



Supplement of

Production and application of manure nitrogen and phosphorus in the United States since 1860

Zihao Bian et al.

Correspondence to: Hanqin Tian (tianhan@auburn.edu)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

This supplementary material includes the following:

- 1) Table S1. Excreted manure nutrients rates per unit weight of livestock
- 2) Table S2. Nutrient assimilative capacity of cropland and pastureland
- 3) Table S3. Nutrient assimilative capacity of 13 types of crop
- 4) Figure S1. Comparing total productions and demands of manure (a) N and (b) P in the contiguous U.S. from 1860 to 2017

Table S1. Excreted manure nutrients rates per unit weight of livestock

Livestock	N excretion rate (kg N / ton animal weight /day)	P excretion rate (kg P / ton animal weight / day)
Beef cows	0.315	0.105
Milk cows	0.400	0.060
Heifers	0.310	0.040
Steers	0.315	0.105
Hogs	0.280	0.150
Sheep	0.450	0.070
Horses	0.280	0.050
Chickens	0.830	0.310
Pullets	0.620	0.240
Broilers	1.100	0.340
Turkey	0.740	0.280

Note: The excreted rate parameters derived from Puckett et al., (1998)

Table S2. Nutrient assimilative capacity of cropland and pastureland

Land-use type	N	P
	kg N / km ²	kg P / km ²
Cropland	13792	1626
Pastureland	6937	2768

Note: Assimilative capacities of cropland and pastureland were calculated based on the data in Kellogg et al., (2000)

Table S3. Nutrient assimilative capacity of 13 types of crop

Crop type	N	P
	kg N / ton product	kg P / ton product
Maize	12.96	2.43
Soybeans	53.67	5.44
Sorghum	15.88	2.92
Cotton	27.56	3.43
Barley	17.01	3.40
wheat	18.65	3.27
Oats	16.73	3.12
Rye	17.33	2.92
Rice	11.34	2.63
Peanuts	36.29	2.72
Sugar beets	2.16	0.43
Tobacco	28.43	2.00
Potatoes	3.27	0.54

Note: Assimilative capacities of crops were derived from Kellogg et al., (2000)

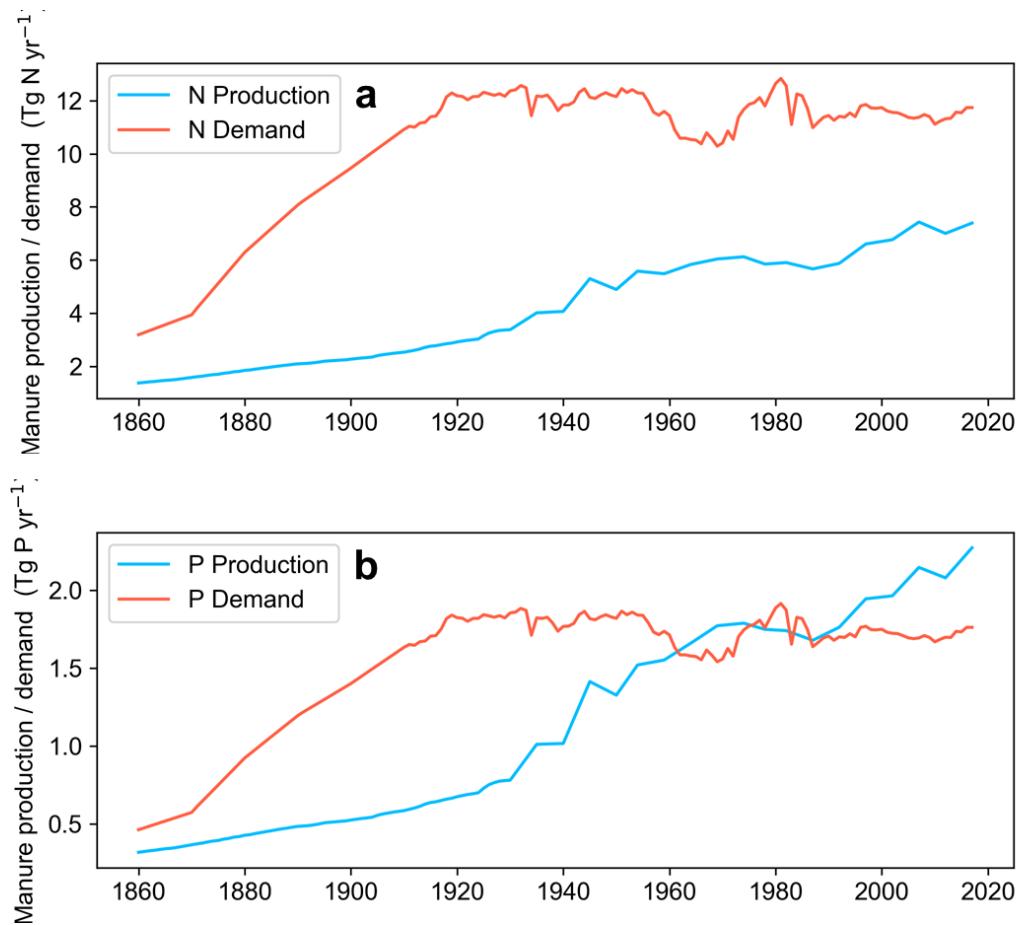


Figure S1. Comparing total productions and demands of manure (a) N and (b) P in the contiguous U.S. from 1860 to 2017

For the contiguous U.S., the total demand for manure N was higher than the production over the study period while the total production of manure P started to exceed demand after the 1980s (Fig.S1). The gap between production and demand has considerably narrowed since the 1920s due to the cease of the increase in nutrient demand. In 2017, total manure N and P productions reached 7.4 Tg N yr^{-1} and 2.3 Tg P yr^{-1} , while total demands were $11.7 \text{ Tg N yr}^{-1}$ and 1.8 Tg P yr^{-1} . However, the total numbers here only displayed limited information on the relationship

between production and demand due to the difficulty of collecting and transporting manure for widespread application in cropland.

References

Kellogg, R. L., Lander, C. H., Moffitt, D. C. and Gollehon, N.: Manure nutrients relative to the capacity of cropland and pastureland to assimilate nutrients, US Dep. Agric. Nat. Resour. Conserv. Serv. Agric. Res. Serv., 2000.

Puckett, L., Hitt, K. and Alexander, R.: County-based estimates of nitrogen and phosphorus content of animal manure in the United States for 1982, 1987, and 1992, US Geological Survey., 1998.