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Additional information
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Filling the phosphorus fertilizer gap in developing countries

To the Editor — In a recent Commentary, Obersteiner and colleagues[1] correctly highlight the conflicting priorities of phosphorus-producing nations, rich phosphorus-consuming nations, and poor nations that continue to manage soils under severe phosphorus deficiency. We agree with their point that a reduction in phosphorus wastage in the developed world, where phosphate waste streams are largest[2], offers significant opportunities for phosphorus recycling — which, in turn, could ultimately make phosphorus more affordable for everyone. We argue, however, that developing countries that lack mineable phosphorus reserves could achieve greater autonomy by recycling the phosphorus contained in agricultural waste products.

One insufficiently explored example in this respect is the phosphorous stored in animal bones. Animal bone products (derived from the grinding or thermal treatment of raw bone) contain a greater concentration of plant-available phosphorus than commercial phosphate rock fertilizer[3,4]. For instance, between 2008 and 2011 the livestock herd in Ethiopia comprised more than 50 million cattle, 23 million sheep and 22 million goats[5], and would have yielded approximately 192,000 to 330,000 tonnes of bone waste annually[6] (Table 1). Recycling of these bones would have yielded around 28 to 58% of annual phosphorus fertilizer supplies to Ethiopia over the same period[7]. Importing an equivalent amount of phosphorus fertilizer costs approximately US$ 50 to 104 million.

Taking the Ethiopian livestock herd as an example, we argue that developing countries already have access to an indigenous supply of phosphate fertilizer, in the form of organic waste products. We suggest that by tapping into this resource, these countries can secure a significant fraction of their phosphorus demands without relying on international markets or the benevolence of rich countries. ❐

Table 1 | Total phosphorus in annual bone residues from slaughtered animals in Ethiopia.

	Total no. of animals[5]	Bone mass[6] (kg per animal)	% of animals slaughtered (per year)	Bone residues (tonnes per year)	Total phosphorus (tonnes per year)
Cattle	50,283,000	20–30	16–17	160,908–256,447	-
Sheep	23,642,000	4–5	19–34	17,968–40,192	-
Goats	22,070,000	4–5	15–30	13,242–33,106	-
TOTAL	95,995,000	-	-	192,118–329,744	17,279–36,272

Averages of total phosphorus from 2008–2011; average phosphorus concentration in bones of 9–11% (taken from ref. 8).

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