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Assessing the harvested area gap in China

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ABSTRACT

Total crop production is a function of the harvested area and the yield. Many studies have investigated opportunities to increase production by closing the yield gap and by expanding cropland area. However, the potential to increase the harvested area by increasing the cropping frequency on existing cropland has remained largely unexplored. Our study suggests that the attainable harvested area gap (HAG) in China ranges from 13.5 to 36.3 million ha, depending on the selected water allocation scenario, relative to the current harvested area of 160.0 million ha. Spatially, South China and the Lower Yangtze region have the largest potential to increase harvested area, as these regions allow triple-cropping, have sufficient water available, and have a good irrigation infrastructure. The results imply that management factors are equally important for exploring the potential against the resource endowment: water allocation has a large impact on both the size and the spatial pattern of the attainable HAG. This indicates the necessity of further examining the spatial-temporal dynamics of HAG at national and regional scales, and its potential contribution to food security and sustainable agricultural development.

1. Introduction

In China, providing enough food for its 1.3 billion inhabitants has always been a challenge. Although food import has increased recently, grain self-sufficiency is still the most important agricultural policy goal for the country (Ye et al. 2012; Ghose 2014; Lu et al. 2015). Previous studies have mostly focused on two ways to increase production: increasing yields on existing cropland, and/or bringing new land under cultivation (Fan et al. 2012; Yu et al. 2012). However, neither approach has much potential in China. On the one hand, there has been very little or no growth in yields of Chinese staple crops such as rice, wheat, and maize for the past decade (Ray et al. 2012; Grassini et al. 2013). The "yield gap" – the difference between yield potential and the average farmers' yield – has decreased in the main breadbaskets across China, and the actual yield reaches nearly 80% of the potential yield at the North China Plain, which is much higher than the global average (Li et al. 2014). Considering that climate change may further reduce the potential yield, the possibility for future yield improvement is extremely low (Wang et al. 2014; Tao et al. 2015). On the other hand, although expanding cropland is a straightforward way to increase crop production (Wu et al. 2014), China has lost nearly 10 million hectares of productive cropland from 1990s to 2010s due to rapid urbanization, industrialization, and ecological restoration (Liu et al. 2014). Cropland expansion to increase crop production is undesirable in China, because it may lead to severe environmental consequences, e.g. land degradation, desertification, deforestation, and loss of biodiversity. (Wu et al. 2014; Eitelberg et al. 2015).

Since China is experiencing both extensive yield stagnation and increasing competition for land resources, new approaches are needed to increase China's domestic crop production along with these traditional solutions (Wu et al. 2014). Although the definition and measurement of land use intensity are still under debate, it basically means the increase of productivity on a given cropland, and can be measured from either input or output perspective (Erb et al. 2013). Cropping frequency is one of the core indicators of intensification as increasing the number of crop cycles per year will increase the production. Much cropland in regions where climate conditions are able to sustain multiple cropping, is left fallow or is harvested less frequently than it could be (Ray and Foley 2013; Iizumi and Ramankutty 2015). Consequently, using a concept similar to the yield gap, a harvested area gap exists if the actual harvested area is lower than the potential harvested area within a specific cropping system.

A recent study from Mauser et al. (2015) reported that the earth's current cropland has the potential to double biomass production by increasing cropping intensity. However, this study did not explicitly map

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