frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 05 April 2023
DOI 10.3389/fenvs.2023.1078565

OPEN ACCESS

EDITED BY
Xiangbin Kong,
China Agricultural University, China

REVIEWED BY
Haozhi Pan,
Shanghai Jiao Tong University, China
Yu Zhang,
Shanghai Jiao Tong University, China

*CORRESPONDENCE
Danshu Qi,
danshu@seu.edu.cn
Taiyang Zhong,
taiyangzhong@163.com

SPECIALTY SECTION
This article was submitted to Land Use Dynamics, a section of the journal Frontiers in Environmental Science

RECEIVED 24 October 2022
ACCEPTED 20 February 2023
PUBLISHED 05 April 2023

CITATION
Liu M, Qi D and Zhong T (2023), Agricultural development policy diffusion associated with leading cadre's experience and expansion of protected agriculture in China.
Front. Environ. Sci. 11:1078565.
doi: 10.3389/fenvs.2023.1078565

Agricultural development policy diffusion associated with leading cadre's experience and expansion of protected agriculture in China

Min Liu[1], Danshu Qi[2]* and Taiyang Zhong[1]*

[1]School of Geography and Ocean Science, Nanjing University, Nanjing, China, [2]School of Humanities, Southeast University, Nanjing, China

Protected agriculture has notably expanded since 2010 in China and many factors have influenced protected agricultural expansion. Yet little attention has been paid to how the successful experiences of protected agriculture demonstration areas have been diffused. Leading cadres are considered to play an important role in the policy diffusion process, yet little attention has been paid to the influence of leading cadres with connections to industry demonstration regions on industry development. Thus, this study examined the impact of mayors and municipal party secretaries connected to four protected agriculture demonstration regions—Shandong Province, Jiangsu Province, Hebei Province, and Liaoning Province—on the expansion of protected agriculture. This study used panel data from 314 prefectural-level cities and 1792 counties for the period 2014–2018 and the multidimensional fixed-effects model for a quantitative study. The results show that connected mayors significantly contribute to the expansion of protected agriculture, with the scale of protected agriculture in the county-level areas under their jurisdiction being on average 10.8% higher than that in areas under the jurisdiction of unconnected mayors. The effect of connected municipal secretaries on the expansion of protected agriculture was not significant. In addition, there were geographical differences in the impact of leading cadres on the expansion of protected agriculture. The positive impact of leading cadres on the protected agriculture expansion is significantly weakened when the area under their jurisdiction is located in the less economically developed western region or is part of the comprehensive climate unsuitable area during the March-June sowing period. The leading cadres connected to Shandong Province, Liaoning Province, and Jiangsu Province respectively had significantly different but positive impacts on the expansion of protected agriculture.

KEYWORDS

protected agriculture expansion, favoritism in leading cadres' decisions, the propensity score matching model, the difference in differences model, China

1 Introduction

Protected agriculture (PA, *SheShiNongYe* in Chinese) refers to a series of agricultural technologies that can increase crop yield, specifically including mulching, high tunnel, greenhouse, controlled environment agriculture, and drip irrigation (Jensen and Malter, 1995; Takeshima and Joshi, 2019). In the process of agricultural transition to sustainable intensification, PA has gained increasing attention as an industrialized agricultural

production method that uses technological engineering tools to control the production environment (Xie et al., 2017). PA has made an important contribution to meeting people's food needs, improving resource utilization efficiency, and promoting farmers' income growth. From 1980 to 2010, the area of PA worldwide has multiplied several times (Takeshima and Joshi, 2019). In China, PA has expanded rapidly since the mid-1990 s. In 2009, the total scale of PA in China was already the largest in the world, and by 2019 it covered 4.1 million hectares, with an annual output value of 980 billion yuan, more than 1/3 of the total agricultural output (Li, 2021); while the current annual output of greenhouse vegetables is 265 million tons, accounting for 1/3 of the total output (Li, 2022). Understanding the trends and driving mechanisms behind the expansion of PA in different regions is an important guide to accelerate the sustainable development of PA and provide a rational orientation for the transformation of agricultural and rural modernization (Wu and Zhang, 2013).

Existing studies have focused more on the development status of PA and have examined multiple factors that influence the expansion of PA, of which policy factors have been widely recognized as one of the most important contextual factors (Zhong et al., 2020). For example, Iceland's tariff policy and electricity subsidy policy have contributed to the continued development of greenhouse agriculture (Butrico and Kaplan, 2018). Chinese government-led food localization programs, aimed at stabilizing the local food supply, had also led to the expansion of greenhouse agriculture (Zhong et al., 2020). In fact, PA is a high-input, technology- and labor-intensive industry that needs to be incentivized by supportive government policies or plans for land use and industrial restructuring (Takeshima and Joshi, 2019). Therefore, the expansion of PA in different regions is not only the independent choice of farmers, but the influence of the diffusion of relevant policies or policy innovations among different governments may be more important (Lybbert and Sumner, 2012). However, few studies have analyzed agricultural development policy diffusion associated with the leading cadre's experience and expansion of PA. Unlike other countries and regions around the world, local officials in China's local political system have strong executive decision-making power (Chen Z. et al., 2019) and are important actors in driving policy diffusion (Liu and Yi, 2021). Research on policy diffusion has focused more on exploring diffusion mechanisms (Shipan and Volden, 2008), and some studies have focused on the facilitation effects generated by leading cadres and leadership transfer networks (Liu and Yi, 2021). However, little attention has been paid to the impact of the experience accumulated by leading cadres in specific regions with prominent industrial development on the diffusion of relevant industrial policy innovations, such as those in regions with prominent PA industry. It has been shown that leading cadres will disseminate and develop professional experience, institutional knowledge, and innovative ideas accumulated continuously in the workplace along their career paths, especially in the development of prominent industries in their birthplace and in the regions where they had served (Liu and Yi, 2021).

This study attempts to examine whether and how the expansion of PA is associated with leading cadres' experiences such as birth place and working place, which could influence agricultural development policy diffusion. According to the 2006 and 2016 agricultural census reports, four regions in China—Shandong Province, Jiangsu Province, Hebei Province, and Liaoning Province—have far surpassed other regions in China in terms of the scale and expansion rate of PA since 2006 (State Statistics Bureau, 2017). These four regions have developed mature models of PA development and play an important role as demonstration leaders in promoting PA expansion and technological innovation. Thus, the influence of policy diffusion on leading cadres' behavior in these four regions cannot be ignored when exploring the driving mechanism of China's PA expansion. To address this gap, this paper applies a multidimensional fixed-effects model to quantitatively analyze data on municipal leading cadres and the scale of PA from 2014 to 2018. This paper attempts to examine the role of leading cadres in the diffusion of PA, particularly to analyze the possible impact of the experience accumulated by leading cadres in Shandong, Jiangsu, Hebei, and Liaoning provinces on the expansion of PA and its differences. This paper offers a new perspective to promote the development of agricultural modernization in China and other countries undergoing rapid transition by exploring the mechanisms of diffusion of experience in the expansion of PA.

The next section theoretically constructs an analytical framework to explore the correlation between the expansion of PA and favoritism in leading cadres' decisions among policy diffusion and to formulate the hypotheses. Section 3 and Section 4 respectively introduce the data and methodology, and the empirical results of testing each hypothesis. Section 5 provides relevant discussions of each hypothesis. Finally, conclusions, policy implications, and research agendas are summarized in Section 6.

2 Theoretical framework

Policy diffusion refers to the spread of policy programs, development models, relevant knowledge, information, or experiences from one sector or region to another (Danaeefard and Mahdizadeh, 2022). Among them, policy actors or change agents play an important role in the process of policy diffusion (Liu and Yi, 2021). Research on policy diffusion suggests that the specific networks in which leading cadres are embedded influence the mechanisms, scope, and effects of policy diffusion (Shipan and Volden, 2012). Over the entire career of a leading cadre, his or her working experience is continuously enriched and gradually internalized into leadership competencies, while the social network of the leading cadre expands as he or she shifts from one place to another (Yi et al., 2018). The informal connection network between leading cadres and their birthplace and served/serve place can lead to governing preference, which in turn affects the governing strategies of leading cadres (Chen Z. et al., 2019; Mansha et al., 2022). Considering that PA is different from traditional agriculture, the former is an industry that requires local governments to make arable land resource utilization and agricultural production plans in advance, and invest more extra costs in terms of equipment, technology, and labor (LaPlante et al., 2021). And connected leading cadres with practical experience in PA would prioritize the application or innovation of relevant knowledge in their jurisdictions. Thus, connected leading cadres can help

facilitate the expansion of PA. Compared with other regions in China, four regions—Shandong Province, Jiangsu Province, Hebei Province, and Liaoning Province—have an early start, faster development, and larger scale of PA. These four regions have developed diverse PA production technologies, management models, and well-developed supply chains for greenhouse vegetables, which are significant concentrations of China's PA industry (State Statistics Bureau, 2017). Also, the mature experiences of these four regions in terms of production technologies and business management models of PA are important references for the widespread expansion of PA and the transformation of agricultural modernization (Bai and Zhang, 2021). Based on this, we propose hypothesis 1 (H1): municipal leading cadres (mayors, municipal party secretaries) who grew up or served/serve in Shandong, Jiangsu, Hebei, and Liaoning provinces are likely to have accumulated more knowledge and practical experience regarding the expansion of PA and would show favoritism in decisions of promoting PA expansion.

The governing decisions of leading cadres are complex and are constrained by a variety of factors such as the initial socioeconomic and resource endowment conditions, the development goals, and the personal experience and ability of the leading cadres (Wang et al., 2016; Wen et al., 2017; Chen Z. et al., 2019; Wang, 2022). On the one hand, considering the differences in development conditions between different served/serve places, rational leading cadres would not blindly copy the successful experiences of other regions, but would selectively apply their acquired experiences or would make adaptive innovations when promoting a certain development model (Liu and Yi, 2021). On the other hand, although the four regions we mentioned, Shandong, Jiangsu, Hebei, and Liaoning provinces, are all prominent in China in the field of PA, they are not exactly the same in terms of specific production models and business models, etc. This means that there would be differences in the diffusion effects of different types of PA development models, e.g., certain models are more adaptable in other regions, making it less difficult and risky for leading cadres to diffuse corresponding policies in these regions. That is, leading cadres connected to different prominent regions of PA acquire different industrial development experiences and social networks, and in turn, they show different governing preferences in the present serve regions. Based on this, we put forward hypothesis 2 (H_2): different regions are differentially influenced by the governing preferences of connected leading cadres in terms of PA expansion, and the leading cadres with connections to Shandong, Jiangsu, Hebei, and Liaoning provinces respectively will have different impacts on the decisions regarding the promotion of PA.

3 Methods and data

3.1 Methodology and model specification

The main purpose of this study is to examine the causal relationship between the decisions of leading cadres with governing preference and the expansion of PA. That is, this study requires a valid measure on governing preferences that may continuously arise during the career transfer process of leading cadres, which is a challenge. This is because the promotion or transfer of leading cadres is not random in China's political system, and the measurement of governing preferences of leading cadres needs to address endogenous formation (Zhang and Yang, 2022). Moreover, it is difficult to directly observe the experience gained by leading cadres in these regions. Leading cadres who have worked longer periods of time may have accumulated more managerial experience and have a greater willingness to adopt a high-input, high-risk, high-output development model (Chen S. et al., 2019). Therefore, the estimation results may incorrectly attribute unobserved capacity differences to the explanation of the impact of leading cadres with governing preference on PA expansion. To measure the causal relationship between leading cadres with governing preference and the expansion of PA, this study considers leading cadres who grew up or served/serve in Shandong, Jiangsu, Hebei, or Liaoning provinces as having governing preferences. And this study constructs a multidimensional fixed effects model that includes the fixed effects of leading cadres characteristics, regions, and years (Xu, 2018). The baseline model is as follows (see Eq. 1):

$$PA_{it} = \beta_0 + \beta_1 Treat_{it} + \beta_2 Time_{it} + \beta_3 Treat_{it} \cdot Time_{it} + \delta \sum_n X_{it} + A_i + B_t + C_p + \varepsilon_{it} \quad (1)$$

Where i represents the region (county-level), p represents the city, t stands for the year, PA_{it} denotes the PA area in year t of county i. $Treated_{it}$, as a treatment variable, denotes "whether there is a leading cadre with governing preference in region i during the study period", and if yes, the sample is the treatment group and $Treated_{it}$ is 1. If otherwise, the sample is the control group, the $Treated_{it}$ is 0. $Time_{it}$, as a time dummy variable, indicates "whether the city p is served by a leading cadre with governing preferences in year t", and if yes, $Time_{it}$ is 1; if otherwise, $Time_{it}$ is 0. $Treat_{it} \cdot Time_{it}$ is the core explanatory variable that indicates the effect of leading cadres with governing preferences on the expansion of PA, and this estimated coefficient needs to be focused. If the value is significantly positive, it indicates that leading cadres with governing preferences promote the expansion of PA. β_0 is a constant term and X_{it} is a set of covariates. A_i indicates the individual fixed effect of county i , which absorbs the heterogeneity associated with the experience accumulated locally by leading cadres. C_p is the regional fixed effect of city p, which is used to absorb the unobserved regional resource endowment. B_t is a time fixed effect to absorb unobserved time shocks and ε_{it} denotes the random perturbation term.

3.2 Dependent and independent variables

Referring to the existing literature, this paper sets the current year's PA land area as the explanatory variable to characterize the development of PA instead of the annual change in land use. Since the PA development level varies from place to place and the scale varies widely, to eliminate possible heteroscedasticity, the area data take a logarithmic form.

This study focuses on the influence of leading cadres with governing preference on the expansion of PA. Studies have shown that provincial leading cadres' decisions are more

TABLE 1 Variables description and summary statistics.

Set	Variable (*variable symbol*)	Definition (unit)	Mean	Max	Min
Outcome	Scale of protected agriculture (*lnPA*)	The log value of the scale of the protected agricultural area (ha)	5.778	14.655	0
Treatment	Treat	Whether the cadre (mayor or municipal party secretary) has grown up or has worked in Shandong, Jiangsu, Hebei, and Liaoning provinces, *Treat* = 1 if Yes; otherwise, *Treat* = 0	0.378, 0.415	1, 1	0, 0
PC	Age (*Age*)	Age of the cadre (ages)	51.974, 53.897	62, 61	38, 43
	Age over 55 (*Age55*)	Whether the cadre aged 55 or over, *Age55* = 1 if Yes; otherwise, *Age 55* = 0	0.235, 0.437	1, 1	0, 0
	Tenure (*Tenure*)	Length of local service of the cadre (years)	2.564, 2.528	11, 9	1, 1
SEC	Municipal GRP (*lnMpgrp*)	The log value of municipal gross regional product *per capita* (10,000 yuan/person)	1.199	3.324	−0.308
	Municipal agricultural output (*Mprimary*)	The ratio of the added value of the municipal primary industry to municipal gross regional product (%)	0.168	0.571	0.014
	County industrial development (*Rsgrp*)	The ratio of the added value of county secondary industry to gross regional product (%)	0.424	0.887	0.013
	Municipal financial pressure (*lnMfpressure*)	The log value of municipal public finance gap (10,000 yuan)	13.872	15.584	−14.35
	County financial pressure 1 (*Rfpressure*)	The ratio of the county public finance gap to gross regional product (%)	0.230	3.781	−0.469
	County financial pressure 2 (*lagFpressure*)	One-period lag value of county public finance gap (10,000 yuan)	174,644	1,202,550	−66471
	Municipal population pressure (*lnMpopulation*)	The log value of municipal population density (people/square kilometers)	5.132	7.776	−0.354
NC	Climate unsuitable area72 (*Unsuit72*)	Whether it is a climate-unsuitable area for conducting protected agriculture from July to February, *Unsuit72* = 1 if Yes; otherwise, *Unsuit72* = 0	0.566	1	0
	Climate unsuitable area36 (*Unsuit36*)	Whether it is a climate-unsuitable area for conducting protected agriculture from March to June, *Unsuit36* = 1 if Yes; otherwise, *Unsuit36* = 0	0.752	1	0

influenced by central government power, while county-level leading cadres are mostly local and rarely experience workplace changes across provinces or municipalities (Yao and Zhang, 2015; Chen S. et al., 2019). Therefore, it is more reasonable to explore the governing preferences of municipal-level leading cadres. Moreover, in China's political system, there are some differences in the responsibilities of mayors and municipal party secretaries. Therefore, this study used the dummy variables *MTreat* and *STreat* to characterize whether the mayor and the municipal party secretaries have governing preferences, respectively, as the core explanatory variables of the model. In addition, the suffixes *s*, *j*, *h*, and *l* were added after the above variable names to distinguish whether the preferences of leading cadres for PA expansion are associated with the experiences gained in Shandong, Jiangsu, Hebei, and Liaoning provinces, respectively.

Since the expansion of PA is also influenced by other factors, three sets of covariates were included in the model with reference to the existing literature to reduce estimation bias caused by omitted variables. As shown in Table 1, one group is *PC* (representing the leading cadres' personal characteristics), one group is *SEC* (representing the socio-economic development characteristics), and the last group is *NC* (representing the regions' natural characteristics).

The personal characteristics of the leading cadres affect the extent to which the government implements different policies (Chen et al., 2017; Chen Z. et al., 2019; Meng et al., 2019). For example, the age and the length of locality tenure of the leading cadres are correlated with their perceptions of career promotion prospects and their identity to served place. Scholars mostly believe that the younger the leading cadres are and the shorter their tenure in the local area, the more they tend to adopt behaviors that will lead to substantial regional economic development in the short term and achieve their promotion goals (Chen et al., 2017). As the age increase, there will be a turning point in the promotion probability of leading cadres. And it has been demonstrated that leading cadres would choose a more conservative governing strategy after that turning point at around 54 years old (Chen S. et al., 2019). Thus, this study used the continuous variables *Tenure* and *Age*, as well as the dummy variable *Age55* (indicating the leading cadre aged 55 or over) to characterize the personal characteristics of the leading cadres. In addition, the prefixes *M* and *S* were added in front of the above variables' names

to distinguish the characteristics of mayors and municipal party secretaries.

The socioeconomic development status of the region is characterized by economic indicators, industrial development indicators, financial pressure indicators, and demographic indicators. Firstly, there is a positive relationship between economic development and agricultural development, and most regions with rapid economic development also experience greater growth in agriculture (Valdés and Foster, 2010). Thus, this study used a continuous variable *lnMpgrp* (representing the log value of municipal gross regional product *per capita*) to reflect the level of regional economic development (Zhang and Lu, 2016). Secondly, the impact of regional industrialization on agricultural development is bilateral. If a city experiences industrialization at the expense of agricultural degradation, landscape fragmentation in that region would inhibit PA expansion (Fan, 2004). If a region adopts a new industrialization technology that coordinates the development of industry and agriculture, it may bring new opportunities for PA expansion (Fan, 2004). An increase in agricultural output effect indicates the improvement of the degree of agricultural modernization and the enhancement of the possibility of PA expansion (Huang, 2010). Therefore, this study includes the continuous variable *Mprimary* (representing the ratio of the added value of the municipal primary industry to gross regional product) to capture the agricultural output effect and the continuous variable *Rsgrp* (representing the ratio of the added value of county secondary industry to gross regional product) to characterize the industrialization of the region. Finally, it has been suggested that the regional fiscal pressure will have an impact on land finance decisions in the following year, while there may be some inertia effects on the scale and structure of financial expenditures (Wu et al., 2019), which will, in turn, affect the PA expansion. Therefore, this study used the continuous variables *lnMfpressure* (representing the log value of municipal public finance gap), *Rfpressure* (representing the ratio of the county public finance gap to gross regional product), and *lagFpressure* (representing the one-period lag value of county public finance gap) to measure the perceived financial pressure of local governments (Wang et al., 2013; Yang and Peng, 2015; Wang and Yin, 2019; Wu et al., 2019). Under fast urbanization, a substantially growing urban population has raised the demand for urban construction land, which in turn has increased the difficulty of expanding PA (Liu et al., 2020). Therefore, this study used the continuous variable *lnMpopulation* (representing the log value of municipal population density) to characterize the demographic pressure on regional development.

The natural characteristic of the region is characterized by regional climatic suitability. Although PA has the advantage of year-round production compared to open-air agriculture, uncertain weather conditions would still affect the construction cost of PA facilities and the management cost in the production process (Eben-Chaime et al., 2011). Due to the vast size of China, the climatic characteristics and the types of natural disasters that may be encountered vary from place to place, resulting in different climatic suitability for the development of PA in different regions (Gao et al., 2022). Zhang et al. (2021) evaluated the climatic suitability of PA based on day-by-day meteorological data from 1990 to 2019 in China. The results showed that during the sowing period from July to February each year, the unsuitable areas were mainly clustered in northeast, northwest, southwest, and north China; during the sowing period from March to June each year, the unsuitable areas were mainly clustered in south-central, north-western, and south-western regions of China (Zhang et al., 2021). In this study, the dummy variables *Unsuit72* and *Unsuit36* were set to characterize the areas that were part of the combined climate unsuitable zone in the two sowing periods, respectively.

3.3 Data sources

This paper uses panel data on the characteristics of municipal-level cadres matched with county-level macro statistics from 2014 to 2018 for quantitative estimation in 314 prefecture-level cities and 1,792 counties in China. On the one hand, personal and tenure information of municipal-level leading cadres is obtained from public platforms such as People's Daily Online, Xinhua Online, and Baidu Search, and is manually compiled by the authors. On the other hand, regional macroeconomic data is collected from the China County Statistical Yearbook (County and City Volume) from 2015 to 2019 (National Bureau of Statistics Rural Socio-Economic National Bureau of Statistics Rural Socio-Economic Survey, 2015, 2019). Considering the special administrative divisions of the four Chinese municipalities (Beijing, Tianjin, Shanghai, and Chongqing), and the missing data of key variables in Hong Kong, Macao, Taiwan, and some other counties and cities, the data of these areas are excluded. The moving average method is used to deal with some missing values.

4 Empirical results

The empirical results of this paper comprise mainly consist of three aspects: the first is to test H1 by examining whether the governing preferences for promoting the PA expansion are associated with the municipal leading cadres with connections to Shandong, Jiangsu, Hebei, and Liaoning provinces. The second is to test H_2 by analyzing whether there are regional differences among the governing preferences of leading cadres and comparing whether there are differences in the governing preferences of leading cadres connected with different regions. And the last is about model robustness tests.

4.1 Estimation results of protected agriculture expansion decisions

Based on the above model settings, the results are shown in Table 2. The coefficient for the core explanatory variable in Model (1) is positive and statistically significant at 1% level. Model (2), which adds covariates into the model, also shows a positive coefficient significant at 1% level. Models (3)–(5) take individual, regional, and time-fixed effects into account, respectively, among which the coefficients of the core explanatory variable regression are similar and remain statistically significant. The model fitting effect gets significantly improved as the increasing value of fitting efficiency (R2), and the decreasing results of Akaike

TABLE 2 Estimation results of leading cadre's favoritism on protected agriculture expansion decisions.

Variable	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
MTreat·Time	**0.443*** (0.066)**	**0.185*** (0.064)**	**0.541*** (0.048)**	0.023 (0.069)	**0.108* (0.069)**	**0.114* (0.069)**
MAge		**0.016** (0.007)**	**0.045*** (0.008)**	**0.012** (0.006)**	**0.011* (0.006)**	**0.012** (0.006)**
MAge55		−0.063 (0.044)	**−0.177*** (0.062)**	−0.064 (0.042)	−0.004 (0.042)	−0.008 (0.042)
Unsuit72		0.000 (0.099)	0.083 (0.052)			
Unsuit36		−0.114 (0.104)	0.062 (0.056)			
Mprimary		**3.292*** (0.585)**	**3.547*** (0.340)**	**1.956** (0.823)**	**2.724*** (0.833)**	**2.707*** (0.851)**
lnMpopulation		**0.583*** (0.033)**	**0.584*** (0.018)**	−0.172 (0.259)	−0.066 (0.257)	−0.116 (0.258)
lnMpgrp		**0.685*** (0.085)**	**0.893*** (0.048)**	0.159 (0.123)	**0.979*** (0.150)**	**0.906*** (0.160)**
lnMfpressure		−0.006 (0.012)	**−0.016* (0.009)**	0.007 (0.009)	0.011 (0.009)	0.012 (0.009)
Rsgrp						0.179 (0.331)
cMTreat·Time_cRsgrp						**0.951***(0.358)**
Constant	**5.638*** (0.046)**	0.710 (0.469)	**−1.249*** (0.442)**	**5.411*** (1.357)**	**3.727*** (1.363)**	**3.925*** (1.365)**
Individual effect	No	No	Yes	Yes	Yes	Yes
Regional effect	No	No	No	Yes	Yes	Yes
Time effect	No	No	No	No	Yes	Yes
R^2_a			0.206	0.763	0.766	0.767
AIC			36,130.033	23,311.063	23,168.213	23,163.036
BIC			36,201.024	23,367.855	23,225.006	23,234.026

Notes: *, **, and*** represent statistically significant at the level of 10%, 5%, and 1%, respectively, the same as below. The meaning of bold font that we want to highlight the significant results of the estimation.

information criterion (AIC) and Schwartz or Bayesian information criterion (BIC) are shown. According to Model (5), connected mayors could significantly increase the scale of PA by 10.8%, which confirms hypothesis 1. In Model (6), the coefficient of the interaction term is statistically significant and positive with 0.951, which indicates that the better-developed secondary industry in county-level areas could significantly enhance the governing preference of connected mayors for PA expansion. Among the results of Model (1)-Model (6), the coefficients of the core explanatory variable and relevant covariates largely maintain consistency in sign, direction, and significance, which means mayors with connections to Shandong, Jiangsu, Hebei, or Liaoning provinces have a significant contribution to PA expansion. Besides, the results of connected municipal party secretaries were not reported due to their insignificant effect on PA expansion.

4.2 Estimation results for the impact of regional differences in governance favoritism

Based on Model (5) above, regional variability among the effects of leading cadres' governing preferences on PA expansion is estimated by adding interaction terms between leading cadres and regional dummy variables and also by replacing the core explanatory variables for leading cadres connected with Shandong, Jiangsu, Hebei, and Liaoning regions, respectively.

The results of Model (7)-Model (9) in Table 3 indicate that the positive impact on PA expansion would be significantly weakened among connected leading cadres who are serving in the western region or the comprehensive climate unsuitable regions. Specifically, the coefficients of the interaction term in Model (7) and Model (8) are both statistically significant and negative, with −0.268 and −0.279. While that of leading cadres' governing preference variables are both statistically significant and positive, with 0.218 and 0.204. This indicates that the positive influence of connected leading cadres on the expansion of PA would be decreased by regional characteristics when the jurisdiction is located in the western region. Similarly, the coefficient of the interaction term in Model (9) is statistically significant and negative, with −0.226. Thus, the positive effect on PA expansion of connected leading cadres who are in areas that are part of comprehensive climatic unsuitable areas during the March-June sowing period would be greatly influenced by climatic characteristics, such as high temperatures and lack of sunlight (Zhang et al., 2021). Besides, the coefficients of the leading cadres' governing preference in Model (10)-Model (12) are significantly positive but different. Mayors with connections to Jiangsu, and municipal party secretaries with connections to Shandong and Liaoning provinces all have significant positive governing preferences for expanding the scale of PA by 0.293, 0.150, and 0.408, respectively. That is, the influence of different regions on

TABLE 3 Estimation results of regional difference on leading cadre's favoritism.

Variable	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)	Model (12)
MTreat·Time	**0.218** (0.088)**					
MSTreat·Time		**0.204** (0.099)**	**0.187* (0.108)**			
MTreat·Time_j				**0.293** (0.122)**		
STreat·Time_s					**0.150** (0.061)**	
STreat·Time_l						**0.408*** (0.154)**
MAge	**0.011* (0.006)**			0.009 (0.006)		
MAge55	−0.007 (0.042)			−0.001 (0.042)		
Age		0.014 (0.009)	0.015 (0.009)			
Age55		**−0.079* (0.041)**	**−0.083** (0.041)**			
SAge					−0.013 (0.008)	−0.011 (0.008)
SAge55					0.045 (0.042)	0.047 (0.042)
Mprimary	**2.842*** (0.835)**	**2.875*** (0.831)**	**2.835*** (0.831)**	**2.674*** (0.833)**	**2.657*** (0.829)**	**2.546*** (0.829)**
lnMpopulation	−0.054 (0.257)	−0.015 (0.258)	−0.010 (0.258)	−0.055 (0.257)	−0.082 (0.257)	−0.035 (0.257)
lnMpgrp	**0.978*** (0.150)**	**1.013*** (0.150)**	**1.047*** (0.150)**	**0.953*** (0.150)**	**1.007*** (0.148)**	**0.994*** (0.148)**
lnMfpressure	0.011 (0.009)	**0.015*(0.009)**	**0.015*(0.009)**	0.011 (0.009)	0.014 (0.009)	0.015*(0.009)
MTreat·Time_Warea	**−0.268** (0.135)**					
MSTreat·Time_Warea		**−0.279** (0.125)**				
MSTreat·Time_Unsuit36			**−0.226* (0.130)**			
Constant	**3.652*** (1.363)**	**3.190** (1.447)**	**3.090** (1.451)**	**3.813*** (1.363)**	**4.996*** (1.418)**	**4.680*** (1.419)**
Individual effect	Yes	Yes	Yes	Yes	Yes	Yes
Regional effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
R^2_a	0.767	0.766	0.766	0.767	0.766	0.766
AIC	23,165.282	23,223.467	23,225.929	23,164.082	23,222.249	23,221.002
BIC	23,229.173	23,287.372	23,289.833	23,220.874	23,279.053	23,277.807

The meaning of bold font that we want to highlight the significant results of the estimation.

the leading cadres with whom they are connected varies, and the successful experience of PA in Liaoning Province may be relatively easier to spread.

4.3 Model robustness test

(1) Changes in estimation method. Considering that the non-random promotion or transfer of leading cadres may cause bias in sample selection and estimation results. Therefore, this part first adopts the PSM method to remove the mismatched samples and then re-estimates the multidimensional fixed-effects model of Model (5). Among them, the PSM method is applied with the kernel matching method, and the covariates of the model include the regional socioeconomic development characteristics and natural characteristics mentioned above. The estimation results of the core explanatory variables and relevant control variables of Model (13) in Table 4 are generally consistent with those of Model (5) in Table 2. This indicates that the results estimated using the multidimensional fixed effects model in the main text are robust and less affected by sample selection bias.

(2) Substitution of independent variables. In this section, the variable *lnPA* is replaced by the original value (*PA*), annual variation (*dPA*), the one-period lag value of PA (*lagPA*), and the log value of the one-period lag value of PA (*lnlagPA*) respectively. The fitting effects of Model (14)-Model (16) in Table 4 are very poor, while the estimation of Model (17) is closer to that of Model (5) in Table 2. This means that the logarithmic treatment for the scale of PA in the main text well reduced the effect of abnormal values. Also, the effect of favoritism in mayors' decisions on PA expansion is rarely affected by the scale of PA in the previous year.

TABLE 4 Estimation results of the robustness test.

Variable	Model (13)	Model (14)	Model (15)	Model (16)	Model (17)
	Y = lnPA	Y=PA	Y = dPA	Y = lagPA	Y = lnlagPA
MTreat·Time	**0.141** (0.070)**	858.872 (1759.831)	831.801 (2,709.682)	27.399 (1713.305)	−0.009 (0.047)
MAge	0.006 (0.006)	23.197 (153.698)	60.051 (236.795)	−39.454 (149.723)	0.006 (0.004)
MAge55	0.013 (0.044)	−57.189 (1,079.347)	−455.821 (1,666.698)	426.056 (1,053.836)	−0.028 (0.029)
Mprimary	**3.797*** (0.892)**	−13740.432 (21,391.828)	−14663.871 (32,840.600)	1856.002 (20,764.785)	**1.934*** (0.566)**
lnMpopulation	−0.074 (0.270)	1986.196 (6,550.040)	42.160 (10,145.080)	1805.732 (6,414.633)	0.110 (0.175)
lnMpgrp	**1.080*** (0.159)**	−1,695.057 (3,827.520)	−2,763.585 (5,897.727)	1,168.681 (3,729.074)	**0.514*** (0.102)**
lnMfpressure	0.015 (0.010)	−64.430 (221.946)	−89.979 (338.478)	32.366 (214.016)	0.010 (0.006)
Constant	**3.801** (1.499)**	−4,516.557 (34,750.333)	3,534.380 (53,731.478)	−7,589.496 (33,973.878)	**3.860*** (0.926)**
Individual effect	Yes	Yes	Yes	Yes	Yes
Regional effect	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes
R2_a	0.745	0.010	−0.251	0.015	0.885
AIC	21,381.098	201,631.209	212,530.237	204,327.501	16,267.119
BIC	21,437.227	201,687.889	212,587.030	204,384.294	16,323.911

The meaning of bold font that we want to highlight the significant results of the estimation.

5 Discussions

5.1 Positive effect of leading cadre's favoritism on protected agriculture expansion

Municipal leading cadres with connections to Shandong, Jiangsu, Hebei, or Liaoning provinces have certain favoritism in decisions for developing PA. The scale of PA in county-level areas under the jurisdiction of connected mayors is on average 10.8% higher than that of those under mayors without connections, and the statistically significant of this estimation is at 10% level. The age of the mayor also has a significant positive effect on PA expansion. As the mayor's age increases by 1 year, the scale of PA will significantly increase by 1.1%. However, unlike connected mayors, the estimates of the effect of connected municipal party secretaries on PA expansion are not statistically significant. This may be due to the difference in the responsibilities between mayors and municipal party secretaries.

According to the theory of agent network division, the career transfer of leading cadres is accompanied by the cross-regional or inter-organizational diffusion of policy innovations (Yi et al., 2018). When leading cadres transfer from jurisdiction *i* to jurisdiction *j*, they will bring their professional experience, management knowledge, and innovative policy ideas accumulated in previous served places to their new workplaces (Liu and Yi, 2021). The older the leading cadres are, the more experience they accumulate, which contributes to policy diffusion. For example, in 2012, an official who was born in Hebei Province and had served in Hebei Province was transferred to Guangyuan City, Sichuan Province, and in 2016 the official was appointed as the mayor of Guangyuan City. From the relevant statistics, it can be seen that the average expansion rate of PA in the city in 2016–2018 has greatly increased compared to that in 2014–2015, from an average growth of 86 ha per year to 163 ha per year (National Bureau of Statistics Rural Socio-Economic Survey, 2015, 2019). Referring to relevant news reports after the official took office, we find that the mayor made a clear commitment to focus on developing modern agriculture in the meeting in which he was officially appointed, and paid particular attention to agricultural modernization and transformation during his subsequent tenure (Guangyuan Agricultural Bureau, 2016; Guangyuan Daily, 2016). He not only visited rural areas several times to investigate the current state of the agricultural industry but also initiated projects for several modern agricultural parks construction and upgrading of existing parks (Sichuan Daily, 2016; Guangyuan Municipal Government Office, 2018). Taken together, the official's positive influence on the agricultural industry transformation and PA expansion likely stems from his professional experience accumulated in his birthplace and former place of employment (Hebei Province), as well as his approximately 4-year tenure in Guangyuan City. These experiences not only gave him a deeper understanding of the modern agricultural development model in Hebei Province but also enabled him to make well-targeted agricultural transformation proposals based on the local resources and industrial characteristics of Guangyuan City, which in turn led to the effective diffusion of the PA model in Guangyuan City.

Connected mayors and municipal party secretaries are not consistent in their influence on policy diffusion among leadership agent networks. In China's local political system, local officials include the mayor and the municipal party secretary (Chen Z. et al., 2019). They have different responsibilities. The former is in

charge of administration, while the latter manages party affairs (Lu and Wang, 2019). Although municipal party secretaries are more powerful than mayors, the mayor has more specific responsibility than the municipal party secretary on decisions regarding economic development and social management (Lu and Wang, 2019). That is, connected mayors have a more prominent positive influence in deciding whether to promote the expansion of PA and in specifying specific plans for PA development, supporting facilities construction, and project initiation. Whereas, connected municipal party secretaries are likely to focus more on adopting practices that will result in rapid and significant regional economic uplift.

5.2 Geographical differences among leading cadre's favoritism and protected agriculture expansion

There are significant geographical differences in the positive impact of connected leading cadres on policy diffusion. For those jurisdictions in western China, the positive effects of connected mayors and municipal party secretaries on PA expansion were significantly weakened and statistically significant were both at 1% level. Also, the positive effect of connected municipal party secretaries on PA expansion was significantly weakened at 10% level, for those jurisdictions that were part of the comprehensive climate unsuitable areas during the March-June sowing period. This may be related to regional characteristics. In addition, there are differences in the positive impact of policy diffusion among leading cadres with connections to different regions. The positive impact of mayors connected with Liaoning province is relatively the highest, followed by municipal party secretaries connected with Jiangsu province, and the relatively lowest is the mayors connected with Shandong province. This may be due to the popular models of PA in these four regions are different and thus differ in terms of diffusion difficulties.

There are regional differences in the benefits of agricultural policy diffusion, considering the industrial structure and climatic suitability characteristics of different regions, as well as the growth characteristics of crops. The motivation of connected leading cadres serving in different regions for the expansion of PA is different. The climatic phenomena that cause regions to be unsuitable for developing PA during the March-June sowing period are mainly high temperature and lack of sunlight, which affects 1,348 county-level areas in the sample, far exceeding the number of county-level areas affected by climate during the July-February sowing period (Zhang et al., 2021). Moreover, March-June is an important sowing period for most grain crops, oil crops, and vegetables (Li et al., 2014), which implies a relatively wider range of exposure to climatic unsuitability during March-June. That is, connected leading cadres whose jurisdictions confront climate unsuitability in March-June will carefully consider whether to expand PA; after all, it may not be economical to invest additional production management costs to cope with climate risks. In addition, in Model (6) of Table 2, the coefficients of the variables gross regional product and the interaction term of the mayor's governing preference and secondary sector output are statistically significant at 1% level. This implies that regions with better economic and secondary sectors could provide sufficient input support for PA, which in turn reinforces the positive influence of connected mayors on PA expansion. However, the economic strength and infrastructure of western regions are relatively weaker (Yin et al., 2019), which makes the expansion of PA more difficult and reduces the motivation of connected leading cadres for PA expansion. Meanwhile, most areas in western China are unsuitable for the expansion of PA. For example, of the 745 counties located in the western region in this study, 645 counties have to face unsuitable climatic conditions during the July-February sowing period, and 671 counties during the March-June sowing period. This means that the agricultural industry in this area does not need to be blindly transformed into PA.

The four Chinese prominent PA development regions - Shandong, Jiangsu, Hebei, and Liaoning provinces—have great differences in PA development history, which is manifested in the differences in technical difficulty and dissemination scope. Shandong and Liaoning provinces are the two major origins of PA in China. Among them, Liaoning province is the largest solar greenhouse area and the key area of PA production, which has formed a large-scale production model that combines multi-seasonal production in solar greenhouses in winter and production in cold sheds in summer (Li et al., 2013). The PA model in Liaoning Province could well cope with the climatic constraints in northern areas (Li et al., 2013; Local customs, 2022). Moreover, Shandong province has become the center of China's greenhouse vegetable production with intelligent solar greenhouses (Ou et al., 2021). As many as seven technology iterations have made Shandong Province very mature in terms of planting technology and management models to support PA. The technical and management advantages of Shandong and Liaoning provinces in terms of PA have made the leading cadres connected with them more motivated to increase PA expansion. However, it is important to note that the "Shouguang vegetables" brand of Shandong Province has been more widely promoted in many places due to the media and the support of government-enterprise cooperation (Chen, 2021), which leads to the possibility of inaccuracy in estimating the influence of leading cadres on PA expansion by just using their connections with Shandong Province. Besides, Jiangsu province is a rapidly developing region for PA in the new era (Jin and Jiang, 2009) and the region has formed a rich cluster area of advantageous industrial in PA, such as the solar greenhouse base in northern Jiangsu province, the steel frame greenhouse base in Jianghuai region, and the intelligent greenhouse base along the coast and river, etc. (Ping et al., 2010). These can provide diverse learning templates for leading cadres connected with Jiangsu Province and enhance their motivation for PA expansion. Lastly, although Hebei Province is the relatively smallest of the four regions in terms of both speed and scale of PA development, it has also formed three major greenhouse vegetable dominant production areas (Han et al., 2017). Since the PA model of Hebei Province still needs to be optimized and its prominent small-scale greenhouse technology does not have outstanding comparative advantages over the other three regions (Gao, 2012), the leading cadres connected with it are less motivated to promote PA technology.

6 Conclusion

The expansion of PA is imperative for future agricultural development. Since 2008, when the Chinese Ministry of Agriculture issued the "Opinions on Promoting the Development of Protected Agriculture" (Agriculture, 2008), PA has become an important direction for agricultural transformation. In China, Shandong, Jiangsu, Hebei, and Liaoning provinces have been areas of rapid development in PA, with the scale of regional PA all far exceeding the national average and playing an important demonstration role in promoting PA technology nationwide.

Based on policy diffusion and official behavior theories, this report scrutinizes the information of leading cadres in 314 prefectural cities in China with data on PA in 1,792 counties for the period 2014–2018. The results show that the leading cadres with governing preferences is critical in promoting relevant policy diffusion. Specifically, mayors connected with Shandong, Jiangsu, Hebei, and Liaoning provinces significantly promote PA expansion, and the scale of PA in county-level areas under these connected mayors is on average 10.8% higher than that of areas under unconnected mayors. Also the mayor's age, level of economic development (*Mprimary*), and agricultural output effect (*lnMpgrp*) have significant positive effects on PA expansion, while the degree of regional industrialization (*Rsgrp*) could reinforce the positive effects of connected mayors on PA expansion. Whereas, the effect of connected municipal party secretaries on PA expansion is not significant, which may be related to the different responsibilities among mayors and municipal party secretaries. In addition, there are geographical differences in PA expansion. This study found that the positive impact of connected leading cadres on PA expansion will be significantly weakened when the areas under their jurisdiction are located in economically underdeveloped western regions or in areas that are climatically unsuitable during the March-June sowing period. Moreover, since the prevalence and difficulty of PA farming technologies in Shandong, Jiangsu, Hebei, and Liaoning provinces vary, there are differences in the motivation of leading cadres connected to each of these four regions to diffuse the relevant technologies. Among them, Shandong and Liaoning provinces, the two major origins of PA in China, have relatively greater positive effects on PA expansion.

In the past 40 years, PA in China has developed rapidly and has made an important contribution to securing people's food needs. This study not only broadens the research field and theoretical understanding of local leading cadres' decision-making behavior and their influence on policy diffusion but also contributes to a deeper understanding of the mechanisms driving farmland conversion in China. In the context of accelerated agricultural modernization, it needs to be noted that the current development of PA still faces obstacles such as low mechanization levels, fragmented land distribution, insufficient scientific and technological innovation, and a lack of professional talents (Takeshima and Joshi, 2019). To this end, reference can be made to our findings that strengthening the connection between leading cadres and regions with better development of PA, especially Shandong and Liaoning provinces, will help to deepen the knowledge of leading cadres in fields such as PA production technology and management models, which in turn would promote the expansion of PA and the transformation of agricultural modernization. Alternatively, if a city wishes to promote policy innovation in a specific area, it may consider strengthening the connections between local leading cadres and regions with successful policy implementation in that area, which would help leading cadres learn from the demonstration regions and also the policy innovations diffusion.

This study does acknowledge several limitations. First, although we spent a great deal of time collecting and quantifying information on officials' career transfers, the way officials establish connections with regions may be through short-term off-site visits, studying central government documents, and media campaigns, in addition to the birthplace and the place where they have served. This makes it difficult to capture all the circumstances under which officials establish connections with regions. Second, during the career transfer process, officials may not always maintain strong connections with all regions, especially those who are transferred because of negative experiences. Therefore, it is not possible to accurately quantify the strength of the connections that officials establish with different regions. In the future, we could try to characterize the connections and the strength of connections between officials and different regions by using spatial weight matrixes and further analyze the impact of officials on the dynamics of policy diffusion. In addition, in-depth interviews or surveys can be combined to analyze the effectiveness of officials on policy diffusion.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Author contributions

ML: Conceptualization, software, methodology, writing. DQ: Supervision, writing—reviewing and editing. TZ: Conceptualization, supervision, writing—reviewing and editing.

Funding

The study was supported by grants from National Natural Science Foundation of China (Grant Nos: 42261144750, 41771189).

Acknowledgments

Our sincere thanks to the National Natural Science Foundation of China [Grant Nos: 42261144750, 41771189], without which this paper would never have come into fruition.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Agriculture, M. O. (2008). "The promotion of the development of protected agricultural," in *Agriculture, M.o*. Ed.

Bai, C., and Zhang, T. (2021). "New landmark of modern agriculture vegetable industry cluster," in *Vegetables*, 1–12.

Butrico, G., and Kaplan, D. (2018). Greenhouse agriculture in the Icelandic food system. *Eur. Countrys.* 10, 711–724. doi:10.2478/euco-2018-0039

Chen, J. (2021). "Become the first province with a total agricultural output value of more than one trillion, how did Shandong do it?," in *Popular newspaper*.

Chen, S., Feng, Z., and Yin, Y. (2019a). Leader sources, local information, and regional economic growth: New evidence from city-level data. *South China J. Econ.*, 120–136.

Chen, Z., Tang, J., Wan, J., and Chen, Y. (2017). Promotion incentives for local officials and the expansion of urban construction land in China: Using the Yangtze River Delta as a case study. *Land Use Policy* 63, 214–225. doi:10.1016/j.landusepol.2017.01.034

Chen, Z., Zhang, X., Huang, X., and Chen, Y. (2019b). Influence of government leaders' localization on farmland conversion in Chinese cities: A "sense of place" perspective. *Cities* 90, 74–87. doi:10.1016/j.cities.2019.01.037

Danaeefard, H., and Mahdizadeh, F. (2022). Public policy diffusion: A scoping review. *Public Organ. Rev.* 22 (02), 455–477. doi:10.1007/s11115-022-00618-9

Eben-Chaime, M., Bechar, A., and Baron, A. (2011). Economical evaluation of greenhouse layout design. *Int. J. Prod. Econ.* 134 (01), 246–254. doi:10.1016/j.ijpe.2011.07.005

Fan, D. (2004). "New industrialization and transformation of Guangxi agriculture," in *Proceedings of the third annual guangxi youth academic conference (social science chapter)* (Nanning, Guangxi, China, 4.

Gao, C., Wu, Q., Dyck, M., Lv, J., and He, H. (2022). Greenhouse area detection in guanzhong plain, shaanxi, China: Spatio-temporal change and suitability classification. *Int. J. Digital Earth* 15 (01), 226–248. doi:10.1080/17538947.2021.2023667

Gao, L. (2012). *The study on facility agriculture and its irrigation water in Hebei province*. Hebei: Hebei Agricultural University.

Guangyuan Agricultural Bureau (2016) *Guangyuan City is building ecological agriculture to promote the green development*.

Guangyuan Daily (2016) "Zou Zijing was elected mayor of Guangyuan," in *What did he promise the 3.14 million people?* Editor G D N Media.

Guangyuan Municipal Government Office (2018). *Speech of zou zijing at the municipal agricultural characteristic industry development promotion meeting*.

Han, P., Di, Z., Qie, D., Zhang, J., Yan, X., and An, Y. (2017). Investigation on the type and distribution of vegetable facilities in Hebei Province. *China Cucurbits Veg.* 30 (04), 36–39. doi:10.16861/j.cnki.zggc.2017.0069

Huang, Z. (2010). China's hidden agricultural revolution. *Rural China Int. J. Hist. Soc. Sci.*, 1–10+259.

Jensen, M. H., and Malter, A. J. (1995). *Protected agriculture: A global review*.

Jin, L., and Jiang, Y. (2009). On the development of facility agriculture in Jiangsu province. *Mod. Agric. Sci. Technol.*, 238–240.

LaPlante, G., Andrekovic, S., Young, R. G., Kelly, J. M., Bennett, N., Currie, E. J., et al. (2021). Canadian greenhouse operations and their potential to enhance domestic food security. *Agronomy* 11 (06), 1229. doi:10.3390/agronomy11061229

Li, H. (2021). Study on the development status, obstacles and countermeasures of facility agriculture in China. *China South. Agric. Mach.* 52 (23), 34–37.

Li, H., Wang, Y., and Guo, X. (2013). *Excellent varieties of vegetable crops in Liaoning Province*. Liaoning: Liaoning Science and Technology Press.

Li, L., Friedl, M. A., Xin, Q., Gray, J., Pan, Y., and Frolking, S. (2014). Mapping crop cycles in China using MODIS-EVI time series. *Remote Sens.* 6 (03), 2473–2493. doi:10.3390/rs6032473

Li, T. (2022). *Asking for food from facility agriculture*. 20 ed. People's Daily.

Liu, M., Zhao, Y. T., and Zhong, T. Y. (2020). Effect on cultivated land preservation from the "cap lower than existing amount" general land-use plan. *China Land Sci.* 34, 84–92.

Liu, W., and Yi, H. (2021). *Policy diffusion through leadership transfer networks: Direct or indirect connections? Governance*, 1–20. doi:10.1111/gove.12609

Local customs (2022). *North aid Jilin, south help Shanghai, this northeast first vegetable province, low profile for too long*.

Lu, S., and Wang, H. (2019). Distributive politics in China: Regional favouritism and expansion of construction land. *Urban Stud.* 57 (08), 1600–1619. doi:10.1177/0042098019835677

Lybbert, T. J., and Sumner, D. A. (2012). Agricultural technologies for climate change in developing countries: Policy options for innovation and technology diffusion. *Food Policy* 37 (01), 114–123. doi:10.1016/j.foodpol.2011.11.001

Mansha, S., Inam Bhutta, A., Antonucci, G., and Hooy, C.-W. (2022). Do political connections matter for firm trade credit? *Emerg. Mark. Finance Trade* 58, 4014–4032. doi:10.1080/1540496X.2022.2083497

Meng, H., Huang, X., Yang, H., Chen, Z., Yang, J., Zhou, Y., et al. (2019). The influence of local officials' promotion incentives on carbon emission in Yangtze River Delta, China. *J. Clean. Prod.* 213, 1337–1345. doi:10.1016/j.jclepro.2018.12.036

National Bureau of Statistics Rural Socio-Economic Survey, 2015 (2019). *China statistical Yearbook county-level*.

Ou, C., Yang, J., Du, Z., Zhang, T., Niu, B., Feng, Q., et al. (2021). Landsat-derived annual maps of agricultural greenhouse in Shandong province, China from 1989 to 2018. *Remote Sens.* 13 (23), 4830. doi:10.3390/rs13234830

Ping, Y., Chen, Y., Chen, M., and Hu, H. (2010). Survey report on the development of facility agriculture in Jiangsu province. *Agric. Equip. Technol.* 36 (05), 43–46.

Shipan, C. R., and Volden, C. (2012). Policy diffusion: Seven lessons for scholars and practitioners. *Public Adm. Rev.* 72 (06), 788–796. doi:10.1111/j.1540-6210.2012.02610.x

Shipan, C. R., and Volden, C. (2008). The mechanisms of policy diffusion. *Am. J. Political Sci.* 52 (04), 840–857. doi:10.1111/j.1540-5907.2008.00346.x

Sichuan Daily (2016). *2016, the comprehensive construction of Guangyuan Modern Agricultural Park was fully launched*. Li, S. (Ed.).

State Statistics Bureau (2017). *The second and third national agricultural surveys*. Bureau, S.S. (Ed.

Takeshima, H., and Joshi, P. (2019). Protected agriculture, precision agriculture, and vertical farming: Brief reviews of issues in the literature focusing on the developing region in asia. doi:10.2499/p15738coll2.133152

Valdés, A., and Foster, W. (2010). Reflections on the role of agriculture in pro-poor growth. *World Dev.* 38, 1362–1374. doi:10.1016/j.worlddev.2010.06.003

Wang, H., and Yin, J. (2019). Environmental governance effects of local complex: An empirical study based on the perspective of official heterogeneity. *J. Yunnan Univ. Finance Econ.* 35, 80–92.

Wang, Q., Wu, S.-d., Zeng, Y.-e., and Wu, B.-w. (2016). Exploring the relationship between urbanization, energy consumption, and CO2 emissions in different provinces of China. *Renew. Sustain. Energy Rev.* 54, 1563–1579. doi:10.1016/j.rser.2015.10.090

Wang, X. (2022). Managing land carrying capacity: Key to achieving sustainable production systems for food security. *Land* 11 (04), 484. doi:10.3390/land11040484

Wang, X., Zhang, L., and Xu, X. (2013). *What determines local fiscal expenditure propensity: On the jurisdiction leaders perspective*, 06. Beijing: Comparative Economic & Social Systems, 157–167+180.

Wen, B., Ma, C., Ke, X., Zhu, L., Jin, Y., and Wu, J. (2017). "Spatio-temporal pattern of Chinese farmland conversion pressure," in *2017 25th international conference on geoinformatics*, 1–6. doi:10.1109/GEOINFORMATICS.2017.8090946

Wu, B., and Zhang, L. (2013). Farmer innovation diffusion via network building: A case of winter greenhouse diffusion in China. *Agric. Hum. Values* 30 (04), 641–651. doi:10.1007/s10460-013-9438-6

Wu, P., Sun, C., and Zhao, B. (2019). *Do incentives for official promotion promote land fiscal expansion? Based on bureaucratic political model and inter-provincial panel data*. Nanjing: Journal of Nanjing University of Finance and Economics, 26–39.03

Xie, J., Yu, J., Chen, B., Feng, Z., Li, J., Zhao, C., et al. (2017). "Chapter one - facility cultivation systems "设施农业": A Chinese model for the planet," in *Advances in agronomy*. Editor D. L. Sparks (Academic Press), 1–42. doi:10.1016/bs.agron.2017.05.005

Xu, G. (2018). The costs of patronage: Evidence from the British empire. *Am. Econ. Rev.* 108 (11), 3170–3198. doi:10.1257/aer.20171339

Yang, Q., and Peng, Y. (2015). "Promotion competition and industrial land conveyance — an empirical study based on the city-level panel data," in *Economic theory and business management*, 5–17.

Yao, Y., and Zhang, M. (2015). Subnational leaders and economic growth: Evidence from Chinese cities. *J. Econ. Growth* 20 (04), 405–436. doi:10.1007/s10887-015-9116-1

Yi, H., Berry, F. S., and Chen, W. (2018). Management innovation and policy diffusion through leadership transfer networks: An agent network diffusion model. *J. Public Adm. Res. Theory* 28 (04), 457–474. doi:10.1093/jopart/muy031

Yin, C., Feng, C., Ren, X., Yang, J., and Cheng, W. (2019). "Research on economic development level of western provinces in China based on cluster analysis," in *2019 4th international conference on mechanical, control and computer engineering (ICMCCE)* (China: Hohhot), 64–643. doi:10.1109/ICMCCE48743.2019.00023

Zhang, N., and Lu, H. (2016). Capital officials communication and environment governance — empirical evidence from Chinese party secretaries and mayors in 109 cities. *J. Public Manag.* 13, 31–43+153-154.

Zhang, X., Zhang, Q., Yang, Z., and Han, J. (2021). "Climate suitablity evaluation of facility agriculture in China at different sowing dates in A whole year," in *Chinese journal of agricultural resources and regional planning*, 1–12.

Zhang, Y., and Yang, H. (2022). "Bureaucratic politics, innovation compatibility, and the dynamic diffusion of subnational decentralization reforms in China," in *Review of policy research* ***n/a***. doi:10.1111/ropr.12514

Zhong, T. Y., Si, Z. Z., Shi, L. F., Ma, L., and Liu, S. (2020). Impact of state-led food localization on suburban districts' farmland use transformation: Greenhouse farming expansion in Nanjing city region, China. *Landsc. Urban Plan.* 202, 103872. doi:10.1016/j.landurbplan.2020.103872