

Impact of Contract Farming on Farmers' Income: A Case of Wuchang Rice in China

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Abstract

This study aims to examine the revenue effects of rice contract farming for small high-value rice farmers and explore the constraints on the adoption of contract farming in China using a face-to-face survey questionnaire as the main instrument of data collection. A probit model and ordinary least-squares (OLS) regression analysis were used to estimate the likelihood of participation in contract farming and the impact of contract farming on rice farmers' income, respectively. A total of 78 household questionnaires collected in Wuchang was considered valid for analysis. This study proves that participating in contract farming is an effective way of increasing rice farmers' income, after control for observable and unobservable household characteristics. Specifically, contract farming contributes toward enhancing the rice farm-gate price and cost-profit ratio. The results also reveal that rice farmers with organic or green planting experience are more likely to participate in contract farming.

Discipline: Social Science

Additional key words: contract farming, farm-gate price, rice farmers' income, Wuchang rice

Introduction

Contract farming has been considered a potentially useful tool to enhance farmers' incomes around the world (Miyata et al. 2009, Maertens & Velde 2017, Bolwig et al. 2009, Briones 2015). This is because contract farming can not only improve farmers' access to inputs, credit, and technology but can also solve information asymmetry between farmers and markets (Minot & Sawyer 2016, Maertens et al. 2017). However, most of the published studies have mainly concentrated on high-value agricultural products, with only a few studies focusing on staple foods. This is because contract farming often involves large-scale buyers who require a steady supply of raw materials meeting high-quality standards and rarely emphasize basic staple food (Miyata et al. 2009). Even for high-value staple food, very few studies have directly examined the effect of contract farming.

As rice is the most important staple food in China, the farmer population comprises a large proportion of rice farmers. In the past decade, small farmers faced the

dilemma of increased production costs and lower farm-gate prices of rice (National Development and Reform Commission 2011, 2016). In order to enhance the income of small farmers, encouraged by the Chinese government, contract farming has recently been alternatively considered a new sales arrangement for tackling these issues. Until now, there have been three main forms of contract farming in China: a company and small farmers; a cooperative and small farmers; and a company, cooperative, and small farmers. Empirical studies show that contract farming can contribute toward upgrading and improving the efficiency of the domestic staple food chain in many developing countries (Gómez et al. 2011, Maertens et al. 2017). Diao et al. (2012) further explained that upgrading and improving the staple food chain can significantly contribute to guaranteeing food security. Previous studies (Miyata et al. 2009, Ma & Abdulai 2016) have clarified the impact of contract farming on vegetable and fruit production in China, but to the best of our knowledge, only very limited studies have discussed the issue of how contract farming can influence high-value

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rice farmers' income in China, which is the focus of this study.

Indica and Japonica rice are the two main rice varieties in China, accounting for 70% and 30% of domestic rice consumption, respectively. One typical kind of high-value Japonica rice, Wuchang rice, is among the most famous and highly profitable brands, with an average market price of up to 80 yuan/kg¹ (Jia & Jiang 2014). It was awarded the gold medal in the 2018 national rice brand appreciation competition, as being the best quality rice in China (Fan 2018). Investigating Wuchang rice as a representative example is beneficial to capture the characteristics of high-value rice production and understand how rice brands can influence farmers' income.

This study aims to examine the revenue effects of contract farming for small high-value rice farmers and explore the constraints on its adoption in China. Specifically, this study addresses two related questions. First, what are the demographic determinants that influence participation in contract farming? Second, what is the impact of participation in contract farming on rice farmers' income?

Survey design and data

The selection of appropriate and representative cultivation sites, and the identification of relevant rice farmers are key steps in this study. The survey was conducted in Wuchang (7,512 km²), located in southernmost Harbin, Heilongjiang Province, China. Wuchang has more than 200 years of history in cultivating Japonica rice, and includes 24 townships (Hong et al. 2010, 2011a, 2011b). The total population of Wuchang is 918,622, including a rural population of 707,216 (National Bureau of Statistics of China, 2016). A face-to-face survey questionnaire was the main instrument of data collection. The survey was conducted from July to August 2017 in Wuchang. The main Wuchang rice cultivation areas are located along the Lalin and Mangniu rivers, tributaries of the Songhua River. The townships based on geographic distribution were randomly selected across Wuchang, regardless of participation in contract farming. Eleven townships were selected to include all the major production areas in the sample (see Fig. 1 for geographical information). All the respondents were randomly selected from the 11 townships.

Contract terms for Wuchang rice mainly concentrate

on the aspects of production, post-harvest, and services. Each year, purchasers and rice farmers would sign a contract around February. Table 1 clarifies the specific contract terms and obligations between the purchasers and rice farmers. In most cases, purchasers provide the seed, fertilizer, and pesticide to rice farmers before planting, and collect the costs thereof from rice farmers at the delivery time. Based on mutual consent, the rice farm-gate price is 0.20 yuan/kg or more, higher than the local average market price. More importantly, if the quality or quantity of Wuchang rice fails to comply with the terms of the contract, or the rice is not delivered on time, then the purchaser reserves the right to refuse the purchase. Simultaneously, depending on the land quality and farmers' will, purchasers would suggest that the rice farmers cultivate different levels of rice. For example, purchasers would like to sign a contract for organic and green rice cultivation with rice farmers, if those neighborhoods have already planted organic and green rice, or rice farmers are willing to cultivate organic or green rice and strictly follow the production regulations. And in order to ensure long-term cooperation with a purchaser, rice farmers only choose one contract partner.

The survey questionnaire included basic information about the farmers (population, age, sex, and education), land conditions (owned land, land leasehold, and lease expenses), crop production situation (e.g., crop structure, planted area, variety, input cost), type of contract, and product sales situation. The survey concentrated on rice production inputs for contract farming and non-contract farming, and its impact on the farm-gate price. In view of previous similar studies and the local conditions, a preliminary survey was conducted in several townships, following which some revisions were made to the final questions. The formal survey questionnaire was based on four categories: household information, production information, paddy rice inputs and costs, and paddy rice outputs and marketing.

Local farmers answered a total of 81 household questionnaires, of which 78 samples were considered valid for analysis. Based on their cultivation methods, the 78 samples were divided into two groups—contract farmers and non-contract farmers. Overall, each household had approximately 2.48 working-age adults and 5.62 ha of paddy under cultivation. The heads of households were 47.67 years old on average, with educational levels equivalent to elementary or junior high school.

Methods

In this study, we first compared statistical differences

¹ The basic unit is the RMB, the official currency of China. The central parity rate of the USD against the RMB is 1: 6.73 (August 1, 2017).

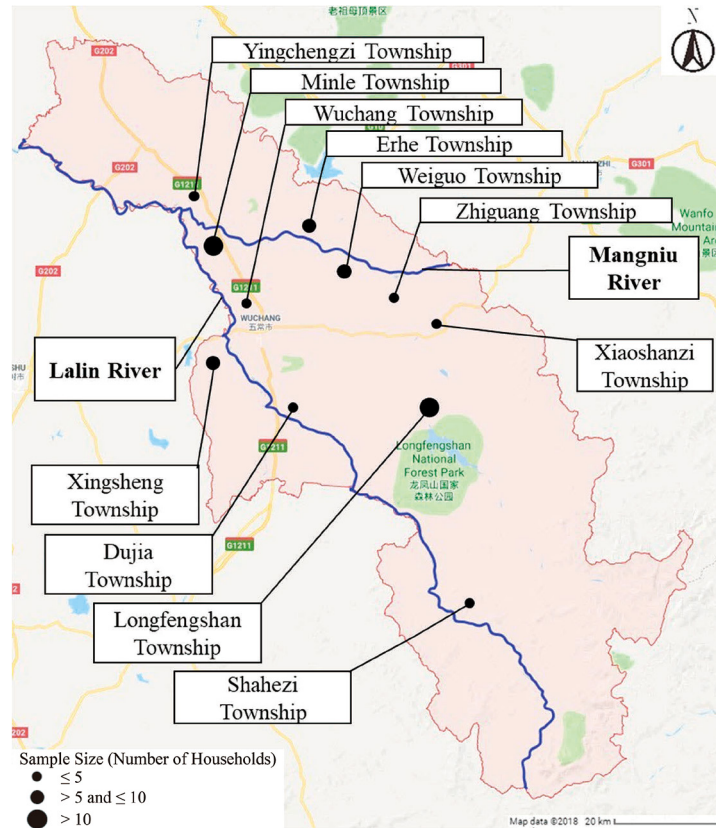


Fig. 1. Geographical locations of the study sites in Wuchang

Source: Google Maps, December 2018

Table 1. Specific contract terms and obligations

Contract terms	Purchasers	Rice farmers
Production		
Planted area		✓
Rice yield (more than 7000 kg/ha)		✓
Seed, fertilizer and pesticide	✓	
Post-harvest		
Quality (moisture content < 17%, extraneous matter < 1%, milled rice rate > 52%, etc.)		✓
Rice farm-gate price	✓	✓
Delivery time and location		✓
Services and standards		
Technology support	✓	
Production regularization		✓

Source: Data acquired from the formal survey

in the cost structure, cost-benefit, and specific inputs between the contract farming group and non-contract farming group. The cost structure of rice production is divided into three categories: materials and services cost, land cost, and labor cost. The costs of materials and

services include seed and seedling-growing cost, fertilizer cost, pesticide cost, and machinery cost, among others. Labor and land costs include the unpaid costs of one's own labor and own land, which are based on their local costs of land lease and hiring labor, respectively (National Bureau of Statistics of China, 2016).

Next, econometric analyses were conducted to determine what household characteristics affect the adoption of contract farming and the impact of contract participation on the rice farm-gate price. First, a probit model was used to estimate the likelihood of participation in contract farming. Second, an ordinary least-squares (OLS) model was applied to analyze how contract farming can influence the rice farm-gate price. Specifically, in the first step, the probit model equation is formulated as follows:

$$CF_i = \beta_0 + \beta_1 Age_i + \beta_2 Gen_i + \beta_3 Edu_i + \beta_4 PE_i + \beta_5 OGPE_i + \varepsilon_i \quad (1)$$

where CF_i denotes contract farming as a dummy dependent variable (contract farming = 1, non-contract farming = 0); $i = 1, 2, 3, \dots, n$ is the farmer index; Age_i is the age of the head of the farm household; Gen_i denotes gender as a dummy variable (male = 1, female = 0); Edu_i represents years of education; PE_i denotes years of

planting experience; $OGPE_i$ denotes organic or green² planting experience (OGPE) as a dummy variable (if a farmer has prior OGPE, then the value will be = 1; otherwise, = 0); β_0, \dots, β_5 are the parameters to be estimated; and ε_i is the error.

In the second step, we used OLS regression analysis to determine how contract farming can influence the rice farm-gate price. The equation for factors influencing the farm-gate price is formulated as follows:

$$P_i = \beta_0 + \beta_1 Age_i + \beta_2 Gen_i + \beta_3 Edu_i + \beta_4 PE_i + \beta_5 CF_i + \beta_6 Lab_i + \varepsilon_i \quad (2)$$

where P_i is the rice farm-gate price; $i = 1, 2, 3, \dots, n$ is the farmer index; $Age_i, Gen_i, Edu_i, PE_i$ and CF_i are the same as in Eq. (1); Lab_i is the labor cost; β_0, \dots, β_6 are the parameters to be estimated; and ε_i is the error.

Results and discussion

1. Comparison between the contract farmers and non-contract farmers

An independent-samples t-test was conducted to compare the means of different factors in contract farming and non-contract farming, so as to determine whether any significant differences exist between both groups. The results reveal statistically significant differences for age, OGPE, land transfer, labor, land, farm-gate price, and cost-profit ratio in the two groups (see Table 2).

Concerning the sociodemographic characteristics for the two groups, the contract farmers were 2.93 years younger on average than the non-contract farmers. Table 2 indicates that rice farmers with OGPE were more in favor of participating in contract farming (73%) as compared to those in the non-contract farming group (accounting for only 19%). More importantly, Table 3 clearly shows that rice farmers with OGPE have an important influence on farm-gate prices. The overall farm-gate price of rice farmers with OGPE (4.98 yuan/kg) is higher than that of farmers without OGPE (4.43 yuan/kg). However, regardless of whether rice farmers have OGPE, contract farming farm-gate prices are significantly higher than those of non-contract farming in all categories. In addition, 80% of contract farmers participated in land transfer, as compared to only 67% of non-contract farmers.

Concerning the cost structure, the labor and land costs accounted for the biggest proportion of cost in both groups, which was over 60% of the total inputs (see Table 2). Specifically, the labor and land costs of the contract group were 1,259.67 yuan/ha and 1,640.27 yuan/ha higher than those of the non-contract group, respectively.

Contract farming is more profitable than non-contract farming because the cost-profit ratio of contract farming (41.00%) is higher than that of non-contract farming (33.23%). The cost-profit ratio is an important indicator when evaluating various production behaviors, and it reflects different levels of profit. Although the costs of contract farming were higher than those of non-contract farming, the income of the contract farming group (36,313.20 yuan/ha) was 5,236.46 yuan/ha higher than that of the non-contract farming group (31,076.74 yuan/ha). The profit for contract farmers was 10,559.57 yuan/ha, while that of non-contract farmers was 7,751.34 yuan/ha. The main reason is that the contract farm-gate price (5.04 yuan/kg) was 0.63 yuan/kg higher than that of the non-contract rice (4.41 yuan/kg), even though the cost was higher than that of the non-contract one. The rice yields for the two groups were also different (7,205.00 kg/ha and 7,046.88 kg/ha for the contract rice and non-contract rice, respectively).

2. Household characteristics and impact of participation in contract farming

The first step involves determining the household characteristics that influence participation in contract farming. Table 4 presents the results of the probit model. The probit model with five predictors produced pseudo $R^2 = 0.39$, and the log likelihood was -38.58 . Additionally, the likelihood-ratio chi-squared test ($P < 0.01$) showed that the model is significant. The age of the head of the farm household showed a weak negative significant value, implying that older farmers are less likely to choose contract farming. OGPE as an important factor has a significant and positive impact on participation in contract farming, meaning that farmers with prior OGPE would be more likely to participate in contract farming.

The second step involves clarifying the effect of contract farming with various personal characteristics on the rice farm-gate price. Table 5 illustrates the OLS regression results. The OLS regression model with all six predictors produced $R^2 = 0.55$, $F(6, 71) = 14.27$, $P < 0.01$. The results for the rice farm-gate price regression are statistically significant. Table 5 shows that the education factor has a weak positive impact, and contract farming and labor input factors have a strong positive impact on the rice farm-gate price. The coefficient on contract

² "Green" is a food certification unique to China, and can be divided into two different levels: Grade AA (meeting the same standards for organic food) and Grade A (the standard for less organic but safe food) (Yu et al. 2014).

Table 2. Cost-benefit analysis of contract farming and non-contract farming for Wuchang rice

Category	Contract farmers		Non-contract farmers		<i>P</i> (<i>T</i> ≤ <i>t</i>)
	Mean	Standard Deviation	Mean	Standard Deviation	
Age (years)	45.90	9.42	48.83	9.42	0.094*
Gender (dummy, male = 1)	0.87	0.35	0.88	0.33	0.924
Education (years)	7.90	2.89	7.56	2.31	0.593
Planting experience (years)	14.13	8.40	15.02	5.81	0.305
OGPE (dummy, if having prior OGPE = 1)	0.73	0.45	0.19	0.39	0.000***
Land transfer (dummy, if conducting land transfer = 1)	0.80	0.16	0.67	0.23	0.088*
Planted area (ha)	5.97	6.46	5.41	5.07	0.354
SFP (yuan/ha)	3,492.86	943.07	3,501.43	846.01	0.476
Machinery (yuan/ha)	2,952.81	1,437.08	3,255.19	1,442.93	0.187
Other (yuan/ha)	1,264.96	323.30	1,425.72	186.62	0.243
Labor (yuan/ha)	5,159.67	2,490.52	3,900.00	2,919.03	0.000***
Land (yuan/ha)	12,883.33	1,529.50	11,243.06	2,506.48	0.000***
Costs (yuan/ha)	25,753.63	2,831.72	23,325.40	3,927.48	0.000***
Rice yield (kg/ha)	7,205.00	453.41	7,046.88	580.39	0.092*
Farm-gate price (yuan/kg)	5.04	0.69	4.41	0.44	0.000***
Income (yuan/ha)	36,313.20	5,763.66	31,076.74	3,644.81	0.000***
Profit (yuan/ha)	10,559.57	4,663.67	7,751.34	4,686.02	0.000***
Cost-profit ratio (%)	41.00	3.36	33.23	3.48	0.000***
Observations	30		48		

Notes: ***, ** and * denote statistical significance at 1%, 5%, and 10%, respectively; ¹ Land transfer: whether farmers rent farmland; ² SFP: the costs of seed and growing seedlings, fertilizer, and pesticide; ³ OGPE: Organic or Green Planting Experience; ⁴ Costs, Rice yield, Income, Profit and Cost-profit ratio are measured in ha; Costs = SFP + Machinery + Other + Labor + Land; Rice yield based on the formal survey data; Income = farm-gate price * rice yield; Profit = income - costs; Cost-profit ratio = profit / costs * 100%.

Source: Data acquired from the formal survey

Table 3. Farm-gate prices based on rice farmers with and without OGPE

Rice Variety	Sample Size	Farm-gate Price (yuan/kg)
Rice farmers (overall)	with OGPE (31)	4.98
	without OGPE (47)	4.43
Rice farmers with OGPE	Contract (22)	5.17
	Non-contract (09)	4.51
Rice farmers without OGPE	Contract (08)	4.68
	Non-contract (39)	4.38

Source: Data acquired from the formal survey

Table 4. Probit model of participation in contract farming

Variables	Coefficient	SD	Pr (> z)
Age	-0.03*	0.02	0.09
Gender	-0.30	0.54	0.59
Education	0.02	0.07	0.73
Planting experience	0.01	0.03	0.58
OGPE	1.57***	0.30	0.00
Intercept	0.40	1.10	0.72
Obs.	78		
Pseudo R ²	0.39		
Log likelihood	-38.58		
LR chi2	26.78***		
Prob > chi2	0.00		

Notes: ***, ** and * denote statistical significance at 1%, 5%, and 10%, respectively.

Source: Data acquired from the formal survey

Table 5. Rice farm-gate price OLS regression

Variables	Coefficient	SD	Pr (> z)
Age	0.01	0.01	0.24
Gender	0.11	0.16	0.51
Education	0.04*	0.02	0.05
Planting experience	-0.01	0.01	0.69
Contract farming	0.49***	0.11	0.00
Labor input	0.01***	0.00	0.00
Intercept	3.24***	0.36	0.00
Obs.	78		
R ²	0.55		
Adjusted R ²	0.51		
F statistic	14.27***		
Prob>F	0.00		

Notes: ***, ** and * denote statistical significance of 1%, 5%, and 10%, respectively.

Source: Data acquired from the formal survey

farming³ indicated that participation in contract farming would increase the rice farm-gate price by 0.49 yuan/kg.

(1) Household characteristics

The age factor has a weak negative correlation with the adoption of contract farming. The result is consistent with previous research and our findings in the survey on respondents in that most young generation farmers are more willing to adopt a new model of production and management (Adebayo & Oladele 2013).

The results also confirmed that OGPE is an important factor that influences a rice farmer to participate in contract farming. Generally, organic or green farming requires advanced farming methods and knowledge, which not only produce high-quality rice but also preserve the environment (Bolwig et al. 2009). For example, chemical fertilizer and pesticide in organic farming are highly restricted, meaning that labor input (manual weeding) and biopesticide use should be strictly monitored in the case of organic and green cultivation. Rice farmers with OGPE are more likely to participate in contract farming because they already know how to produce high-quality rice and can usually meet the contractual requirements (MacDonald & Korb 2011, MacDonald et al. 2004, Otsuka et al. 2016). Gender, education, and planting experience factors have no

impact on the adoption of contract farming.

(2) Higher rice farm-gate price for contract farmers

Contract farming as an important factor has a significant and positive impact on the rice farm-gate price (see Table 5). The result is consistent with our findings from the survey on respondents in that when the farmers entered into a new contract with purchasers, the farmers' price for contract farming was at least 0.20 yuan/kg higher than that of the local average market price. Rehber (2007) explained that farmers comply with contract terms under great pressure in order to avoid a breach of contract and side-selling, thus ensuring the quality and quantity of paddy rice. The respondents from the survey claimed that participation in contract farming would help them to hire labor for weeding; consequently, they would avoid the use of herbicides. They also claimed that contract farming would help them rent superior quality and contiguous land. This study is in line with previous studies revealing that contract farming helps rice farmers overcome failures associated with managing input resources and planning for an optimal allocation of resources (Key & Runsten 1999, Glover & Kusterer 1990, MacDonald et al. 2011, 2004, Otsuka et al. 2016). Our study shows that rice farmers participating in contract farming received a higher farm-gate price and income.

Conclusion

Based on the cost-profit structure and econometric analyses, this study showed that participation in contract farming is an effective way to increase the rice farm-gate price. The total profit of contract farmers was 2,808.23 yuan/ha more than that of non-contract farmers. Specifically, participation in contract farming can increase the rice farm-gate price by approximately 0.49 yuan/kg, after control for observable and unobservable household characteristics, because contract farming helps control pesticide and intensified land use, which could help produce better quality rice. Most Chinese consumers believe that rice cultivated without pesticide represents safety; this belief influences their willingness to buy rice even at a higher price (Liu et al. 2013, My et al. 2018). Concerning the household characteristics, young farmers and farmers with prior organic or green planting experiences are more likely to participate in contract farming, given their interest and willingness to accept new models of production and management.

The survey samples were randomly selected and covered all the main paddy rice production areas in Wuchang. This research confirmed that contract farming has a positive impact on the revenue of small high-value rice farmers. More importantly, this finding showed that

³ In order to exclude selection bias for contract farming, this study uses the Heckman selection-correction model to estimate all the parameters at the same time. The results show no selection bias in the OLS model and confirm that contract farming has a significant positive impact on the rice farm-gate price.

contract farming could be implemented not only for high-value vegetables and fruits but also for high-value staple food crops in China. The survey also found that rice farmers with prior organic or green planting experience could get a higher farm-gate price compared with rice farmers without such experience. Although this study mainly focused on the impact of participating in contract farming, given the rapid development of people's living standards and increasing environmental awareness, further research should consider how organic and green rice planting could improve rice farmers' income.

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