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TITLE: Exploring global changes in nitrogen and phosphorus cycles in agriculture induced by livestock production over the 1900?2050 period

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ABSTRACT:

Crop-livestock production systems are the largest cause of human alteration of the global nitrogen (N) and phosphorus (P) cycles. Our comprehensive spatially explicit inventory of N and P budgets in livestock and crop production systems shows that in the beginning of the 20th century, nutrient budgets were either balanced or surpluses were small; between 1900 and 1950, global soil N surplus almost doubled to 36 trillion grams (Tg)·y ?1 and P surplus increased by a factor of 8 to 2 Tg·y ?1 . Between 1950 and 2000, the global surplus increased to 138 Tg·y ?1 of N and 11 Tg·y ?1 of P. Most surplus N is an environmental loss; surplus P is lost by runoff or accumulates as residual soil P. The International Assessment of Agricultural Knowledge, Science, and Technology for Development scenario portrays a world with a further increasing global crop (+82% for 2000?2050) and livestock production (+115%); despite rapidly increasing recovery in crop (+35% N recovery and +6% P recovery) and livestock (+35% N and P recovery) production, global nutrient surpluses continue to increase (+23% N and +54% P), and in this period, surpluses also increase in Africa (+49% N and +236% P) and Latin America (+75% N and +120% P). Alternative management of livestock production systems shows that combinations of intensification, better integration of animal manure in crop production, and matching N and P supply to livestock requirements can effectively reduce nutrient flows. A shift in human diets, with poultry or pork replacing beef, can reduce nutrient flows in countries with intensive ruminant production.

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