Front. Earth Sci. China 2009, 3(1): 1–8
DOI 10.1007/s11707-009-0007-7

RESEARCH ARTICLE

Immediate impacts of the Wenchuan Earthquake on the prices and productions of grain and pork products

Xiangzheng DENG (✉)[1,2], Quansheng GE[1], Zhigang XU[1,2], Shaoqiang WANG[1], Hongbo SU[1], Qunou JIANG[1], Jifu DU[3], Yingzhi LIN[1]

1 Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China
2 Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing 100101, China
3 College of the Humanities and Social Sciences, Graduate University of the Chinese Academy of Sciences, Beijing 100049, China

Abstract Based on field survey and statistical analysis, the immediate impacts of the Wenchuan Earthquake happened on May 12, 2008, are evaluated from two aspects, i.e., the influence on the prices and yields of grain and pork products in the local region and that on China. Wenchuan Earthquake, undoubtedly, has some negative effects on the local agricultural yields in Sichuan Province. It has caused immediate impacts on the grain and livestock breeding industry in the earthquake worst-hit counties. For example, due to the earthquake, the grain yields in Sichuan Province will decreased more than 0.4% and the pork productions decrease 5% at least. Thus, prices of grain and pork products are likely to rise in local mountainous areas over a short term. Our studying results that the disaster rate, the hazard rate and the complete loss rate of grain productions are 18%, 10% and 6% respectively in the earthquake worst-hit counties, while the disaster rate in the eastern plain areas even reach to 30%–49%. Even so, the results of model analysis for sample survey indicates that Wenchuan Earthquake has caused only marginal impacts on agricultural production, does not heavily hurt the stability of the prices and yields of grain and pork products at the national level. In other words, Wenchuan Earthquake had not affected the overall situation of national agricultural production. It is estimated that the reduction rate of national grain yield is as low as 0.006%, and the price changes of grain and pork products are no more than 0.5% and 2.2% respectively.

Keywords Wenchuan Earthquake, agricultural production, grain and pork products, Sichuan Province

Received June 2, 2008; accepted October 8, 2008

E-mail: Dengxz.ccap@igsnrr.ac.cn

1 Introduction

At 14:28 Beijing time (06:28 GMT), May 12, 2008, an earthquake measuring 8.0 on the Richter scale struck Wenchuan county, Sichuan Province, China. Neighboring cities such as Jiangyou, Pengzhou, Guangyuan, Mianyang and Chengdu received extensive damage and continual aftershocks (Fig. 1). The epicenter of the recent earthquake in Sichuan was in Wenchuan county, 80 kilometers northwest of Chengdu, the capital of the Sichuan province (China Earthquake Administration, 2008). All but few provinces in China felt the shock of the earthquake wave. Wenchuan Earthquake has caused great impacts on the production and life of the people living in the earthquake-hit regions. At least 5 million people lost their homes, although the number might have been topped to 11 million. Yields of livestock and agricultural products are also affected. Statistics shows that 365.75 million pigs died in six worst-hit countries. It is estimated that the off-take number of commercial pigs will decrease to 550 million, and the damaged food crops area is about 27 million hectares (National Economic Prosperity Monitor Center of China, 2008). In a word Wenchuan Earthquake, undoubtedly, exert certain negative effects on the local agricultural production. The great impacts on the grain and animal breeding industry have been identified in the earthquake worst-hit regions especially.

In this paper, based on field survey for 30 earthquake worst-hit counties and statistical analysis, the immediate impacts of the Wenchuan Earthquake on the prices and yields of local and national agricultural production are estimated quantitatively.

The following parts of this paper are organized into three sections. Section 2 presents the data and methodology. The analysis and results are included in section 3 while section 4 shows the conclusion.

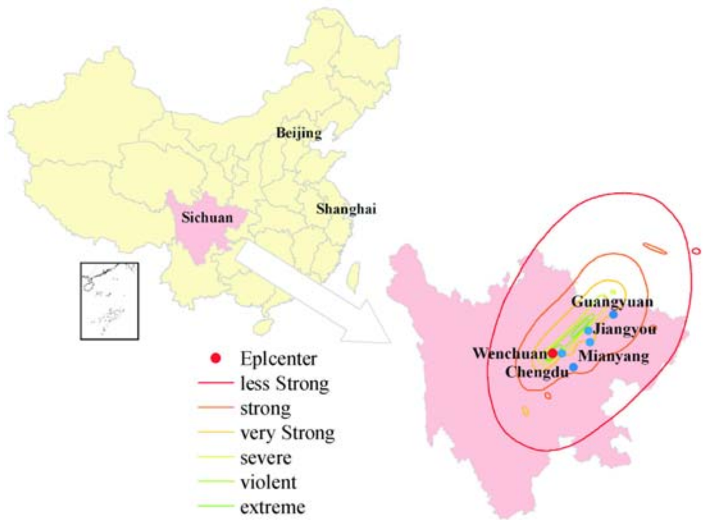

Fig. 1 Shake area of Wenchuan Earthquake

2 Data and methodology

2.1 Data

The methodology used in this paper actually depends on the availability of the data of the grain and pork products loss for the 30 worst-hit counties in Sichuan earthquake disaster area, which suffered the worst damage. In this paper, most of the data are collected through field survey in the 30 sampled counties and the information submission from related departments and local authorities. The data used to estimate disaster degrees largely based on scenarios design. Part of the data is provided by the Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences (CAS). The raw data of agricultural production before Wenchuan Earthquake is extracted from Statistical Yearbooks of each earthquake-hit province.

2.2 Methodology

2.2.1 Model for estimating the impacts from the earthquake on

The modeling framework of China’s Agricultural Policy Simulation Model (CAPSiM), which is one of the most comprehensive models of food demand, supply and trade analysis (Huang and Li, 2003), is used to establish a partial equilibrium model to analyze and estimate the impacts of the Wenchuan Earthquake on the prices and yields of grain and pork products in China. The evaluation of the impacts of the Wenchuan Earthquake on agricultural production, the market, or the supplies and prices of national agricultural production, is developed by building and analyzing the partial equilibrium model of agricultural departments with the specific focus on the effects or responses of grain production and animal product supplies.

Originally, CAPSiM included two major modules in terms of supply and demand balance for each agricultural commodity and all 19 commodities (Huang et al., 1999). Supply includes production, import, and stock changes. Demand includes food demand, feed demand, industrial demand, waste, and export demand. Market clearing is reached simultaneously for each agricultural commodity and all 19 commodities (or groups). Production equations, which are decomposed by area and yield of crops and total output of meat and other products, allow producers’ own- and cross-price market responses, as well as the effect of shifts in technology stock on agriculture, irrigation stock, three environmental factors including erosion, salinization, and the breakdown of the local environment, and yield change due to exogenous shocks of climate and other factors. Demand equations, which are broken out by urban and rural consumers, allow consumers’ own-and cross-price market responses, as well as the effect of shifts in income, population level, market development and other shocks (Huang and Bouis, 2001).

Most of the elasticities used in CAPSiM were estimated econometrically at the Center for Chinese Agricultural Policies (CCAP) in China Academy of Science, using the state-of-the-art econometrics, including the assumptions for consistency of estimated parameters with theory. Demand and supply elasticities vary over time and across income groups (Huang et. al., 1999; Rozelle et al., 1996; Rozelle and Huang, 2000).

2.2.2 Models for identifying the regional difference of the impacts from the earthquake

We develop new models to identify the regional difference of the impact from the earthquake on agricultural production. It is one of the prerequisite to identify the identical unit of similar characteristics before analyzing the regional difference (Alston et al., 2000). An algorithm by the following steps was used to achieve the goal:

(1) Statistical treatment of the variables which identify or measure the characteristics of agricultural production, geophysical condition, social and economic condition, management and input (Table 1) is used to avoid the influence of the measurement scale on the final clustering analysis;

(2) Choosing the cluster number, K, for the 30 worst-hit counties and the initial center position of each class, to choose K cohesive points identical with the agricultural production characteristics;

(3) Calculating the distance between each pair of samples, and using $K-$means clustering according to the principle of minimum distance. An initial classification result is proposed;

(4) Determining the center point of each class after clustering as the new cohesive points;

(5) Checking the clustering result when the iteration is finished or the group center remains stable in two successive clustering analyses, otherwise, continue to do the looping calculation.

If the classification units are not enough, all the identical units including the necessary experiment data cannot be guaranteed. Thus, we adopt a calculation which can adjust the classification numbers adaptively. After the classification, we use the identical characteristics of a classification to estimate the disaster rate, the hazard rate and the complete loss rate of crop production in other counties. Then, we re-cluster the classification to improve the convergence condition of the identical units. Repeat above steps to estimate the disaster rate, the hazard rate and complete loss rate of crop production in the 30 worst-hit counties of the earthquake.

First, we utilize the estimated loss of crop production obtained by the past field survey of the 30 worst-hit counties to calculate the disaster rate, the hazard rate and the complete loss rate of crop production. Then, a relation equation describing the relationship among the disaster rate, the hazard rate, the complete loss rate and other variables, is established to evaluate the loss level of crop production in each county.

The relation equation of the disaster rate, the hazard rate and the complete loss rate is designed according to Seemly Unrelated Regression (SUR) model (Zellner, 1962). And the key variables include geophysical condition, agricultural production characteristics, social and economic condition, seismic intensity, management and input, and the dummy variable derived from the identical unit of the regional agricultural production characteristics.

The equation of the SUR model can be written as follows:

$$R_i = f(X_1, X_2, X_3, X_4, X_5, X_6),\ i = 1,2,3,$$

where X_1 is the geophysical characteristics; X_2 is the agriculture production characteristics; X_3 represents the

Table 1 Key variables used to identify the identical unit of agricultural production characteristics

variable	unit	mean	standard deviation
geophysical condition			
–mean annual air temperature	°C	9.6	5.0
–accumulated temperature above 10°C	°C	3853.6	1445.4
–mean annual precipitation	mm	776.0	312.8
–elevation	m	1513.6	1039.9
agricultural production characteristics			
–average yield of grain	10^4t	18.8	17.6
–total sown area of grain	10^4ha	3.8	3.4
–irrigation area	10^4ha	1.9	1.5
–wheat yield	10^4t	4.0	4.6
–rice yield	10^4t	8.3	1.0
–maize yield	10^4t	3.7	4.8
–edible oil plant yield	10^4t	1.7	2.0
social and economic condition			
–population	10^4 person	135.6	162.8
–GDP	10^4 RMB	15.5	39.3
management and Input			
–amount of plastic film used in the field	t	426.2	531.9
–amount of pesticide used in the field	t	384.7	400.5
–power consumption in the rural area	kWh	80820.3	96120.0

social and economic characteristics; X_4 measures the seismic intensity; X_5 stands for the management and input characteristics; X_6 is the region derived from the consistency unit of the agricultural production characteristics; R_1, R_2 and R_3 are the disaster rate, the hazard rate and the complete loss rate of crop production, respectively.

Based on the logarithm operation of all the variables, the modelling results the relationship among the disaster rate, the hazard rate, the complete loss rate of crop production and agricultural production characteristics. Thus we can estimate the disaster rate, the hazard rate, the complete loss rate of various kinds of crops in each earthquake-hit county.

3 Results

3.1 Estimated impacts from Wenchuan Earthquake on the prices of the grain and pork production

Our studying results revealed that the Wenchuan Earthquake had left only marginal impacts on the prices and yield of national grain and pork products. Regardless of whether over the short-term or over the medium and long term, the change in national grain price is no more than 0.5%. Based on the obtained agricultural production loss data and the model results, it is estimated that the nation aggregate grain yield will decline by 0.006%, which merely leads to a 0.02% rise of national grain price. Wenchuan Earthquake will cause 30% reduction in crop yield in the local area over the medium and long term, which is equivalent to 0.45% reduction in national aggregate grain yield. Thus the national grain price will only rise by 0.51% correspondingly (Table 2).

Statistics show that the Wenchuan Earthquake caused a slight decrease in pork prices over the short-term. The change in pork price is no more than 2.2%, either in the short-term or in the medium and long term scenario (Table 2). Model analysis results indicate that the loss of live pigs in Sichuan earthquake-hit regions is equivalent to 0.15% reduction of the national aggregate pork production, resulting in a rise in pork products prices by 0.25%. Although the case is more complicated in the medium and long term, it is estimated that the live pig supply in those

Table 2 Impacts of Wenchuan Earthquake on price of grain and pork products

items	grain sown areas	grain yield	supply of living pigs	supply of pigs in market	pork products
proportion of the considered items in the right columns of Sichuan province to those of China /%	6.2	5.8	11.6	11.0	10.4
proportion of the considered items in the right columns of the worst-hit regions to those of Sichuan /%	28	26	26	29	28
proportion of the considered items in the right columns of the worst-hit regions to those of China /%	1.7	1.5	3.0	3.2	2.9
impacts in short term					
scenario Ⅰ:					
loss of the considered items in the right columns by /%	0.4	0.4	5.0		5.0
resulting in the loss at the national level by /%		0.006			0.15
estimated price changes of the items in the right columns at national level /%		0.02			0.36
scenario Ⅱ:					
loss of the considered items in the right columns by /%		5			30
resulting in the loss at the national level by /%		0.08			0.9
estimated price changes of the items in the right columns at national level /%		0.25			2.2
impacts in medium and long term					
scenario Ⅰ:					
loss of the considered items in the right columns by /%		10			5.0
resulting in the loss at the national level by /%		0.15			1.5
estimated price changes of the items in the right columns at national level /%		0.22			1.4
scenario Ⅱ:					
loss of the considered items in the right columns by /%		30			75
resulting in the loss at the national level by /%		0.45			2.2
estimated price changes of the items in the right columns at national level /%		0.51			2.0

worst-hit regions would greatly decline, leading to the rise in pork products price, which will stimulate the increase in production of pork products in other regions and finally restrain the price increase. Analysis results also indicate that, if the live pig supply in those worst-hit regions decrease by 75% in the medium and long term, it will only cause 2.2% reduction of pork products in the national market in the future, and the price of national pork products will only rise by 2.0% correspondingly (Table 2).

3.2 Regional difference of the impacts from the earthquake

Considering the production characteristics of each agricultural type, the 30 earthquake worst-hit counties have been classified according to their agricultural production characteristics, geophysical condition, social and economic condition, management and input. Based on the analysis of the grain loss data collected from the 30 earthquake worst-hit counties, we estimate the disaster rate, the hazard rate and the complete loss rate of the production of grain as well as the loss situation of breeding industry in the 30 earthquake worst-hit counties. According to the relatively identical principle of agricultural production characteristics, we can estimate the loss rate of each relative unit, and get a basic judgment on the spatial distribution of grain disaster areas and breeding industry disaster area in the 30 earthquake worst-hit counties.

To identify the identical unit of agricultural production characteristics, we use mathematics optimization algorithm as mentioned above, and then identify the regional differences of the impacts.

3.2.1 Regional difference of the impacts from the earthquake on the spring crops

Wenchuan Earthquake has caused various levels of damages in spring crops in different earthquake-hit regions. Our estimation shows the disaster rate, the hazard rate and the complete loss rate of growing crops are 18%, 10% and 6%, respectively in some western mountainous regions, and the disaster rate in the eastern plain regions even reach to 30%–49%. The spatial distribution of spring sown crops loss areas in earthquake worst-hit counties shows an obvious spatial variability. The damage of crops in eastern regions in or near the epicenter is heavier, while that in western mountainous regions is relatively light. Wenchuan Earthquake destroyed a large fraction of farmlands in plain regions near the earthquake epicenter. For example, a great amount of crop fields are buried under the landslide debris. And masses of refugees and rescuers also caused some damage to the spring crops, which suggests that the crops yield in Sichuan province would decrease by more than 0.4%. Due to the earthquake, the spring crops cannot be harvested in time, resulting in late planting for the rice and other summer crops. Besides, these plain regions are the major agricultural devastated area. For example, in Guanghan city, a prefecture with the largest devastated area in this earthquake, about 24,665 hect-ares of spring sown crop were damaged. Some other earthquake-hit counties including Pengzhou city, Qingchuan city, and Shifang city also suffered heavy damages (Fig. 2). Spring crop disaster areas and complete loss areas are mainly located in those regions where the spring sown crops are seriously destroyed (Figs. 3 and 4).

3.2.2 Regional difference of the impacts from the earthquake on the livestock breeding industry

The livestock breeding industry of Sichuan province sufferes a heavy loss in Wenchuan Earthquake. Statistics shows that Wenchuan Earthquake caused 12.5 million livestock death in Sichuan province, and some counties with breeding farms located in the suburb es (Fig. 5). Pixian County in which about 1.395 million livestock are buried when the Wenchuan Earthquake hit, suffering the heaviest damage in the livestock breeding industry. The loss number of livestock in Wenchuan county is 953000. In Shifang city, the livestock loss number is above 600000. The household farmers in transition zones from the plain region to the mountainous region also sufferes heavy losses, and the average death number of livestock is more than 20000 in most of these southern towns. And the northern mountainous areas has a relative small loss of livestock for they are far away from the region.

4 Conclusions

Wenchuan Earthquake has a great influence on human life and social production in earthquake-hit regions. Large number of people hold the idea that the earthquake also seriously harmed the growing crops in the earthquake-hit regions. Our estimation, however, reveals that it only had marginal effects on the changes of prices and yields of grain and pork products over a short term and does not have a heavy influence on the stability of agro-productions at national level. The impact of the earthquake event on the general situation of national agricultural production is not significant over the short term or over the medium and long term. Studying results also show that the rises of grain price and pork price is no more than 0.5% and 2.2% at the national level, respectively.

Even so, Wenchuan Earthquake has caused certain damages to agricultural production in earthquake-hit regions. It is estimated that the yearly mean yield of crops in Sichuan province will decrease by above 0.4% over the short term while no more than 10% in the medium and long term. The spatial distribution of spring sown crops loss areas in worst-hit regions shows an obvious spatial variability. Crops in the eastern regions which are in

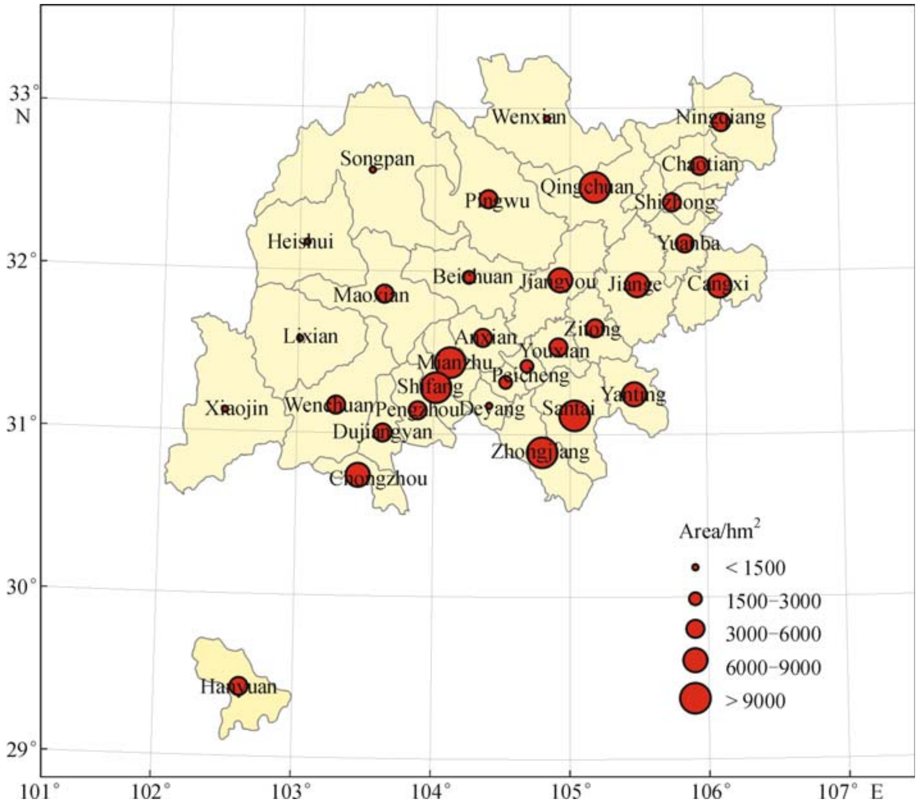

Fig. 2 Spatial distribution of disaster area for the Spring crops in the worst-hit counties of Wenchuan Earthquake

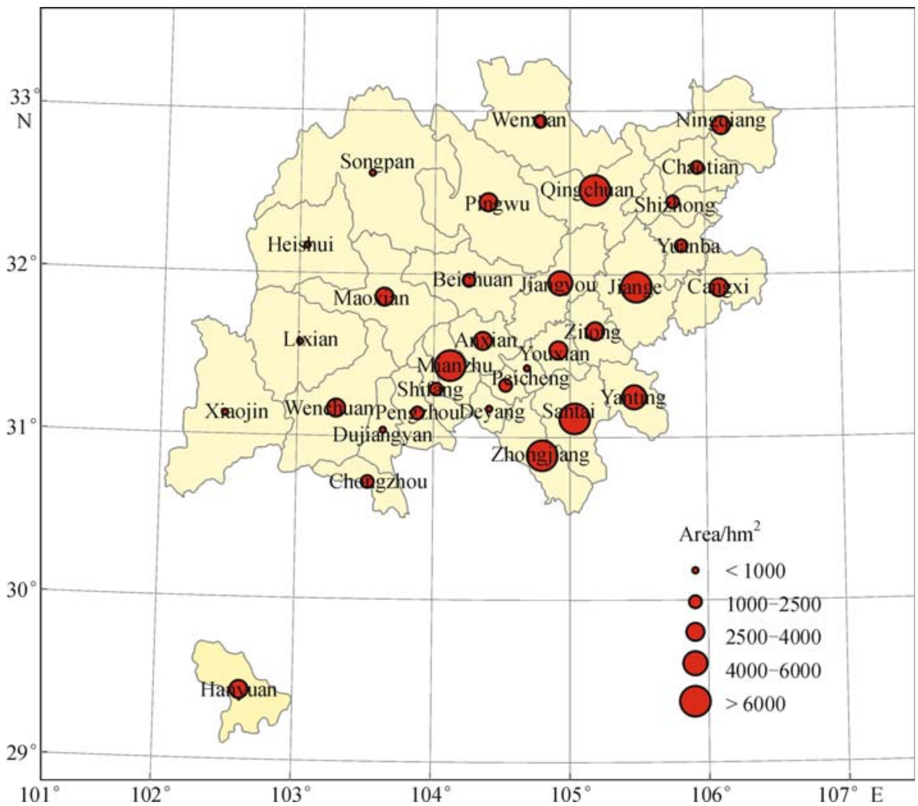

Fig. 3 Spatial distribution of hazard area for the Spring crops in the worst-hit counties of Wenchuan Earthquake

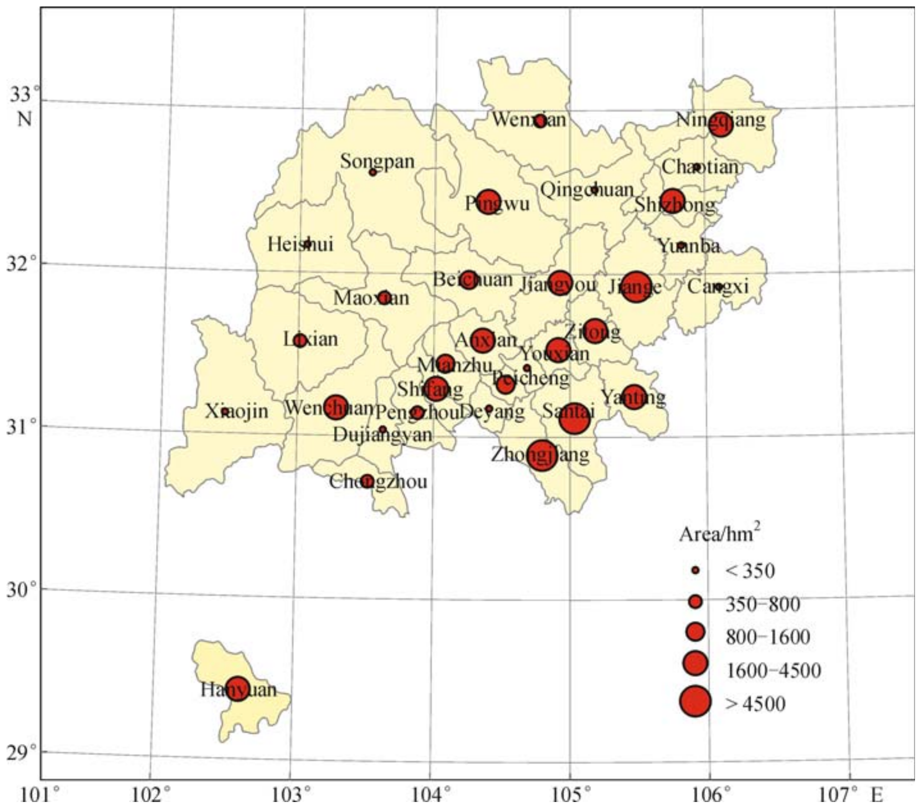

Fig. 4 Spatial distribution of completely lost area for the Spring crops in the worst-hit counties of Wenchuan Earthquake

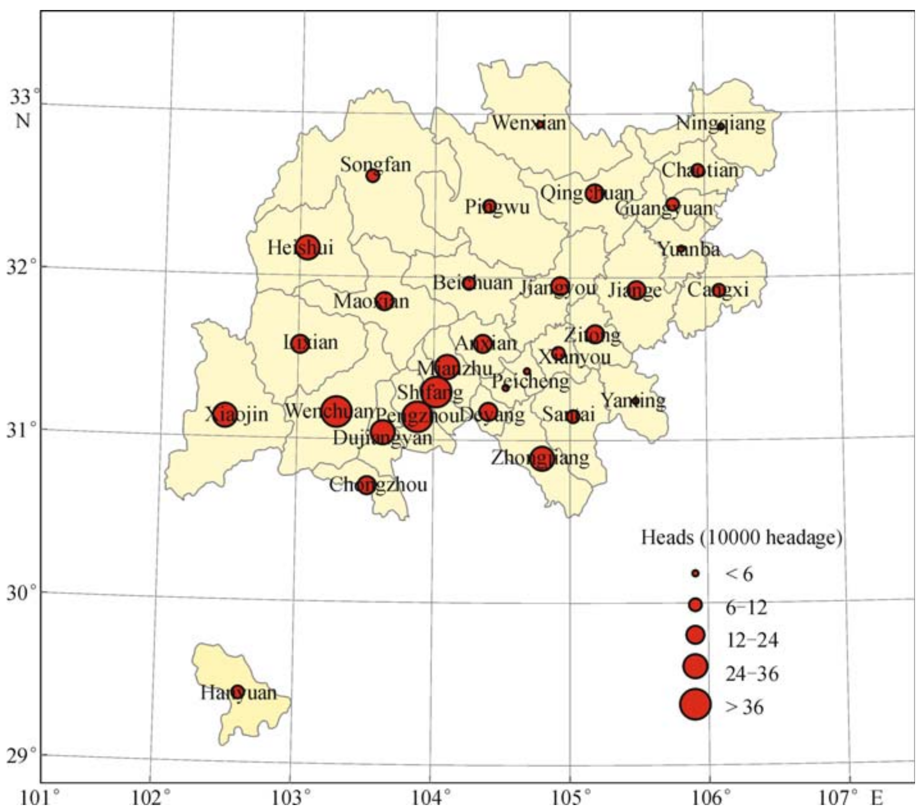

Fig. 5 Spatial distribution of disaster area for breeding industry in the worst-hit counties of Wenchuan Earthquake

or near the epicenter region suffers a relative worse damage, while the crops damage of western mountainous regions are relatively small. In addition, a large number of croplands in plain areas located in or near the earthquake epicenter are also damaged, and a great number of corns were buried under the landslide debris. As a result, grain production will undoubtedly be significantly affected and will face many difficulties during the rapid restoration and reconstruction period.

Acknowledgements This work was supported by the Rapid Response Project of Wenchuan Earthquake and National Key Technology R&D Program (Nos. 2006BAC08B02,2006BAC08B06) from the Ministry of Science and Technology of China, by the National Scientific Foundation of China (Nos. 70503025;70873118) and by the Chinese Academy of Sciences (Nos. KZCX2-YW-305-2,KSCX2-YW-N-039,KZCX2-YW-326-1).

References

Alston J M, Alston P G, Wood L (2000). Strategic Technology Investments for LAC Agriculture: A Framework for Evaluating the Local and Spillover Effects of R&D. International Food Policy Research Institute, Washington D C

de Brauw A, Huang J K, Rozelle S (2004). The sequencing of reform policies in China's agricultural transition. The Economics of Transition, 12 (3): 427–465

China Earthquake Administration (2008). Report on Wenchuan Earthquake (in Chinese)

Huang J K, Bouis H (2001). Structural changes in the demand for food in Asia: empirical evidence from Taiwan. Agricultural Economics, 26 (1): 57–69

Huang J K, Li N H (2003). China's agricultural policy simulation and projection model-CAPSIM. Journal of Nanjing Agricultural University (Social Sciences Edition), 3(2): 30–41 (in Chinese)

Huang J K, Rozelle S D, Rosegrant M W (1999). China's food economy to the 21st century: supply, demand and trade. Economic Development and Cultural Change, 47: 737–766

The National Economic prosperity monitor center of China (2008). Preliminary assessment on the disaster situation of Wenchuan Earthquake, Information for Deciders Magazine (in Chinese)

Rozelle S, Huang J K (2000). Transition, development and the supply of wheat in China. Australian Journal of Agricultural and Resource Economics, 44(4): 543–571

Rozelle S, Huang J K, Rosegrant M W (1996). Why China will not starve the world. Choices, First Quarter: 18–26

Zellner A (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. Journal of the American Statistical Association, 57: 348–368