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RESEARCH ARTICLE

Booming research on rice physiology and management in China: A bibliometric analysis based on three major agronomic journals

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Abstract

Rice research has always been the top priority in China and China produces the highest number of scientific journal papers on rice, particularly on rice genetics and breeding. In this study, we used a bibliometric approach to analyze the trends of papers published by Chinese researchers on rice physiology and management. Data were collected from three major agronomic journals (i.e., *Agronomy Journal*, *Crop Science*, and *Field Crops Research*) by searching in the Web of Science on September 8, 2017. A total of 186 rice papers were published by Chinese researchers on crop physiology and management in the three journals since their establishment. Yearly average number of such papers was 1.6, 6.5, and 21.0 for the periods of 1993–2005, 2006–2011, and 2012–2017, respectively. Their quality in terms of citation performance has also improved significantly in the recent decade. Huazhong Agricultural University, Yangzhou University, and Nanjing Agricultural University were leading organizations and published 54.4% of all 186 papers. Huang Min of Hunan Agricultural University and Peng Shaobing of Huazhong Agricultural University published the most number of rice papers on crop physiology and management as the first and corresponding authors, respectively. Yield potential and nitrogen-related research such as nitrogen use efficiency, nitrogen management, and plant nitrogen diagnosis have been the research focuses for rice crop. In recent years, research on global warming including high temperature stress, direct seeding, zero tillage, *Bt* rice, and critical nitrogen dilution curve were becoming popular. New research is emerging on yield gap, rice ratooning, and simplified and reduced-input practices in rice production.

Keywords: agronomic journals, bibliometric analysis, China, crop management, crop physiology, rice

1. Introduction

Rice is the staple food for more than 65% of the population in China (Zhang *et al.* 2005) and plays a pivotal role in the nation's food security. Rice yield in China has increased by more than two times over the last five decades (FAO 2017), which is largely attributed to the advances in rice research and development. Investment in rice research by the Chinese government is the highest among all major crops. For example, rice received 2.5 times more funding

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than maize from the National Natural Science Foundation of China in the past two decades (Liu *et al.* 2017b).

Crop yield increase depends on genetic improvement and management improvement. In the past, agricultural scientists have reached a consensus that breeding and crop management contributed equally to the increase in crop yield (Peng 2008). However, the contribution of crop management to rice yield may gradually surpass genetic improvement because (1) it is more difficult to increase rice yield potential through breeding, (2) there is a huge gap between yield potential and farmers' actual yield which needs to be closed by improved crop management, and (3) global climate change has to be dealt with the development of climate-smart crop management practices.

Chinese government is paying more attention to crop management research in recent years. The Ministry of Science and Technology (MOST) launched a project on "Basic Research on High Yield Cultivation and Resource Efficient Utilization of Main Grain Crops" in 2009. This is the first time that the National Basic Research Program (973 Program) of the MOST funded a project on crop management research. The MOST has also supported the Science and Technology Engineering Project for Grain Bumper Harvest since 2004, which mainly promotes applied research on improved crop management practices and their adoption for the three major grain crops (i.e., rice, wheat, and maize). In addition, the Special Fund Program for Agro-scientific Research in the Public Interest of China from the Ministry of Agriculture (MOA) supported a project on Crop Physiology and Management Practices for Achieving High Yield and High Efficiency in the Production Systems of Major Crops from 2012 to 2016. These projects have improved the funding situation for crop physiology and management research, especially for rice crop, in China in the past decade.

Increased investment in research on rice physiology and management has contributed greatly to the rice yield increase. It is expected that further increase in research funding would result in great output of scientific journal papers. Bibliometric analysis has been used to compare the scientific output among countries, disciplines, or crops and to identify hot research topics. Liu *et al.* (2015) studied the competitiveness of Chinese research organizations in crop science based on bibliometric analysis and concluded that crop science research in China is gaining momentum. The trends of rice research were studied for the world by Sun and Lu (2012) and Liu *et al.* (2017a) and for Japan by Morooka *et al.* (2014) using bibliometric method. Wei *et al.* (2017) reported that China took over Japan in 2006 and became the top country in the number of journal papers on rice. In these studies, the scientometic profiles of research publication were analyzed for all crops or for all disciplines within rice crop. No study has been carried out to determine the trends of paper publication on rice physiology and management in China.

There are 83 journals that are categorized as agronomic journals by the Journal Citation Reports, ISI, Clarivate Analytics. Among them, *Agronomy Journal* (AJ), *Crop Science* (CS), and *Field Crops Research* (FCR) published papers on crop physiology and management. The three journals are considered by crop scientists as seminal journals because of their high scientific standard. In this study, we conducted bibliometric analysis on rice papers published by Chinese researchers on crop physiology and management in AJ, CS, and FCR since their establishment. Our objectives are (1) to determine the trends of rice papers published by Chinese researchers on crop physiology and management, (2) to identify the most active researchers and organizations in China that publish in these areas, and (3) to evaluate the quality of these journal papers in terms of citation performance.

2. Data and methodology

Two sets of data were collected from Web of Science on September 8, 2017. For the first set of data, the total number of papers with rice in the title was found first for every year in AJ, CS, and FCR since the establishment of the journal. A total of 1 688 papers were found in this search. Then, the same search was done to select only papers with "China" in the address. A total of 331 papers were found in the second search. These data were used to calculate the percentage of rice papers with authors from Chinese research organizations to total rice papers published in the three journals every year from their establishment to September 8, 2017. Search was limited only to SCI-EXPANDED in Web of Science, while documental type included only articles and the language was restricted to English.

For the second set of data, we did topic search with rice as the keyword and included only papers with "China" in the address in the three journals. A total of 420 papers were found in this search. Topic search instead of title search was done in order to include all possible rice papers. All these 420 papers were scrutinized to exclude papers on other crops rather than rice and to include only papers on crop physiology and management. Papers that studied both rice and wheat in rice-wheat system were kept. Papers on rice varieties such as super rice, aerobic rice, and *Bt* rice, soil fertility and quality, diseases, and biochar were included if they were related to crop physiology and management. Furthermore, we included papers only with Chinese researchers as the first or corresponding author. A total of 186 papers are left after the above screening. The next step was to assign each of the 186 papers to a Chinese organization. Among the 186 papers, there were 19 papers in which the

address of corresponding author was in a foreign country but the first author has been working in China or returned back to China in recent years. For these 19 papers, the first Chinese organization in the authors' affiliation list was used. Scientific research cooperation network analysis was conducted using CiteSpace 5.0 to determine the co-occurrence of collaborating researchers and organizations in the 186 papers according to Chen (2006) and Chen *et al.* (2012).

Performance of the 186 papers in terms of citations was analyzed based on Web of Science (up to September 8, 2017). Average citation per paper, average citation per paper and per year, and h-index were calculated. The h-index is defined as the number *n* of papers that have all received at least *n* citations. Papers with international collaboration were separated to determine the frequency of foreign countries with co-authors in the 186 papers. The citation performance of papers with and without international collaboration was compared. Keywords of the 186 papers were analyzed to identify hot research topics.

3. Results

AJ, CS, and FCR started publishing papers in 1949, 1966, and 1978, respectively (Fig. 1), but AJ published its first paper with rice in the title until 1962 while the other two journals published rice paper in the same year when they were established. AJ, CS, and FCR published the first rice paper with authors from Chinese research organizations until 2001, 1987, and 1994, respectively (Fig. 1). The percentage of rice papers with authors from Chinese research organizations to total rice papers increased rapidly since then for the three journals. It peaked at 55.6% in 2016, 71.4% in 2014, and 54.5% in 2017 for AJ, CS, and FCR, respectively.

Fig. 2 focuses only rice papers published by Chinese researchers as the first or corresponding author on crop physiology and management in the three journals. The first such paper was published by AJ, CS, and FCR in 2001, 1993, and 1994, respectively. Since then, this kind of rice papers increased rapidly in FCR. Consequently, FCR published the highest number of rice papers from China on crop physiology and management, followed by AJ and CS. Yearly average number of rice papers from China published by the three journals on crop physiology and management was 1.6, 6.5, and 21.0 for the periods of 1993–2005, 2006–2011, and 2012–2017, respectively (Fig. 3-A), suggesting a booming research on the crop physiology and management of rice plants in recent years in China.

The Chinese research organizations that published at least four papers on rice physiology and management in AJ, CS, and FCR were listed in Table 1. Huazhong Agricultural University, Yangzhou University, and Nanjing Agricultural University took the top three positions. These three universities published 54.4% of all 186 papers. Huang Min of Hunan Agricultural University, followed by Yang Lianxin and Yang Jianchang of Yangzhou University published the most number of rice papers as the first author on crop physiology and management in AJ, CS, and FCR (Table 2). Among the top eight first authors in terms of paper number, four were from Yangzhou University and two from Huazhong Agricultural University. For the corresponding author, the top three positions belonged to Peng Shaobing of Huazhong Agricultural University, Yang Jianchang of Yangzhou University, and Zhu Yan of Nanjing Agricultural University (Table 3). Among the top eight corresponding authors in terms of paper number, three were from Yangzhou University and two each from Huazhong Agricultural University and Nanjing Agricultural University. The frequency of occurrence and co-occurrence of the authors (including all co-authors) and

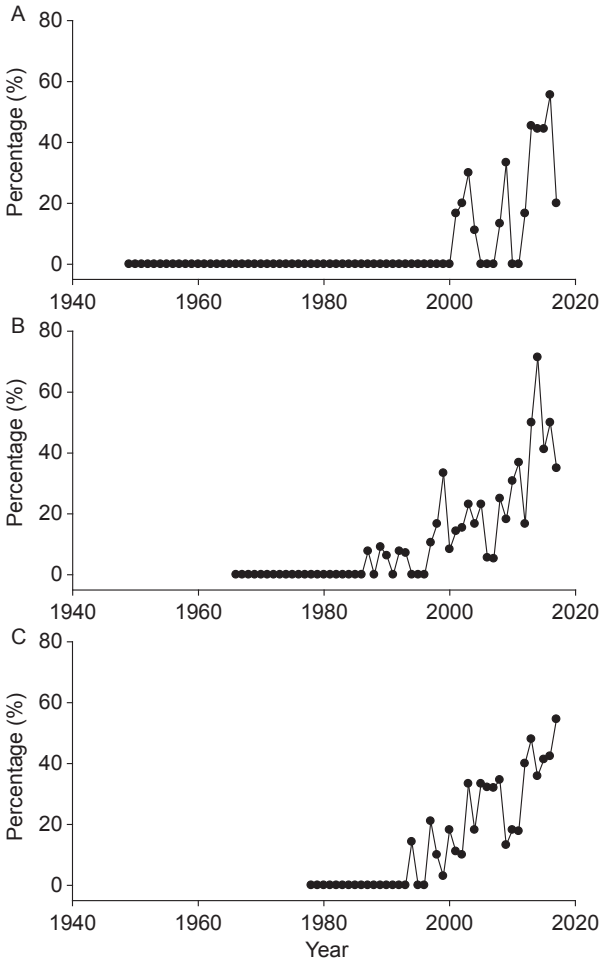

Fig. 1 Trends in the percentage of rice papers with authors from Chinese research organizations to total rice papers from the beginning of the journal establishment to September 8, 2017 in *Agronomy Journal* (A), *Crop Science* (B), and *Field Crops Research* (C). Rice papers are those with "rice" in the title from Web of Science.

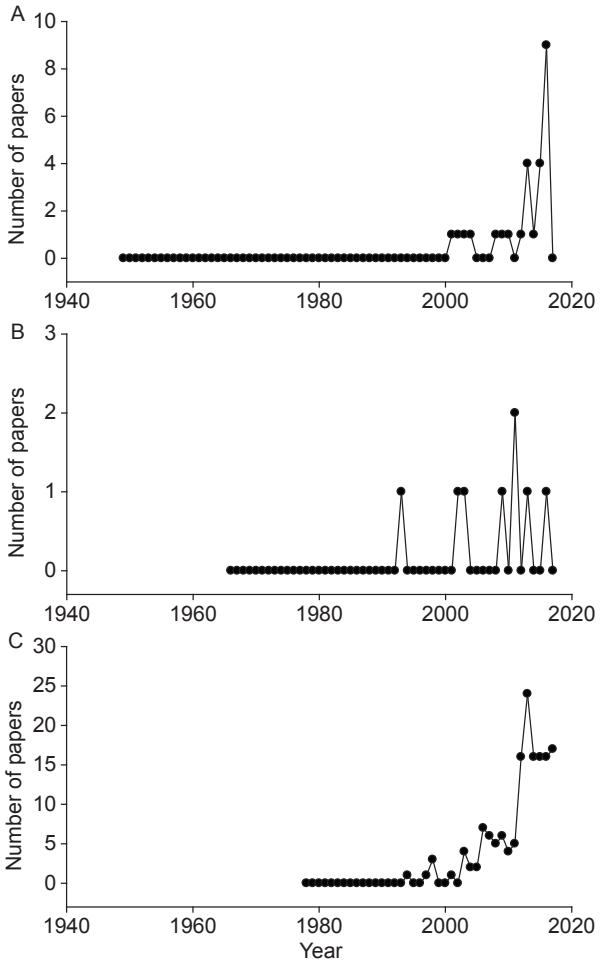

Fig. 2 Changes in the number of rice papers published by Chinese researchers as the first or corresponding author on rice physiology and management in *Agronomy Journal* (A), *Crop Science* (B), and *Field Crops Research* (C). The period covers from the beginning of the journal establishment to September 8, 2017.

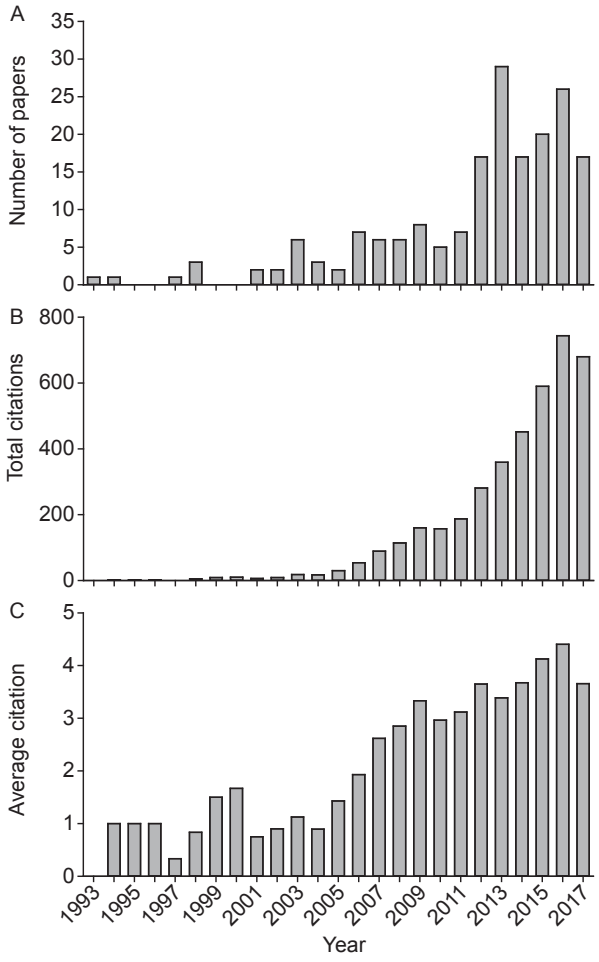

Fig. 3 The number of rice papers and their citation performance from 1993 to September 8, 2017. These papers were published by Chinese researchers as the first or corresponding author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*. No such paper was published prior to 1993 in these three journals. Average citation was the number of citations per paper and per year.

organizations (including all collaborating organizations and foreign organizations) in the 186 papers are depicted in Fig. 4. Table 4 shows the most frequently used keywords in the 186 papers. Nitrogen (N)-related keywords occupied three of the top five positions.

Total citations of rice papers published by Chinese researchers as the first or corresponding author on crop physiology and management in AJ, CS, and FCR have also increased rapidly in recent years (Fig. 3-B). Average citation per paper per year was 1.0 between 1993 and 2006, and it increased to 3.4 between 2006 and 2017 (Fig. 3-C). Total citations of each paper and the h-index of the 186 papers were shown in Fig. 5. The maximum number of total citation was 216 and the h-index of the 186 papers was 34. Table 5 shows the frequency of foreign countries with co-authors in the 186 papers. Collaboration was most frequent with the Philippines, followed by USA and Germany. The papers with international collaboration have much better citation performance than the papers without international collaboration (Table 6).

4. Discussion

A total of 83 journals are categorized as agronomic journals by the Journal Citation Reports, ISI, Clarivate Analytics. Among them, AJ, CS, FCR, *European Journal of Agronomy* (EJA), *Journal of Agronomy and Crop Science* (JACS), *Agronomy for Sustainable Development* (ASD), and *Rice* published papers on rice crop physiology and management, and those journals have impact factors greater than 1. Chinese researchers published 25, 11, 8, and 6 rice papers

as the first or corresponding author on crop physiology and management in EJA, JACS, ASD, and Rice, respectively, from the beginning of the journal establishment to September 8, 2017 (data not shown). In this study, bibliometric analysis was done on the 186 rice papers published by Chinese researchers on crop physiology and management in AJ, CS, and FCR.

Rice papers published by Chinese researchers on crop physiology and management in AJ, CS, and FCR have increased several folds in recent years, suggesting a booming research in these areas in China. Their quality in terms of citation performance has also improved significantly in recent decade. This finding is supported by the fact that China had five organizations ranked in the top 10 organizations that published most number of high quality papers on crop science in SCI journals in 2012 (Liu *et al.* 2015). Wei *et al.* (2017) reported that China has produced the highest number of rice papers since 2006 and the number of rice papers from China was 1.75 times higher than that of Japan or USA in 2014. The rapid increase in journal papers was largely due to increased funding to support rice research in China in recent years.

Huazhong Agricultural University, Yangzhou University, and Nanjing Agricultural University were leading organizations in the number of rice papers published on crop physiology and management in the three major agronomic journals. International connection could explain better performance of these three organizations in terms of publication. Peng Shaobing worked at International Rice Research Institute (IRRI) between 1991 and 2010, started collaboration with Huazhong Agricultural University in 2002, and joined Huazhong Agricultural University as a full-time professor in 2011. When Peng Shaobing was working at IRRI, Huang Jianliang, Cui Kehui, and Nie Lixiao of Huazhong Agricultural University conducted Ph D thesis research at IRRI. Yang Jianchang of Yangzhou University has collaborated closely with Zhang Jianhua of Hong Kong Baptist University since the end of the last century. Yang Jianchang also had a collaboration with Peng Shaobing at IRRI. Huang Min who

Table 1 Chinese research organizations that published at least four papers on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*[1)]

Organization	No. of papers	Percentage (%)
Huazhong Agricultural University	39	21.0
Yangzhou University	34	18.3
Nanjing Agricultural University	28	15.1
China Agricultural University	15	8.1
Hunan Agricultural University	13	7.0
Chinese Academy of Sciences	11	5.9
Zhejiang Agricultural University	7	3.8
Chinese Academy of Agricultural Sciences	6	3.2
Sichuan Agricultural University	6	3.2
China National Rice Research Institute	4	2.2

[1)] The period covers from the beginning of the journal establishment to September 8, 2017.

Table 2 Chinese authors who published at least two papers as the first author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*[1)]

Name	Organization	No. of papers	Percentage (%)
Huang Min	Hunan Agricultural University	8	4.3
Yang Lianxin	Yangzhou University	6	3.2
Yang Jianchang	Yangzhou University	5	2.7
Jiang Yang	Huazhong Agricultural University	4	2.2
Peng Shaobing	Huazhong Agricultural University	4	2.2
Xu Xinpeng	Chinese Academy of Agricultural Sciences	3	1.6
Zhang Hao	Yangzhou University	3	1.6
Chu Guang	Yangzhou University	2	1.1
Deng Fei	Sichuan Agricultural University	2	1.1
Fan Mingsheng	China Agricultural University	2	1.1
Gu Junfei	Yangzhou University	2	1.1
Li Ganghua	Nanjing Agricultural University	2	1.1
Lin Xianqing	China National Rice Research Institute	2	1.1
Liu Leilei	Nanjing Agricultural University	2	1.1
Liu Meiju	China Agricultural University	2	1.1
Liu Yang	Nanjing Agricultural University	2	1.1
Wang Kai	Huazhong Agricultural University	2	1.1
Wang Yuan	Chinese Academy of Sciences	2	1.1
Wu Wei	Huazhong Agricultural University	2	1.1
Yin Xinyou	Jiangxi Agricultural University	2	1.1
Zhang Zichang	Jiangsu Academy of Agricultural Sciences	2	1.1

[1)] The period covers from the beginning of the journal establishment to September 8, 2017.

Table 3 Chinese authors who published at least three papers as the corresponding author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*[1)]

Name	Organization	No. of papers	Percentage (%)
Peng Shaobing	Huazhong Agricultural University	21	11.3
Yang Jiangchang	Yangzhou University	14	7.5
Zhu Yan	Nanjing Agricultural University	7	3.8
Huang Jianliang	Huazhong Agricultural University	6	3.2
Lin Shan	China Agricultural University	6	3.2
Wang Yulong	Yangzhou University	6	3.2
Cao Weixing	Nanjing Agricultural University	5	2.7
Zhang Jianhua	Yangzhou University	5	2.7
Cao Cougui	Huazhong Agricultural University	4	2.2
Ding Yanfeng	Nanjing Agricultural University	4	2.2
Li Ganghua	Nanjing Agricultural University	4	2.2
Nie Lixiao	Huazhong Agricultural University	4	2.2
Ren Wanjun	Sichuan Agricultural University	4	2.2
Zou Yingbin	Hunan Agricultural University	4	2.2
He Ping	Chinese Academy of Agricultural Sciences	3	1.6
Huang Min	Hunan Agricultural University	3	1.6
Miao Yuxin	China Agricultural University	3	1.6
Wang Shaohua	Nanjing Agricultural University	3	1.6
Zhang Fusuo	China Agricultural University	3	1.6
Zhang Hongcheng	Yangzhou University	3	1.6

[1)] The period covers from the beginning of the journal establishment to September 8, 2017.

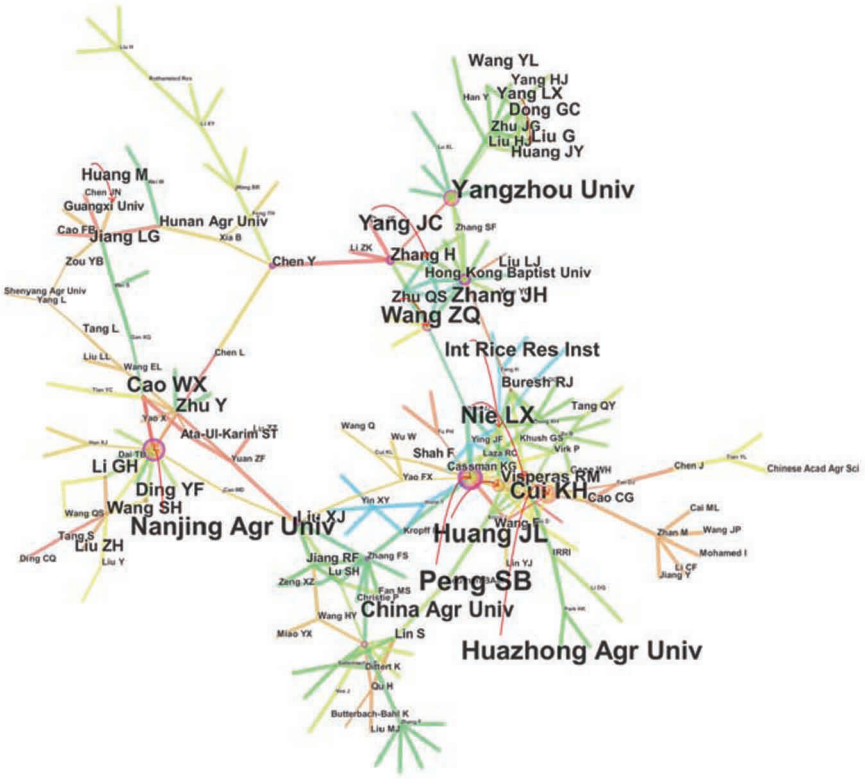

Fig. 4 Co-occurrence analysis of collaborating researchers and organizations for the 186 papers published by Chinese researchers as the first or corresponding author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*. CiteSpace 5.0 was used for the scientific research cooperation network analysis.

published the highest number of papers as the first author (Table 3) was graduated from Zou Yingbin's laboratory in Hunan Agricultural University. Zou Yingbin had a close collaboration with IRRI as early as 2000 and Peng Shaobing

Table 4 The most frequently used keywords in the papers published by Chinese researchers as the first or corresponding author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*[1)]

Keywords	Frequency	Keywords	Frequency
N use efficiency	27	Plant type	8
N management	26	*Bt* rice	7
Yield potential	21	High temperature	7
Plant N diagnosis	15	Rice-wheat	7
Grain quality	11	Aerobic rice	5
Non-flooded mulching	11	Critical N dilution curve	5
Alternate wetting and drying	10	Tillage	5
Integrated crop management	10	Global warming	4
Free-air CO_2 enrichment	9	Sheath blight	4
Super rice	9	Site-specific N management	4
Direct seeding	8	Soil fertility	4
Modeling	8	Water deficit	4

[1)] The period covers from the beginning of the journal establishment to September 8, 2017.

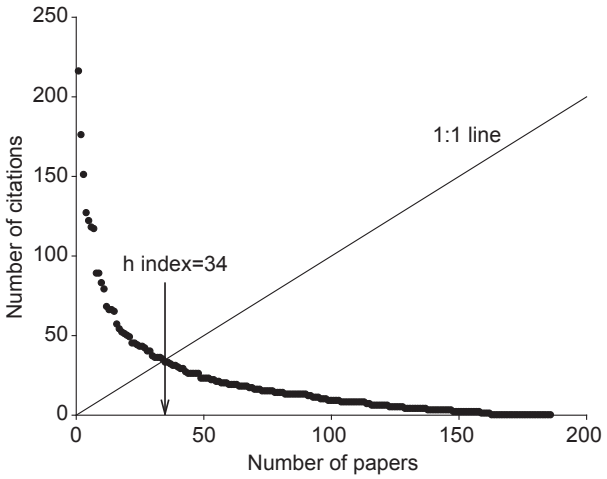

Fig. 5 The number of total citations of each of the 186 papers published by Chinese researchers as the first or corresponding author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*. The crossover point with the 1:1 line is the h-index of these 186 papers.

Table 5 Countries/Territories with co-authors in the papers published by Chinese researchers as the first or corresponding author on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*[1)]

Country/Territory	No. of papers	Percentage (%)
Philippines	27	14.5
USA	15	8.1
Germany	8	4.3
Australia	6	3.2
Pakistan	6	3.2
Japan	5	2.7
Canada	3	1.6
Egypt	3	1.6
Netherlands	3	1.6
England	2	1.1
Finland	2	1.1
India	2	1.1
North Ireland	2	1.1
Malaysia	1	0.5
South Korea	1	0.5
Spain	1	0.5

[1)] The period covers from the beginning of the journal establishment to September 8, 2017.

was associated with Hunan Agricultural University from 2004 to 2008 under the Furong Scholar Program funded by the Hunan Provincial Government. Scientific research cooperation network analysis using CiteSpace 5.0 demonstrated some of the connections between collaborating researchers and organizations (Fig. 4). For Nanjing Agricultural University, Cao Weixing established a strong research program on crop physiology and management in the late 1980s after graduation from Oregon State University, USA with a Ph D degree.

Among the 186 papers, the first paper was published by Yuan Shaochun of Huazhong Agricultural University in CS in 1993, which summarized the environmental effects on pollen fertility of photoperiod-sensitive genic male-sterile rice (Yuan *et al.* 1993). Since then, Huazhong Agricultural University started to publish papers on N use efficiency (NUE) (Peng *et al.* 2006), N management (Huang *et al.* 2008), yield potential (Yuan *et al.* 2011), and *Bt* rice (Wang *et al.* 2012; Jiang *et al.* 2013). The main subjects of publication for Yangzhou University were effects of water deficit on grain filling (Yang *et al.* 2001), grain filling and yield potential of *japonica*/*indica* hybrid (Yang *et al.* 2002), and CO_2 enrichment (Yang *et al.* 2006). Nanjing Agricultural University published papers mainly in plant N diagnosis (Xue *et al.* 2004), yield potential of super rice (Li *et al.* 2009), and modeling (Liu *et al.* 2013). Main publishing areas were non-flooded mulching for China Agricultural University (Liu *et al.* 2003; Tao *et al.* 2006), yield potential of super rice (Zhang *et al.* 2009) and zero tillage

Table 6 Citation performance of the papers published by Chinese researchers with and without international collaboration on rice physiology and management in *Agronomy Journal*, *Crop Science*, and *Field Crops Research*[1)]

	No. of papers	Total citations	Average citation per paper	h-index
With international collaboration	67	1933	28.9	21
Without international collaboration	119	2045	17.2	26
Total	186	3978	21.4	34

[1)] The period covers from the beginning of the journal establishment to September 8, 2017.

(Huang *et al.* 2012) for Hunan Agricultural University, and global warming (Ma *et al.* 2007) and modeling (Yu *et al.* 2012) for Chinese Academy of Sciences.

Analysis on the frequency of keywords suggested that yield potential has always been the research focus (data not shown). In addition, N-related research such as NUE, N management, and plant N diagnosis has dominated from 2001 to present. It is worth to note that N management research has gradually been shifted to integrated crop management (Xue *et al.* 2013). In recent years, popular research subjects were global warming including high temperature stress (Dong *et al.* 2011), direct seeding (Qi *et al.* 2012), zero tillage (Huang *et al.* 2012), *Bt* rice (Wang *et al.* 2012), and critical N dilution curve (Ata-Ul-Karim *et al.* 2013). New research is emerging on yield gap (Xu *et al.* 2016), rice ratooning (Dong *et al.* 2017), and simplified and reduced-input practices (Yuan *et al.* 2017).

Rice production is in the unprecedented period of transition in China (Peng 2014) due to a serious labor shortage in the rural areas (Cai and Wang 2010), an increase in the prices of agro-chemicals and seeds (NDRC 2015), and a high pressure of rice farming on the environment (Zhang *et al.* 2013). In the past, high rice yields were achieved with ample supply of labor, water, and agro-chemicals. In recent years, however, Chinese government has advocated greener manners in rice production to increase production efficiency with reduction in various inputs (MOA 2015; Fang *et al*. 2016). Furthermore, global climate changes are threatening rice production, and its frequency and severity are increasing over time. Therefore, more research on rice physiology and management is needed to meet these challenges in addition to research on rice genetics and breeding. We envisage that integrated crop management, direct seeding, yield potential, NUE, and water use efficiency will continue to be the research focuses for a long period of time, while rice ratooning, climate-smart crop management practices, simplified and reduced-input practices, and yield gap analysis are becoming hot research topics in the near future.

5. Conclusion

The number of papers published by Chinese researchers on rice physiology and management in the major agronomic journals has increased dramatically in the recent decade. Such trend will continue with China's economic development. More research on rice physiology and management is needed as China's rice production is facing new challenges. It is expected that research on rice physiology and management will play a more important role for sustainable rice production in a changing environment.

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References

Ata-Ul-Karim S T, Yao X, Liu X J, Cao W X, Zhu Y. 2013. Development of critical nitrogen dilution curve of *japonica* rice in Yangtze River Reaches. *Field Crops Research*, **149**, 149–158.

Cai F, Wang M Y. 2010. Growth and structural changes in employment in transition China. *Journal of Comparative Economics*, **38**, 71–81.

Chen C M. 2006. CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology*, **57**, 359–377.

Chen C M, Hu Z G, Liu S B, Tseng H. 2012. Emerging trends in regenerative medicine: A scientometric analysis in CiteSpace. *Expert Opinion on Biological Therapy*, **12**, 593–608.

Dong H L, Chen Q, Wang W Q, Peng S B, Huang J L, Cui K H, Nie L X. 2017. The growth and yield of a wet-seeded rice-ratoon rice system in central China. *Field Crops Research*, **208**, 55–59.

Dong W J, Chen J, Zhang B, Tian Y L, Zhang W J. 2011. Responses of biomass growth and grain yield of midseason rice to the anticipated warming with FATI facility in East China. *Field Crops Research*, **123**, 259–265.

Fang K M, Shen H F, Shuang Q Y, Zhong G M, Qiu S S, Yu J X. 2016. Problem of fertilizer application increase in rice and

countermeasures of 'zero increase'. *Chinese Agricultural Science Bulletin*, **32**, 200–204. (in Chinese)

Food and Agriculture Organization (FAO). 2017. FAOSTAT database: agriculture production. [2017-10-10]. http://www.fao.org/faostat/en/#data/QC

Huang J L, He F, Cui K H, Buresh R J, Xu B, Gong W H, Peng S B. 2008. Determination of optimal nitrogen rate for rice varieties using a chlorophyll meter. *Field Crops Research*, **105**, 70–80.

Huang M, Zou Y B, Jiang P, Xia B, Feng Y H, Cheng Z W, Mo Y L. 2012. Effect of tillage on soil and crop properties of wet-seeded flooded rice. *Field Crops Research*, **129**, 28–38.

Jiang Y, Huang S Q, Cai M L, Li C F, Kong X, Zhang F, Mohamed I, Cao C G. 2013. Yield changes of *Bt*-MH63 with *cry1C** or *cry2A** genes compared with MH63 (*Oryza sativa* L.) under different nitrogen levels. *Field Crops Research*, **151**, 101–106.

Li G H, Xue L H, Gu W, Yang C D, Wang S H, Ling Q H, Qin X, Ding Y F. 2009. Comparison of yield components and plant type characteristics of high-yield rice between Taoyuan, a 'special eco-site' and Nanjing, China. *Field Crops Research*, **112**, 214–221.

Liu B, Zhang L, Wang X W. 2017a. Scientometric profile of global rice research during 1985–2014. *Current Science*, **112**, 1003–1011.

Liu B, Zhang L, Zhang Y. 2017b. An input-output analysis of basic research projects on rice and maize supported by NSFC. *China Science Foundation*, **3**, 222–231. (in Chinese)

Liu L L, Zhu Y, Tang L, Cao W X, Wang E L. 2013. Impacts of climate changes, soil nutrients, variety types and management practices on rice yield in East China: A case study in the Taihu region. *Field Crops Research*, **149**, 40–48.

Liu M J, Wang T, Yuan X, Yan Y, Xu Y H, Chen L. 2015. Chinese institutions' disciplinary competitiveness in crop science based on bibliometrics. *Outlook of Agricultural Science and Technology*, **3**, 59–65. (in Chinese)

Liu X J, Wang J C, Lu S H, Zhang F S, Zeng X Z, Ai Y W, Peng S B, Christie P. 2003. Effects of non-flooded mulching cultivation on crop yield, nutrient uptake and nutrient balance in rice-wheat cropping systems. *Field Crops Research*, **83**, 297–311.

Ma H L, Zhu H G, Liu G, Xie Z B, Wang Y L, Yang L X, Zeng Q. 2007. Availability of soil nitrogen and phosphorus in a typical rice-wheat rotation system under elevated atmospheric [CO_2]. *Field Crops Research*, **100**, 44–51.

Ministry of Agriculture of China (MOA). 2015. National agricultural sustainable development plan (2015–2030). [2017-10-10]. http://www.moa.gov.cn/ztzl/mywrfz/gzgh/201509/t20150914_4827900.htm

Morooka K, Ramos M M, Nathaniel F N. 2014. A bibliometric approach to interdisciplinarity in Japanese rice research and technology development. *Scientometrics*, **98**, 73–98.

National Development and Reform Commission (NDRC). 2015. *National Agricultural Product Cost and Income Data Compilation*. China Statistics Press, Beijing. (in Chinese)

Peng S. 2008. The importance of improved crop management to world rice production. *Crop Research*, **22**, 207–208. (in Chinese)

Peng S. 2014. Reflection on China's rice production strategies during the transition period. *Scientia Sinica Vitae*, **44**, 845–850. (in Chinese)

Peng S B, Buresh R J, Huang J L, Yang J C, Zou Y B, Zhong X H, Wang G H, Zhang F S. 2006. Strategies for overcoming low agronomic nitrogen use efficiency in irrigated rice systems in China. *Field Crops Research*, **96**, 37–47.

Qi X L, Nie L X, Liu H Y, Peng S B, Shah F, Huang J L, Cui K H, Sun L M. 2012. Grain yield and apparent N recovery efficiency of dry direct-seeded rice under different N treatments aimed to reduce soil ammonia volatilization. *Field Crops Research*, **134**, 138–143.

Sun X H, Lu W R. 2012. Research trends of rice science based on Web of Science. *Chinese Journal of Rice Science*, **26**, 607–614. (in Chinese)

Tao H B, Brueck H, Dittert K, Kreye C, Lin S, Sattelmacher B. 2006. Growth and yield formation of rice (*Oryza sativa* L.) in the water-saving ground cover rice production system (GCRPS). *Field Crops Research*, **95**, 1–12.

Wang F, Ye C, Zhu L Y, Nie L X, Cui K H, Peng S B, Lin Y J, Huang J L. 2012. Yield differences between *Bt* transgenic rice lines and their non-*Bt* counterparts, and its possible mechanism. *Field Crops Research*, **126**, 8–15.

Wei Y P, Li C Y, Han M J, Zhao Y. 2017. Comparison in international academic impact among global major rice research institutions. *World Agriculture*, **457**, 56–64. (in Chinese)

Xu X P, He P, Zhao S C, Qiu S J, Johnston A M, Zhou W. 2016. Quantification of yield gap and nutrient use efficiency of irrigated rice in China. *Field Crops Research*, **186**, 58–65.

Xue L H, Cao W X, Luo W H, Dai T B, Zhu Y. 2004. Monitoring leaf nitrogen status in rice with canopy spectral reflectance. *Agronomy Journal*, **96**, 135–142.

Xue Y G, Duan H, Liu L J, Wang Z Q, Yang J C, Zhang J H. 2013. An improved crop management increases grain yield and nitrogen and water use efficiency in rice. *Crop Science*, **53**, 271–284.

Yang L X, Huang J Y, Yang H J, Dong G C, Liu G, Zhu J G, Wang Y L. 2006. Seasonal changes in the effects of free-air CO_2 enrichment (FACE) on dry matter production and distribution of rice (*Oryza sativa* L.). *Field Crops Research*, **98**, 12–19.

Yang J C, Peng S B, Zhang Z J, Wang Z Q, Visperas R M, Zhu Q S. 2002. Grain and dry matter yields and partitioning of assimilates in *japonica*/*indica* hybrid rice. *Crop Science*, **42**, 766–772.

Yang J C, Zhang J H, Wang Z Q, Zhu Q S, Wang W. 2001. Remobilization of carbon reserves in response to water deficit during grain filling of rice. *Field Crops Research*, **71**, 47–55.

Yu Y Q, Huang Y, Zhang W. 2012. Changes in rice yields in

China since 1980 associated with cultivar improvement, climate and crop management. *Field Crops Research*, **136**, 65–75.

Yuan S, Nie L X, Wang F, Huang J L, Peng S B. 2017. Agronomic performance of inbred and hybrid rice cultivars under simplified and reduced-input practices. *Field Crops Research*, **210**, 129–135.

Yuan S C, Zhang Z G, He H H, Zen H L, Lu K Y, Lian J H, Wang B X. 1993. Photoperiodic-reactions in photoperiod-sensitive genic male-sterile rice. *Crop Science*, **33**, 651–660.

Yuan W L, Peng S B, Cao C G, Virk P, Xing D Y, Zhang Y B, Visperas R M, Laza R C. 2011. Agronomic performance of rice breeding lines selected based on plant traits or grain yield. *Field Crops Research*, **121**, 168–174.

Zhang F S, Chen X P, Vitousek P. 2013. An experiment for the world. *Nature*, **497**, 33–35.

Zhang X F, Wang D Y, Fang F P, Zhen Y K, Liao X Y. 2005. Food safety and rice production in China. *Research of Agricultural Modernization*, **26**, 85–88. (in Chinese)

Zhang Y B, Tang Q Y, Zou Y B, Li D Q, Qin J Q, Yang S H, Chen L J, Xia B, Peng S B. 2009. Yield potential and radiation use efficiency of “super” hybrid rice grown under subtropical conditions. *Field Crops Research*, **114**, 91–98.

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