Estimation of Organic Nutrient Sources and Availability for Land Application

By Shutian Li, Xiaoyong Liu, and Wencheng Ding

Knowledge of the status and characteristics of organic nutrient resources in China is essential for their efficient management in agricultural production.
Provincial and regional level estimates are provided for the amount of organic wastes, their nutrient supply capacity, as well as their availability to cropland.

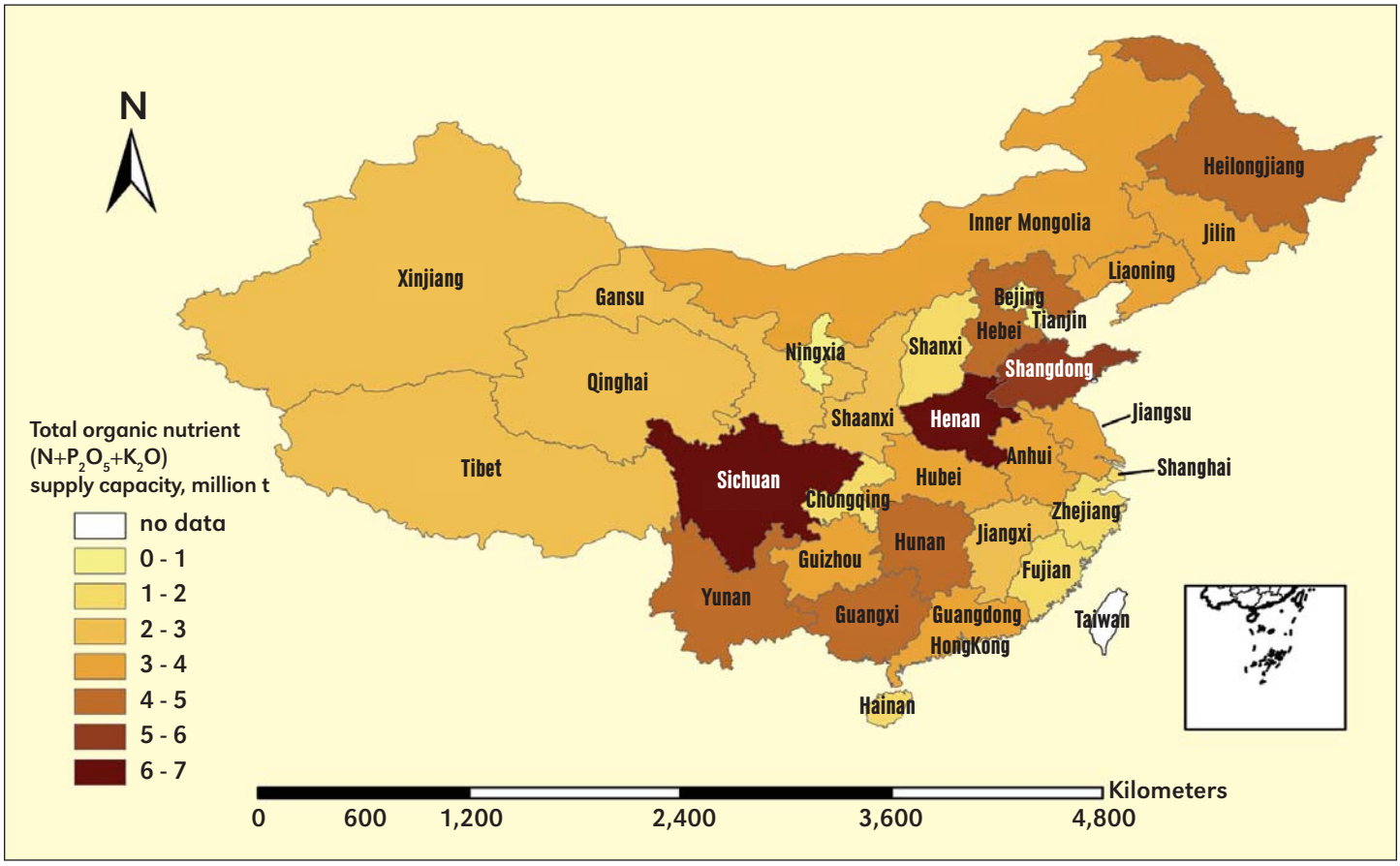

Figure 1. Total organic nutrient supply capacity by province in China in 2013. Nine provinces show capacities above 3 M t of $N+P_2O_5+K_2O$. Li et al. 2016

Great increases in Chinese crop production and livestock farming have in turn produced large amounts of nutrient-laden animal wastes and crop residues. Organic wastes from human activities, and of legume manures are also viewed as valuable organic resources. The recent government policy of "zero growth by 2020" for fertilizer sources is increasing the focus on how all available nutrient sources can be used best. Part of this focus is placed on an increased interest in using organic nutrient sources, like livestock manure, to offset inorganic fertilizer use. The estimation of the nutrient supply capacity and availability from these organic resources is important for understanding nutrient input/output balances in the Chinese agricultural system, and will have a great effect on nutrient management and fertilizer application in China.

Abbreviations and notes: N = nitrogen: P = phosphorus: K = potassium; MLY = middle/lower reaches of Yangtze River.

As a whole, the total organic resource in China amounts to more than 5.0 billion t in fresh weight (Li et al., 2016). This total product amounts to 79.7 million (M) t of NPK nutrients including 31.7, 14.4, and 33.6 M t of N, P_2O_5, and K_2O, respectively. This represents an amount similar to the N and P_2O_5 that was applied via fertilizers during 2013 in China, while the organic K_2O total is almost four times that applied as fertilizer that year. Sichuan, Henan, and Shandong have been the top three provinces in terms of organic nutrient supply capacity—each with more than 5 M t (**Figure 1**).

The contribution of the various organic sources, relative to all organic resources, varied greatly among provinces. Animal waste has accounted for 28 to 96% (mean of 50%) of the total organic nutrient resources, straw was 2.3 to 56% (mean of 31%), human excreta was 1.2 to 48% (mean of 18%), and legume green manure was less than 5% (mean of 1.5%).

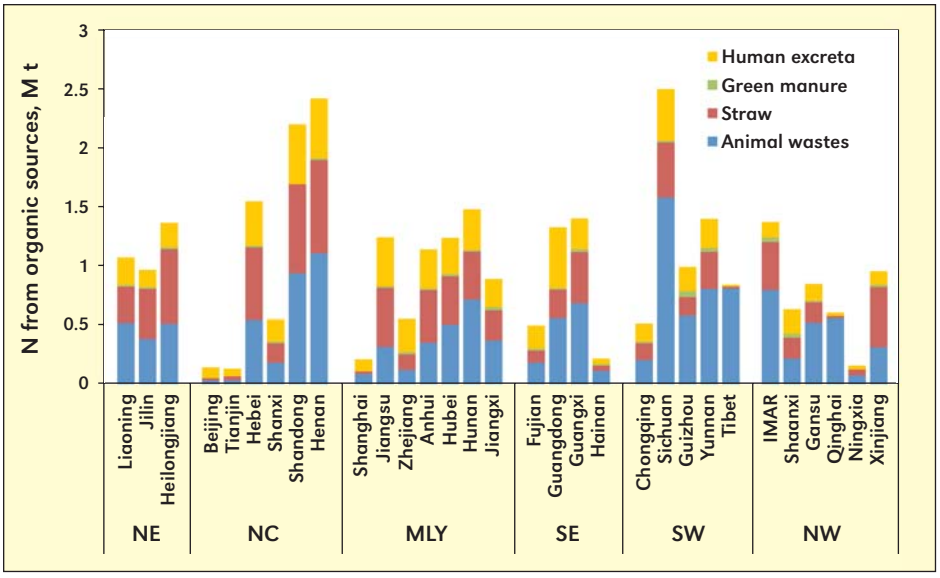

Figure 2. Total amount of nitrogen from different organic sources in 2013 assuming zero losses. Li et al. 2016.

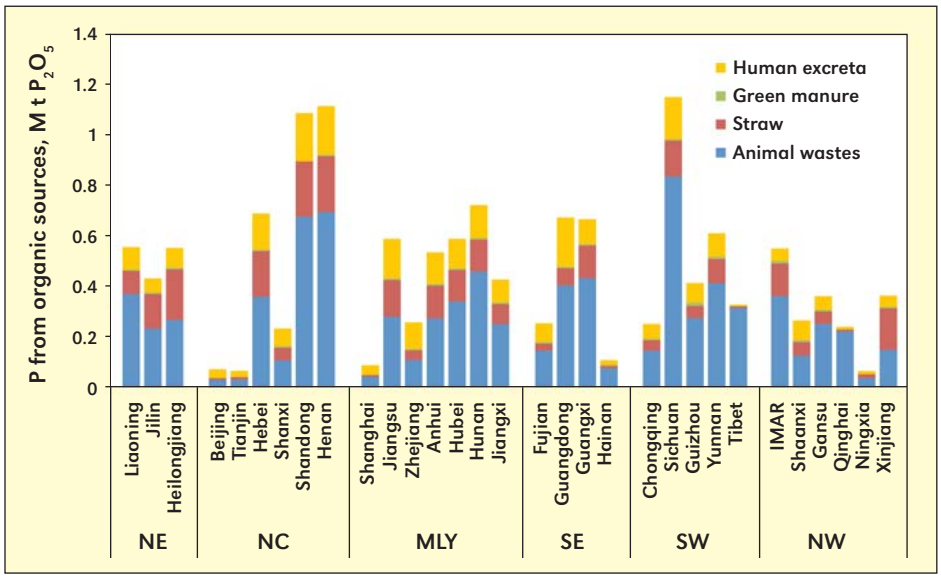

Figure 3. Total amount of phosphorus from different organic sources in 2013. Li et al. 2016.

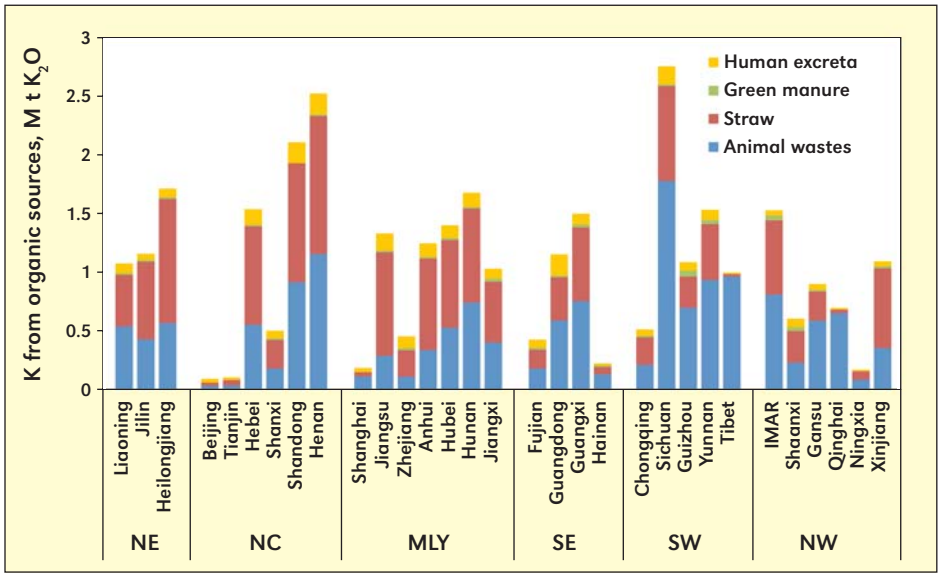

Figure 4. Total amount of potassium from different organic sources in 2013. Li et al. 2016.

Characteristics of Organic Nutrients and Their Regional Availability

There are large differences in the organic N sources that are present within the distinct regions in China (**Figure 2**). In the northeast region, organic N is mainly from animal manures (42%) and crop residues (39%). In the northwest and southwest regions animal manure is the main N source, accounting for an average of 55% and 64% of total organic N sources, respectively. In north central and southeast China, and the middle/lower reaches of the Yangtze River, crop residues and human excreta are the main N sources in addition to animal manures, accounting for 58%, 61%, and 53% of the total organic N, respectively.

Animal wastes are the main source of organic P in all provinces (**Figure 3**). Comparing regions, the northeast, north central, middle/lower reaches of the Yangtze River, southeast, southwest, and northwest had 57%, 58%, 55%, 62%, 72%, and 62% of its organic P originating from animal manures.

Potassium is the most significant nutrient contained within organic nutrient sources, mainly animal manures and crop residues (**Figure 4**). In the northeast, north central, and the middle/lower reaches of the Yangtze River regions, straw K represented 54%, 48%, and 54% of the total organic K resource. While in the southeast, southwest, and northwest regions, animal wastes were the main organic K source, accounting for 51%, 67%, and 55% of the total.

Considerations for Organic Nutrient Resources

If properly used these organic nutrient resources would be appropriate substitutions for fertilizers, especially in the case of potash. However, the potential for mismanagement of these organic sources can be high given traditional application practices, and there are significant risks towards serious environmental issues for China's surface and shallow water sources from both over application of organic materials, and the heavy metal loading common in some of these waste products. Organic wastes are mainly applied to land directly or as composts within an area near their origin because of the associated transportation costs. Only a small portion of these organic wastes are used to produce commercial organic-inorganic

Limited carry-over of maize residue, leaving minimal crop stubble, has been common in Hebei Province where the majority is removed and used for other purposes.

Returning maize straw back to cropland in Jilin Province.

fertilizer that can be transported across regions.

These estimates of organic sources and nutrient capacity/availability can vary considerably based on parameters such as daily excrement of livestock animals, nutrient content of manures, and the proportion of manure/crop residues that can be returned to land. Although these estimates show there are very large organic nutrient resources available in China, the potential for nutrient losses during storage and processing, especially for manure N, is also large and seemingly unavoidable. The amount of recoverable organic nutrient that is available to be returned to cropland varied greatly among provinces (**Figure 5**). Amounts ranged from 0.04 to 0.92 M t N, 0.03 to 0.66 M t P_2O_5, and 0.05 to 1.41 M t K_2O for individual provinces, with a total of 9.5, 7.1, and 16.2 M t for N, P_2O_5, and K_2O for China.

It is estimated that the percentage of organic nutrient N, P_2O_5, and K_2O returned to cropland was 18 to 38%, 39 to 64%, and 37 to 62% of the total supply capacity for individual provinces, with an average of 30%, 49%, and 48% nationally. These data suggest that more than half of the total organic nutrients are not recycled to agricultural land. A concerted effort is needed to increase the use of organic nutrients and balance their use with fertilizers, but this will require both scientific and policy support.

Summary

China has sufficient organic sources with a nutrient-supplying capacity that exceeds recent totals for fertilizer consumption. The challenge of recovering these nutrients, transporting them, addressing the challenge of accumulated heavy metals, and applying them uniformly across agricultural lands still remains. Regardless, China's organic nutrient sources could make a significant contribution to the current policy promoting a zero increase in fertilizer consumption by 2020. Every effort should be made to try and capture 50% or more of these organic nutrients that are currently not being returned to croplands. BC

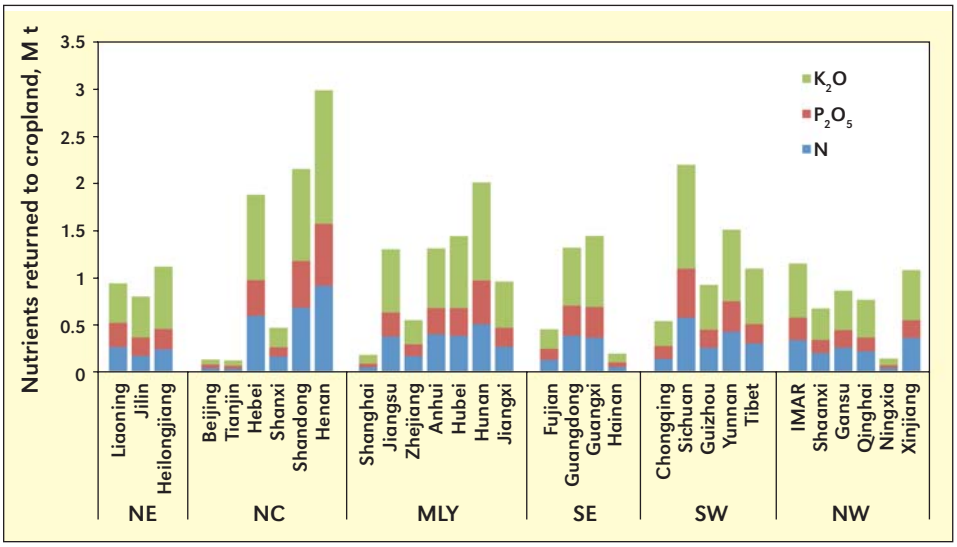

Figure 5. The amount of organic nutrient N, P_2O_5, and K_2O returned to cropland in 2013. Li et al. 2016.

Dr. Li (e-mail: sli@ipni.net) is a Deputy Director, IPNI China Program, Mr. Liu is a Ph.D. student and Mr. Ding is a M.Sc. student at the Graduate School of the Chinese Academy of Agricultural Sciences in Beijing, China.

Reference

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