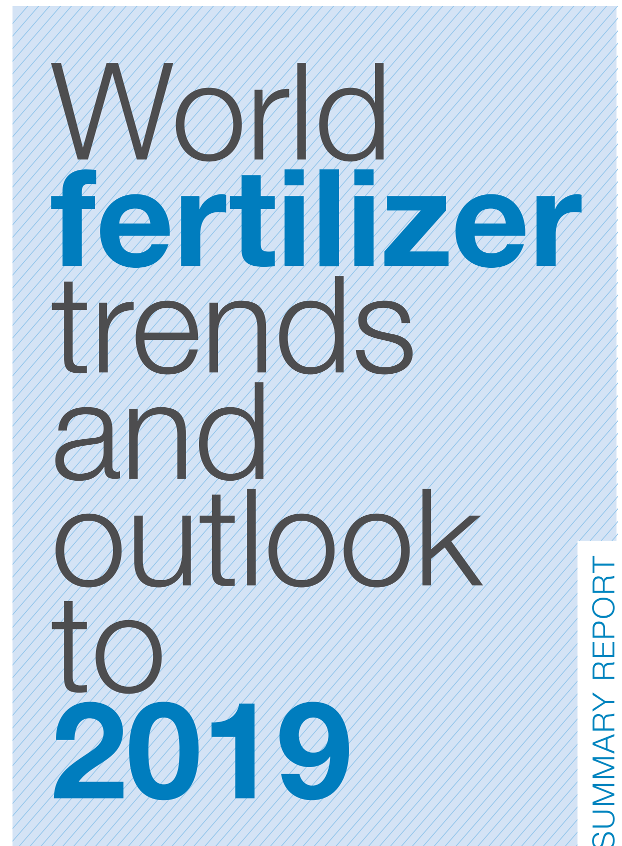
William F. Sheldrick[1], J. Keith Syers[2,*] & John Lingard[3]

[1]*Department of Agricultural and Environmental Science, University of Newcastle, Newcastle upon Tyne, NE1 7RU, UK;* [2]*Department of Natural Resources and Environmental Sciences, Naresuan University, Phitsanulok 65000, Thailand;* [3]*Department of Agricultural Economics and Food Marketing, University of Newcastle, Newcastle upon Tyne, NE1 7RU, UK (*Corresponding author)*

Where is potash needed?

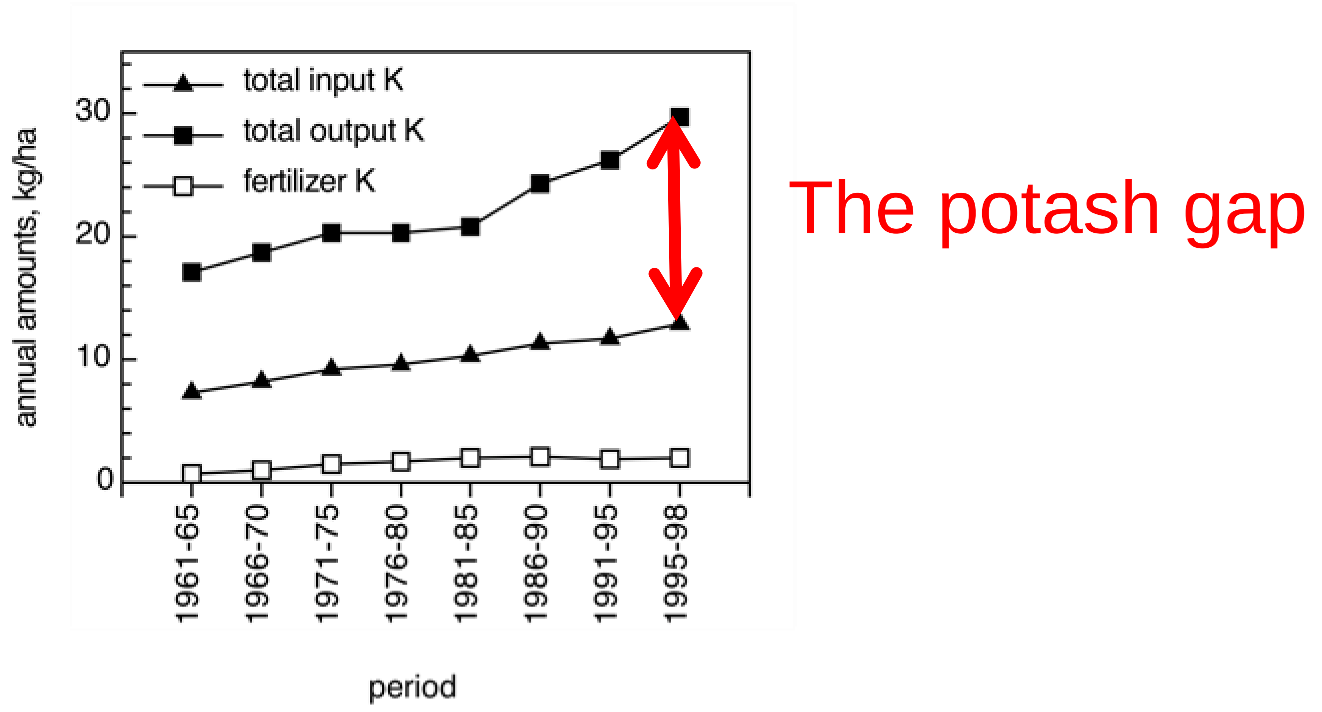
Food and Agriculture Organization of the United Nations

Expert assessments indicate demand, such as the FAO:



Africa, for example:

Sheldrick and Lingard (2004), nutrient audits:



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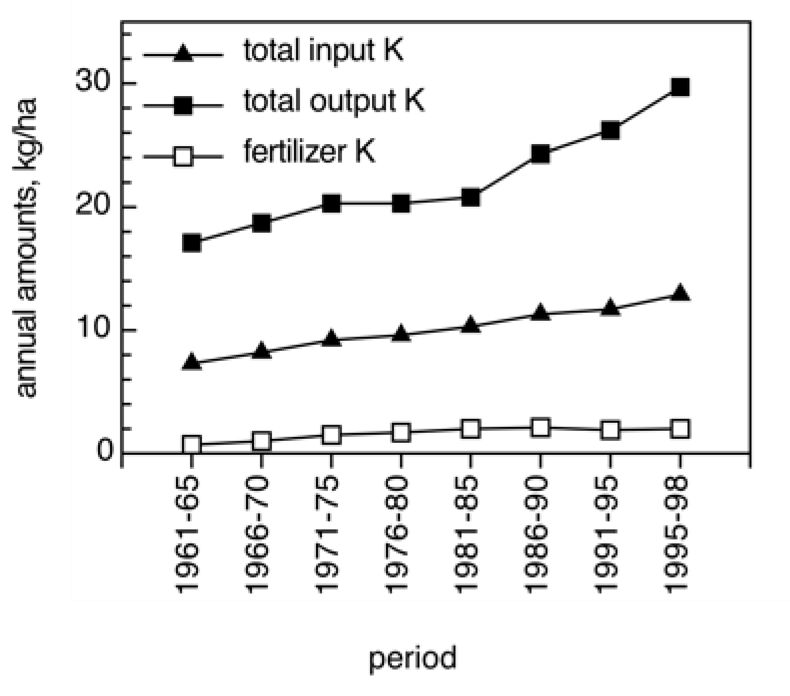

From FAO data for 2014:

Africa consumes 629000 T potash/year.

47/57 African countries buy no K fertiliser.

About 1.5% of world potash production feeds 15% of the world's population.

Africa, for example:

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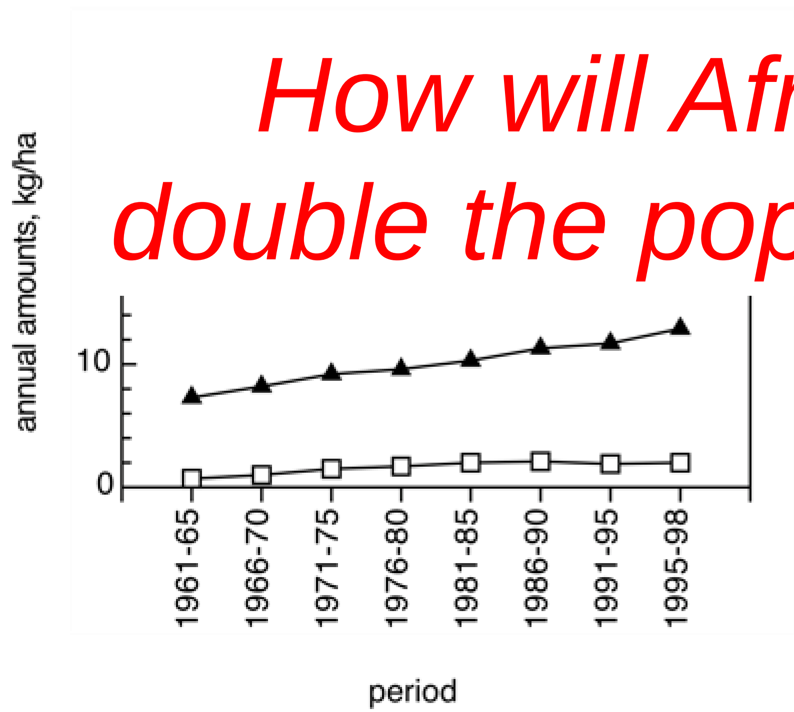

How will Africa cope with double the population in 2050?

From FAO data for 2014:

000

es

buy no K fertiliser.

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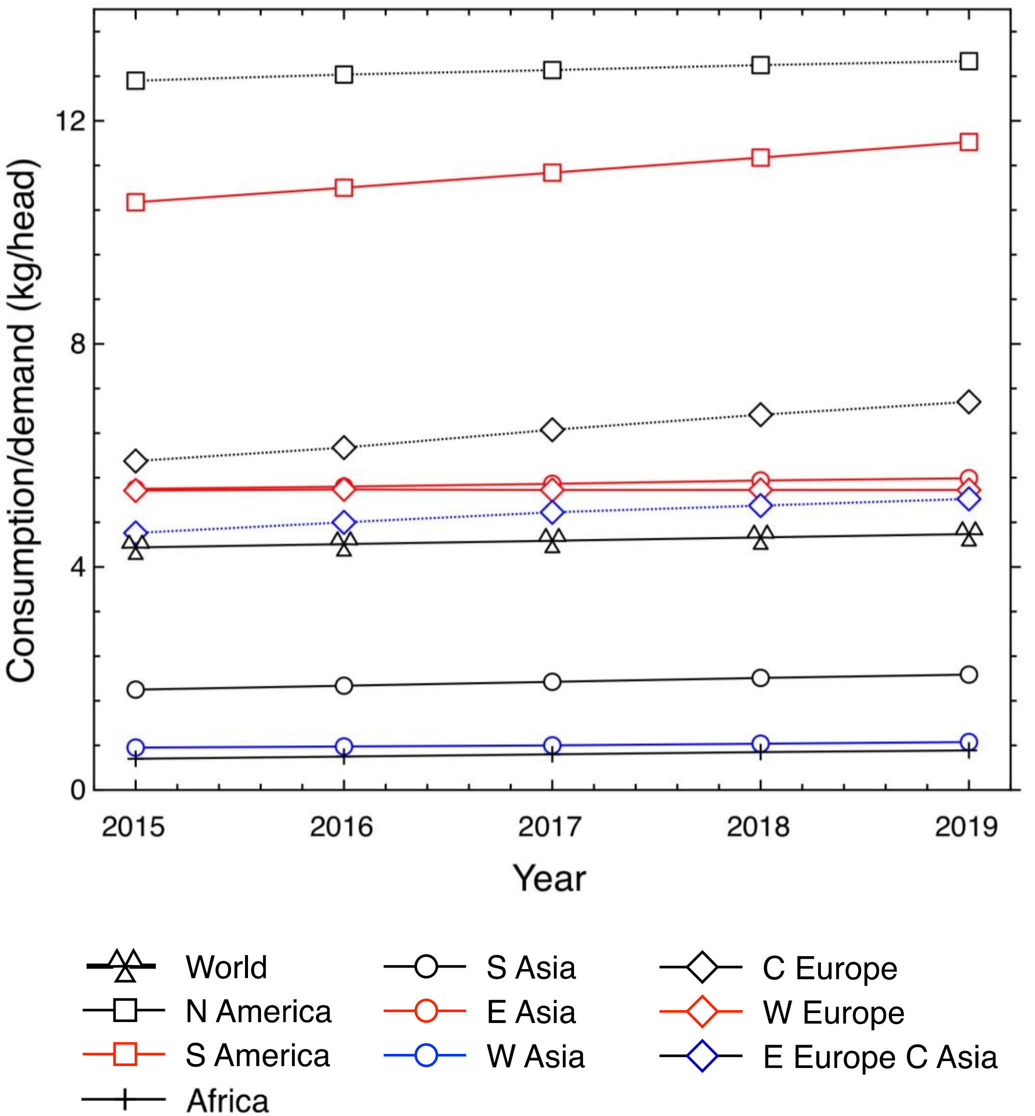
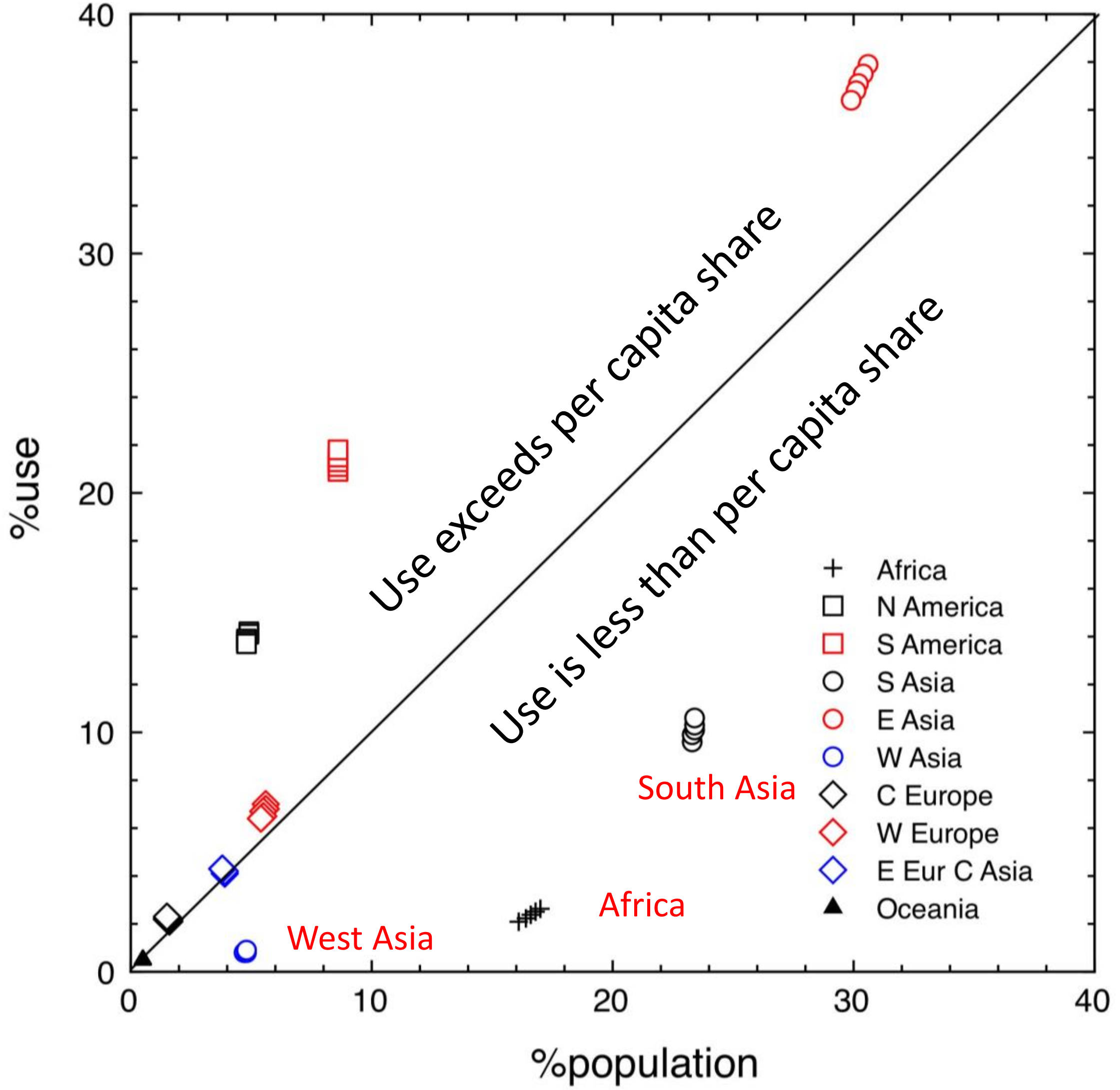
Where is potash needed?

FAO figures for 'Consumption/demand' expressed per head
Most of the world gets by on 4-6 kg potash per person annually

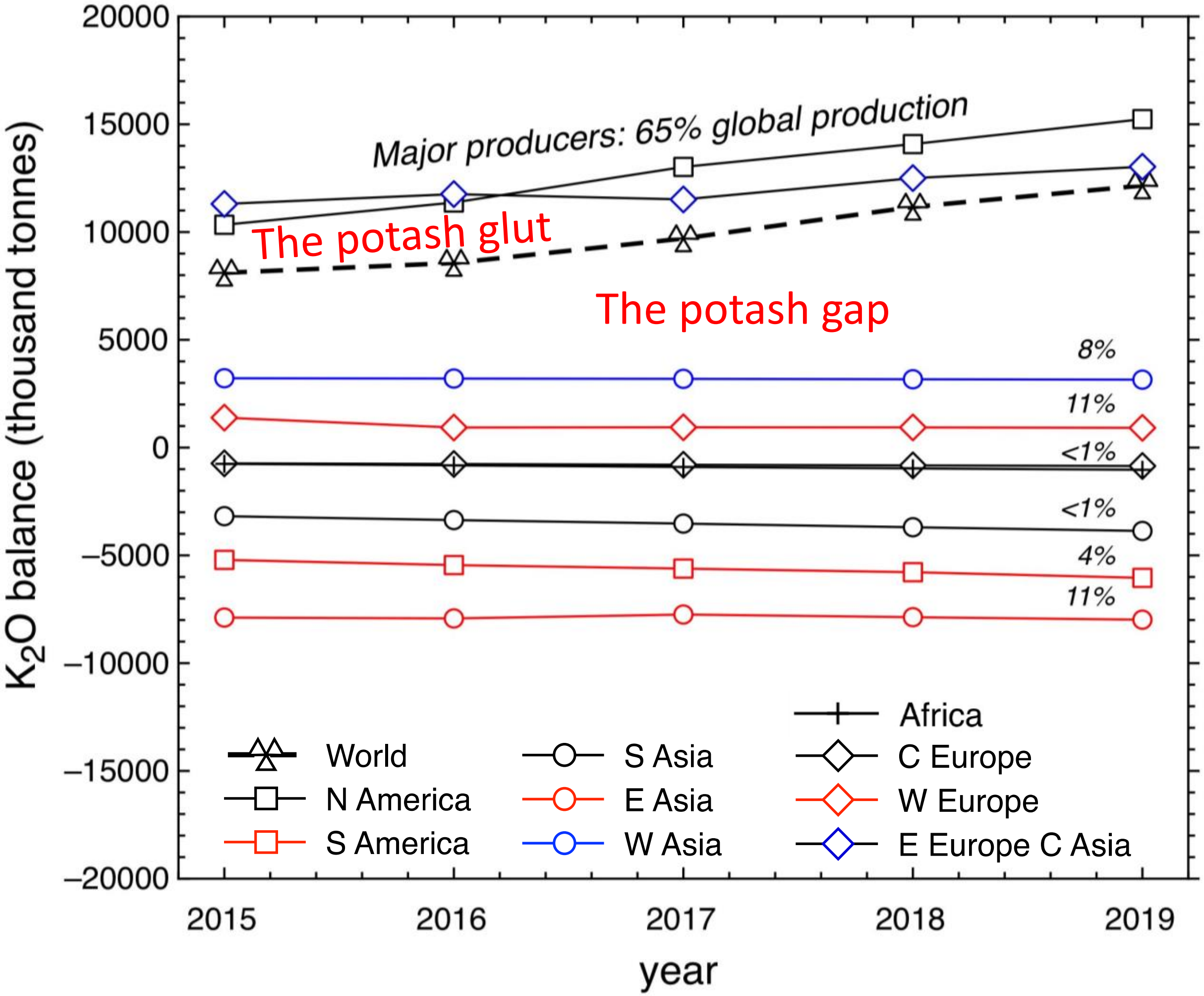


Where is potash needed?



Where is potash needed?

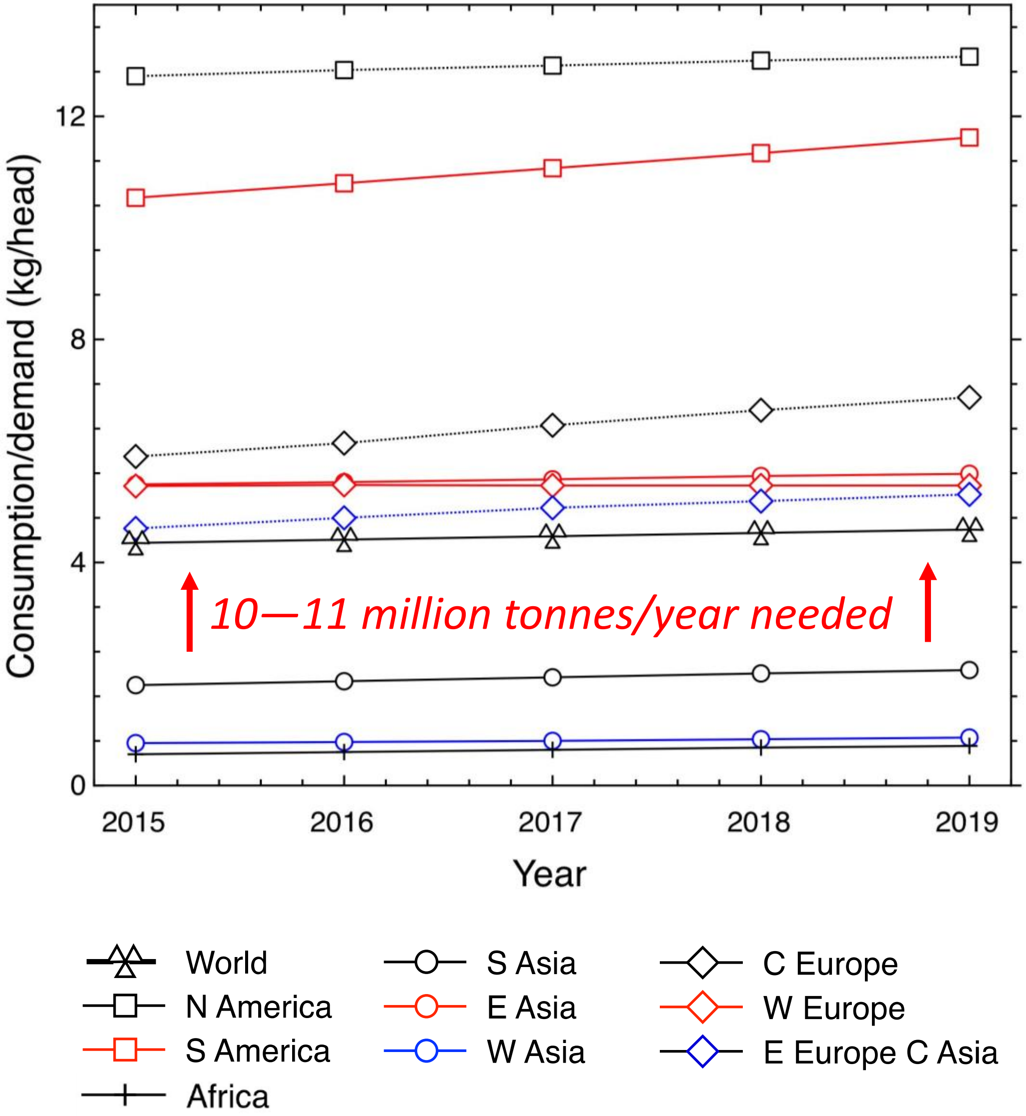
Potential K_2O balance = (K_2O available as fertilizer) – (consumption/demand)



Where is potash needed?

FAO figures for ‘Consumption/demand’, expressed per head

10-11 million tonnes/year additional production needed to bring Africa, South Asia and West Asia up to around 4 kg per person



Sources of potash

- Where will the extra potash come from?
- It has to be mined…

Mineral sources of K

Mineral	Formula	% K_2O
K salts		
Sylvite	KCl	63
Carnallite	$MgCl_2.KCl.6H_2O$	17
Polyhalite	$K_2SO_42CaSO_4MgSO_42H_2O$	16
K silicates		
K-feldspar	$KAlSi_3O_8$	17
Leucite	$KAlSi_2O_6$	21
Nepheline	$(Na,K)AlSiO_4$	15
Micas (eg muscovite)	$KAl_3Si_3O_{10}(OH)_2$	11

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salts

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silicates

An alternative view: potash production is focused on the needs of the global north – what about the south?

Leonardos et al (1987): *"Unfortunately, the standard concept and technology of soil fertilizer … is behind that of the superphosphate concept developed by J. B. Lawes in England, 150 years ago. ……..* ***Had this technology been originally developed for the deep leached laterite soils of the tropics*** *instead for the glacial and rock-debris-rich soils of the northern hemisphere* ***our present fertilizers might have been quite different****."*

Dissolution rate not grade is critical

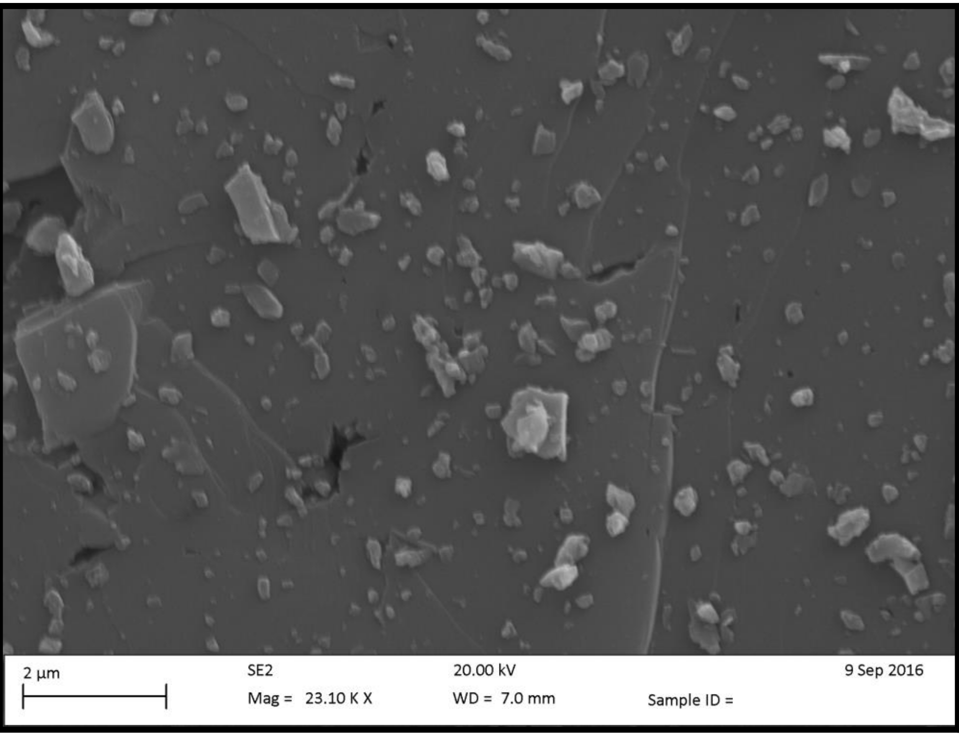
Mineral	Formula	Weight % K_2O	Relative dissolution rate
Potassium feldspar	$KAlSi_3O_8$	16.9	1-2
Leucite	$KAlSi_2O_6$	21.6	10,000
Nepheline	$(Na,K)SiO_4$	<15.7	10,000,000
Kalsilite	$KAlSiO_4$	29.8	10,000,000 (est)

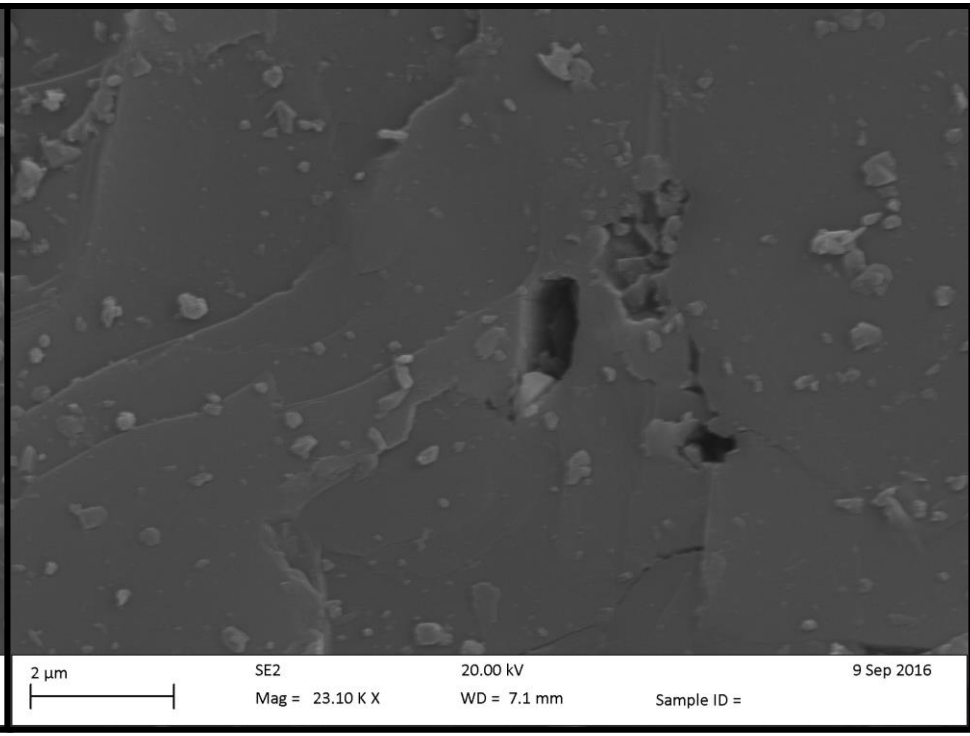
Feldspar family Feldspathoid family

Biology is critical

- Silicate dissolution rates in soils are evidently greater than those determined in clean laboratory experiments

Feldspar from experiment



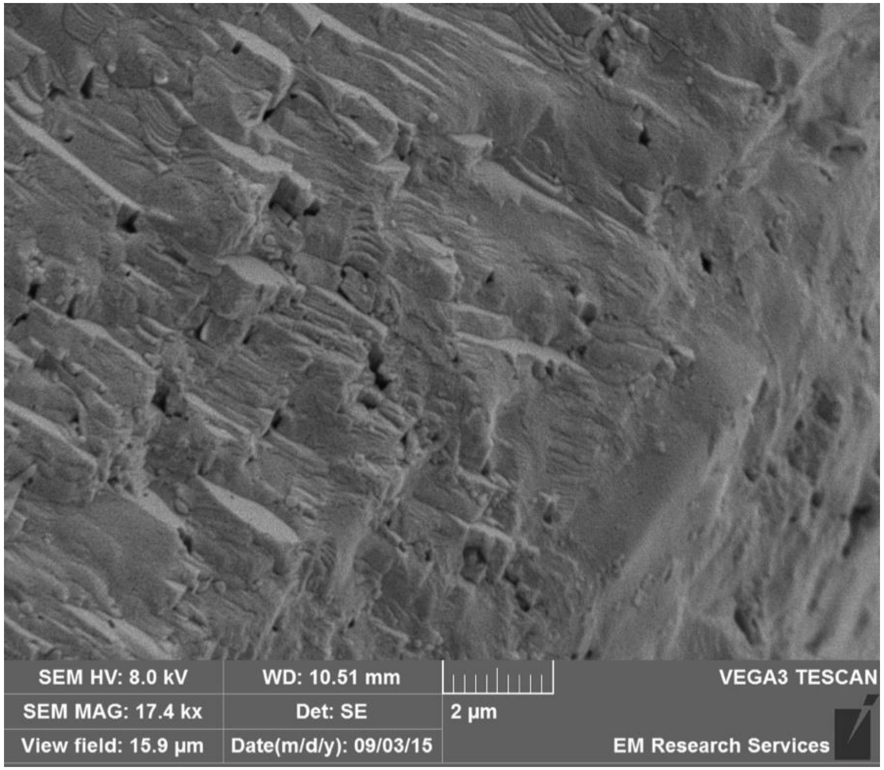


Before

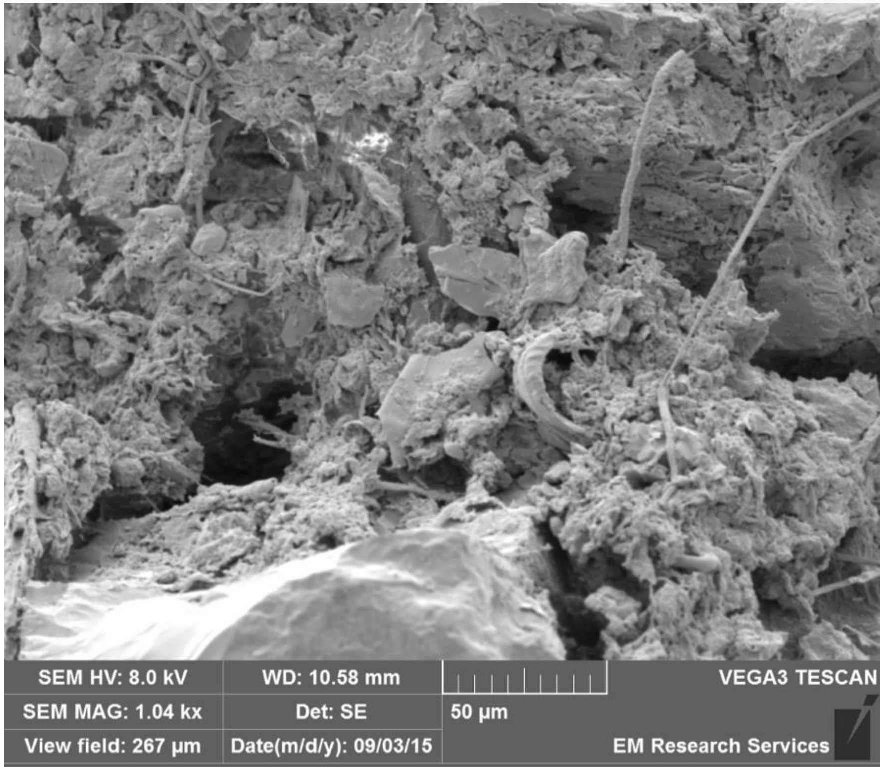
After 10 weeks

The surface coating of fine particles has been removed

Feldspar from soil: 10 years exposure



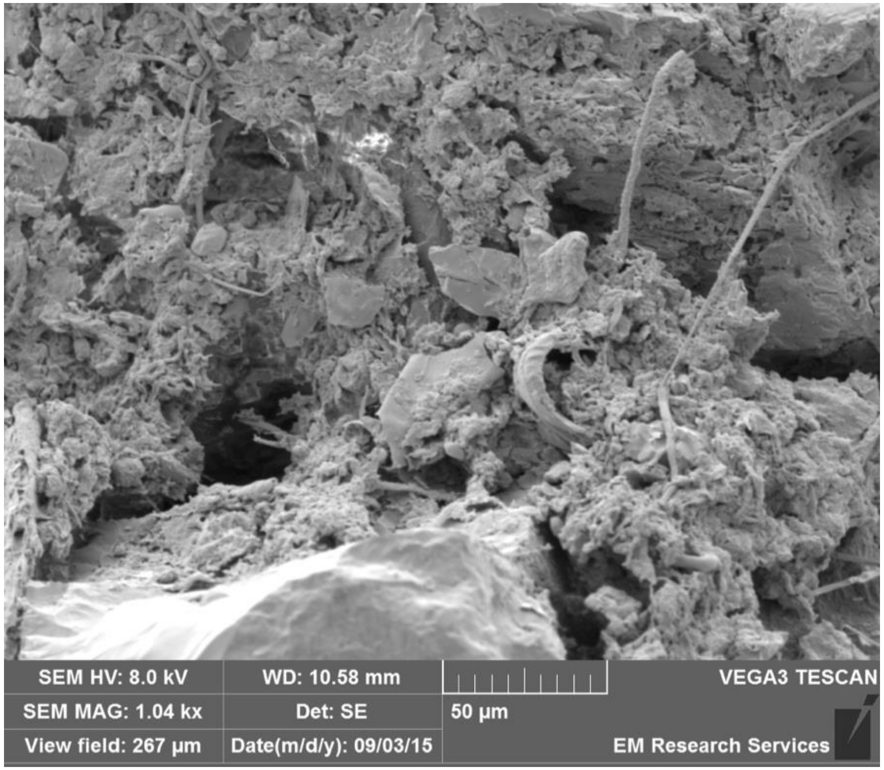
Poorly corroded grains

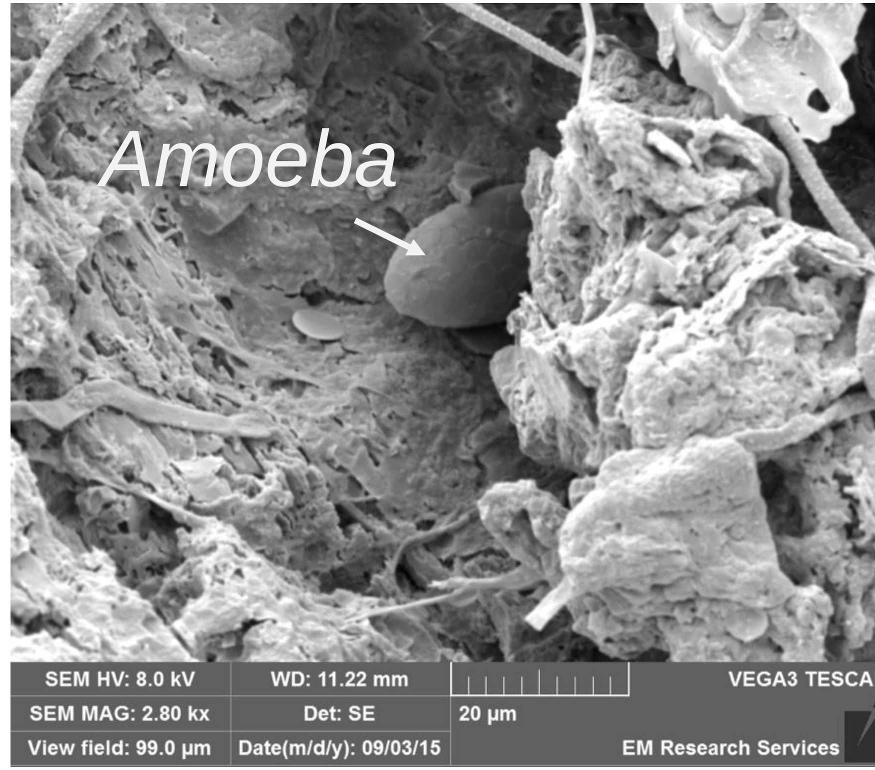


Heavily corroded grains

Irregular corroded surface, with fungal filaments

Feldspar from soil: 10 years exposure

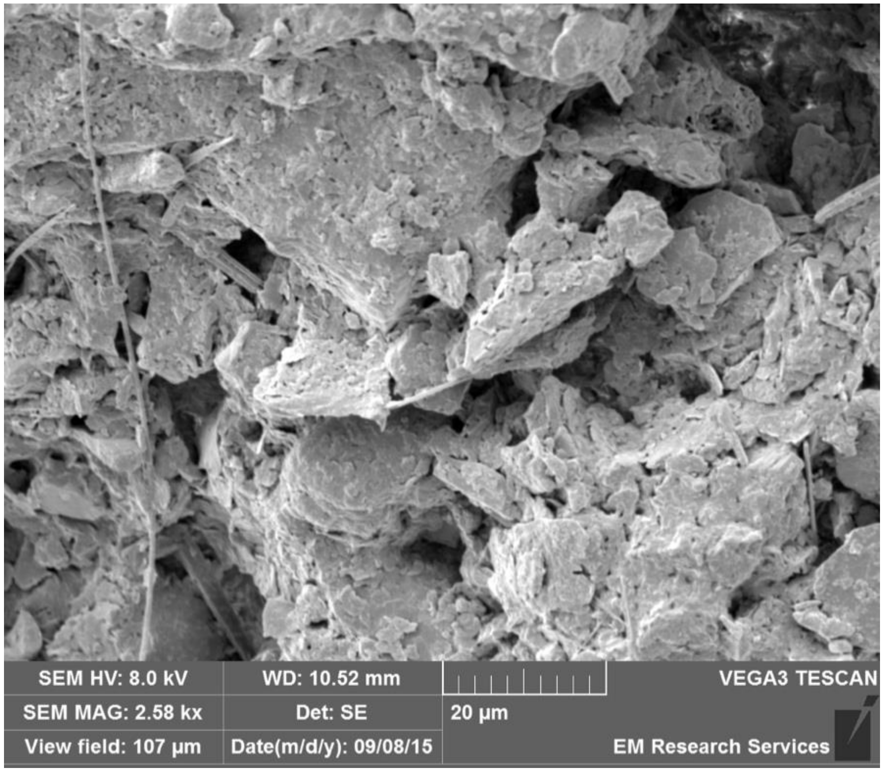


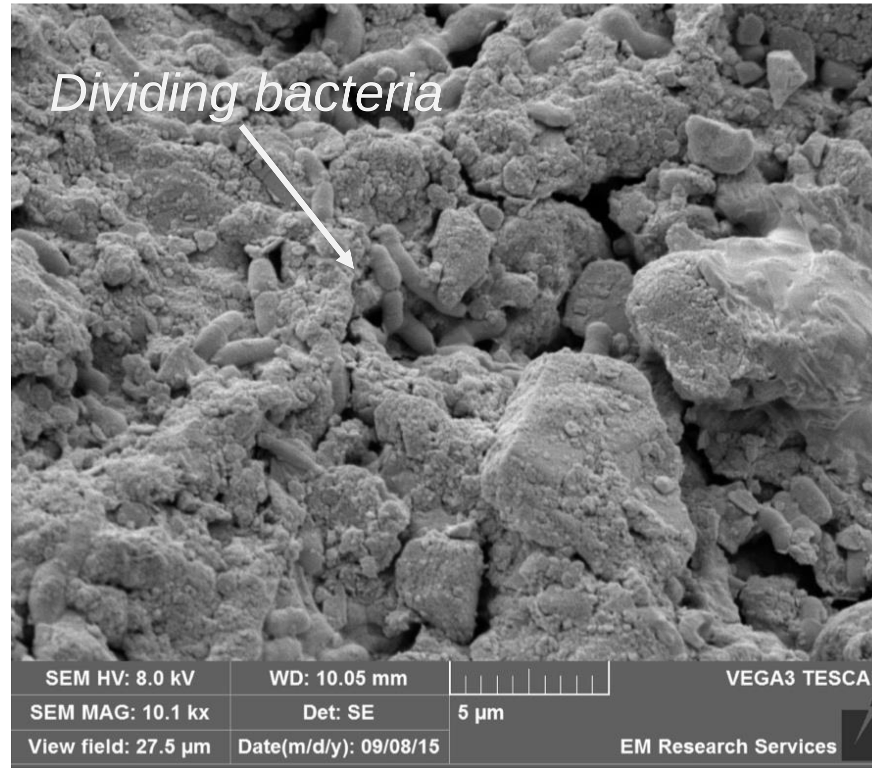


Heavily corroded grains with testate amoeba

The shells of testate amoeba (a type of protozoa) are made of silica

Feldspar from Brazil soil: unknown exposure





Heavily corroded grains with dividing bacteria

How do soil feldspars differ from lab feldspars?

- Surfaces are colonised by a community
  - Bacteria
  - Fungi
  - Protozoa
- Is this community as a whole more important than its individual parts?

Feldspar corrosion

- A 1 mm diameter grain will last 1,000,000 years, according to lab-derived dissolution rates (which are faster than field).
- **We observe that corrosion after 10 years gives cavities of the order of 0.1 mm – so a 1 mm grain would last of the order of 100 years.**
- Such corrosion is normally associated with the development of a complex biological community
- Does biology open the door to using silicates as a source of K?

Conclusions

- Potash consumption and demand vary greatly
- Yet every person has the same basic needs for food
- 10-11 million tonnes additional K_2O needed annually to feed the world, ideally more than this
- New evaporites coming on stream - polyhalite
- Local (within country) sources of silicate rock have a contribution to make, especially in deeply-leached tropical soils
- There’s room for innovation and alternatives

Thank you

david.manning@ncl.ac.uk