

# CONTRIBUTION OF GROUP LOAN TO SUSTAINABILITY OF CHINESE AGRICULTURAL COMMUNITIES: COLLABORATIVE DEVELOPMENT OF COMMUNITY DISASTER-PREVENTION INFRASTRUCTURE

**WEIBIN YU**

Department of Urban Management, Graduate School of Engineering, Kyoto University  
Gokasho, Uji, 611-0011, Japan  
E-mail: yu@drs.dpri.kyoto-u.ac.jp

**MUNETA YOKOMATSU**

Disaster Prevention Research Institute, Kyoto University  
Gokasho, Uji, 611-0011, Japan

**NORIO OKADA**

Disaster Prevention Research Institute, Kyoto University  
Gokasho, Uji, 611-0011, Japan

**Abstract:** Chinese agricultural communities suffer much from disasters because agricultural production very much depends on weather, while the disaster-prevention infrastructure is undeveloped. More and more farmers have to move to urbanized area because of the subsistence constraint and an increase in income in cities. This means that the sustainability of Chinese agricultural communities is under a direct threat. For mitigating the above problem, governments at all levels are required to develop community-based disaster-prevention infrastructures. But the subsistence constraint and welfare difference between rural areas and cities make farmers lacking in motivation to develop disaster-prevention infrastructures. This paper supposed the collaborative development of infrastructure based on group loan to expand the possibility of preserved infrastructure, Pareto improving and sustainable community. Furthermore, we found that the complementarity between revised institutions and local conventional culture or functions is important and meaningful for disaster risk management in agricultural sectors of China.

**Keywords:** Chinese agricultural communities, sustainability, disaster-prevention infrastructure, collaborative development, group loan

## 1. Introduction

In agricultural communities of China, production depends very much on weather, the construction of infrastructure, such as communication and traffic system, is undeveloped, the farmers' habitations are obscure and in-concentrated, villages are located in vulnerable areas, residents' awareness and ability for disaster prevention and mitigation is poor and the early warning system is devoid. All these things make agricultural sectors of China suffer deeply from disasters. Since 2000, in each year, the area of farmland affected by natural disaster is more than 500 thousand sq. km., and decreased agricultural production induced by natural disaster is about 23 million tons.<sup>1)</sup> Each year, more than 80% of the disaster-caused casualties and most of the disaster-caused building collapses happen in rural China.<sup>2)</sup> Correspondingly, more and more farmers have to move to urbanized areas because of the subsistence constraint and an increase in income in urban areas. That makes the urbanization in China occur too fast. At the same time, too much farmland is occupied, and the sustainability of agricultural communities is under a direct threat.<sup>3)</sup>

For improving rural disaster prevention and reduction to mitigate the above problem, the central government requires governments at all levels to improve the development of community-based disaster-prevention infrastructures, such as early warning systems, shelters, emergency preplans, disaster prevention facilities, and residents' awareness of disaster prevention and mitigation.<sup>4)</sup>

Unfortunately, farmers do not have enough motivation to develop community-based disaster-prevention infrastructures because of the following reasons.<sup>5)</sup>

(1) Farmers are too poor to be involved in developing the infrastructure. Although the disaster-prevention infrastructure will make the after-disaster harvest enough for farmers' subsistence, its development takes time. Before the infrastructure is finished, the farmers' after-disaster harvest is still very low and cannot afford the infrastructure development and their own subsistence at the same time. So, farmers will face the subsistence problem if they spend money for infrastructure developing;

(2) Even if some farmers have enough money to develop the disaster-prevention infrastructure, it will not be economical and efficient because their production scale is always very small.

On the other hand, there are potential incentives for farmers (including the former farmers working in cities) to develop community-based disaster-prevention infrastructures. First, the infrastructure development will increase their after-disaster harvest. Second, after collaborative work on the infrastructure, farmers' interpersonal relationships will become strengthened and active community culture and awareness on disaster-prevention will come out. This will improve the community's ability to do disaster mitigation and relief, such as mutual aid, special care for disadvantaged groups, and mutual enlightenment or comfort. All these things compose some kind of social capital that will also increase farmers' after-disaster welfare in rural areas. Obviously, the former farmers working in cities cannot benefit from the similar social capital existing among urban residents. It

is impossible for them to be involved in urban community disaster-prevention because they work and live in urban area provisionally.<sup>6), 7), 8), 9)</sup> This means the development of the community disaster-prevention infrastructure can induce the welfare rise that will attract former farmers working in cities to go back to agricultural communities and be involved in infrastructure developing. Then, the sustainability of agricultural communities will increase.

Now, we can conclude the key problem as follows. Although the infrastructure can improve every farmer's welfare by increasing the after-disaster harvest and developing community social capital, it is not economical and efficient for partial farmers to develop the infrastructure without the help of others. In other words, this requires the collaborative work that also requires the participation and contribution of former farmers working in cities. On the other hand, although the welfare rise induced by the infrastructure is attractive to former farmers working in cities, they cannot come back to agricultural communities and take part in the development of the infrastructure because they cannot survive during the process of infrastructure development. So, our job is to figure out how to bring out the collaborative work by making former farmers survive during the process of infrastructure development with some mechanism design based on community.

Rural Credit Cooperatives (RCCs) were founded in the 1950s.<sup>10)</sup> And after several decades, RCCs became one important part of the main rural financial institutions because they focused on farmers' loan demand and the lending procedure is relatively simple.<sup>11)</sup> After 1999, national commercial banks (including the Agricultural Bank of China) and post offices canceled their loan business at the county level.<sup>12)</sup> This made RCCs the only formal financial institution that supplies farmers with loans in rural China. For improving rural loan supply, RCCs put into practice the individual and group microcredit loan (without guarantee requirement) in 1996, which have gradually been popularized since 2000. At the end of 2002, 93% of RCCs operated using the microcredit loan, and more than 20% of rural households made use of it.<sup>13)</sup> In general, the amount of the microcredit loan does not exceed the local farmers' average annual income, while the interest rate is decided by each RCC, considering it should be close to the basic interest rate given by the People's Bank of China. The contract term is one year in most cases. In the case where a larger amount is demanded, the group microcredit loan is available with the loan group consisting of 3-5 rural households.<sup>14), 15)</sup> The group microcredit loan from RCCs has been supplying farmers with necessary funds for after-disaster reconstruction and restoring of production.<sup>16), 17), 18)</sup> For example, after the earthquake in Sichuan, China on May 12, 2008, Jiulong Rural Credit Cooperative (in Wangcang County, Guangyuan City, Sichuan Province) supplied the affected farmers (who do not have a guarantee) with group loans for after-earthquake reconstruction.<sup>16)</sup>

From the above statement, we found that the group loan from RCCs can help rural disaster victims with disaster risk financing for subsistence and after-disaster reconstruction. This means farmers can refer themselves to group loans when they face the after-disaster subsistence problem under the situation where they are developing a disaster prevention infrastructure. So, for relaxing the subsistence constraint and motivating cooperative development of infrastructure, we would like to involve group loans in developing the disaster-prevention infrastructure to improve community-based disaster prevention and agricultural communities' sustainability in rural China.

## 2. The model

### 2-1 Model Environment

For simplification, we proposed a two-period model. There are two farmers: R (skilled) and P (unskilled). Formal loan from RCCs is applicable only if the household can repay it after one-period time. With a disaster, R can survive through two periods, while P has to move to an urbanized area for subsistence. For developing the community-based disaster-prevention infrastructure, R and P should work together. To help P to survive, R supplies P with internal subsidy. At the same time, as an option, R can choose to obtain group loan with P or just get an individual loan from RCCs.

### 2-2 Variable Assumptions

- (1) Disaster (such as drought) occurs in the middle of each period. This assumption is based on reality. Northwest rural areas in China suffer drought every year;<sup>19)</sup>
- (2) Two farmers: R (skilled) and P (unskilled);
- (3)  $F_R(l) = \sigma l$ : Production function of R in which  $\sigma > 1$ ;
- (4)  $F_P(l) = l$ : Production function of P;
- (5)  $l_{ij}$ : Labor invested for production by farmer  $i$  in period  $j$ ;
- (6)  $\delta$ : After-disaster remaining rate of production when there is no any disaster prevention.  $\delta < 1$  That means, in each period, farmer R will get  $\delta\sigma l_{Rj}$  and farmer P will get  $\delta l_{Pj}$ ;
- (7)  $L$ : Labor endowment for each farmer in each period is assumed to be  $L > 1$ ;
- (8)  $\bar{c}$ : The subsistence constraint for each period (minimum consumption for surviving each period);
- (9) Formal loan is applicable only if the household can repay it after one period time. And we assume RCCs can forecast farmers' ability to repay in the future;
- (10) Net interest rate of loan is zero both for individual and group loan;

- (11)  $\delta L < \bar{c}$  : Farmer P needs to borrow  $\bar{c} - \delta L$  after disaster in Period 1 because  $\delta L < \bar{c}$  . However, farmer P cannot repay the loan in Period 2 because  $\delta L - (\bar{c} - \delta L)$  (residual money after repaying)  $< \bar{c}$  (minimum consumption for surviving each period). So, formal lender (RCCs) does not lend to farmer P in Period 1;
- (12)  $\delta\sigma L > \bar{c}$  : Farmer R can survive each period even if there is no disaster-prevention infrastructure;
- (13)  $z$  : The disaster-prevention infrastructure in the community.  $z$  is public goods/service (having non-competitiveness in consumption), such as farm water systems. The community disaster-prevention infrastructure is preserved in period 1 by investing 1 unit of capital and 1 unit of labor, and it will only work in period 2 because developing infrastructure takes time. Under the situation with  $z$  , the after-disaster remaining rate of production will increase to  $\delta^z$  ;
- (14)  $\delta^z L > \bar{c}$  : This means that with disaster-prevention infrastructure, farmer P can make enough production for surviving each period;
- (15)  $U(c_{i1} + c_{i2}, z) = c_{i1} + c_{i2} + v^z$  : Farmer  $i$ 's utility function for two periods.  $U(c_{i1} + c_{i2}, z)$  is subject to  $c_{i1}, c_{i2} \geq \bar{c}$  and  $v^z$  meaning farmer  $i$ 's utility-rise because of  $z$  . We assume  $v^z$  induced by the "social capital" or "community culture" that is brought after collaborative work and enjoyed by R and P together in period 2;
- (16)  $\delta\sigma + 1 > \delta^z\sigma L - \delta\sigma L$  : This means it is not economical for R to develop the infrastructure alone;
- (17)  $\delta(L-1) + \delta^z L < 2\bar{c}$  : which means P cannot make the individual loan even if disaster-prevention infrastructure is developed in period 2. The assumption is equivalent to  $\delta < (2\bar{c} - \delta^z L)/(L-1)$  .
- (18)  $m$  : Periodical wage in urbanized area where there is no opportunity for former-farmers to enjoy the community disaster-prevention infrastructure.  $m \geq \bar{c}$  . That means P can survive if they migrate to cities. Here, we assume  $\sigma > m/(\delta L) \Rightarrow 2m < 2\delta\sigma L$  , which means R has no motivation to move to a city. Later, for comparative analysis, we will also analyze the case where  $\sigma < m/(\delta L) \Rightarrow 2m > 2\delta\sigma L$  , which motivates R to move.

### 2-3 Case I: Group Loan (GL) is not Provided

If there is no community disaster-prevention infrastructure, R consumes his production, while P leaves the community at the beginning of period 1 and lives in an urban area because he knows that he would not be able to survive after a disaster in rural area. Then R's, P's and social welfare will be

$$R: W_R(N(\text{no GL}), 0(\text{no community infrastructure})) = U(c_{R1} + c_{R2}, 0) = 2\delta\sigma L; \quad (1)$$

$$P: W_P(N, 0) = 2m. \quad (2)$$

$$SW(N, 0) = 2\delta\sigma L + 2m \quad (3)$$

If farmer R and P decide to develop a community disaster-prevention infrastructure, R gets 1 unit loan from RCCs at the beginning of period 1 (it should be repaid at the end of period 1) and invests it for the infrastructure. At the same time, R requests P to provide 1 unit labor for the infrastructure by promising to supply P with internal subsidy in the future. After a disaster, R supplies consumption goods,  $s$  , to P to let P consume  $\bar{c}$  at the end of period 1. For his own subsistence in period 1, R borrows an individual loan,  $b$  , from formal lender (RCCs) and repays it in period 2. As for the concrete event sequence, please refer to Fig.1.

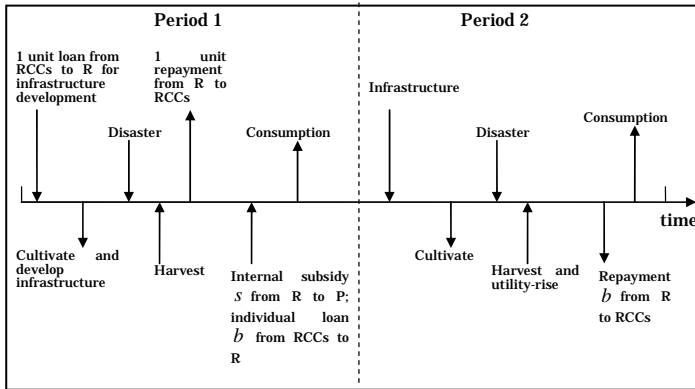


Fig.1 Event Sequence of Case I

Then R's and P's welfares will be as follows.

$$R: W_R(N, z) = \{\delta\sigma L - 1 - s + b\} + \{\delta^z\sigma L - b\} + v^z \quad (4)$$

$$P: W_p(N, z) = \{\delta(L-1) + s\} + \delta^z L + v^z \quad (5)$$

Subject to

$$\delta(L-1) + s = \bar{c} \quad (\text{subsistence constraint for farmer P in period 1}) \quad (6)$$

$$\delta\sigma L - 1 - s + b = \bar{c} \quad (\text{subsistence constraint for farmer R in period 1}) \quad (7)$$

$$\delta^z L \geq \bar{c} \quad (\text{subsistence constraint for farmer P in period 2}) \quad (8)$$

$$\delta^z \sigma L - b \geq \bar{c} \quad (\text{subsistence constraint for farmer R in period 2 same as the borrowing constraint of farmer R: } b \leq \delta^z \sigma L - \bar{c}) \quad (9)$$

where  $b$  is the loan of farmer R from formal lender (RCCs) and  $s$  is the internal subsidy from R to P.

According to the above analysis, the conditions that this case is feasible and Pareto improving are as follows:

$$\delta(L-1) + s = \bar{c} \quad (\text{subsistence constraint for farmer P in period 1}) \quad (6)$$

$$\delta\sigma L - 1 - s + b = \bar{c} \quad (\text{subsistence constraint for farmer R in period 1}) \quad (7)$$

$$\delta^z L \geq \bar{c} \quad (\text{subsistence constraint for farmer P in period 2}) \quad (8)$$

$$\delta^z \sigma L - b \geq \bar{c} \quad (\text{subsistence constraint for farmer R in period 2}) \quad (9)$$

$$W_R(N, z) > W_R(N, 0) \Rightarrow \delta\sigma L + \delta^z \sigma L - 1 - s + v^z > 2\delta\sigma L \quad (10)$$

$$W_p(N, z) > W_p(N, 0) \Rightarrow \delta(L-1) + s + \delta^z L + v^z > 2m \quad (11)$$

where formula (10) and (11) make sure there is Pareto improving.

Based on above conditions, we have the following deduction.

$$\text{Formula (6)} \Rightarrow s = \bar{c} - \delta(L-1) \quad (12)$$

$$\text{Formula (7) and (12)} \Rightarrow b = 2\bar{c} + 1 - \delta[\sigma L + (L-1)] \quad (13)$$

If  $\sigma < [2\bar{c} + 1 - \delta(L-1)]/(\delta L)$ ,  $b$  is positive; otherwise,  $b$  is negative, which means R can save part of their income for the next period.

Assumption (14) makes (8) always true.

Now, (9) is the critical condition that represents the borrowing constraint in the individual loan, which is with (13) transformed into

$$\sigma \geq [3\bar{c} + 1 - \delta(L-1)]/(\delta L + \delta^z L) \quad (14)$$

$$\text{Formula (10) and (12)} \Rightarrow v^z > \delta[\sigma L - (L-1)] + \bar{c} + 1 - \delta^z \sigma L \quad (15)$$

$$\text{Formula (11) and (12)} \Rightarrow v^z > 2m - \bar{c} - \delta^z L \quad (16)$$

We conclude the above deduction as follows.

The conditions for R and P's subsistence constraint (survival of the community) are as follows.

$$s = \bar{c} - \delta(L-1) = s_1^* \quad (12)$$

$$b = 2\bar{c} + 1 - \delta[\sigma L + (L-1)] = b^* \quad (13)$$

$$\sigma \geq [3\bar{c} + 1 - \delta(L-1)]/(\delta L + \delta^z L) = \sigma_1^* \quad (14)$$

As for the conditions for Pareto improving, we would like to do the following analysis:

$$\text{Let } \sigma_1^{**} = [\delta^z L + 2\bar{c} + 1 - 2m - \delta(L-1)]/(\delta^z L - \delta L) \quad (17)$$

When  $\sigma \leq \sigma_1^{**}$ , we have  $\delta[\sigma L - (L-1)] + \bar{c} + 1 - \delta^z \sigma L \geq 2m - \bar{c} - \delta^z L$ . This means we only need  $v^z > \delta[\sigma L - (L-1)] + \bar{c} + 1 - \delta^z \sigma L$  to make sure that Pareto is improving. Similarly, we only need  $v^z > 2m - \bar{c} - \delta^z L$  when  $\sigma > \sigma_1^{**}$ . We can conclude the condition for Pareto improving as follows:

$$v^z > v_1^z(\sigma) = \begin{cases} \delta[\sigma L - (L-1)] + \bar{c} + 1 - \delta^z \sigma L & \text{if } \sigma \leq \sigma_1^{**} \\ 2m - \bar{c} - \delta^z L & \text{if } \sigma > \sigma_1^{**} \end{cases} \quad (18)$$

Based on formula (14) and (18), we find that Pareto improving can be realized and the community disaster-prevention infrastructure will be preserved if and only if  $\sigma \geq \sigma_1^*$  and  $v^z > v_1^z$ .  $\sigma \geq \sigma_1^*$  makes sure R and P can survive period 2 in the case of supplying P with internal subsidy in period 1 and repaying the loan to RCCs in period 2. And  $v^z > v_1^z$  makes sure R's and P's welfares will be increased after the infrastructure development. With the development of the infrastructure, R's two-period utility in the agricultural community will increase. Similarly, with developing infrastructure, the two-period utility P can get in agricultural community will be larger than that in an urbanized area, and P would like to come back to agricultural communities. R and P both are motivated to do cooperative development for the infrastructure. In a word,  $\sigma \geq \sigma_1^*$  makes sure the community has the ability (R can supply P with internal subsidy to help him survive period 1) to preserve the infrastructure, and  $v^z > v_1^z$  makes sure R and P have the incentives to develop the infrastructure. Then, with the infrastructure, R's welfare, P's welfare and the social welfare will be as follows:

$$W_R(N, z) = \delta[\sigma L + (L-1)] + \delta^z \sigma L - 1 - \bar{c} + v^z \quad (19)$$

$$W_P(N, z) = \delta^z L + \bar{c} + v^z \quad (20)$$

$$SW(N, z) = W_R(N, z) + W_P(N, z) = \delta[\sigma L + (L-1)] + \delta^z (\sigma L + L) - 1 + 2v^z \quad (21)$$

Where

$$\sigma \geq \sigma_{1^*}^* \quad (22)$$

$$v^z > v_{1^*}^z \quad (23)$$

#### 2-4 Case II: Group Loan (GL) is Provided

In this case, R borrows 1 unit loan (it should be repaid at the end of period 1) from RCCs and invests it for the infrastructure at the beginning of period 1. At the same time, R requests P to provide 1 unit of labor for infrastructure by promising to supply P with internal subsidy in the future. As for subsistence in period 1, R and P borrow the group loan,  $B = b_R + b_P$  ( $b_R$  for R and  $b_P$  for P), from RCCs.  $b_R$  is just enough to make sure R can consume  $\bar{c}$  in period 1. Similarly,  $b_P$  is just enough to make sure P can consume  $\bar{c}$  in period 1. And in period 2, after repaying the group loan to RCCs, R supplies P with internal subsidy,  $S$ , to let P consume  $\bar{c}$  in period 2. As for the concrete event sequence, please refer to Fig.2.

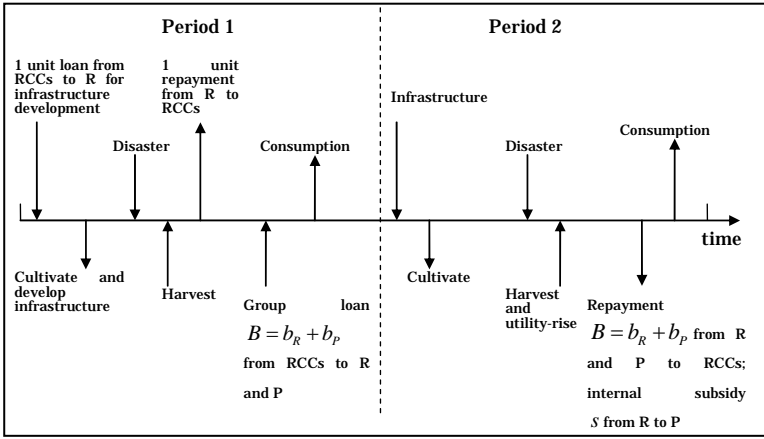


Fig.2 Event Sequence of Case II

Then R's and P's welfares are as follows.

$$R: W_R(G, z) = \{\delta\sigma L - 1 + b_R\} + \{\delta^z \sigma L - b_R - s\} + v^z \quad (24)$$

$$P: W_P(G, z) = \{\delta(L-1) + b_P\} + \{\delta^z L - b_P + s\} + v^z \quad (25)$$

$$\delta(L-1) + b_P = \bar{c} \quad (\text{subsistence constraint for farmer P in period 1}) \quad (26)$$

$$\delta\sigma L - 1 + b_R = \bar{c} \quad (\text{subsistence constraint for farmer R in period 1}) \quad (27)$$

$$\delta^z L - b_P + s = \bar{c} \quad (\text{subsistence constraint for farmer P in period 2}) \quad (28)$$

$$\delta^z \sigma L - b_R - s \geq \bar{c} \quad (\text{subsistence constraint for farmer R in period 2}) \quad (29)$$

where  $b_R$  is the loan of farmer R from the formal lender (RCCs) and  $b_P$  is the loan of farmer P from the formal lender (RCCs).

The combination of the last two constraints equals the borrowing constraint of the community:

$$b_R + b_P \leq \delta^z (\sigma L + L) - 2\bar{c} \quad (30)$$

which means the total production net of the minimum consumption in period 2 is larger than the repayment of the loan.

According to variable assumptions and the above analysis, the conditions that this case is feasible and Pareto improving are as follows.

$$\delta(L-1) + b_P = \bar{c} \quad (\text{subsistence constraint for farmer P in period 1}) \quad (26)$$

$$\delta\sigma L - 1 + b_R = \bar{c} \quad (\text{subsistence constraint for farmer R in period 1}) \quad (27)$$

$$\delta^z L - b_P + s = \bar{c} \quad (\text{subsistence constraint for farmer P in period 2}) \quad (28)$$

$$\delta^z \sigma L - b_R - s \geq \bar{c} \quad (\text{subsistence constraint for farmer R in period 2}) \quad (29)$$

$$W_R(G, z) > W_R(N, 0) \Rightarrow \delta\sigma L + \delta^z \sigma L - 1 - s + v^z > 2\delta\sigma L \quad (31)$$

$$W_P(G, z) > W_P(N, 0) \Rightarrow \delta(L-1) + s + \delta^z L + v^z > 2m \quad (32)$$

where formula (31) and (32) make sure there is Pareto improving.

Based on the above conditions, we have the following deduction:

$$\text{Formula (26)} \Rightarrow b_p = \bar{c} - \delta(L-1) \quad (33)$$

$$\text{Formula (27)} \Rightarrow b_R = \bar{c} + 1 - \delta\sigma L \quad (34)$$

If  $\sigma < (\bar{c} + 1)/(\delta L)$ ,  $b_R$  is positive; otherwise,  $b_R$  is negative which means R can save in period 1 either for his consumption or the fund for internal subsidy to P in period 2.

$$\text{Formula (28) and (33)} \Rightarrow s = 2\bar{c} - \delta^z L - \delta(L-1) \quad (35)$$

From assumption (17),  $s$  is positive, meaning P needs the internal subsidy from R.

Now, we substitute (34) and (35) into the borrowing constraint for the group loan, (30), to have

$$\sigma \geq [4\bar{c} + 1 - \delta^z L - \delta(L-1)]/(\delta L + \delta^z L) \quad (36)$$

$$\text{Formula (31) and (35)} \Rightarrow v^z > 2\bar{c} + 1 + \delta[\sigma L - (L-1)] - \delta^z(\sigma L + L) \quad (37)$$

$$\text{Formula (32) and (35)} \Rightarrow v^z > 2m - 2\bar{c} \quad (38)$$

We conclude the above deduction as follows.

The conditions for R and P's subsistence constraint (survival of the community) are as follows:

$$s = 2\bar{c} - \delta^z L - \delta(L-1) = s_2^* \quad (35)$$

$$B = b_R + b_p = 2\bar{c} + 1 - \delta[\sigma L + (L-1)] = B^* \quad (39)$$

$$\sigma \geq [4\bar{c} + 1 - \delta^z L - \delta(L-1)]/(\delta L + \delta^z L) = \sigma_2^* \quad (36)$$

As for the conditions for Pareto improving, we would like to do the following analysis:

$$\text{Let } \sigma_2^{**} = [4\bar{c} + 1 - 2m - \delta(L-1) - \delta^z L]/(\delta^z L - \delta L) \quad (40)$$

When  $\sigma \leq \sigma_2^{**}$ , we have  $2\bar{c} + 1 + \delta[\sigma L - (L-1)] - \delta^z(\sigma L + L) \geq 2m - 2\bar{c}$ . Meaning, we just need  $v^z > 2\bar{c} + 1 + \delta[\sigma L - (L-1)] - \delta^z(\sigma L + L)$  to make sure Pareto improving. Similarly, we just need  $v^z > 2m - 2\bar{c}$  when  $\sigma > \sigma_2^{**}$ . We can conclude the condition for Pareto improving as follows:

$$v^z > v_2^{z*}(\sigma) = \begin{cases} 2\bar{c} + 1 + \delta[\sigma L - (L-1)] - \delta^z(\sigma L + L) & \text{if } \sigma \leq \sigma_2^{**} \\ 2m - 2\bar{c} & \text{if } \sigma > \sigma_2^{**} \end{cases} \quad (41)$$

Pareto improving can be realized and the community disaster-prevention infrastructure will be preserved if and only if  $\sigma \geq \sigma_2^*$  and  $v^z > v_2^{z*}$ .

Similarly as in case I,  $\sigma \geq \sigma_2^*$  makes sure the community has the ability to get the group loan for subsistence and preserve the infrastructure, and  $v^z > v_2^{z*}$  makes sure R and P have the incentives to develop the infrastructure. Then, R's welfare, P's welfare, and the social welfare will be

$$W_R(G, z) = \delta[\sigma L + (L-1)] + \delta^z(\sigma L + L) - 1 - 2\bar{c} + v^z \quad (42)$$

$$W_P(G, z) = 2\bar{c} + v^z \quad (43)$$

$$SW(G, z) = W_R(G, z) + W_P(G, z) = \delta[\sigma L + (L-1)] + \delta^z(\sigma L + L) - 1 + 2v^z \quad (44)$$

where

$$\sigma \geq \sigma_2^* \quad (45)$$

$$v^z > v_2^{z*} \quad (46)$$

## 2-5 Comparative Analysis

For comparing case I and II, we additionally define the following value.

$$(1) \text{ Let } \sigma^{***} = [3\bar{c} + 1 - 2m - \delta(L-1)]/(\delta^z L - \delta L) \quad (47)$$

(2) Based on the assumption,  $\bar{c} < \delta^z L$ , we have  $\sigma_2^* < \sigma_1^*$  and  $\sigma_2^{**} < \sigma^{***} < \sigma_1^{**}$ . For simplification, we assume  $\sigma_2^* > m/(\delta L)$ ,  $\sigma_1^* < \sigma_2^{**}$ , and  $\sigma_1^{**} < 1/[\delta^z L - \delta(L+1)]$ .

Considering the consistency of the above additional assumptions and those in section 2-2 (variable assumptions), we set down the concrete values of parameters as follows.

$$\bar{c} = 6.088; \delta = 0.806; L = 7.196; \delta^z = 0.92; m = 6.088. \text{ And the range of } \sigma \text{ should be } m/(\delta L) < \sigma < 1/[\delta^z L - \delta(L+1)].$$

According to the above settings, we can get the following numerical values of endogenous variables.

$$\sigma_1^* = 1.149; \sigma_1^{**} = 3.202; \sigma_2^* = 1.106; \sigma_2^{**} = 1.904; \sigma^{***} = 2.553; m/(\delta L) = 1.05; 1/[\delta^z L - \delta(L+1)] = 69.716; s_1^* = 1.094;$$

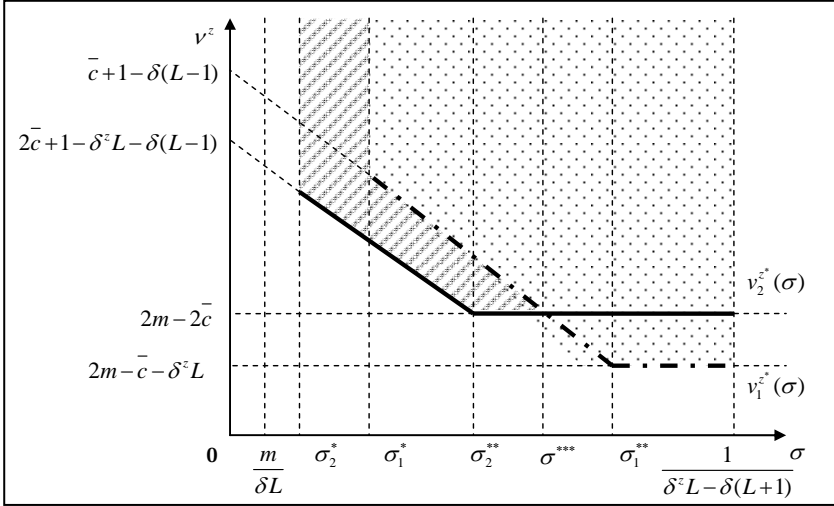


Fig.3 Results of the comparative analysis between case I and II ( $\sigma > m/(\delta L)$ )

$S_2^* = 0.562$ . Please refer to Fig.3 for the results of the comparative analysis.

The area filled with dots stands for the case in which there is no group loan. Within that area, we have  $\sigma \geq \sigma_1^*$  and  $V^z > V_1^{z*}$ . The community has the ability and incentive to do cooperative development of the community-based disaster-prevention infrastructure, and the community's sustainability will increase. And the area beyond the thick line stands for the case in which there is a group loan. Within that area, we have  $\sigma \geq \sigma_2^*$  and  $V^z > V_2^{z*}$ . In that area, with the group loan, the community has the ability and incentive to do cooperative development of the community-based disaster-prevention infrastructure, and the community's sustainability will increase. Obviously, when the local production level is relatively low ( $\sigma < \sigma^{***}$ ), the application of group loans can expand the possibility of preserving the infrastructure, Pareto improving, and sustainability of the community. The increased possibility is the area filled with oblique lines.

Additionally, from the comparative analysis, we have the following results.

- (1)  $S_1^* > S_2^*$  That means the application of the group loan can decrease P's dependence on R.
- (2)  $b^* = B^*$  That means the application of the group loan will not change the community's loan demand.

We began studying the situation where the monetary income in urban areas is larger even for R. That means  $2m^0 > 2\delta\sigma L \Rightarrow \sigma < m^0/(\delta L)$ , and R has the motivation to move to the city. Correspondingly, in case I, the condition for Pareto improving changed to be as below.

$$V^z > V_1^{z*}(\sigma) = \begin{cases} 2m^0 + \bar{c} + 1 - \delta^z \sigma L - \delta[\sigma L + (L-1)] & \text{if } \sigma \leq \sigma_1^{**0} \\ 2m^0 - \bar{c} - \delta^z L & \text{if } \sigma > \sigma_1^{**0} \end{cases} \quad (48)$$

$$\text{where } \sigma_1^{**0} = [2\bar{c} + 1 + \delta^z L - \delta(L-1)]/(\delta^z L + \delta L) \quad (49)$$

And in case II, the condition for Pareto improving changed to be as below.

$$V^z > V_2^{z*}(\sigma) = \begin{cases} 2m^0 + \bar{c} + 1 - \delta[\sigma L + (L-1)] - \delta^z(\sigma L + L) & \text{if } \sigma \leq \sigma_2^{**0} \\ 2m^0 - 2\bar{c} & \text{if } \sigma > \sigma_2^{**0} \end{cases} \quad (50)$$

$$\text{where } \sigma_2^{**0} = [3\bar{c} + 1 - \delta^z L - \delta(L-1)]/(\delta^z L + \delta L) \quad (51)$$

Additionally, there is no change on  $\sigma_1^*$ ,  $\sigma_2^*$ ,  $s_1^*$ ,  $s_2^*$ ,  $b^*$  and  $B^*$ .

For comparative analysis, we would like to do the following additional assumptions:

- (1) Let  $\sigma^{***0} = [3\bar{c} + 1 - \delta(L-1)]/(\delta^z L + \delta L)$ . (52)
- (2) Because of the assumption of  $\bar{c} < \delta^z L$ , we have  $\sigma_2^{**0} < \sigma_2^* < \sigma_1^* = \sigma^{***0} < \sigma_1^{**0}$ . For simplification, we assume  $\sigma_1^{**0} < m^0/(\delta L) < 1/[\delta^z L - \delta(L+1)]$ .

Considering the consistency, we let  $m^0$  be equal to 20. And the range of  $\sigma$  should be  $\bar{c}/(\delta L) < \sigma < m^0/(\delta L)$ .

According to the above settings, we can get  $\sigma_1^{**0} = 1.192$ ;  $\sigma_2^{**0} = 0.616$ ;  $\sigma^{***0} = 1.149$ ;  $\bar{c}/(\delta L) = 1.05$ ;  $m^0/(\delta L) = 3.448$ .

Please refer to Fig.4 for the results of the comparative analysis.

The area filled with dots stands for the case in which there is no group loan. Within that area, we have  $\sigma \geq \sigma_1^*$  and  $V^z > V_1^{z*}$ . The community has the ability and incentive to do cooperative development of the community-based disaster-prevention infrastructure, and the

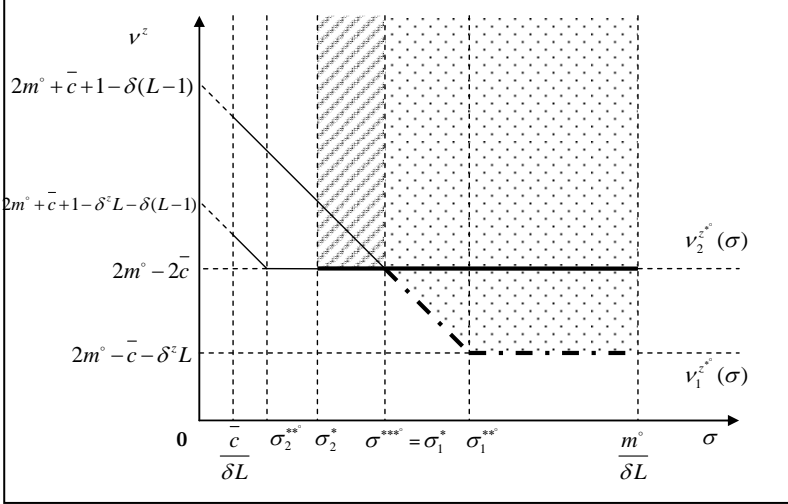


Fig.4 Results of comparative analysis between case I and II ( $\sigma < m^\circ /(\delta L)$ )

community's sustainability will increase. And the area beyond the thick line stands for the case in which there is a group loan. Within that area, we have  $\sigma \geq \sigma_2^*$  and  $V^z > V_2^z$ . The community has the ability and incentive to do cooperative development of the community-based disaster-prevention infrastructure and the community's sustainability will increase. Obviously, when the local production level is relatively low ( $\sigma < \sigma^{***}$ ), the application of the group loan can expand the possibility of preserving the infrastructure, Pareto improving and sustainability of the community. The increased possibility is the area filled with oblique lines.

Similarly with the comparative analysis when  $\sigma > m^\circ /(\delta L)$ , we have the following additional results.

- (1)  $S_1^* > S_2^*$
- (2)  $b^* = B^*$

According to the above parameters setting, we have

$$\begin{aligned} \bar{c}/(\delta L) = m^\circ/(\delta L) < \sigma_2^{**} < \sigma_2^* < \sigma_1^* = \sigma^{***} < \sigma_1^{**} < \sigma_2^{**} < \sigma^{***} < \sigma_1^{**} < m^\circ/(\delta L) < 1/[\delta^z L - \delta(L+1)] \quad (53) \\ 2m^\circ - \bar{c} - \delta^z L > v_2^z(\sigma_2^*) \quad (54) \end{aligned}$$

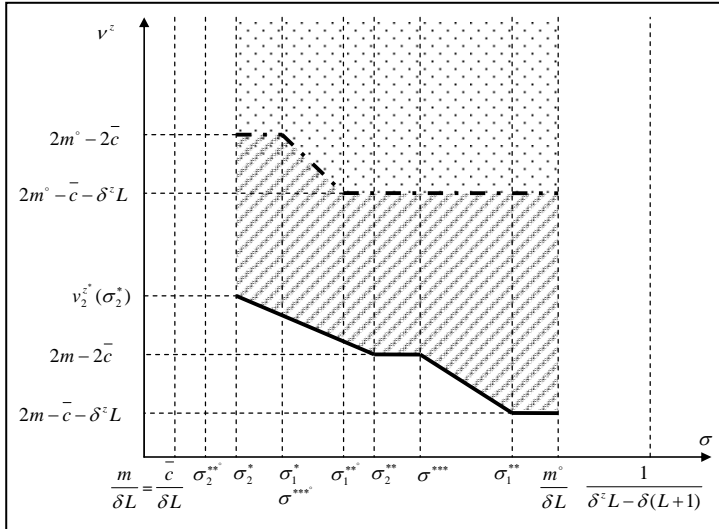
Based on formula (53) and (54), we put Fig.3 and Fig.4 together to get Fig.5 to compare the situation in which there is no motivation for R to move to the city with the situation where R has the incentive to migrate. Here, we suppose  $\sigma < m^\circ /(\delta L)$ . If  $\sigma > m^\circ /(\delta L)$ , R does not have motivation to move. Then, it is not necessary to do comparative analysis. In Fig.5, the area filled with dots stands for the case where the periodical wage in the urbanized area is high ( $m^\circ > \sigma\delta L$ ); Pareto improving can be realized; infrastructure will be preserved, and the agricultural community is sustainable. And the area filled with dots and oblique lines stands for the case where the periodical wage in the urbanized area is low ( $m^\circ < \sigma\delta L$ ); Pareto improving can be realized; infrastructure will be preserved, and the agricultural community is sustainable. Obviously, high periodical wage in cities will decrease the possibility of a sustainable community. The area filled with oblique lines is the decreased amount. Furthermore, the higher wage level will induce less possibility of the sustainable community because the thick and dashed line in Fig.5 will rise and the area filled with oblique lines will increase.

### 3. Conclusions

In this chapter for relaxing the subsistence constraint and promoting cooperative action among farmers, we involved the group loan in the community-based disaster-prevention infrastructure development in rural China. Besides making the comparative analysis between non-group-loan and group-loan cases, we also studied the situation where the periodical wage in the urbanized area is high enough to motivate skilled farmers to migrate. From that, we got the following conclusions.

- (1) With community-based disaster-prevention infrastructure, the farmers' welfare will increase because of the increased after-disaster harvest and utility rise induced by "social capital" or "bond," coming from collaborative work and involvement in the development of the infrastructure. This will attract former farmers working in cities to come back to rural sectors and make agricultural communities more sustainable. But there are two obstacles for the community-based disaster-prevention infrastructure development in rural China: subsistence constraint and welfare difference between rural and urban areas. The former makes agricultural communities have not enough ability to develop the infrastructure. And the latter one makes farmers (at least partially) not have the motivation to be involved in the cooperative development of the infrastructure.





**Fig.5 Comparative Analysis between High-wage and Low-wage Situations**

(2) Under the situation where R and P decide to develop the community-based disaster-prevention infrastructure, the application of group loans can decrease P's dependence on R. With the group loan, P can also get the loan from RCCs in period 1 after a disaster. With a group loan, the occasion when R should supply P with internal subsidy changes from period 1 to period 2. And in period 2, with the infrastructure, P's after-disaster harvest increases compared with that in period 1. Correspondingly, P's demand for subsidy in period 2 decreases compared with that in period 1. This positive effect induced by the application of the group loan can expand the possibility of the preserved infrastructure. In other words, the application of the group loan can extend the cooperative development of the disaster-prevention infrastructure to the rural areas where the community's ability to supply internal subsidy is relatively low. For example, the northwest rural areas of China are suffering poverty and drought at the same time. We can motivate local RCCs to carry out group loans, considering cooperative development of farm water system correspondingly.

(3) The application of the group loan will not increase the community's loan demand. The design of group loans just changes the way to allocate loan among the community. Without the group loan, RCCs simply supply R with a loan. And with the group loan, RCCs also supply P with a loan. This change in allocation will not change the whole community's demand for loans that are necessary to make sure R and P both survive period 1 after a disaster without a community disaster-prevention infrastructure. This is good news for rural development because the present loan supply in rural China is far from enough. If this idea of developing infrastructure by applying group loans will induce an extra loan demand, it will become less practical.

(4) When the local agricultural production level is relatively low, the application of the group loan can expand the possibility of the preserved infrastructure, Pareto improving, and sustainability of the community. First, the application of the group loan will decrease the requirement on the community's ability (R's production level,  $\sigma$ , will decide if R can get a larger enough loan from RCCs to make sure the whole community (including R and P) survives period 1) to implement the cooperative development of the infrastructure. Second, the application of the group loan can reduce the minimum amount of welfare rise that is asked by farmers (including R and P) to get enough incentives to do the cooperative development of the infrastructure. Definitely, this positive effect induced by the group loan can make the idea of the cooperative infrastructure development suitable for more rural areas, especially the relatively undeveloped agricultural communities located in middle and western China. This can be very meaningful for Chinese rural development and even the development of all of China because the current Chinese guideline for development is to strengthen economy development in middle and west areas of the country. The development in these areas depends very much on rural development because agricultural communities are the main part there. Obviously, developing the disaster-prevention infrastructure by applying group loans can accelerate local rural development by improving agricultural communities' sustainability and ability to prevent and mitigate disaster.

(5) The level of periodical wage in urbanized areas will not affect the requirement on the community's ability (R's production level,  $\sigma$ , that will decide R can get a large enough loan from RCCs to make sure the whole community (including R and P) survive period 1) to implement the cooperative development of the infrastructure. That means the local agricultural production level is the pivotal factor for applying the group loan to promote the cooperative development of the infrastructure. In some senses, this will give encouragement to those agricultural communities located in relatively undeveloped provinces where urban areas cannot supply rural areas with much support for development. Again, that is good news for rural development in the middle and west areas of China where the whole economy is relatively undeveloped, and agriculture and rural areas cannot get much support from industry and cities.

(6) The high wage level in the cities will decrease the possibility of the preserved infrastructure, Pareto improving and sustainability of the community. Former farmers working in urbanized areas will ask more welfare rise from the developing infrastructure to be incentives for coming back to agricultural communities and joining in the cooperative development of the infrastructure when their income in cities increases. Additionally, skilled farmers will also migrate to cities if the wage level in cities is high enough. This will make it more difficult to attract enough farmers back to agricultural communities to do the cooperative development of the infrastructure. Furthermore, too much migration from rural areas to cities induced by large income differences will damage the local agricultural production ability and worsen the situation of farmland occupied by urban construction.

This will decrease the local agricultural production level and deteriorate the rural ecological environment. Rural communities' ability to do disaster-prevention and mitigation will become worse and worse, which is not good for rural development and agricultural communities' sustainability. This requires the government to carry out some practical and efficient macro-policies to reduce income differences between rural areas and cities. This will help to implement the mechanism of developing the community-based disaster-prevention infrastructure with group loans or other efficient ideas to improve agricultural communities' sustainability and ability of disaster-prevention and mitigation in the future.

(7) The utility-rise,  $V^z$ , induced by the "social capital" or "community culture," which is brought after collaborative work and enjoyed by farmers together, is very important to reduce the welfare difference between rural and urban areas and give farmers enough motivation to be involved in the cooperative development of the disaster-prevention infrastructure. If there is no  $V^z$  and farmers only care about monetary income, even R will become more inclined to migrate to an urbanized area when the income in cities is relatively high. Then, the cooperative infrastructure development based on the group loan will not be carried out, and the advantage of the group loan in motivating the cooperative infrastructure development will not make sense. As one kind of revised institution, the application of the group loan in improving the disaster-prevention infrastructure needs to be combined with developing community-based social capital or culture (such as mutual aid, special care for disadvantaged groups, and mutual enlightenment or comfort that will increase farmers' after-disaster utility) to make cooperative infrastructure development more beneficial, attractive, practical, efficient, and obtainable. And in general, this kind of social capital or culture is based on local interpersonal relationships or traditional functions. This requires us to pay attention to improving and extending local conventional culture or functions when we apply some innovative ideas in improving the community disaster-prevention infrastructure. In other words, the complementarity between revised institutions and traditional functions is important and meaningful for disaster risk management in agricultural sectors of China.

## Reference

- 1) Chen, H.: Improve Disaster Prevention and Mitigation to Develop Rural China, Journal of the Party School of CPC Xiamen Municipal Committee, No. 1, pp. 72-75, 2007.
- 2) Qin, D.H.: Improve Disaster Prevention and Mitigation System in Rural China, the Fourth Session of the Tenth CPPCC National Committee, 2006.  
Available: [http://www.cma.gov.cn/old\\_cma\\_new/qxzt/shzyxnc/ljdh/t20060427\\_127463.phtml](http://www.cma.gov.cn/old_cma_new/qxzt/shzyxnc/ljdh/t20060427_127463.phtml)
- 3) Zhou, M.J.: What Kind of Urbanization We Need, China Development Observation, 2006.  
Available: <http://www.chinado.cn/ReadNews.asp?NewsID=577>
- 4) the General Office of the State Council: the Outline of China's the Eleventh Five-year Plan for National Integrated Disaster Mitigation, 2007.  
Available: [http://www.xjhm.gov.cn/shownews.asp?news\\_id=2805](http://www.xjhm.gov.cn/shownews.asp?news_id=2805)
- 5) Chen, L.Y.: Research on Disaster Prevention System in the Rural Area of Minbei, Minbei Daily, 2008 (the time refer to).  
Available: [http://www.66163.com/Fujian\\_w/news/mbrb/041213/3\\_1.html](http://www.66163.com/Fujian_w/news/mbrb/041213/3_1.html)
- 6) Zhao, S.Q., Zhou, Y. and Zhao, S.L.: Study on Mechanism of Earthquake Prevention and Disaster Reduction in Urban Community in China, City and Disaster Mitigation, No. 6, pp. 10-12, 2004.
- 7) Li, M.S., Wang, D.L., Yan F.: A Exploratory Discussion on Preventing Agriculture Calamities in the Construction of New Rural Areas, Chinese Journal of Agricultural Resources and Regional Planning, No. 4, pp. 6-9, 2006.
- 8) Liu, Z.X.: Construction of public safety in community, City and Disaster Mitigation, No. 4, pp. 16-18, 2007.
- 9) San, S.: Construction of Safe Community: Fundamental Engineering for Society's Disaster Reduction, City and Disaster Mitigation, No. 4, pp. 9-14, 2005.
- 10) Baidu: The History of Rural Credit Cooperatives, 2008.  
Available: <http://zhidao.baidu.com/question/19275082.html>
- 11) Park, A. and Ren, C.Q.: Microfinance with Chinese Characteristics, World Development, Vol. 29, No. 1, pp. 39-62, 2001.
- 12) Yin, W.: Research on Status, Problems and Countermeasures of Rural Financial System, Law-lib.com, 2008 (the time refer to).  
Available: [http://www.law-lib.com/lw/lw\\_view.asp?no=3944](http://www.law-lib.com/lw/lw_view.asp?no=3944)
- 13) Kawahara, S.: The Progress of the Rural Finance and the Character of Organization of Rural Credit Cooperatives in China, Journal of Agricultural Policy Research, No.9, pp.1-32, 2005a.
- 14) the People's Bank of China: the Direction on the Management of Group-lending Loan from Rural Credit Cooperatives, 2000.
- 15) the People's Bank of China: the Direction on the Management of Microcredit Loan from Rural Credit Cooperatives, 2001.
- 16) Chen, J.: Jiulong Rural Credit Cooperative Supports After-disaster Reconstruction, Guangyuan News Net, 2008.  
Available:  
<http://www.scgy.gov.cn/scgy/2008zxzx.nsf/d7b59df07550a43b48256d740024d5d0/6dd19d0fb58ba93d482574670005268b!OpenDocument>
- 17) Anhui Rural Credit Cooperative Union: Opinion on Developing Microcredit to Support the Industry of Raising Living Pig, 2007.  
Available: <http://www.china-ah.com/news/2007/11/20/136339.html>
- 18) Zhuang, Y. and Wu, X.Y.: Zhouning Rural Credit Cooperative Supports Restoring Spring Ploughing, Fujian Dongnan News Net, 2008.  
Available: [http://www.fjsen.com/fujian/2008-03/06/content\\_440211.htm](http://www.fjsen.com/fujian/2008-03/06/content_440211.htm)
- 19) www.news.cn: Drought Disaster in Northwest Rural Areas of China, 2007.  
Available: [http://news.xinhuanet.com/local/2007-03/25/content\\_5892757.htm](http://news.xinhuanet.com/local/2007-03/25/content_5892757.htm)