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Rebuilding the linkage between livestock and cropland to mitigate agricultural pollution in China

Chuanzhen Zhang[a,1], Shen Liu[b,c,1], Shuxia Wu[c], Shuqin Jin[d], Stefan Reis[e,f], Hongbin Liu[c,**], Baojing Gu[a,g,*]

[a] Department of Land Management, Zhejiang University, Hangzhou, 310058, China
[b] Aisino Corporation Inc., Beijing, 100195, China
[c] Key Laboratory of Nonpoint Source Pollution Control, Ministry of Agriculture, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing, 100081, China
[d] Research Center for Rural Economy, Ministry of Agriculture of China, No. 56 Zhuanta Hutong, Xicheng District, Beijing, 100810, China
[e] Centre for Ecology & Hydrology, Penicuik, EH26 0QB, United Kingdom
[f] University of Exeter Medical School, Knowledge Spa, Truro, TR1 3HD, United Kingdom
[g] School of Agriculture and Food, The University of Melbourne, Victoria 3010, Australia

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ABSTRACT

An increasing disconnect between livestock production and croplands has been observed in many world regions, including China, which has the world's largest livestock production sector. Here we propose a cropland-based livestock production system to rebuild the linkage between livestock and cropland from both agriculture production and human consumption perspectives for China. In 2015, the total excretion nitrogen (N) generated by livestock production operations was 14.6 Tg N, and it would grow to 15.0 Tg in 2030 by extrapolating current trends. The optimal demand of total N by crops in China was estimated to be 23.0 Tg N in 2030, suggesting that Chinese livestock would be within the carrying capacity of cropland on national level, but substantial variations were found across provinces. The carrying capacity of cropland with regard to N input from manure would be exceeded in 74% provinces, under the assumption that manure providing half of the N supply for crops. Furthermore, from the perspective of domestic feed supply for livestock production, about 51% of feed N needs to be imported. If following the optimized dietary structure of China to manage livestock sector, livestock production could be reduced by 37% in excretion nitrogen, which would not only benefit the food security and human health, but also mitigate the agricultural pollution. Accordingly, policy regulations on reduction and spatially reallocation of livestock production on a regional scale could substantially reduce manure N loss from 10.5 Tg yr^{-1} to 1–1.2 Tg yr^{-1} under different recoupled scenarios.

1. Introduction

To feed an increasingly affluent population, the global livestock sector has been observed to grow and global *per capita* consumption of livestock products has more than doubled in the past 40 years (Raney et al., 2009). Livestock production has become the largest consumer of grains in many world regions, contributing to food insecurity (Bai et al., 2018). Furthermore, the losses of substantial amounts of livestock nitrogen (N) from excretion to air and water constitute threats to the health of environment, ecosystems and human being (Tamminga, 2003; Galloway et al., 2004). To reduce the impacts of livestock-induced environmental pollution, manure application to cropland is a crucial pathway to reduce N losses in the cascade (Galloway et al., 2008). However, in many world regions such a recycling process which requires close spatial links between livestock production and cropland at local scale is decoupled with the development of industrialized livestock production without associated cropland areas (Fig. 1). The long-distance transportation of feed (Naylor et al., 2005; Sun et al., 2018), the excessive use of chemical fertilizer to replace N inputs from manure (Savci, 2012; Chadwick et al., 2015) and the environmental

* Corresponding author at: Department of Land Management, Zhejiang University, Zijingang Campus, 866 Yuhangtang Road, Hangzhou, 310058, China.
** Corresponding author at: Key Laboratory of Nonpoint Source Pollution Control, Ministry of Agriculture, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, No. 12 Zhongguancun South Street, Beijing, 100081, China.
E-mail addresses: liuhongbin@caas.cn (H. Liu), bjgu@zju.edu.cn (B. Gu).
[1] These authors contributed equally to this work.

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