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Author(s): G.L. wang et al.
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We deeply appreciate the reviewers' time and effort to help improve the manuscript. And we have considered the suggestions seriously. Below are our replies to the detailed and constructive comments/suggestions.

Overview of Anonymous Referee #1

Experimental design and context: The study focusses on the application of synthetic N fertilizer in the form of urea solely and no mention of the application of other forms of N sources either in the form of manure and/or in the form of N provided by N fixing legumes as pre-crops. As this study has also the focus to improve smallholder-based cropping systems in China, it's hard to believe that the agricultural land under study is solely fertilized with synthetic N sources. Smallholder agriculture is typically characterized by a high degree of self-sufficiency meaning that livestock plays an essential role and their excrements deliver part of the required fertilizers and contribute to soil organic matter (SOM) reproduction.

Furthermore, the productivity of croplands will decrease over time due to SOM losses along with the decrease in soil structure and other soil quality aspects if organic inputs are not applied on croplands and/or a proper residue management is not considered. In this context carbon release from SOM mineralization might be further stimulated if only mineral N fertilizer is applied without substantial replenishment of SOM pools by organic inputs. This is state of the art knowledge.

Therefore, improved cropping strategies, that's what the current manuscript is aiming at, in the 21st century should somehow consider the integrated use of synthetic and organic N inputs as has been postulated in various scientific reviews including the IPCC report of the year 2007. This manuscript bears the risk that with the further promotion of its concept and the outcomes the wrong incentives might be set for agricultural sustainability. The implementation of organic fertilization practices in the experimental setup would be straight forward.

Reply:

For the doubt about that the study focusses on the application of synthetic N fertilizer in the form of urea solely without considering the application of other forms of N sources, such as the form of manure and/or the form of N provided by N fixing

legumes as pre-crops, the explanation is as followed:

1) The application of synthetic N fertilizer in the form of urea is the main and typical fertilization method for maize in NCP (North China Plain) as well as in other regions in China (mentioned in Page 2644, line 9 from Biogeosciences Discuss., 11, 2639–2664, 2014). As developing fertilizer industry, more and more synthetic N fertilizer was used. A study indicated that, in China synthetic N fertilizer accounted for less than 5% of total N input in various forms before 1960, and increased to more than 70% after 2010, including 70% N fertilizer in the form of urea (Ma et al., 2014; Zhang et al., 2013). And more than 90% of cereal crop land area was fertilized with synthetic N fertilizer after 2000 (Ma et al., 2014). Generally, various factors affected farmers' willingness to use organic fertilizer. A survey of 200 farmers selected from Shandong Province in NCP was conducted in 2008 showed that the share of non-copping income in total income, awareness of organic fertilizer benefiting agricultural sustainability, confirming the quantity of organic fertilizer needed by the crops were significant factors (Liu et al., 2010). As mentioned in Discussion, NCP where our study was conducted is the major region with typical smallholder agriculture system in China. In this system, each farmer operates on <1 ha of land, and many educated young farmers have left the industry to other industry with higher profit , leaving the farming work to the older and less-educated individuals. And thus fertilizing organic N was always neglected, and smallholder agriculture with typical high degree of self-sufficiency was broken.
2) Lacking of the methods for estimating various reactive N losses from organic N fertilizer at regional scale. Many empirical models and mechanism models were established based on synthetic N fertilizer to estimate reactive N losses at regional scale (Cui et al., 2014; Xia and Yan, 2012). However, Reactive N losses were significantly different between synthetic N fertilizer and organic N fertilizer. For example, with the same N rate application, N_2O-N emission for synthetic N fertilizer was only half of that for organic N (Meng et al., 2005). Thus, other models must be established based on organic N rate for estimating N losses from organic N fertilizer. Generally, the study about organic N fertilizer mostly focused on the effect on grain yield or soil quality, less attention was paid on its' N losses. And thus, the shortage of sufficient data about reactive N losses from organic N fertilizer made the difference for understanding various reactive N losses from organic N fertilizer at regional scale.
3) First of all, we must optimize synthetic N fertilizer rate for decreasing negative environment effect without yield losses in China with fast economic development. As an "insurance", an excessive amount of N fertilizer has usually been applied for summer maize production in NCP in last two decades (Cui et al., 2008). The

investigation showed that an average application of 249 kg N ha^{-1} as mineral fertilizer (50-600 kg N ha^{-1}) to summer maize (n=370) in Shandong province, exceeding crop requirements for maximum grain yield (Cui, 2005). Therefore, developing a feasible N recommendation method that can harmonize N requirement and environmental protection is very important. In China, the conceptual model for optimal crop production to achieve synchronously increasing crop productivity, improving resource use efficiency, and environmental protection, has been come forward and been accepted (Fan et al., 2011). In this conceptual model, optimal synthetic N fertilizer rate was initial and cruciate for sustainable agriculture in China, especially for regions with intensive crop production such as NCP. While improving soil productivity need further effort by applying existed technologies, such as increasing organic N input. In this study, we focused on optimal synthetic N fertilizer rate, and organic fertilization practices would be considered in the future work.

Methodological approach: The calculation of the ecologically optimal N rate lacks the consideration of CO_2 and N_2O emissions from N fertilizer production. This is an import source of agricultural greenhouse gases and their reduction/avoidance by technological means is actually an important part of carbon-offset activities in the agro-chemical industry sector.

Reply:

Yes, CO_2 is an import source of agricultural greenhouse gases and its' reduction/avoidance by technological means is actually an important part of carbon-offset activities in the agro-chemical industry sector. However, in our study our aim is to determine the optimal nitrogen rate. And it is very complex to understand the carbon balance because of only changing nitrogen input. Generally, CO_2 emission would increase because of N input, while CO_2 would be sequestered by crop production and soil because of the increase in yield (Zhang et al., 2012; Huang et al., 2013). Many studies also indicated that there was debate that crop land as a part of biogeochemical cycle of carbon whether would be a source of C or C-sink (Han et al., 2009, Yang et al., 2003). On the other hand, with the empirical model, N_2O-N emission was estimated based on N rate, while there was lack of similar method for estimating CO_2 emission based on different N rate at regional scale. Furthermore, in our study, we focused on the reactive N losses via N_2O emission, N leaching and NH_3 volatilization, connecting with environment problems (mentioned in Page 2642, line 27 and 28 from Biogeosciences Discuss., 11, 2639–2664, 2014).

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