

Practice of barren hilly land consolidation and its impact: A typical case study from Fuping County, Hebei Province of China

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Abstract: Land is the root of rural revitalization, and its core is to reinvigorate land resources through the building up of land capacity. Since the late 1990s, land consolidation efforts have been widely extended to all parts of China. Land consolidation has served as an essential instrument for reinvigorating stock land, strengthening intensive land use, timely supplementing cultivated land, and promoting agricultural modernization, as well as urban-rural integration. This study uses a typical poor village (Dadao Village) in a state-designated impoverished county (Fuping County, Hebei Province), to analyze the socioeconomic benefits and eco-environmental impacts of land consolidation. With the aid of first-hand data from questionnaire surveys, face-to-face interviews and the visual interpretation of land use and land cover changes (LUCC), we found that: 1) the barren hilly land consolidation (BHLC) helps to promote the transformation of resource-advantages into asset-advantages in poverty-stricken areas. In 2017, 60.16% households in the study area gained the additional transferred-income with an annual average of 2843 yuan, while 19.11% households received the wage-income with an annual average of 9871 yuan. 2) Land consolidation inspires farmers' enthusiasm to participate in village government and helps alleviate rural poverty. From 2014 to 2017, land consolidation has helped 585 poor in the village out of poverty. Meanwhile, by land consolidation, most farmers' attitudes towards land consolidation have shifted from "not caring" to "have great concern," and their identity cognition has gradually changed from being bystanders to becoming decision makers and supervisors. 3) Further analysis demonstrated that land consolidation could not only increase the quantity and quality of arable land, but also have a certain impact on eco-environment. During 2014–2016, the BHLC in the study area transformed 242.12 ha unused barren hilly land and open forest land into well-facilitated arable land, and increased the average arable land by 0.19 ha per capita. Also, the index of

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land use intensity increased by 27.01% between 2014 and 2016. Farmers' perceptions of environmental awareness have confirmed that such high-intensity LUC were significant enough to make two-side impacts on eco-environment. We appeal to establish a combined organization and encouragement mechanism of rural land consolidation, to take the full breadth and depth of farmers' participation into consideration, and to formulate more scientific and sustainable land consolidation planning. Also, we put forward some suggestions and notes for the implementation and promotion of BHLC model. These findings can provide beneficial references for those involved in policymaking and planning in the areas of land consolidation and poverty alleviation in China, as well as other developing countries around the world.

Keywords: land consolidation engineering; barren hilly land; socioeconomic effect; rural revitalization; China

1 Introduction

Accelerating rural revitalization in an all-round way is part of a major strategic plan to promote urban-rural integration and rural sustainable development in China (Liu and Li, 2017a; Liu, 2018). Of all the elements in a rural territorial system (Long and Tu, 2017), land is the root of rural revitalization; its core is to reinvigorate land resources through the building up of land capacity. Land consolidation provides a central approach to reinvigorate stock land, strengthen intensive land use, timely supplement cultivated land, improve land productivity, and to address various increasingly prevalent land-use problems (Liu *et al.*, 2010; Chen *et al.*, 2012; Sayilan, 2014; Jiang *et al.*, 2015; Hiironen and Riekkinen, 2016; Du *et al.*, 2018). As such, land consolidation has been highly valued by the Chinese government as a crucial instrument to realize land capacity building, guarantee food security, deepen new countryside construction, improve farmers' livelihood, and to promote agricultural modernization and urban-rural transformation (Long *et al.*, 2010; Liu *et al.*, 2016; Wang *et al.*, 2016).

The concept of land consolidation was firstly raised by Western countries in the 14th century, and was traditionally used to solve land fragmentation, and for enhancing systematic land use in the rural areas (Pašakarnis and Maliene, 2010; Janus and Markuszewska, 2017; Cay *et al.*, 2010). Nowadays, modern land consolidation practices in the Western world has changed into multiple goals (Demetriou *et al.*, 2012), and have established relatively sound legal protection, administrative management and complete public participation systems, as well as scientific engineering technologies (Adrianna *et al.*, 2014; Niels, 2015; Pia *et al.*, 2018). By contrast, China did not make it clear (at a legal level) until 1999, in the PRC Law on Land Management, that “the state encourages land consolidation” (Yan *et al.*, 2016). Hence, domestic land consolidation studies are currently at an early, exploratory stage (Wu *et al.*, 2011; Yun, 2011; Li *et al.*, 2014). The National Land Consolidation Plan (2016–2020) just came into force, and put forward the national strategic plan for land consolidation in the next five years. The plan calls for adhering to the concept of “Green Development”, and promoting “Ecological Land Consolidation (ELC)” in China. In response to this call, a series of ELC practices has been carried out in regions with serious soil erosion, land desertification, land salinization, soil pollution and ecological degradation, to improve the self-restoration capability of degraded land and promote the man-land harmonious coexistence (Liu *et al.*, 2008; Li *et al.*, 2017; Liu and Li, 2017b; Wang and Liu, 2018). Of all these practices, the barren hilly land consolidation (BHLC) is a great attempt to stimulate the

vitality of degraded land on barren hills and turning that land into invaluable assets (Han *et al.*, 2015; Liu *et al.*, 2015). The BHLC follows the regulations of AISS (asset income support system), proposed by the Chinese central government for rural residents in poor areas. Under AISS, local governments should guide farmers to share land contract management rights with various enterprises, cooperatives or family farms, on the premises of keeping the collective land ownership unchanged, not crossing the red line of farmland, and not to prejudice farmers' interests (Zhou *et al.*, 2018). Also, the BHLC is conducive to regional ecological conservation, characteristic industries development, agricultural scale management and land capitalization, targeted poverty alleviation and the stimulation of endogenous motivation in rural community.

While local and external land consolidation studies have achieved some fruitful results, there have been far fewer empirical studies on the subsequent effects of barren hilly land consolidation for the beneficiaries, especially at a micro scale and from farmers' perspectives. Therefore, this study selects a typical village (Dadao Village) in a state-designated impoverished county (Fuping County, Hebei Province), as the study area. Fuping County is constructing one of the largest BHLC projects at county level in China. With the aid of firsthand data from questionnaire surveys, face-to-face interviews, and artificial visual interpretation data of the LUCC (land use and land cover changes), we analyze the socio-economic benefits and eco-environmental impacts of BHLC, by a farmer-oriented perspective. This study attempts to provide an empirical reference for the in-depth study of land consolidation, as well as a scientific basis for the policymaking and planning of urban-rural integration, poverty alleviation and rural revitalization, both at home and abroad.

2 Materials and methods

2.1 Study area

Fuping County (N38°09'–39°07', E113°45'–114°31') is located in the Taihang Mountains, west of Baoding City, Hebei Province (Figure 1a). As one of the state-designated impoverished counties in China, Fuping has taken the BHLC as a strategic breakthrough to accelerate agricultural development and targeted poverty alleviation since 2013. A wide mountainous area (217,333 ha) and rich reserve arable land resources (170,667 ha) has endowed eastern eight towns and 141 villages (population of no less than 70,000) in Fuping with great potential for land consolidation and utilization. After land consolidation, the newly-developed arable land will amount to approximately 13,330 ha, with an increase of 2.86 mu (1 mu equals 0.067 ha) per capita for the farmer involved in land consolidation.

The study area, Dadao Village, is located 7 km southeast of Fuping (Figure 1b). There were 304.76 ha of unused grassy slope land, accounting for nearly two-thirds (62.92%) of the total area in Dadao. However, the average original arable land was no more than 1 mu per capita. According to the Fuping's *Land Consolidation and Comprehensive Agricultural Development Plan*, Dadao is one of the first villages in Fuping to carry out land consolidation projects on barren hilly land (started in July 2015, and completed by October 2016). Also, all the barren hilly land in Dadao was included in the land consolidation planning range. Moreover, Dadao is a typical poverty-stricken village, with 497 households and 1,308

permanent residents. Of those totals, 327 households and 673 persons in the village were registered as poverty-stricken since 2014. Therefore, the study area was selected to accurately represent the typical characteristics of Fuping (such as deep poverty, abundant mountain resources and a shortage of arable land).

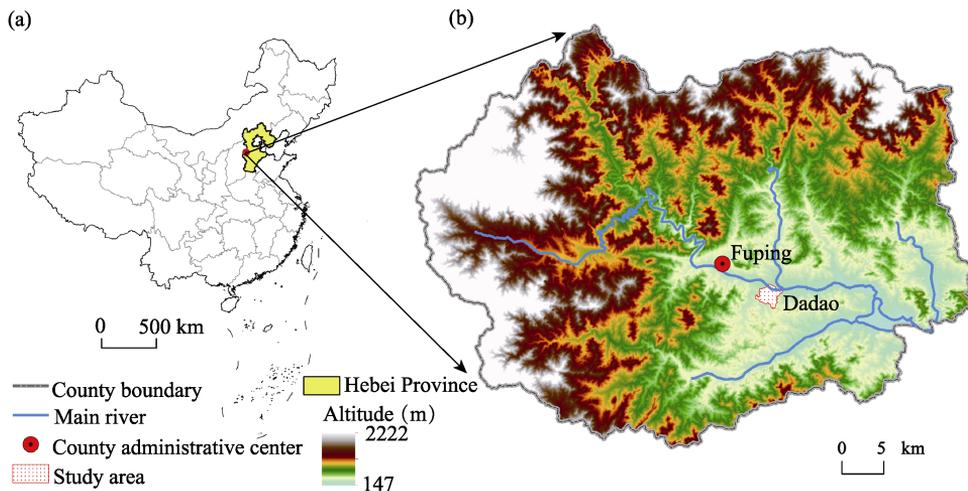


Figure 1 Location of Fuping County (a) and the study area (b) in China

2.2 Data sources

By employing random sampling and sequential interviewing (Small, 2009), this study conducted questionnaire-type surveys of farmers who have been involved in land consolidation in Dadao. The site investigation started in August 2015 (before land consolidation). The investigation mainly took the form of interviews with farmers, the community-level first secretary, poverty relief team leaders, and the manager and staff of the agricultural company. Thus, when the decision was made to carry out week-long questionnaire surveys in May 2018 (after land consolidation), the authors had already formed a rudimentary knowledge of the study area, which helped them to better identify the accuracy of the questionnaires' feedback information. With the first-hand data obtained by site investigation, the authors tried to analyze the socioeconomic benefits of land consolidation from the perspective of the local farmers. Then, the LUCC that occurred before, during and after land consolidation were interpreted, in order to analyze the corresponding eco-environmental impacts over the years covered by this study.

2.3 Methods

2.3.1 Theoretical framework of BHLC effects analysis

In Fuping's BHLC model, the village committee serves as a coordinator between farmers and the company. This committee organizes farmers to vote on every major decision regarding land consolidation. After signing a contract with the village committee, the agricultural company is given independent land management rights for 50 years. Meanwhile, the company (as the land user) must farm the land and cannot use it for other purposes (Liu *et al.*, 2016). Local governments dominate the formulation of land consolidation planning, and invites qualified enterprises (which are usually professional agricultural companies) to im-

plement the planning. There are land use policies that give priority to poverty-stricken counties like Fuping. These policies state that, in state-designated and province-designated impoverished counties, the index of the requisition-compensation balance of arable land can be exchanged within the same province¹. Through land consolidation measures, local governments can obtain a considerable amount of financial income to promote county development.

Farmers are the main body and direct beneficiaries of land consolidation practices in rural China. Nevertheless, few studies have evaluated the effects of rural land consolidation from the perspective of farmers. In previous research, the most commonly-used evaluation indexes focused on the land itself. These evaluation indexes included the production capacity of land, the rate of investment return per unit area, the improvement of farmland infrastructure, and the landscape fragmentation rate (Li *et al.*, 2006; Huang *et al.*, 2012; Yang *et al.*, 2013; Zhang and Gao, 2017). To further explore the socioeconomic effects and eco-environmental impacts of land consolidation on local farmers, this study formulates the following five hypotheses based on site investigation works (Figure 2):

1) Land consolidation, as one of the primary policies designed to help people escape from poverty in the study area, has effectively reduced poverty headcount ratio (the proportion of the poverty-stricken population to the total population). 2) Farmers are now benefiting from “three incomes” (i.e., the transferred-income of land circulation, the wage-income from land consolidation, and the profit-bonus income with the agricultural company), which has brought significant changes to this area’s family income structure. 3) Farmers are involved in land consolidation in various ways, and their identity cognition has gradually changed from being bystanders to becoming decision makers and supervisors. 4) Local farmers have the most intuitive feelings regarding the environmental changes that occur in the study area after land consolidation, and both the farmers’ positive and negative perceptions do help in the analysis of the eco-environmental impacts of land consolidation. 5) Land consolidation is known to be one of the most important driving forces behind the LUCC, and it inevitably results in certain influences on ecosystem services (such as regulating the regional climate, improving soil productivity, and increasing vegetation coverage) (Yu *et al.*, 2011; Wang *et al.*, 2015; Liu *et al.*, 2018). The above five hypotheses will be respectively verified from the following aspects: poverty alleviation, income structure, farmers’ identity cognition and environmental awareness, and the LUCC and its ecological impacts.

2.3.2 Questionnaire surveys and face-to-face interviews

The contents of the questionnaires include the general information of each household (family size, age, gender, education level, area and structures of land, etc.), farmers’ participation in the land consolidation process (structure of “three incomes”, frequency of attendance, participation in construction, etc.), as well as the changes in farmers’ identity cognition (knowledge of land consolidation, reasons for participation, availability of information, degree of concern for and recognition of land consolidation, etc.).

In Dadao, 299 households are involved in land consolidation. In sample surveys, with such a small sample size (a population below 1,000), more respondents are needed, so a sampling rate of no less than 30% is required (Shao, 2012). In addition, face-to-face surveys

¹ This regulation was cited from the document No. 41, released by the Ministry of Land and Resources of the PRC in April, 2017.

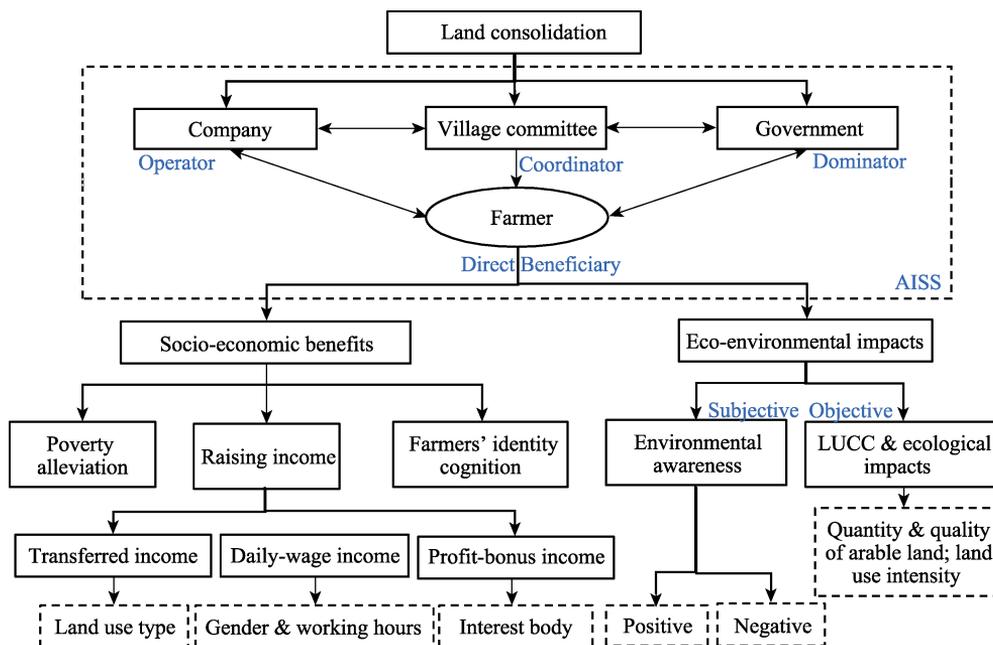


Figure 2 Theoretical framework of barren hilly land consolidation effects analysis

Notes: 1) Further explanation of the “three incomes”: the transferred land circulation compensation was paid according to the original usages of unconsolidated land, and by discounting the yield of a cornfield with an equal area¹. 2) The agricultural company hired local farmers to cultivate the newly-developed arable land, and the daily wage-income of a male laborer is 80 yuan. Female laborers were paid 60 yuan each day, per person. 3) The third type of income is the share of profit-bonus with the agricultural company. From the fifth year, farmers who have obtained transferred-income shall further receive a corresponding 30% split of profit-bonus with the agricultural company².

can increase the rate of answers to questions and reduce bias in sampling or responses (Czaja and Blair, 2005). Farmers were randomly selected from the list of all the householders involved in land consolidation provided by the village committee (299 households), and the identity information of each interviewee was verified through their ID card. Phone contacts were necessary if the householder was not at home, to ensure the reliability of data. Eventually, 100 of the 299 households were interviewed, with 98 (98.0%) valid questionnaires obtained. The sampling fraction is 32.78%, which covers an age range from 20s to 80s and effectively represents the beneficiaries.

2.3.3 LUCC and land use intensity

This study attempts to intuitively display the LUCC through the interpretation of high-resolution remote sensing data. The actual boundary of the administrative village has been amended, with the aid of field investigation and based on the oral testimonies and

¹ The irrigated land is valued at 6000 kg of corn per ha; the arid land is valued at 4500 kg of corn per ha; the jujube forest land is valued at 6000 kg of corn per ha for the first four years and 4500 kg of corn per ha from the fifth year on.

² The profits for distribution are the net gross income every year (excluding the operation and management costs, regulation fees and taxes) from the newly-developed arable land. From the fifth to the seventh year, the share of profit-bonus shall not be less than 9000 yuan per ha, and after the eighth year no less than 12,000 yuan per ha. If the profits cannot meet the minimum standards, the agricultural company shall make up the shortfall.

conventional landmarks or boundary lines (e.g., a row of poplar trees between adjacent villages) provided by the elderly villagers. Thus, there might be a deviation of the interpreted area from the village's rough statistics, but this study's version is closer to the truth. To ensure the continuity and comparability of image data, we selected remote sensing images from Google Earth that cover three periods in the same month in three different years, namely: 2014-08-10, 2015-08-27, and 2016-08-26.

Land use intensity has a positive relationship with eco-supplying and eco-cultural services, while the relationship is negative for eco-regulating and eco-supporting services (Shi *et al.*, 2010). In this study, we adopted the index of land use intensity to measure the impacts of LUCC on eco-environment. The formula is:

$$I = \sum_{i=1}^n (G_i \times P_i) \times 100\% \quad (1)$$

where I refers to the intensity of LUCC, G_i denotes the intensity grade of land use type i , P_i represents the area proportion of type i , and n is the number of land use types. Here, n is 7. The higher the intensity grade is, the higher will be the degree of human interference to the natural surroundings. Based on previous studies (Huang *et al.*, 2011), six grades of land use intensity were set in the study area, namely: 1 for the water area, 2 for the flood plain, 3 for the forest land, 4 for both the existing arable land and newly-developed arable land, and 5 for rural construction land. The unused slope land (with basically native grassland and a few areas of wild forest, as well as several intercrops), which has a land use intensity situated between the forest land and the arable land, was valued at 3.5.

3 Results and analysis

3.1 General information of the respondents

Statistics from the questionnaire surveys (Table 1) show that the average age of respondents was 57 years, with the oldest being 79 and the youngest 27. Among all the respondents, only 12.24% were aged 40 or below, while 42.86% were aged 40 to 60, and the other 44.90% were more than 60 years old. The average number of permanent residents in each household is 2.82 persons, while the average number of persons capable of work in each household was 1.82 persons. A total of 89.80% of the respondents have finished education of no more than middle school level, and only three of the interviewees have ever received a college education. Therefore, it was apparent that most of permanent residents in the village were the middle-aged and elderly, who were not well educated and who had only limited labor skills.

3.2 Socioeconomic effects of land consolidation

3.2.1 Poverty alleviation by land consolidation

The lack of arable land is one of the main causes of poverty in remote mountainous villages such as Dadao. According to the village's poverty alleviation and development plan, land consolidation has become the first step and primary path to escape from poverty. Moreover, land consolidation has brought about considerable income gains for poverty-stricken families, who were given priority to work for the agricultural company. In this paper, LTF refers to farmers who receive transferred-income of land circulation; DWF refers to farmers who

Table 1 Descriptive statistics of interviewees’ general information in Dadao Village, Fuping County in May 2018

General information	Sample size	Explanation and choices	Min	Max	Mean
Age	98	The real age (not China’s nominal age)	27	79	57
Gender	98	Male=50, Female=48			
Education level	98	No more than primary school=40 Middle school=48 High school=7 College and above=3			
Permanent residents	98	Population that stays at home for more than 6 months throughout the year	0	8	2.82
Population of working ages	98	16–64 years old, except those incapable of work	0	4	1.82
Usage of the land at pre-consolidation stage ¹	98	Farm by themselves=86 Left unused=11 Other=2			
Area of household transferred land	94	Land transferred for land consolidation Unit: mu (1 mu equals 0.067 ha)	0.22	25	3.55
Transferred-income of land circulation	94	Unit: yuan / annum	176	2000	2843
Attendance days ²	20	Days of work on the newly-developed arable land in one year; unit: day	7	464	167
Wage-income from land consolidation	20	Unit: yuan / annum	420	39320	12847

Notes: 1) This was a multiple-choices question. 2) The attendance days of a farmer in one year may be more than 365, because some of the work was done in the evening, and the extra time was converted into daytime attendance.

receive wage-income from land consolidation. Statistics show that 239 LTF (79.93%) and 84 DWF (88.42%), who are involved in land consolidation in the study area, belong to poverty-stricken families. Of the farmers who have obtained two or more types of the “three incomes”, 39 of the 41 have been registered as living in poverty-stricken households since 2014.

According to the data from interviews and questionnaire surveys (Figure 3), the number of households that were able to shake off poverty increased from 38 to 320, with 778 people escaping from poverty during 2014 and 2017. Meanwhile, the number of people remain stuck in poverty reduced from 801 to 216, and the poverty headcount ratio decreased from 61.24% to 16.51%; the average income per capita increased from 2780 yuan to 3027 yuan per annum. However, despite the existing results of poverty alleviation through land consolidation, there were 118 households and 216 people still stuck in poverty at the end of 2017, in the study area. Through face-to-face interviews, it was found

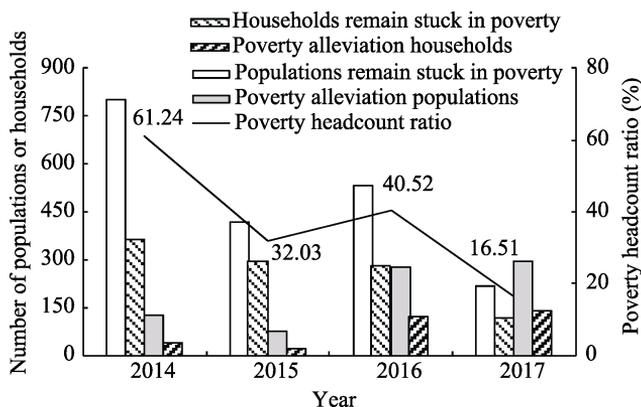


Figure 3 Effects of poverty alleviation in Dadao Village, Fuping County from 2014 to 2017

Note: Owing to the launch of the dynamic identification mechanism at the end of 2016, there was a slight increase in the amount and availability of poverty data in 2016.

that elderly farmers who are incapable of manual work shall share the transferred-income from land circulation with their children, after household division and land blocks separation. This may discount the actual benefits of land consolidation. That's also probably one of the reasons elderly respondents expressed more negative feelings when they were asked about the changes land consolidation has brought about to their livelihoods. Although land consolidation is an effective poverty alleviation measure in poverty-stricken regions with abundant reserve arable land resources, the indications from this study are that the role of a single agricultural-industry based on land consolidation has failed to work as well as has been planned in the short term.

3.2.2 The “three incomes” of farmers

The original financial statements provided by the agricultural company and the village committee showed that farmers from 299 households have obtained the transferred-income in the past three years, with an annual average of 2843 yuan each household (Figure 4a). A total of 177 farmers employed by the agricultural company in 2017 were from nearby villages. Of these 95 are from Dadao Village. These farmers have earned an average wage-income of 9871 yuan per annum (Figure 4b). To verify the authenticity of these official statistics, a further verification of the respondents' “three incomes” during the last year was sought in the questionnaire. It was reported that 74 of the 99 respondents are benefiting from land circulation (Figure 4c), and 20 of the 99 respondents had been hired by the agricultural company (Figure 4d). That figure accounts for a proportion of no less than one-fifth of all the beneficiaries. According to the statistics obtained through site investigation, the average transferred-income of the respondents was 3625 yuan per annum, and the

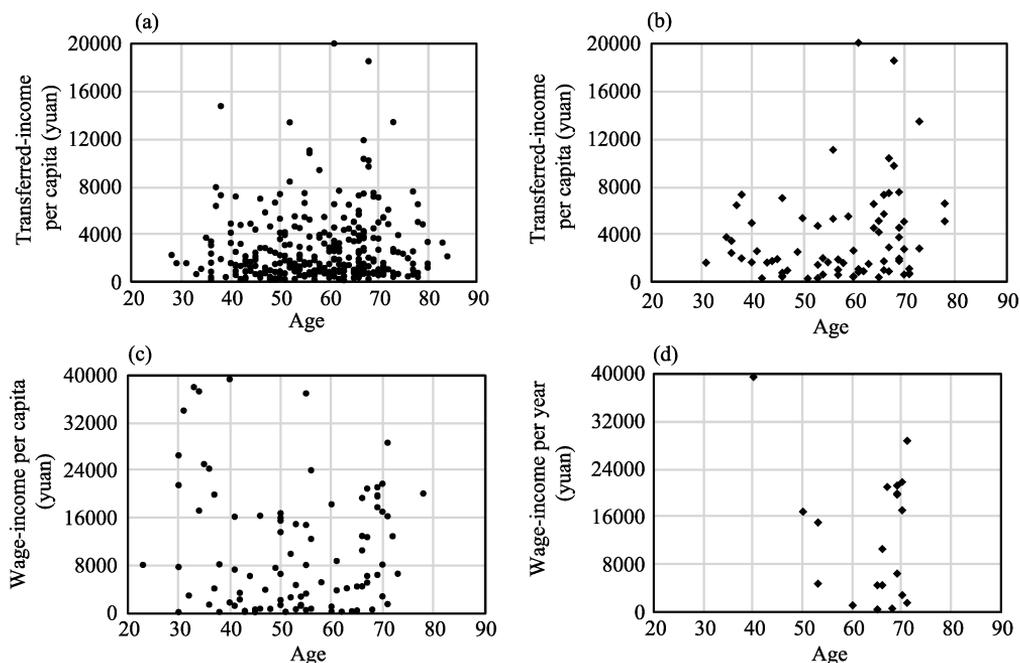


Figure 4 Transferred-income (a, b) and wage-income (c, d) of farmers in Dadao Village, Fuping County in 2017
 Note: The data of (a) and (c) originated from the financial statements of the village committee and the agricultural company, and the data of (b) and (d) are the statistics from the site investigation.

wage-income per capita from land consolidation was 12,847 yuan. It was suggested that farmers have indeed gained considerable economic benefits from land consolidation, and the amount of the “three incomes” varies with age.

Though there was no significant linear correlation relationship between the ages and the “three incomes” of respondents, the above figure does show that the younger employees earned more than the elderly in terms of wage-income, with the highest DWF aged from 30 to 40 years. Meanwhile, the elderly farmers gained more transferred-income of land circulation than the younger, with the maximum LTF mainly aged from 60 to 70 years. This is probably because young farmers are capable of more kinds of agricultural work, and their wage-income is proportional to the time invested. Meanwhile, old farmers own more land before household division and land blocks separation, and their transferred-income is proportional to the area of land.

The average age of DWF respondents is 64 years, which is much higher than the average age of LTF respondents (57 years). Income structures (Table 2) show that farmers with the largest proportion of both transferred-income and wage-income are between 60 and 70 years old. Also, 72.97% of the LTF are no less than 50 years old, and of that total, 37.84% are in their 60s or 70s. In addition, 95% of the DWF are 50 or older, and of that total, 55% are 60 to 70 years old. Farmers who gained a transferred-income below 3000 yuan every year made up 60.81% of the respondent group, while only 6.76% gained 10,000 yuan per annum or more. Also, 60% of the DWF had more than 5000 yuan per annum wage-income, of whom 55% earned no less than 10,000 yuan per year. It was suggested that more than half of the LTF and DWF are farmers over 50 years of age, and the latter seemed to earn more than the former.

Table 2 Proportions and structures of farmers’ “three incomes” in Dadao Village, Fuping County in 2017

Age (years old)	Proportion of farmers (%)		Income per year (yuan)	Proportion of farmers (%)	
	Transferred-income	Wage-income		Transferred-income	Wage-income
Below 30	0	0	Below 1000	28.38	10.00
30–40	9.46	0	1000–3000	32.43	15.00
40–50	17.57	5.00	3000–5000	10.81	15.00
50–60	21.62	15.00	5000–10,000	21.62	5.00
60–70	37.84	55.00	10,000–20,000	5.41	30.00
70–80	13.51	25.00	20,000–30,000	1.35	20.00
80–90	0	0	Above 30,000	0	5.00
Average age	57	64	Average income	3625.00	12847.40

Note: The sum of proportions is not always exactly 100%, due to the rounding of data.

Land consolidation can promote the employment of surplus rural labor forces as well. This is especially true for the female and aging populations, and this employment can bring about considerable wage-income benefits for a rural family. However, the demand for labor each month is greatly affected by the schedule of agricultural activities and the weather conditions. Little work is available on rainy days or in the slack farming periods. Statistics indicate that the average farmer works approximately 167 days each year, with the highest attendance in March, and the lowest attendance in January. Hence, job opportunities created

by the land consolidation in Dadao are facing the dilemma of a shortage and instability of supply.

3.2.3 Changes of farmers' identity cognition

This study's site investigation process discovered the enhancement of farmers' personal identity cognition. Whether for personal benefit or for better participation, farmers have tried to understand land consolidation through various channels. At the beginning, land consolidation was something with which local farmers were unfamiliar, and 41.84% of respondents said they did not know anything about it. Another 29.59% had only heard of land consolidation, and a mere 13.27% of respondents thought they had good knowledge of the upcoming land consolidation work (Figure 5a). Moreover, at the pre-stage of land consolidation, nearly two-thirds (64.89%) of the respondents did not have any independent consciousness on decision-making about land consolidation. These people became involved in land consolidation due to a herd mentality (Figure 5b). When it comes to the post-stage of land consolidation, more than half of the respondents (55.37%) enhanced their knowledge of land consolidation, mainly through publicity from the village committee or village cadres (Figure 5c).

During the process of land consolidation, farmers' attitudes towards land consolidation

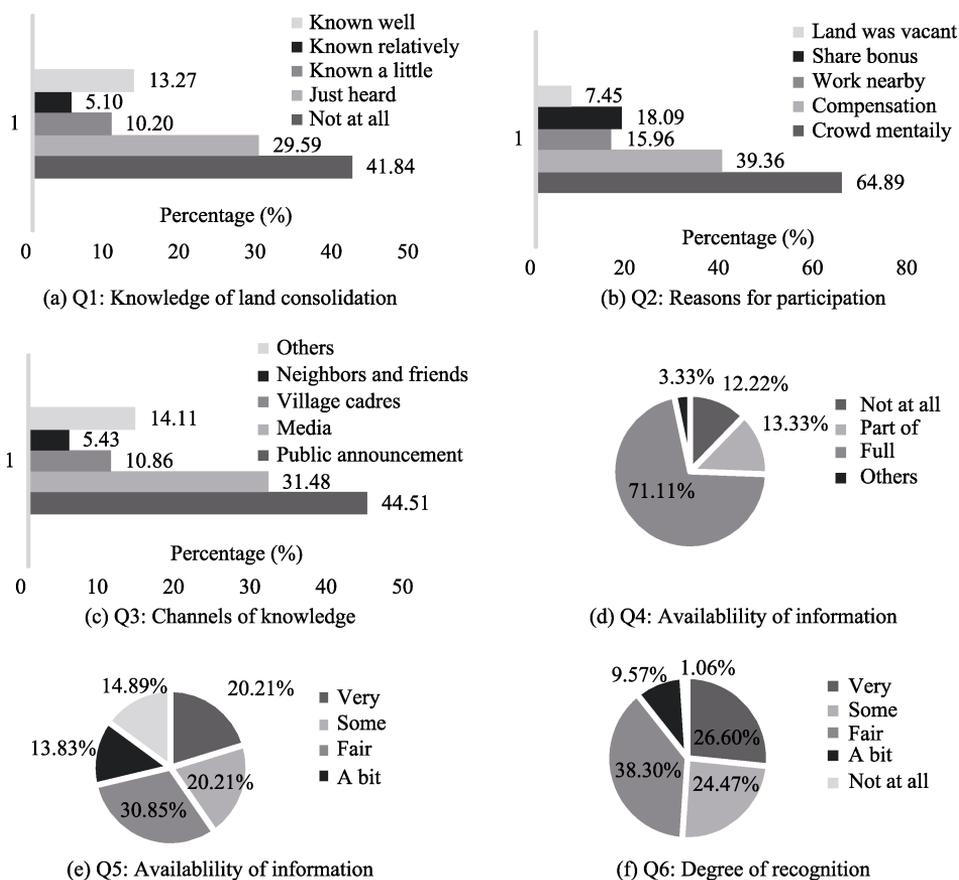


Figure 5 Statistical results of questions concerning the changes of farmers' identity cognition

Note: Some of the questions are multiple-choice, and the percentages of choices are calculated based on frequency. Thus, the sums of percentages are not always equal to 100.

have shifted, from “not caring” to “have great concern.” In interviews, 71.11% of the respondents said the information concerning land consolidation was relatively open, and they could have full access to this information. Another 13.33% of the respondents thought the information was partially open (Figure 5d). However, approximately four-fifths (79.79%) of the respondents also admitted that, even though the information was completely open to them, they did not concern themselves about land consolidation too much. Those who were very concerned about land consolidation under construction only account for 20.21% of the respondents, while 14.89% said they did not concern themselves about it at all (Figure 5e). After land consolidation, most of the respondents (89.36%) appreciated land consolidation in the village, and 26.60% are particularly satisfied (Figure 5f). Also, 68.97% of all respondents expressed their confidence in the future operation and development of land consolidation. Therefore, the third hypothesis above has been proved. Farmers in Dadao have broadened their ways of participating in the different stages of land consolidation. They have also enhanced their sense of responsibility, through measuring land area at the pre-consolidation stage, voting for every decision that needed to be made in the process, and participating in later management, at the post-consolidation stage.

3.3 Eco-environmental impacts of land consolidation

To visually display the LUCC before, during and after land consolidation in the study area, three periods of thematic land use maps have been drawn, and corresponding field photographs have been attached (Figure 6).

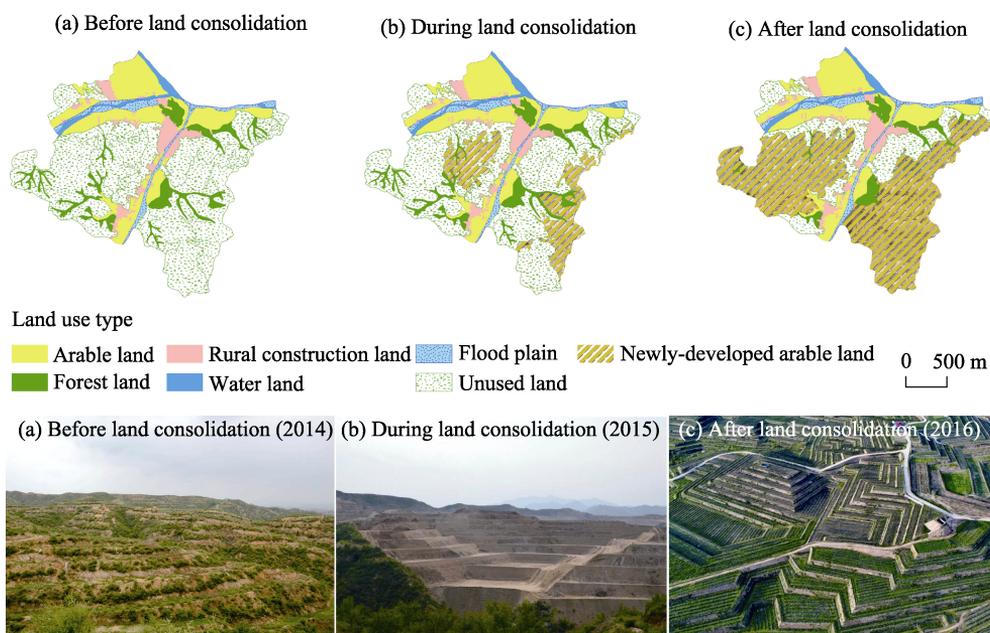


Figure 6 The LUCC in Dadao Village, Fuping County before (a), during (b) and after (c) land consolidation
 Note: The above photographs were taken by Zhao S. Y.

As can be seen in the LUCC statistical table for the last three years (Table 3), at the pre-consolidation stage, 62.92% of the land in Dadao was comprised of unused barren hilly

land (304.76 ha). The amount of arable land was 83.73 ha, with an average area of 0.06 ha per capita. Meanwhile, the average arable area for all of China was 0.10 ha per capita in 2014, or 1.5 times that of Dadao. During land consolidation, the LUCC data indicated that the unused slope land and open forest land within the planning range were gradually being changed into newly-developed arable land. When it came to the post-consolidation stage, the biggest transformation of LUCC occurred in the unused land. There were 224.41 ha of unused barren hilly land and 17.71 ha of open forest land that had been changed into newly-developed arable land, representing an increase of 0.19 ha of arable land per capita. According to the questionnaire surveys, 90.53% of the respondents used to plant jujube trees on the barren hilly land, and each household has gained an average income of 2427 yuan per annum by selling jujube fruits. However, the unit price of jujube fruits has been quite volatile over the last five years, varying in price from 0.4 yuan/kg to 2.0 yuan/kg. Consequently, most of the land was left abandoned and returned once again to a state of barren hilly land. After consolidation, all the newly-developed arable land has passed the county-level acceptance standard of well-facilitated farmland¹. According to the manager of the agricultural company, the newly-developed arable land was mainly planted with high-yielding pear trees, as well as some grape vines, cherry trees, medical herbs and other vegetation. These will not only bring about a considerable amount of economic profit from the fourth year on, but these crops will also create more job opportunities for residents.

Table 3 The total amount and structures of LUCC of three periods in Dadao Village, Fuping County

Land utilization types	Unit	2014	2015	2016	Change of proportion (%)
Arable land ¹	Area (ha)	83.73	83.24	82.97	-0.16
	Proportion (%)	17.29	17.19	17.13	
Forest land	Area (ha)	38.61	38.61	20.90	-3.66
	Proportion (%)	7.97	7.97	4.31	
Rural construction land	Area (ha)	27.16	27.69	28.03	0.18
	Proportion (%)	5.61	5.72	5.79	
Water area	Area (ha)	10.06	10.06	10.06	0.00
	Proportion (%)	2.08	2.08	2.08	
Flood plain	Area (ha)	20.04	20.02	20.02	-0.01
	Proportion (%)	4.14	4.13	4.13	
Unused grassy slope land	Area (ha)	304.76	233.35	80.35	-46.33
	Proportion (%)	62.92	48.18	16.59	
Newly-developed arable land ²	Area (ha)	0.00	71.40	242.04	49.97
	Proportion (%)	0.00	14.74	49.97	
Total area	Area (ha)	484.37	484.37	484.37	0.00
Index of land use intensity	(%)	351.67	359.16	378.68	27.01

Notes: 1) The term “arable land” here is used to represent the original arable land in the village, which already existed before land consolidation. 2) The “newly-developed arable land” specifically refers to the arable land added by barren hilly land consolidation, which includes arable land and agricultural facilitated land (roads, reservoirs, drains, etc.).

¹ The width of each field shall not be less than 6 m, and the area of a single block shall not be less than 0.5 mu (1 mu equals 0.067 ha). The thickness of the active soil layer shall not be less than 1.2 m, among which the thickness of cultivated horizon shall not be less than 0.5 m, etc.

The index of land use intensity increased from 351.67% to 378.68% during 2014–2016, representing a 27.01% growth rate. Such short-term and high-intensity land use change has even far exceeded the changes of China's rapid-urbanization areas over the past 20 years (Shi *et al.*, 2010). However, the influence of LUCC on the ecosystem services takes time before becoming apparent, and these influences could not be detected in such a short term. Thus, we tried to further understand the eco-environmental changes occurring in Dadao through the interviewees' most intuitive feelings, and 96.81% of the respondents believed that land consolidation has changed the landscape in the village. Of that figure, 6.67% thought the changes were significant. These changes are perceived as both positive and negative. The positive aspects are mainly reflected in the greening of barren hilly land, the flattening of slope land, and the beautifying of the environment. The negative side, on the other hand, is reflected in the destroying of original natural vegetation, increased dust floating in the air, the burying of old jujube trees, over-pumping of groundwater, and the potential risks of landslides. All these comments from local farmers regarding environmental awareness will help prevent future negative eco-environmental impacts caused by land consolidation.

4 Conclusions and discussion

4.1 Conclusions

(1) The barren hilly land consolidation can promote the transformation of resource-advantages into asset-advantages in such poverty-stricken areas (with abundant unused land resources) like Dadao. Farmers who are participating in land consolidation in the study area are benefiting from three types of income, i.e. the transferred income of land circulation, the wage income from land consolidation and profit-bonus income with the enterprise. In 2017, 60.16% households in the village gained the additional transferred-income, and 19.11% households received the wage-income. However, the annual average wage income is 9871 yuan, which is much higher than the average transferred-income (2843 yuan). The average age of the LTF is 57 years, which is much younger than the average age of DWF (64 years). Thus, the structure of the "three incomes" varies with age and may have failed to provide farmers with the expected quantity of universal economic benefits.

(2) Land consolidation could inspire farmers' enthusiasm to participate in village government and help alleviate rural poverty. At the beginning, nearly two-thirds (64.89%) of the respondents did not have any independent consciousness on decision-making about land consolidation, and 79.79% of the interviewees did not concern themselves about land consolidation too much. When it comes to the post-stage of land consolidation, more than half of the respondents (55.37%) enhanced their knowledge of land consolidation, and 68.97% of the interviewees expressed their confidence in the future operation and development of the BHLC model. Therefore, farmers' attitudes towards land consolidation have shifted from "not caring" to "have great concern". Farmers' identity cognition has also gradually changed from being "bystanders" to becoming "decision makers" and "supervisors". Additionally, during 2014–2017, land consolidation has effectively reduced the poverty headcount ratio of the village from 61.24% to 16.51%, and helped 585 people shake off poverty.

(3) Land consolidation could not only increase the quantity and quality of arable land, but also have a certain impact on eco-environment. From 2014 to 2016, the BHLC model in the study area transformed 224.41 ha unused barren hilly land and 17.71 ha open forest land into arable land. As a result, the average arable land of the villager increased from 0.06 ha per capita to 0.25 ha per capita. All the newly-developed arable land was covered with a thick cultivated horizon (at least 0.5m), and has passed the county-level acceptance standard of well-facilitated farmland. Meanwhile, the index of land use intensity increased from 351.67% to 378.68%, due to land consolidation. Farmers' perceptions of environmental awareness confirmed that such short-term and high-intensity LUCC are significant enough to make two-side impacts on eco-environment. Some 96.81% of the respondents believed that the BHLC has changed local environment, and of that figure, 6.67% thought the changes were significant.

4.2 Discussion

Most land consolidation efforts in China are government-led, while the masses are usually involved in relatively simple forms of public participation during the process (Luo *et al.*, 2013). Moreover, our study indicates that farmers' lack of master consciousness during the land consolidation process tended to display a herd mentality with regard to major decisions, which has discounted their real engagement in land consolidation. Therefore, we appeal to establish a combined organization and encouragement mechanism of rural land consolidation, and take the full breadth and depth of farmers' participation into consideration. Local governments are expected to carry out various forms of professional technology training and publicity work, so as to motivate farmers' sense of initiative and responsibility.

Land consolidation works as a valid external policy intervention in rural revitalization and has strongly stimulated the vitality of "population, land, industry and capital", the key elements in China's rural territorial system (Long *et al.*, 2018). However, our study also demonstrated that rural land consolidation is still in an experimental phase, and overly depends on policy preferences and financial subsidies from local governments. The improper development and consolidation of land resources is also likely to cause the widely known "resource curse" issue, especially in poverty-stricken regions (Li *et al.*, 2016). Thus, we suggest that land consolidation in the new era should not blindly pursue short-term interests, and need more scientific and sustainable planning. Additionally, agricultural industries on the newly-developed arable land urgently requires the planting of high added-value crops and the provision of stable jobs opportunities, so as to attract the backflow of migrant workers and to inject sustainable vitality into the development of rural society.

The BHLC practices have indeed brought about universal and considerable benefits for farmers, local governments, agricultural companies and village committees. Even though the side influences on the ecosystem of such short-term and high-intensity land use change are not detectable at the moment, the BHLC model is worthy to be learned by other countries, especially for under-developed world to alleviate extreme poverty. At the same time we should note that: (1) rural land consolidation should firstly respect the natural law of rural development and should not be rushed. (2) Full play should be given to the exemplary role of the pilot rural-communities, and efforts should be made to prevent neighboring regions from blindly following and causing irreparable losses. (3) Policies related to ecological

compensation for the rapid recovery of vegetation are also in need to accelerate the restoration of vegetation and minimize the impacts on the ecosystem.

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