Labor productivity of small-scale agriculture and its influence on agricultural landscape conservation in mountainous areas in China: a case study of rice farming in Hani terraced region

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Abstract

Small-scale agriculture (SA) is regarded as unsustainability because of its low benefit. To protect traditional agricultural landscapes like terraces through SA will be difficult. However, in China, terraces are still maintained well by smallholders now. This study takes the family as a basic unit and SA in Hani terraced region as an object to explore its sustainability from the perspective of labor productivity (LP) through the questionnaire method. The findings are that peasant households work on both farm and non-farm jobs. They get a low income (3854.5 yuan RMB) from hybrid-rice-cropping and a high income (44,665.8 yuan RMB) from non-farm jobs but spend a small part of labors (34.23 person•days) in growing hybrid-rice and expended lots of labor (522 person•days) for non-farm jobs. In conclusion, LP of hybrid-rice-cropping is 1.32 times that of non-farm jobs for a household. The result shows SA in Hani terraced region has a higher return of labor investment than non-farm jobs. It is different from the common impression of the low benefit of SA and also explains why SA still continues to exist in the mountainous area in China now. However, SA in Hani terraced region also faces challenges with salary level rise of non-farm jobs and part-time farmers' requirement for living quality improvement. In the future, promoting industrial integration development in this region to add local employment for improving farmers' income is a feasible approach to protect terraced landscapes.

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Introduction

With rapid economic development and urbanization, lots of rural laborers continuously migrate into urban areas. The migrant workers from rural areas were 140 million in 2008, increased to 159 million in 2011, and up to 172 million in 2017 (Ministry of Human Resources and social security of China 2018). The situation has resulted in changes of agricultural and village landscapes like seasonal farmland abandonment and hollow villages, and rural social problems in provision for the aged, children's family education, and aging of agricultural population (Chen 1999; Liu et al. 2003, 2010, 2013; Ge et al. 2012; Li et al. 2015c; Lyu et al. 2018). Chinese agriculture is characterized by a small-scale, which as a basic industry, plays an irreplaceable role in socio-economic development of China. Therefore, who will farm in the future had become a widely concerned problem in Chinese society (Wang 2014).

Many studies on Chinese small-scale agriculture (SA) suggest that agriculture is an industry with very low benefit (Mao

and Cheng 2017; Li et al. 2015a). The low benefit is the essential cause of rural population outmigration, which would lead to agricultural decline (Lieskovský et al. 2013; Špulerová et al. 2015). However, although the rural population is still moving into urban areas, agriculture seems not to decline. Chinese food yield was keeping a stable state (National Bureau of Statistics of China 2019). At present, in China, most peasant households are both farming and doing non-farm jobs (National Statistical Bureau of China 2017). Some farmers in a household just become part-time farmers (also called as migrant workers who usually farm in the busy farming seasons and do non-farm jobs in slack farming seasons) (Du et al. 2017). They do not, actually, give up farming. Obviously, the opinion that SA has a lower benefit than non-farm employment cannot explain the economic behavior that lots of peasant households persist in farming now. Therefore, exploring a scientific method for assessing the economic benefit of SA is necessary for revealing the economic behavior of peasant households.

Existing studies on the economic behavior of peasant household mainly focused on agricultural investment decision-making mechanism like the influence of land system and policy (Qu and Long 2018), farmland operation scale decision-making (Lu et al. 2018; Xie and Lu 2017; Li et al. 2015b), total factor productivity, and agricultural technology productivity (Huang et al. 2018; Chen et al. 2008). But few studies analyze the benefit of SA from the perspective of labor productivity (LP) (earning per unit labor input) and its influence on household employment selection. The LP has become the determinant to impact a person's economic behavior under the market economic environment (Mccullough 2017). Hence, to calculate the LP of SA is significant to account for the economic behavior of migrant-workers and to promote rural sustainable development by the integration of three industries (Zhang et al. 2018).

The terraced landscape as a kind of sustainable land-use system supported by SA, distributed in mountainous areas around the world, has received wide attention because of its multiple values. For example, Ifugao terraces in the Philippines and Hani terraces in China have been listed as the World Cultural Heritage (WCH) by the United Nations Educational Scientific and Cultural Organization (UNESCO) and designated as the Globally Important Agricultural Heritage Systems (GIAHS) by the Food and Agriculture Organization of the United Nations (FAO) (Zhang et al. 2019). Longji terraces, Youxi terraces, Ziquejie terraces, and Shangbao Hakka terraces have also been designated by FAO as GIAHS in 2018 (FAO 2019). As typical mountainous agricultural landscapes, these terraces are easy to be abandoned by farmers due to the small farmland area, hard work, and difficulty to mechanize. But, they are still maintained well by local farmers through SA production now. From the perspective of LP, to examine the comparative economic benefit

of the terraced agriculture will reveal its economic sustainability, and contribute to assess terraced conservation risk and to propose conservation measures. More importantly, it can also help to understand the mystery that Chinese SA widely exists.

Honghe Hani rice terraces in southwest China, distributed in Ailao Mountain, were designated by FAO as GIAHS in 2010 and listed in WCH in 2013 (Zhang et al. 2016). In the area, rice production is a typical SA that is operated by households as a basic unit. As a dual world-level heritage, the conservation for the terraced landscapes is an important task. Whether the LP of SA in this area has an advantage over non-farm employment may directly affect the economic sustainability of Hani terraced landscapes. Therefore, taking Hani terraced region as a case and the household as an economic unit, this study tries to calculate the real LP of SA and non-farm jobs, and to compare their contribution to a family income, eventually to provide the policy-making evidence to promote sustainable development of Hani terraces. It can also extend the method on agricultural economic benefit assessment and the study perspective of agricultural landscape conservation.

Methodologies

Study area

The study area is located in Yuanyang County, South Honghe Hani and Yi Autonomous Prefecture (Fig. 1), which performs the landform of alternative distribution of middle mountains and canyons. Its terrain slopes from northwest to southeast, with the altitude ranging between 1000 and 2000 m. There are no large pieces of farmland in this area (Photo 1). Terraces are the main type of arable land (Photo 2). Low-latitude plateau subtropical monsoon climate is the main climate type of this area, which presents obvious differences between the dry and the wet seasons, and a small temperature change during a year but a obvious vertical temperature change. The mean annual temperature varies from 18 to 25 °C, and the rainfall is distributed in summer and autumn with mean annual precipitation between 700 and 900 mm. Latosol soils, red soils, and yellowish red soils are the main soil types in this area, which belong to clayey soil with high water storage capacity. The natural conditions are suitable for rice growth. Hani terraces were built by Hani ethnic minority and Yi ethnic minority in the slope of the mountains, which are a sustainable system comprised of forests on the top of mountains, villages and terraces on the slopes, and rivers in valleys.

Yuanyang County is a typical county in which agriculture is the main industry and ethnic minority accounts for 87% of the total population (Yuanyang Statistical Bureau 2015). Hani people constitute most of the local total population. At the end of 2015, the total population of Yuanyang County was 442.9
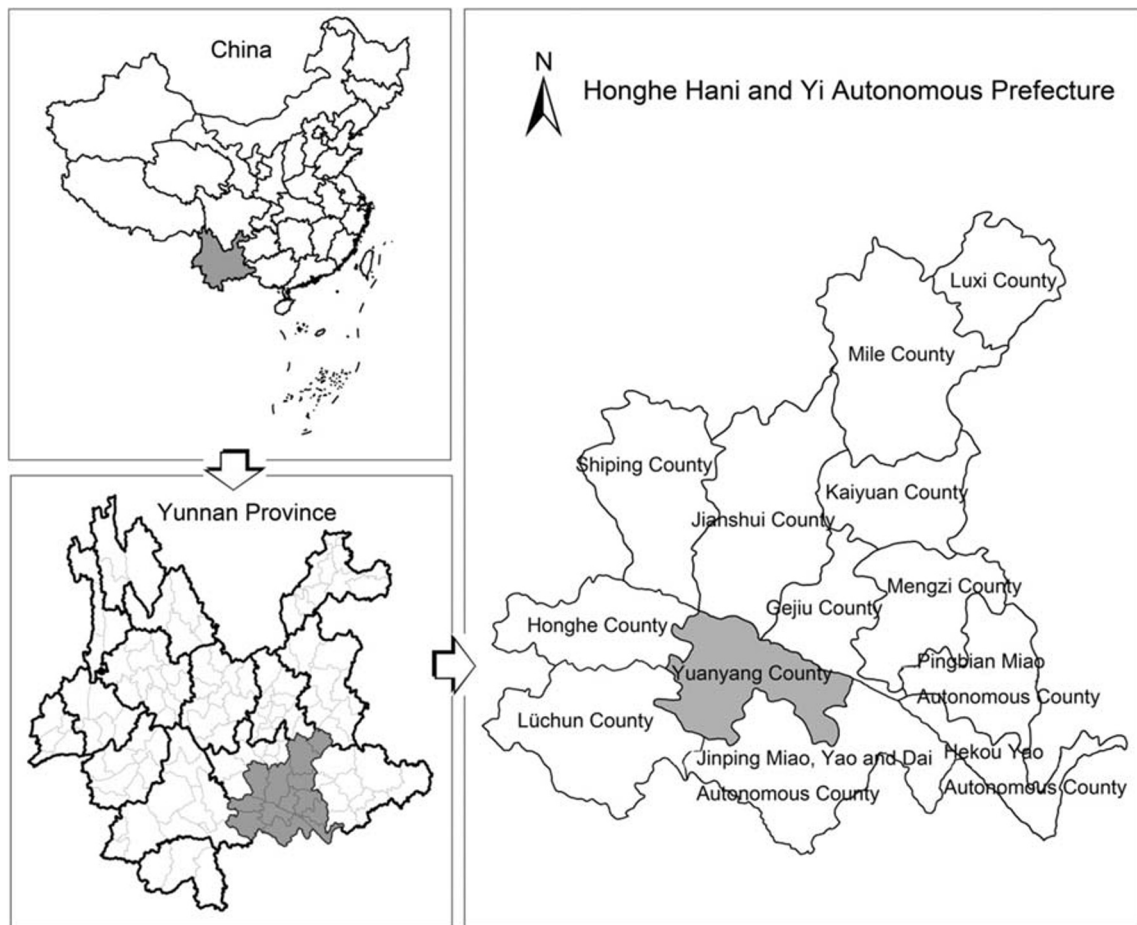
Fig. 1 Location of study area

thousand persons, and the agricultural population constituted 90.9% of the total population. In industrial structure, Yuanyang County was 30.1: 31.2:38.6 (Yuanyang Statistical Bureau 2015). The farmland area was less than 0.067 ha per capita. In 2015, the per capita disposable income was 6426 yuan RMB for Yuanyang County. Hani nationality has affluent traditional festivals, customs, songs and dances, and handicrafts (Zhang et al. 2016). These traditional cultures still play important roles in rural social activities. Generally, local villagers take part in collective activities in their important festivals. Especially for the Worshiping Village-God Festival, Worshiping Dragon Festival, Moqiu Festival, and October Festival, all villagers need to participate according to local traditional custom.

In Hani terraced region, rice cropping plays the most important role in safeguarding local food security and improving economic income now, but its economic function had been reduced with urbanization. Young laborers go out for non-farm jobs during the slack farming time or are engaged in full-time non-farm jobs. They usually go back home several times each year. Therefore, as part-time farmers, they just spend part of a year to work on non-farm jobs outside.

Study methods

In Hani terraced region, the family is a basic economic unit. Members in a family have their division of labor, and their employment selections are usually decided based on the whole family condition. Therefore, this study took the peasant household as a sample. Currently, a peasant household both grows rice and works on non-farm jobs. In order to reveal the phenomenon, the LP of hybrid-rice-cropping and non-farm employment in a peasant household was first calculated, and then their labor consumption and economic contribution to a family were then analyzed comparatively, respectively. The detailed calculation and comparison of methods can be seen below.

LP of hybrid-rice-cropping

In Hani terraced region, rice is the primary crop. The hybrid rice monocropping covers all the paddy areas with low altitude due to the high yield of hybrid rice and the lower labor requirement (Zhang et al. 2017b). In China, the national government not only fully rescinds agricultural taxes but also

Photo 1 Hani terraced landscape in May

gives cash subsidy to the farmers for encouraging to farm food crops since 2006 (Wang and Shen 2014). Excluding impacts of the agricultural subsidy policy, this study just considered that the direct inputs for hybrid-rice-monocropping include seeds, chemical fertilizers, pesticides and herbicides, and animal power. Owing to the steep slope, above 25°, agricultural machinery cannot be used for agricultural production. Thus, human beings and animals are still the main powers. The animal power cost is comprised of breeding expenses. The outputs of hybrid-rice-monocropping contain rice and straws. Of which, the straws are usually used to breed farm cattle, so it did not generate earning for farmers (Zhang et al. 2015).

Based on the actual condition above, the net profit of hybrid-rice-monocropping a hectare (NPHH) can be calculated according to Eq. (1), yuan RMB/ha.

$$NPHH = \sum_{i=1}^{n} Y_i \times P_i - \sum_{j=1}^{m} UC_j \tag{1}$$

Here, Y_i is the yield of agricultural product i per unit area, i = 1, 2, 3,…, n, kg/ha; P_i is the price of agricultural product i, yuan RMB/kg; UC_j is the cost of input j per unit area, j = 1, 2, 3,…, m, yuan RMB/ha.

The net profit of hybrid-rice-monocropping per household (NPHPH) can be calculated as Eq. (2), yuan RMB/household.

$$NPHPH = NPHH \times MPAPH \tag{2}$$

Here, MPAPH means the mean paddy area per household, ha/household.

Hani terraces are just used to grow hybrid rice for one time in a year. They are usually fallowed in other times. Furthermore, in the period of hybrid-rice-monocropping, just a few days are spent in working for plowing farmland; strengthening farmland ridges; seeding; managing, like fertilizing and preventing pests; and harvesting in the farmland. Thus, the labor input for hybrid-rice-monocropping can be calculated by person·days. The total labor input a hectare (TLIH) can be calculated as Eq. (3), person·days/ha.

$$TLIH = \sum_{t=1}^{k} L_t \tag{3}$$

Photo 2 Hani terraced landscape in July

L_t is the labor amount per ha that the process t needs, $t = 1,2,3,\ldots k$, person·days/ha.

The labor input for hybrid-rice-monocropping per household (LIHPH) can be calculated as Eq. (4), person·days/household.

$$\text{LIHPH} = \text{TLIH} \times \text{MPAPH} \tag{4}$$

LP of hybrid-rice-cropping (LP_h) can be calculated as Eq. (5), yuan RMB/person•days.

$$\text{LP}_h = \frac{\text{NPHPH}}{\text{LIHPH}} \tag{5}$$

LP, labor input, and total income of non-farm employment

Migrant workers in Hani terraced region gain usually different salary levels due to employment in different cities. Their mean monthly wage (MMW) can be calculated as Eq. (6), yuan RMB/month per person. From the perspective of return of labor input, MMW is the LP_n of the non-farm jobs. The mean yearly work time (MYWT) is varied for migrant workers who are employed in different cities, which can be calculated as Eq. (7), month/person.

$$\text{LP}_n = \text{MMW} = \frac{\sum_{p=1}^{5} W_P \times N_P}{\sum_{P=1}^{5} N_P} \tag{6}$$

$$\text{MYWT} = \frac{\sum_{p=1}^{5} T_P \times N_P}{\sum_{P=1}^{5} N_P} \tag{7}$$

W_P means the salary of migrant workers in p place, yuan RMB/month, $p = 1$ (inside towns (IT)), 2 (inside the counties but outside towns (ICOT)), 3 (inside the prefecture but outside the county (IPOC)), 4 (inside the province but outside the prefecture (IPOP)), and 5 (outside the province (OP)); N_p means the number of migrant workers in p place, persons; T_p means the work time of migrant workers in p place, mouths.

The labor input of non-farm jobs (LINJ) in a family can be calculated as Eq. (8).

$$\text{LINJ} = \text{MYWT} \times \text{NMWPH} \tag{8}$$

The net income of non-farm jobs per household per year (NINJPH) can be calculated as Eq. (9), yuan RMB/household.

$$\text{NINJPH} = \text{MMW} \times \text{MYWT} \times \text{NMWPH} \tag{9}$$

Here, NMWPH means the number of migrant workers per household, persons/household.

Ratio of hybrid-rice-cropping to non-farm jobs in LP and total labor amount a family

Currently, the income per unit labor input is becoming the determinant that a laborer selects his/her job. Whether farmers continue to farm is decided by whether SA has an advantage over non-farm jobs in LP. It can be shown by the ratio of hybrid-rice-monocropping to non-farm jobs in LP (RHNL). RHNL can be calculated as Eq. (10)

$$\text{RHNL} = \text{LP}_h / \text{LP}_n \tag{10}$$

When RHNL > 1, it means agriculture has comparative benefit advantage, i.e., small-scale hybrid-rice-monocropping has comparative benefit in this study; or else, small-scale hybrid-rice-monocropping has not.

The total labor per household (TLPH) on average can be calculated as Eq. (11), person•days/household.

$$\text{TLPH} = \text{LA}_T \times 365 \tag{11}$$

LA_T means the average number of laborer in a family, persons/household. The "365" in Eq. (11) means the days of 1 year.

Data sources

For getting the data, our research team conducted questionnaire surveys in Yuanyang County from July to October 2015. The surveyed objects were local households. The content of the questionnaire includes two parts: the basic information of interviewed households and the questions. The basic information contained informant age, sex, family population number, labor number, and number of migrant workers. The questions covered material inputs and outputs of hybrid-rice-monocropping and the labor input in each production stage, the work place and salary of non-farm jobs, and the work time of non-farm jobs. The survey sites included 15 villages in Xinjie Town and Niujiao Town (Fig. 2). According to the principles of stratified random sampling method, the informant numbers in each village varied from 5 to 15. The informants in each village were selected randomly. Each informant was in different families in order to get information from different households. During the surveys, prior informed consent and international codes of ethics were abided enough as presented in Rosenthal (2006). All the informants were not required to provide their private information such as their name, telephone number, and identity number. There were 142 questionnaires to be handed out and 137 ones to be eventually collected. Of these, 103 questionnaires were effective.
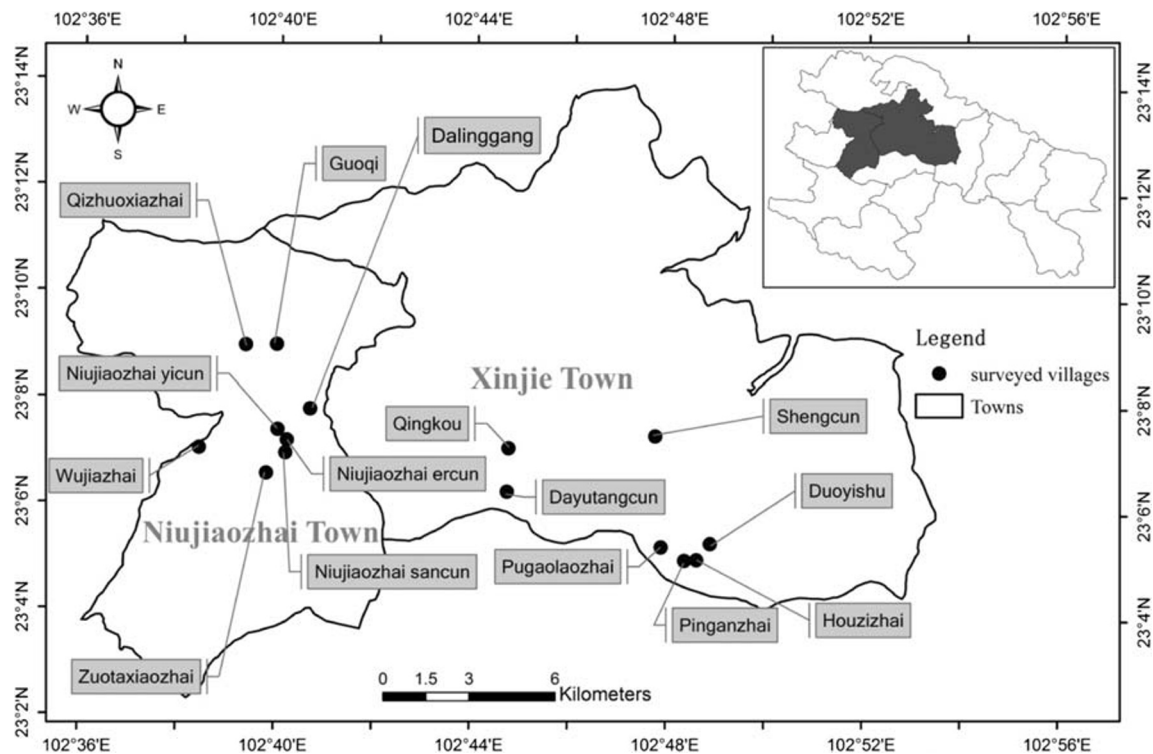
Fig. 2 Surveyed villages in Hani terraced region

Results

Basic characteristic of samples

In the informants, the proportion of males (71.8%) was higher than that of females (28.2%). A total of 86.4% of the informants were from 26 to 55 years old. This is because villagers in the age stage constituted the main part of agricultural laborers and males knew more knowledge and technologies on rice cropping than females. Thus, when we interviewed a household, the head of the household was recommended to accept our interview. According to the results of our survey, most informants had a low educational level (Table 1). Of these, 20.3% and 44.7% just enrolled in junior primary school and senior primary school, respectively. In Hani terraced region, the population number and the laborer number were various in different families. There were 5.6 persons of the

mean population per household and 3.2 laborers per household. But just part of the laborers can go out for non-farm jobs because each family had young children or old people needed to care. According to our surveys, the mean number of migrant workers per household was 2 persons.

Rice cropping material input-output and labor input in a household livelihood

Input-output of rice cropping

According to our surveys, the hybrid-rice-monocropping in Hani Terraces needed to input seeds, chemical fertilizers (mainly include superphosphate and urea), herbicides and pesticides, animal powers, and so on forth. As shown in Table 2, the cost of chemical fertilizers (superphosphate and urea) was the highest part of the total direct material cost, up to 2322

Table 1 Basic characteristics of informants in Hani terraced region

Sex	Percent	Age	Percent	Education	Percent	Population	Number
Male	71.8	Below 25	9.7	Junior primary school	20.3	Family population	5.6 ± 1.9
Female	28.2	26–35	22.3	Senior primary school	44.7	Family laborers	3.2 ± 1
		36–45	39.8	Junior middle school	28.2	Family migrant worker	2 ± 1
		46–55	24.3	Senior middle school	4.9		
		Above 56	3.9	College graduate and above	1.9		

Table 2 Hybrid rice input-output

Category	Details	Mean	SD	Total cost
Direct material inputs (yuan RMB/ha)	Seeds	981	150	4849
	Superphosphate	535	161	
	Urea	1787	313	
	Herbicides and pesticides	464	199	
	Animal power (breeding animal cost)	1095*	-	
Output	Rice yield (kg/ha)	8594	1536	23,203.8
	Rice price (yuan RMB/kg)	2.70	0.03	

*Means the data from the literature (Zhang et al. 2015), which is a comprehensive cost including the feed cost

yuan RMB/ha and accounting for 48%. Then was the animal power, 1095 yuan RMB/ha, according to the available literature (Zhang et al. 2015). The seeds and herbicides and pesticides were third and fourth, respectively.

Outputs of the hybrid-rice-monocropping mainly contain rice and straw. Actually, just rice can generate the economic value due to no market for straws in Hani terraced region. Straws are usually either burnt as biofuel or fed to cattle. Based on the surveys, the mean rice yield per hectare in Hani terraces was 8594 kg/ha, and the mean rice price was 2.7 yuan RMB/kg in 2015.

According to Eq. (1), the total material input cost was 4849 yuan RMB/ha, and the output value was 23,203.8 yuan RMB/ha (Table 2). The NPHH was 18,354.8 yuan RMB/ha. In Hani terraced region, each household had a mean of 0.21 ha hybrid rice depending on our surveys, i.e., MPAPH was 0.21 ha/household. According to Eq. (2), the NPHPH was 3854.5 yuan RMB/household.

Labor input and LP of hybrid-rice-cropping

In Hani terraces, the hybrid rice growth cycle was about 180 days (Fig. 3). The farmland was in the fallow period from the mid-to-late of October last year to April of this year. The farmland was plowed by human beings and through animal power from the first half of April. Transplanting rice seedlings was conducted from the second half of April to the beginning

of May. Then the rice went into the growth period until September. In the growth period, many field management works needed to be done, for example, weeding, fertilizing, and preventing pests and plant diseases. From the end of September to the beginning of October, local farmers began to harvest rice, including cutting rice, threshing, and drying and storing food.

In the hybrid rice growth cycle, it was not long that needs to input lots of labor. According to the rice cropping process, the labor was inputted in four stages. i.e., seeding period, harvest period, plowing and strengthening terraced ridges, and field management period. According to our surveys, each period needed a different labor amount. As shown in Table 3, the field management needed to input the most labors, up to 83.8 person·days/ha; then, harvesting needed about 42.5 person·days/ha; Plowing and strengthening terraced ridges and seeding just needed 22.3 person·days/ha and 14.4 person·days/ha, respectively. According to Eq. (3), TLIH was 163 person·days/ha. Based on Eq. (4), LIHPH was 34.23 person·days/household.

By using Eq. (5), the LP of the hybrid-rice-cropping in Hani terraced region was 112.6 yuan RMB/person•days.

Non-farm employment's conditions and LP

Although agriculture still played an important role in safeguarding the livelihood of local households, it had not
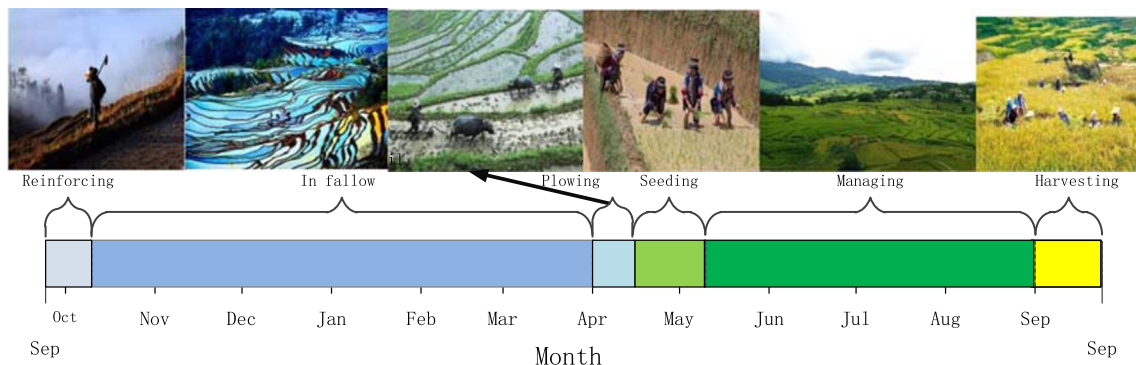

Fig. 3 Seasonal distributions of agricultural activities in Hani terraces

Table 3 Labor inputs in different stages of hybrid-rice-cropping

Categories	Labor input (person·days/ ha)	
	Mean	SD
Seeding	14.4	1.7
Harvesting	42.5	2.6
Plowing and strengthening terraced ridges	22.3	3.1
Field management	83.8	4.2
Total	163	

been the main income source. Our questionnaire surveys found that quite a proportion of households has at least one laborer to do non-farm jobs. These migrant workers' places include IT, ICOT, IPOC, IPOP, or OP. In Table 4, it is obvious that most of them worked on non-farm jobs in the Honghe Prefecture. Of these, the number of migrant workers in IPOC and IT was the first and the second, respectively. The migrant workers in IPOP or OP were few. Overall, the work time and wage level of the migrant workers increase with the increase of the distance away from their home except for the migrant workers in IT. These migrant workers were mainly engaged in temporary physical works such as construction works, hourly services like housekeeping, or restaurant and shop waiters. Of which, the construction works are the hardest but have a higher wage. This is why migrant workers in IT earned a higher mean wage than in ICOT and IPOC.

According to Eq. (6), MMW in Hani terraced region was 2567 yuan RMB/month per person. According to our surveys, most migrant workers were occupied in temporary jobs and they did not usually rest on weekends. Therefore, each migrant worker worked for 30 days per month. MMW in Hani terraced region equals to 85.6 yuan RMB/person·days. In other words, LP_n of non-farm jobs was 85.6 yuan RMB/person·days. MYWT was 8.7 months/person as calculated by Eq. (7). On average, NMWPH was 2 persons/household (Table 1), i.e., two migrant workers per household. Based on Eq. (8), LINJ was 522 person·days/household, i.e., a household expended 522 person·days for non-farm jobs. As a result, NINJPH was 44,665.8 yuan RMB/household calculated by Eq. (9).

Comparison of hybrid-rice-monocropping and non-farm jobs

As the calculated results above, the LP of the hybrid-rice-cropping and the non-farm jobs was 112.6 yuan RMB/person•days and 85.6 yuan RMB/person•days, respectively. RHNL was 1.32 according to Eq. (10). This result suggests, for a peasant household, hybrid-rice-monocropping has a higher return of labor input than non-farm jobs. It means hybrid-rice-monocropping has a comparative benefit advantage.

In Hani terraced region, the non-farm jobs and hybrid-rice-cropping jointly contribute 48,520.3 yuan RMB to a family income, but the contributions have a great difference between them. The former was 11.6 times of the latter. Likewise, the labor input for the two kinds of work also has a huge gap. Non-farm jobs and hybrid-rice-cropping spent 522 person•days and 34.23 person•days in a year, respectively, as the calculated results before. It can be gotten that the labor input for non-farm jobs was 15.4 times for hybrid-rice-cropping in a household. In a whole, for a peasant household, though hybrid-rice-monocropping gained a low income in a year, it consumed less labor.

In addition, because of 3.2 laborers in a household in Hani terraces region (Table 1), TLPH was 1168 person·days/household in a year according to Eq. (11). Through further calculating, non-farm jobs and hybrid-rice-cropping took 44.7% and 2.9% of the total labor of a family, respectively.

Discussion

This study demonstrates that the benefit of SA is not lower than that of the migrant work of farmers. In Hani terraced region, the LP of hybrid-rice-monocropping is 1.32 times that of the non-farm jobs by the migrant workers. It indicates that SA has a higher return rate of labor input than the migrant work. Besides, this study did not consider the living cost of migrant workers. The income of migrant workers from non-farm jobs would reduce if there was a deduction in their income because of their living expenses and traffic fee due to coming back home frequently (Zhang et al. 2017a). Therefore,

Table 4 Non-farm work places and wage level

Place	Migrant-worker number	Work time (month/year)	S.D.	Wage (yuan RMB/month)	SD
IT	52	8.46	0.54	2643	254
ICOT	24	7.50	1.03	2138	228
IPOC	67	8.8	0.41	2593	213
IPOP	10	9.60	0.93	2700	607
OP	10	10.80	0.20	2904	599

the real LP of hybrid-rice-cropping is higher than the current result. The result overturns the common impression held by people and also explains why peasant households do not abandon the SA having a quite limited contribution to the family income now.

Our study showed Hani terraces are used to grow rice from April to September, and the other time is in fallow for half a year. In the fallow period, the SA needs no labor inputs. In the busy farming period, the hybrid-rice-cropping just needs 2.5 months for the main agricultural activities such as plowing, seeding, and harvesting (Table 3). It consumes only a little labor due to the small area of farmland. During rice growth period, the field management takes less labor. In sum, growing the rice just consumes approximately 34.23 person·days/household, less than 10% of migrant work. SA saves lots of labor for a family and allows surplus labor to go out for non-farm jobs to earn more income. If not flowing out, these surplus laborers will be wasted. Hence, farmers actually become migrant workers not because the SA has a low benefit but because there is a need of not so much labor.

Agriculture in Hani terraced region is a representative of Chinese SA. In China, a large part of farmers are just part-time farmers who both do farm and do non-farm works at present (Guo et al. 2014; Zhu and Yang 2017). Though farmers migrate into cities, most of them do not give up farming. As an economic factor, the high LP of SA supports its sustainability nowadays. Hani terraces as a GIAHS and WCH need to be conserved and maintained well by local farmers (Yuan et al. 2014; Zhang et al. 2016, 2018) and the local government should keep an eye on it. Obviously, current high LP of growing rice plays a crucial role in maintaining the sustainability of Hani terraces. However, the advantage of high LP will gradually disappear with the salary rise of non-farm jobs due to the skilled

level improvement of the young farmers (Zhang et al. 2017a). Therefore, the effective approach is to enhance the yearly income level of local employment by developing local industries to reduce population outmigration.

On the other hand, there are lots of other factors resulting in full-time farmers becoming part-time farmers rather than urban residents, for example, farmers' individual qualities like low skills and low adaptive capacity (Zhang et al. 2017a), urban household registration (hukou) system obstacle, the high living cost in cities (Zhang 2010; Ning and Qi 2017), and sociocultural conditions like relative relationship and cultural attachment to hometowns (Chen and Liu 2016). Agriculture is also a livelihood safeguard for migrant workers without urban social security when the economic crisis happens. For instance, during the financial crisis in 2008, one-third of migrant workers in the Yangtze Delta and the Pearl Delta, China, returned to their homes due to unemployment (Feng 2010). Overall, numerous factors benefit sustainability of agricultural landscapes under the context of China's policies at present.

From the perspective of the rural historical development of China, peasant livelihood strategies have been going through continual evolution. The evolution deeply influences on agricultural landscape conservation. But, it can also reveal why important agricultural landscapes continue to exist and are undergoing challenges. This provides us with clues that protect those landscapes in the future. In the agricultural society before the reform and opening-up, cities had not enough jobs to absorb rural surplus labor, and policies also restricted the population flow. Farmers completely lived on agricultural production. Taking Hani people as an example, every family spent all their labor on agricultural production including crop production, forestry, animal husbandry, and fishery for increasing food yield
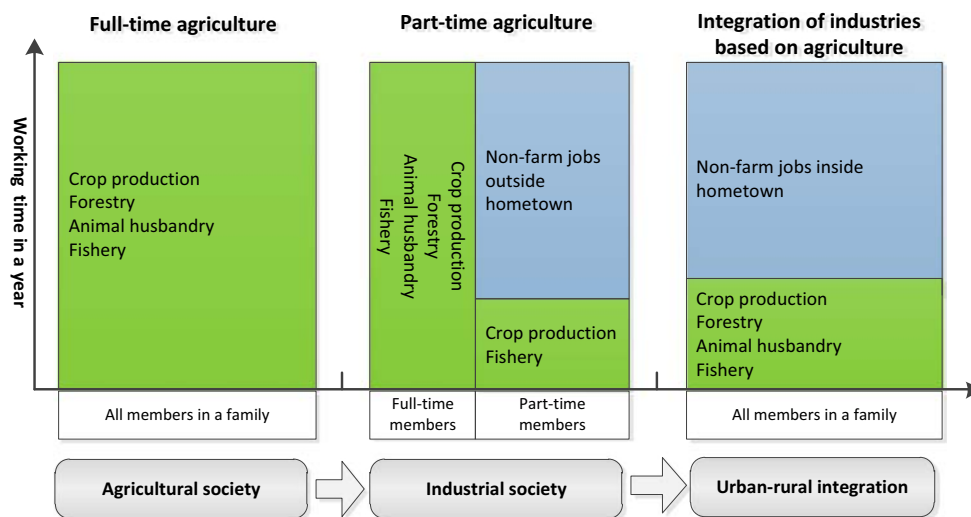

Fig. 4 Evolution of smallholder livelihood strategies in Hani terraced region

to improve living quality (Fig. 3). Therefore, the terraced landscape in the area was maintained well by farmers through agricultural production.

After the reform and opening-up, loose policies on population flow and increasing employment positions in urban areas opened the gate that farmers flow into cities (Fig. 4). The use of agricultural technologies raised agricultural LP and generated more rural surplus labors (Ji et al. 2012). A great many farmers flew into cities for non-farm jobs for increasing earnings. China gradually began to become an industrialized society. In this stage, most households operated part-time SA. For a family, agricultural production is just managed by a part of the members. Other members become part-time farmers who farm in the busy farming seasons and are engaged in non-farm jobs in the slack farming season for extra income to meet their families' expenditure (Zhang et al. 2010; Xie and Jiang 2016; Carter and Yao 2002). Accordingly, agricultural structure in peasant households is simplified (Li and Tonts 2014). Traditional agricultural models and landscapes began to encounter serious challenges owing to labor reduction (Long and Zou 2010). Hani terraces are also like that becoming an example of labor shortage. Their challenges mainly show that planted crop species lower and dry crops replace rice (Zhang et al. 2017b). Although rice growing is higher than non-farm jobs in LP in Hani terraced region, the hard work and the social structure change due to population outmigration make Hani rice terraces face difficulties (Zhang et al. 2015).

With the rural vitalization strategy proposed, the Chinese central government is striving to achieve the urban-rural integration development through policy support stimulating rural endogenous development potential.[1] The industrial integration development based on agriculture is becoming a new industrial status of rural areas (Zhang et al. 2018). For Hani terraced region, diverse resources including agricultural products, ethnic cultures, and terraced landscapes are the advantages for industrial integration development in Hani terraced region. The policy provides a good economic development opportunity for Hani terraced region. Besides, low labor input of SA also gives local households opportunities to develop the secondary and tertiary industry for improving their income (Zhang et al. 2018), for example, developing processing industries and manufactures based on local agricultural products and tourism depending on agricultural landscapes and local traditional cultures (Zhang et al. 2017b). Local industrial integration development can absorb lots of seasonal surplus labor and keep the stability of local social structures to reduce social problems, for instance, balancing marriage market,

decreasing rural and urban crime rate, improving support for the elderly, maintaining the integrity of farmers' family to benefit children healthy growth, and conserving for native culture (Luo et al. 2012; Wang et al. 2017; Yiu and Yun 2017). Especially for GIAHS and WCH conservation, it has an important significance.

In the future, an ideal employment status for terraced landscape conservation will be that Hani people realize enough local employment. Namely, as shown in Fig. 3, the families in Hani terraced region constituted by full-time farmers and part-time farmers (do non-farm jobs in cities) at present change into the families entirely comprised of part-time farmers (do non-farm jobs in Hani terraced region) through local industrial integration development. Overall, the key to maintain Hani terraces is to help farmers to obtain employment in their hometowns.

Conclusions and suggestions

This study examines the input-output of SA in Hani rice terraces from the perspective of LP. The findings are that agricultural production just expends a small part of labor for a household in the Hani terraced region because of a long fallow period and a small farmland area. The agricultural income accounts for a low proportion of the total income of a peasant household, but it has a high return rate of labor input. Comparing with the non-farm jobs done by migrant workers from the Hani terraced region, SA generates 1.32 times higher return per unit labor. The result is different from a common impression on low agricultural benefits. LP index as an important variable may give researchers a new perspective to consider why currently lots of farmers in mountainous areas in China do not abandon the low income of SA when they are occupied in non-farm jobs in cities. At the same time, the results also show that SA in mountainous areas makes local farmers have lots of free time and precious resources such as beautiful agricultural landscapes, and these advantages provide local farmers with opportunities to develop non-farm industries.

Hani terraces as WCH and GIAHS are an important protected object. To enhance the yearly income level of local agriculture and non-farm employment is the key approach to reduce population outmigration and to realize terraced sustainability. Local government should make relative policies below: (1) making the payment for ecosystem services (PES) policy to increase farmers' income from rice-growing; (2) setting up GIAHS and WCH funds to award the farmers who persist in growing rice in terraces for enhancing their income from agriculture; (3) making multi-stakeholder participatory mechanism and preferential policies to stimulate villagers to develop terraced tourism to improve non-farm income in the local; and (4) perfecting local land transfer system

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[1] Opinions of the CPC central committee and the state council on establishing and improving the system, mechanism, and policy system of integrated urban and rural development. http://www.gov.cn/zhengce/2019-05/05/content_5388880.htm

to promote part of households to professionally operate moderate-scale special and compound agriculture for reducing time waste in the fallow period.

Abbreviations FAO, Food and Agriculture Organization of the United Nations; GIAHS, Globally Important Agricultural Heritage Systems; ICOT, Inside the Counties but Outside Towns; IPOC, Inside the Prefecture but Outside the County; IPOP, Inside the Province but Outside the Prefecture; IT, Inside Towns; LIHPH, Labor Input of Hybrid-rice-monocropping Per Household; LINJ, Labor Input to Non-farm Jobs; LP_h, LP of hybrid-rice-cropping; LP, Labor Productivity; LP_n, LP of non-farm jobs; MMW, Mean Monthly Wage; MPAPH, Mean Paddy Area Per Household; MYWT, Mean Yearly Work Time; NINJPH, Net Income of Non-farm Jobs Per Household; NMWPH, Number of Migrant Workers Per Household; NPHH, Net Profit of Hybrid-rice-monocropping a Hectare; NPHPH, Net Profit of Hybrid-rice-monocropping Per Household; OP, Outside the Province; RHNL, Ratio of the Hybrid-rice-monocropping to Non-farm jobs in LP; SA, Small-scale Agriculture; TLIH, Total Labor Input for a Hectare; TLPH, The Total Labor Per Household; UNESCO, United Nations Educational Scientific and Cultural Organization; WCH, World Cultural Heritage

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