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Innovative uses of geological materials as crop nutrients

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The world's population is expected to rise from 7 billion now to 9 billion in 2050, with Africa's population doubling to 2 billion over the same time period. Already there is severe pressure on the world's soils to produce enough food for 7 billion people, and geological materials play a vital role in replacing the mineral nutrients removed with every crop ('offtake'). The fertilizer industry depends on mined materials for the production of K and P fertilizers, and on fossil fuels for the production of N fertilizers. Nutrient audit studies carried out by agronomists have shown that, globally, N and P fertilizer applications compensate overall for removal of these nutrients by offtake [1]. However, global application of K needs to double to replenish soil stocks. This implies that world mining of K should double to feed current populations. The situation with K is particularly serious in Africa; the continent has 15% of the world's population and imports around 1.5% of the world's K fertilizer production.

K fertilizers are derived from mined potassium salts, dominated by sylvite (KCl), with interesting prospects for polyhalite ($K_2SO_4.2CaSO_4.MgSO_4.2H_2O$). However, these salts vary in their effectiveness in different soils, and in deeply-leached tropical soils there is scope for using silicate minerals as alternatives. Potassium feldspar and micas have been investigated in the context of deeply le ached tropical soils in Brazil, and have been shown to be effective as sources of K (and Si) for plant growth [2].

To meet the needs of growing populations for food production, conventional fertilizers are often unavailable to farmers who need to maintain a sustainable soil for crop growth on the grounds of cost or logistical access. In these circumstances, locally available alternatives that might be shunned by wealthy highly developed countries have a role to play as sources of plant nutrition. A sound understanding of the geochemical processes of silicate mineral weathering in deeply leached tropical soils indicates that feldspathoids, feldspars and micas might be better suited to use as fertilizers than conventional more soluble chemical fertilizers. Mineral dissolution rates support the historically-investigated use of nepheline-bearing rocks for this purpose [2,3]. Given the need evident from agronomic studies, the time is right to consider a range of potassic silicate rocks as sources of K, especially in countries where access to conventional fertilizer sources is difficult.

References:

[1] Manning DAC (2015) Smith R (2011) Proc Geol Assoc 126(1): 14-17

[2] Ciceri et al. (2015) Sci Total Environ 502: 590-601

[3] Manning DAC (2010) Agron Sustain Dev 30: 281-294