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Topic Insights

Sustainable Resource Use in Enhancing Agricultural Development in China

Jianbo Shen [a], Fusuo Zhang [a], Kadambot H.M. Siddique [b]

[a] National Academy of Agriculture Green Development, Center for Resources, Environment and Food Security, College of Resources and Environmental Sciences, China Agricultural University, Beijing 100193, China
[b] Hackett Professor and Director of the UWA Institute of Agriculture, The University of Western Australia, Perth, WA 6001, Australia

1. Introduction

China is entering an impressive era of grain production since its reform and opening up in 1978. At present, China feeds 22% of the world population with only 9% of the world's arable land [1]. Thus, China has become a leader in the global fight against hunger [2]. Grain production has increased dramatically, from about 3×10^8 t in 1978 to 6.21×10^8 t in 2016, which is an annual increase rate of 9% [3]. The increase rate of grain production has surpassed the growth rate of the population, resulting in an evident decrease in the proportion of malnourished people in China. However, the doubling of agricultural food production since 1978 in China is partly attributed to a three-fold increase in nitrogen (N) fertilization, an 11-fold increase in phosphorus (P) fertilization, and a 1.5-fold increase in the amount of irrigated cropland [3,4]. Huge inputs of various agricultural resources (fertilizers, water, insecticides, etc.) for grain production have caused an enormous waste of resources [4], which is a great challenge for realizing the goal of green development in agriculture and sustainable grain production in the future.

2. Overuse of fertilizers

Excessive fertilization due to the mismanagement of chemical fertilizer has caused low nutrient-recovery efficiency and high environmental costs in grain production. N overuse has resulted in a series of environmental damages in China. For example, the overuse of ammonium (NH_4^+) and urea-based N fertilizer caused soil pH to decrease by 0.5 in the 2000s. Meanwhile, N overuse can lead to high greenhouse gas (GHG) emissions in grain production. Compared with optimal N management strategy in China's wheat production, GHG emissions increased by 50% due to a 30% overuse of N [5]. Subsequent environmental impacts such as N deposition, N leaching, and high nitrate concentration in groundwater are directly related to N overuse [6]. Lack of awareness of nutrient management and inappropriate policy guidelines could explain the excessive fertilization that occurs in China's major croplands. In the most rural areas of China, untrained workers conduct farming without recognizing the importance of nutrient management, due to a lack of efficient channels to transfer technologies to Chinese farms [7]. In certain areas, some farmers do not know how much N fertilizer should be applied to attain a high yield. As a result, these farmers often apply more N than the crops demand, as they take an insurance-based approach that is based on the experience of their relatives and neighbors [8].

3. Technological and policy interventions

However, China's government has made grain production and food security a top priority due to past experiences of famine and political instability. In the 2000s, China produced enough food to feed its enormous population [1,7,9]. Now, China has set a new target of green growth in future grain production; this target includes high efficiency and low environmental risk while maintaining a relatively high grain yield on a regional scale. It is urgent for China to develop strong policy incentives for environmental protection and green growth in grain production. Going forward, Chinese agriculture will continue to put into practice the vision of innovative, coordinated, rural revitalization and green development. The science and technology backyard (STB) model, which was established by scientists from China Agricultural University, could provide an effective approach to realize the green development of agriculture, as it aims to close gaps in China by empowering smallholder farmers through integrating researchers, farmers, the government, and agro-enterprises [7,10].

4. Conclusions

The Chinese government has initiated a series of programs to promote the transformation of China's grain production [11]. One of the most influential plans focuses on zero growth of fertilizer consumption; according to this plan, the annual increase in total fertilizer use is projected to be less than 1% from 2015 to 2019 (with no further increases from 2020) without yield penalty. We have proposed a novel model to address these challenges by improving the sustainability of nutrient use in intensive agriculture. Our model uses root-zone nutrient management to maximize

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root/rhizosphere efficiency and thus reduce dependence on external chemical fertilizer input [12]. This method is based on a precise soil nutrient supply to the root zone that does not exceed its capacity, optimal root responses and root-soil interactions, efficient genotypes, and appropriate soil management [13]. Undoubtedly, China's success or experience in improving sustainable resource use and increasing grain production will enhance food security while decreasing poverty and the environmental footprint, and thus contribute to the global goal of sustainable development. To meet new demands of Chinese agriculture in a new era, as well as for promoting further implementation of United Nations (UN) Sustainable Development Goals (SDGs), the National Academy of Agriculture Green Development and the International School of Agriculture Green Development have been launched by China Agricultural University on 22 July, 2018. Chinese agriculture green development (AGD), as a national strategy issued by central government, is likely to provide valuable experience and practices to global sustainable agricultural development as a dominant part of SDGs, particularly, other developing countries that are facing or will soon face similar challenges.

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