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ADAPTATION TO CLIMATE CHANGE

Benefits Comparison Analysis of Different Rice and Wheat Cropping Patterns to Adapt to Climate Change

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Abstract

Based on the input-output survey of farmers and experts in one of the Jiangsu GEF project areas, the Cost-Benefit analysis method and greenhouse gas estimation method recommended by IPCC were applied to evaluate and compare the social, economic and ecological benefits of artificial transplanting (ATR), mechanical transplanting (MTR) and direct seeding (DSR) rice under wheat-rice Double Late mode (late rice harvest and late wheat sowing). Results showed that the MTR and DSR rice achieved obvious social benefits. Farming measures resulted in excessive emission of anthropogenic greenhouse gases. Through the use of ATR rice and wheat rotation mode it is possible to obtain most economic and ecological benefits. The Double Late mode of action had good application prospects, but the key to implementation was the timely exploitation of the recently increased availability of agricultural climate resources. The cropping pattern of combining the wheat-rice Double Late mode with the ATR was a better choice in mitigating and adapting to climate change.

Keywords: climate change; adaptation; yield; benefit; greenhouse gas emissions

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1 Introduction

Agriculture is one of the areas which are most sensitive to climate change, as well as the industry which is most reliant on climate. Adopting active adaptation measures could mitigate or eliminate the potential damage caused by climate change, promote sustainable development in agriculture, ensure food supply and the national economic development, and increase farmers' income [*Jiang*, 2008; *ECSCNARCC*, 2011; *Song et al.*, 2012]. In recent years, China's agricultural sector has established a series of policies on agriculture to adapt to climate change, and summarized abundant practice experience to develop corresponding adaptation technology [*CNACDO*, 2010; *Ju et al.*, 2011]. Peasants have also taken adaptation actions actively or passively [*Lü and Chen*, 2010]. Analyzing and evaluating the integrated benefits of adaptation measures is significant in carrying out correct and prompt adaptation and playing the seeking advantages and avoiding disadvantages role of adaptation technology adequately for government and farmers.

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Global Environment Facility (GEF) to extend the adaptation measure of wheat-rice rotation and multiple cropping Double Late mode of action (hereinafter referred to as wheat-rice Double Late mode) in one of the Jiangsu GEF project areas. To what extent did this mode of action benefit from climate factors? What was the benefit likely to be? How substantial was the potential likely to be? All of these were valuable research areas. Most recent researches focused on one or several crops' production cost and benefit, or compared the economic effect of using different cropping measures on one crop [*Zhu et al.*, 2011; *Chen*, 2009; *Chen and Chen*, 2011; *Wen et al.*, 2007]. Few of them were based on the ideas and concepts of climate change adaptation, or researched the rotation system in a region through quantitive data over a period of years, especially on the comprehensive benefits of rice planting methods and wheat-rice Double Late mode in the southern part of China's Huang-Huai-Hai Plain. Based on the input-output questionnaire survey of farmers and experts in one of the Jiangsu GEF project areas, the Cost-Benefit analysis method and greenhouse gas (GHG) estimation method recommended by IPCC were applied to compare the social, economic and ecological benefits of three kinds of rice planting methods, including artificial transplanting (ATR) of strong seedlings, mechanical transplanting (MTR) of weak seedlings and direct seeding (DSR), and wheat-rice Double Late mode to evaluate their applications' potential to adapt to climate change.

2 Material and methodology

2.1 *Study area*

The impacts of climate change were also observed, from a global warming perspective, in Jiangsu GEF project areas. The increasing rate of temperature was 0.26°C per decade from 1961 to 2008 and has risen to 0.58°C per decade since the 1990s. Annual precipitation fluctuated with an increasing trend of 2.9 mm per decade [*Zhang et al.*, 2011]. The agricultural climate resources measured by agricultural demarcation temperature changed significantly as well. In the case of Xuzhou, accumulated temperature of above 0°C and 10°C increased by 148.9 and 146.0°C d per decade respectively, while days of above 0°C and 10°C increased by 2.2 and 4.3 d per decade respectively from 1980 to 2011 (Fig. 1).

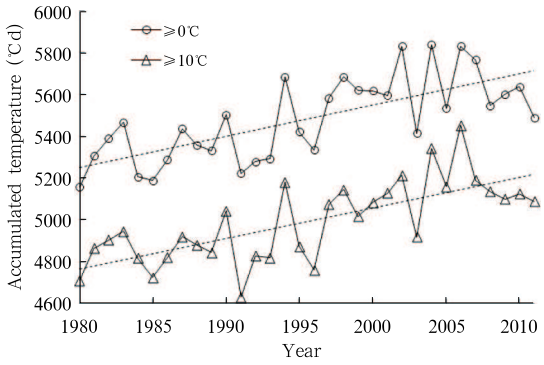

Figure 1 Active accumulated temperature of above 0°C and 10°C in Xuzhou from 1980 to 2011 (dashed line: linear trend; data from http://cdc.cma.gov.cn/home.do)

Wheat-rice rotation and multiple cropping was the primary planting pattern in northern Jiangsu. Due to the recent rise in labor cost, farmers expanded the planting scale of ATR and DSR to save labor and guarantee self-supporting food production, resulting in the coexistent situation of ATR, MTR and DSR, while the wheat was still cultivated using the traditional method of direct seeding.

Xinyi, one of the key GEF counties in Xuzhou, Jiangsu province, was the survey area in the study. Most rice was cultivated using artificial transplanting and mechanical transplanting in Xinyi, while the use of direct seeding was scarce. Compared with ATR, MTR and DSR were harvested late, and following the increased popularity of the GEF project, the sowing date of winter wheat was postponed from late September to early and mid- October, leading to wheat-rice Double Late mode (late rice harvest and late wheat sowing).

2.2 *Survey method and content*

After confirming the background of the GEF project area and the character of adaptation technology through literature's overview, and informal discussion with officials and experts, three sets of questionnaires on the rice and wheat harvested in 2010 and 2011 were designed and revised for the households, village committee and agricultural materials shops.