# Outsourcing Agricultural Production: Evidence from Rice Farmers in Zhejiang Province

Selected Paper prepared for presentation at the 2015 AAEA & WAEA Joint Annual Meeting, San Francisco, California, 26-28 July 2015

**Hongdong Guo[1], , Chen Ji[2], Songqing Jin[3], Zuhui Huang[4]**

[1]Professor, Department of Agricultural Economics and Management, Management School, Zhejiang University
[2]Corresponding author, assistant professor, Department of Agricultural Economics and Management, Management School, Zhejiang University; Email: jichen@zju.edu.cn
[3] Associate Professor, Department of Agri., Food and Res. Econ., Michigan State University
[4] Professor, Department of Agricultural Economics and Management, Management School, Zhejiang University

# Outsourcing Agricultural Production: Evidence from Rice Farmers in Zhejiang Province


## Abstract

China has recorded positive grain production growth ratesfor the past eleven consecutive years. This is aremarkable achievement given that China's rapid industrialization and urbanization has led to a vast reduction of arable land and agricultural labor to non-agricultural sectors. While there are many factors contributing to this happyoutcome of China's grain production, one contributing factor that has begun to receive increasing attention is the emergence of agricultural outsourcing, a new rural institution that has emerged in recent years. This study aims to contribute to the limited but growing literature on agricultural outsourcing in China. Specifically, this study analyzes factors affecting farmers' decisions to outsource any or some production tasks using data from rice farmers in Zhejiang province. Results from a logistic model show that farm size, prices, and government subsidy encourage farmers to outsource while ownership of agricultural machines and land fragmentation have negative effects on farmers decisions to outsource any task. Results also showed that determinants of outsourcing decisionsvary with the production tasks that farmers outsourced.



**Keywords:**Determinants, agricultural outsourcing; rice farmers; Zhejiang Province, China
**JEL Classification:** D24,O12,O13


## 1. Introduction

Food security has always been at the heart of the Chinese government' development policy. This is not surprising in light of the fact that China has to feed one fifth of the world's population from less than one tenth of the world's arable land. However, maintaining food security for its huge population with limited resources has been increasingly challenged by the rapidly changing economic and environmental landscapes. The rapid urbanization and industrialization process in combination withenvironmental degradation has caused the arable landto shrink at an alarming rate (Su et al. 2011). In the meantime, China continues to experience steady flow of labor from rural to urban and from agricultural sector to non-agricultural sectors. According to data from theNational Bureau of Statistics (NBSC 2011), the total number of migrants reached 261 million in 2010.One would expect that the loss of huge amount of arable land and agricultural labor would only cause China's grain production to fall sharply. Yet China has enjoyedpositive growth of grain productionfor 11 consecutive years (xxx).

Many factors have contributed to thesustained growth of China's agricultural production for the past decade. There is little doubt that new technologiescreated byChina's public research system (e.g., high yield varieties, and improved agronomic practices, etc.)has been the major driving force (World Bank 2014). Among other contributing factors, one factor that has drawn increasing attention from the policy makers and scholars is the agricultural outsourcing service, a new institution that is emerging rapidlyin rural China, especially in the coastal provinces where the challenges faced by the agricultural sector is more pronounced. Agricultural outsourcing means that a farmer contractssome or all production tasks to individualsor organizations that specialize in providing production services.

While international literature on agricultural outsourcing is almost in non-existence, the research about agricultural outsourcing in China is growing in recent years.[5] The literature offered several possible reasons why agricultural outsourcing caninfluencecrop production. First, agricultural outsourcing allows the possibility for farmers who have comparative advantage in migration or local off-farm employment but do not want to give up farming to continue to farm on their own land (Li and Sheng 2015; Wang et al. 2015). Agricultural outsourcing can also help farmers who do not own agricultural machine to outsource agricultural machinery services(Zhang et al. 2015; Wang et al. 2015). Considering machine ownership is positively correlated with farm size, agricultural outsourcing would help smallfarmers to overcome small farm disadvantage in machine use. The agricultural outsourcing services may also help farmers who are lack of certain skills to overcome the skill constraints (Liao et al. 2011). There are also other benefits for farmers to out-source. For example, outsource services is expected tolower cost and increase profit by taking advantage of specialization of work, and economies of scale, etc. (Juan 2014; Liao et al. 2011).

To contribute to the growing but scant literature, this study analyzes factors affecting farmers' decisions to outsource using data from rice farmers in Zhejiang Province. Results from a logistic model show that farm size, service price, and government subsidy encourage farmers to outsource while ownership of agricultural machines and land fragmentation have negative effects on farmers decisions to outsource any task. Results also showed that the determinants of farmers' outsourcing decisions alsovary with the specific task (production stage) for which farmers

[5] With the exception of a couple of papers (Yang et al. 2013; Yang et al. 2015), majority of the papers on this topic are published in Chinese journals.

outsource and farming scale. This paper contributes to the literature in a few aspects. First, this paper isamong the first few to bring this important institution to the attention of international communities. Second, Zhejiang Province is an ideal place to study agricultural outsourcing considering it is one of the most urbanized and industrialized province with traditional importance in rice production, which we will provide more detailed description in the next section.Third, we differentiateoutsourcing decisions by operational scale, which is not explored systematically in the past.

The rest of the paper will be organized as the following: Section 2 briefly discussesthe agricultural production history and the role of outsourcing services in Zhejiang province. Section 3 develops a number of hypotheses based on a conceptual frame. Data, summary statistics and empirical method are discussed in Section 4. Econometrics results are discussed in Section 5, and section 6 concludes with some policy implications.

## 2. Background

Zhejiang Province is located on the East Coast of China, and it used to be one of the majorgrain production basesin the pre-reform era. Since the beginning of China's rural reforms in 1978, Zhejiang province has consistently been one of the front runners in economic development.The unprecedented pace and scale of industrialization and urbanizationin Zhejiang Province has resulted in a substantial reduction of arable land for agricultural production. According to a recent statistics, the total crop area and crop production has been reduced by 63.9% and 46.6% from 1978 and 2012. By the end of 2012, the average crop production area per capita in Zhejiang Province was 0.023 hectare, and its crop self-sufficiency ratio was less than 40%, and the gap between crop demand and supply was 1.2 million tons, which made itthe second biggest food deficient province in the nation (xx). Therefore, how to stabilize and increase its crop production is one of the provincial and local government policy priorities.

Zhejiang Province has enjoyed a long history of grain production, and rice is the main staple food of Zhejiang citizens. In terms of production scale, rice production entities in Zhejiang province can be divided into one of the 5 categories: small scalefarmer (<20 mu or 1.3 ha), bigscalefarmer (20-100 mu), big commercial farmer (>100 mu), rice cooperative and specialized riceproduction company.What to follow is a brief discussion of general cha of the first three types of rice producers because our study sample concentrate on these three types of farms. The

rice cooperative and rice companies are not household-based farms so their decision to outsource would be very different from the household-based farms.

Typically in their sixties, small scale farmers produce rice on their own farm land or on farmland of their relatives/friends with no or low rental cost. They are farmers who traditionally produce rice for their own consumption instead of generating income. Their production technology is “experience”, and they rely on others to provide harvesting and plough services.

Big scalefarmers rent land from small scale farmers or from village community with inexpensive cost to expand their rice production scale. They choose to produce rice because they were grown up as farmers andhave the skills and interest in growing. They generate most of their household income from producing rice. They also receive government subsidy for growing rice. These farmers own small agricultural machines and undertakealmost allrice production activities by themselves. Meanwhile, they provide some agricultural services (e.g. ploughing) to small scale farmers. They need to expand or at least retain their scale to achieve economies of scale; otherwise they will shift from producing rice to working in cities. They are typically in their fifties.

Mostly born in cities, the big commercialfarmers with commercialized farmland areretired people who used to operate their own businesses or worked as employees in cities. They operate big farmland (more than 100 mu, in many cases more than 500 mu). They purchase and/or rent land from village community or individual farmers and hire workers to work on their farmland. These people produce rice because they are driven by local policies which encourage development of commercialized farms and rice production profits. They mainly sell rice to government with contracts.

The composition of these 5 categories of rice producers is evolving over time: Both the number and farm size of small scale farmers have dropped considerably over time, big scale farmers experienced reductionin size but not in number, both big commercial farmer and grain cooperatives has increased in both the number and the production scale, and grain companies remains few with enormous production scale (. By 2012, the area share of each of the five categories (from small to large) in total area is 66%, 7.2%, 16.5%, 10.2% and 0.6%, respectively. So despite the trend of shifting from small scale to large scale farms, small farms with farm size less than 1.3 ha are still the dominant rice production entity in Zhejiang in 2012.

Rice production in Zhejiang province is an ideal case to study agricultural outsourcing.First, agricultural outsourcing has been widely adopted by rice farmers in Zhejiang Province. Farmers outsource production activities at all stages ranging from land preparation, seedling and seedling transplantation, crop protection, harvesting and post-harvesting activities. Second, Zhejiang is one of the most developed coastal province with vibrant rural non-farm economy which creates an environment for high demand and supply of agricultural outsourcing services. The demand for agricultural outsourcing is high because farmers faces abundant employment opportunities in the non-farm sectors and therefore the opportunity costs of working on farm is high. The supply of outsourcing is high because the provincial and local government has been taking strong stances to support scale farming and agricultural cooperatives.Third, rice is the most important grain crops in Zhejiang province and it is the most suitable crop for outsourcing because it typically has a long crop seasonwith the mix of labor-intensive tasks in some key phases (land preparation, transplantation, harvesting, etc.) and technique-intensive in other phases (seedling nursery, plant protection, etc.). The existing studies of agricultural outsourcing by domestic scholars almost exclusively focus on rice production (Liao et al. 2012; xxx). And finally, the coexistence of different types of farms allow us to compare the determinants of agricultural outsourcing across production scale, which is valuable to guide the future development of agricultural outsourcing given the vibrant change of farm structure over time.

## 3. Theoretical discussion and hypotheses

As outsourcing agricultural production is not a common phenomenon in developed countries, finding published work on agricultural outsourcing in other countries is rare. However, there has beenincreasing research on agricultural outsourcing by Chinese scholars with the focus on analyzingfarmers' decisions to outsource. The reasons why some farmers outsource and others do not is a relatively straightforward economic question. Followingthe existing studies in the literature,we treat farmers as rationale economic agents so theirdecisions on whether to outsource any or not or outsource individual task(s) are influenced by all the factors that could potentially affect the benefits and costs between the two competing production options: outsourcing ornot-outsourcing. Specifically,the decision rule to outsource or not to outsource is to compare the net earnings of the two competing options as follows:

Option 1 (not outsourcing): If farmersdecide to do the work by themselves, they earn the income from selling the rice, but they need to purchase machines to plough land, protect or harvest their crop etc. So, their net earnings under this option are as follows:

$$\text{Net Earnings}_{(\text{make/do})} = \text{P}_{\text{rice}} \times \text{Q}_{\text{rice}} - \text{C}_{\text{machine and equipment}}$$

Option 2 (outsourcing): If farmers choose to buy the service from other farmers, cooperatives or specialized companies. Then farmers may use the time which they would use to plough, protect or harvest their crop to earn non-farm income by working as non-farm self-employers or wage workers. At the same time, farmers still earn income from selling rice (i.e., $\text{P}_{\text{rice}} \times \text{Q}_{\text{rice}}$).Rice quality may be influenced by the outsourcing service quality, we use ρ to reflect the uncertainty in outsourced service quality. By an assumption$\rho \in (0,1)$, we assume the quality of outsourced services is generally not as highas the quality of services that are performed by farmers themselves. Farmers pay the price of service ($P_{service}$) for the quantity of services used ($Q_{service}$). Therefore, net earnings of farmers under this alternative option are as follows:

$$\text{Net Earnings}_{(\text{buy})} = \text{T}_{\text{non-ag}} \times \text{P}_{\text{non-ag}} + \rho \times (\text{P}_{\text{rice}} \times \text{Q}_{\text{rice}}) - \text{P}_{\text{service}} \times \text{Q}_{\text{service}}$$

Based on the net earnings equations above, farmers outsource if

$$\text{Net Earnings}_{(\text{buy})} \geq \text{Net Earnings}_{(\text{make/do})}, \text{ or}$$

$$\text{P}_{\text{rice}} \times \text{Q}_{\text{rice}} - \text{C}_{\text{machine and equipment}} \geq \text{T}_{\text{non-ag}} \times \text{P}_{\text{non-ag}} + \rho(\text{P}_{\text{rice}} \times \text{Q}_{\text{rice}}) - \text{P}_{\text{service}} \times \text{Q}_{\text{service}},$$

Or if the inequality sign is reserved, farmers would choose not to outsource. It is obvious that all the factors that may affect net earnings of either of the two options would influence farmers' outsourcing decisions. Based on this simple decision rule, we can put forwardthe following hypotheses:

*Hypothesis 1: Outsourcing service price has negative effects on a farmer'sdecision to outsource.*

*Hypothesis 2: Government's subsidy has positive effect on a farmer'sdecision to outsource.*

*Hypothesis 3: Farmers who had experience in working outside of countryside are more likely to outsource.*

*Hypothesis 4: Farmers who own machines and applicants are less likely to outsource.*
*Hypothesis 5: Regional GDP per capita has positive relationship with a farmer'sdecision to use outsourcing services.*

## 4. Survey design and datadescription, and empirical strategy

A household survey was jointly implemented by the Agriculture Department and Crop Bureau of Zhejiang Province, Zhejiang University, and Zhejiang Normal University from Dec 2012 to January 2013 (?). Ten counties (five in South Zhejiang and five in North Zhejiang) from 10 different prefectures were selected as our sample counties.[6] Figure 1 shows how these ten counties are geographically distributed in Zhejiang Province. In each of the ten counties, two townships were selected, and in each township, four villages were chosen. As a result, a total of 40 villages were surveyed. The following criteria were used to select the sample counties and villages:

Each sample county isa large rice production basein its respective prefectureand has at least one "Rice Production Functional Zone" (RPFZ). Zhejiang government started to establish RPFZs in 2010, aiming to encourage rice production with modernized machine and set somedemonstration zones for the entire province. RPFZs share a number of standard features: First, scattered farmlandswere consolidated to produce rice at a bigger scaleto achievethe economies of scale. Second, agricultural infrastructure and irrigation tools are more efficiently utilized in RPFZs, andthe economies of scope are achieved. Third, compared with non-RPFZs, RPFZs have more rice production cooperatives and other organizations that provide rice production services to farmers. Fourth, governments provide more subsidies to the farmers in RPFZs to promote rice production. Fifth, the total rice production in an average RPFZ is much higher than any other parts of the county. By the end of 2012, there were 694 rice production functional zones in these ten sample counties, and the total production from all the RPFZsaccount for 29.39% of the total rice production in the ten sample counties. Because of the significant role that RPFZs have played in rice production, it is important we include RPFZs villages in our sample.

As mentioned earlier, various types of rice producers (small scale farmer, large scale farmer, big

[6]The five counties from North Zhejiang are Xiaoshan (Hangzhou prefecture), Jiashan (Jiaxing prefecture), Nanxun (Huzhou prefecture), Yinzhou (Ningbo prefecture), Zhuji (Shaoxing prefecture) and the five counties from South Zhejiang include Wenling (Taizhou prefecture), Pingyang (Wenzhou prefecture), Wucheng (Jinhua prefecture), Jiangshan (Quzhou prefecture), Jinyun (Lishui prefecture).

commercial farmer, rice production cooperatives, and rice production companies) co-exist in Zhejiang Province. We stratify our sample of rice producers to include different types of rice producers to explore whether factors affecting decisions to outsource agricultural productiondiffer across different types of producers and why. Given that the first three types of farmers are household-based farms but the last two (rice cooperatives and rice companies) involve several households in decision makings, our sample do not include rice cooperatives and rice companies to maintain comparability of farms. The final stratified sample includea total of 271 (??) rice producers.

The survey was conducted through November, 2012 to February, 2103 by faculty members and graduate students from Zhejiang University and Zhejiang Normal University. Before doing the survey, questionnaires were carefully and purposively designed through multiple rounds of discussions and field testing. Student enumerators were trained how to conduct interviews beforethey conducted real interviews. Data for 271 rice producers were effectively collected. Table 1 shows the distribution of the 271 surveyed rice producers in the ten counties.

Before we econometrically analyze the factors affecting rice farmers' decisions to outsource production activities, we first conduct a descriptive analysis of the data to have a better understanding of the demographic, economic and agricultural production characteristics and their outsourcing behaviors of the different types of rice farmers in our sample.

*Demographic characteristics of sample farmers*

Our data show that more than 65% of household heads (those in charge of the rice production) in our sample are older than 45, and more than 70% have received primary to high school education. Table 2 also indicates that more than 30% of heads have ever worked in non-agricultural sector in cities (see table 2). This is in line with the real situation in China, that young generations of farmers tend to work in cities to pursue non-farm employments that pay better than they can earn from working on farm.

In terms of operational scale, small scale farmers(<20 mu) account for more than 40% of the whole sample, so they remain as the main rice producers in Zhejiang Province. However, the number of small farmers (<20 mu) and big farmers (20-100mu) have declined considerably between 2010 and 2012, while farmers with more than 100 mu have increased (see figure 2, figure 3 and figure 4).

While 37% of rice producers rented land, the rest 63% of rice farmersonly cultivated their own land, suggesting that rice production in Zhejiang province remain fragmented and low production scale.However, big rice producers are increasingly renting and purchasing land from other farmers to enlarge their production scales, which is a trend in Zhejiang Province. Our data also show a steady rise of land rental price in Zhejiang, with an average rental price of 274 yuan per mu in 2010 to 354 yuan per mu in 2012.

*Demand and supply of agricultural production service*

In this research, we categorize all these services into labor-intensive services and technique-intensive services according tolabor or technical skills required to complete the specific tasks performed. For example, seedling nursery, rice seedling transplantation and plant protection require great techniques and experience to complete, therefore are categorized as technique-intensive services.On the other hand, plowing, harvesting, drying, transportation and stocking are labor-intensive services. Labor-intensive services are easily performed by machines through the substitutability between labor and machines in completing these services, while technique-intensive services are difficult to be performed by machines. In figure 6, we can see that stocking and processing services are least likely to be outsourced (less than 20% farmers doing so), which is in stark contrast to the fact that more than 60% of farmers outsource ploughing, harvesting and plant protection tasks to outsourcing providers.There are several explanations why farmers choose to outsource these services: (1) to overcome labor shortage for labor intensive tasks; (2) to overcometechnique constraints for technique-intensive tasks,(3) to increase rice production scale; (4) to enhance rice quality; and (5) to raise production efficiency.

The data also show that the outsourcing behaviors vary with thetypes of rice production entities. Small rice farmers enjoy fewer outsourcing services than big producers (see table 4). For production tasks such as plowing, seedling nursery, rice transplantation, plant protection, harvest and processing, there's no significant difference in likelihood to outsource with production scale. For services like drying, transportation and stocking, the bigger the production scale, the more likely the outsourcing service isused.

Regarding providers who offer agricultural services, rice production cooperatives and big rice producers are the main providers (see table 5). Farmers rented machines from their friends or relatives (big rice producers), or agricultural cooperatives to complete production tasks that is requires machines to complete.Regarding the demand side of agricultural services, we find that

different rice producers have different demand in each stage of rice production (see table 6). Rice production cooperatives have much more agricultural services in different stages, while small rice farmers and big rice farmers are much less likely to outsource agricultural services. Big commercial farmers are mostly likely to outsource processing services.

With regard to government subsidy, we found that all kinds of rice producersreceive subsidies for growing rice, for purchase high quality seeds and for cultivation and plant protection. But when it comes to subsidies to agricultural machinerypurchases, land renting, and agricultural insurance, rice producers with bigger farm scale tend to receive more subsidies. The data are largely consistent with our expectation. For example, while small scale farmers mainly benefited from direct production subsidy, subsidy for purchasing high qualityseed and other material inputs, large scale farmers benefited mostly fromsubsidies to support agricultural machine purchase, land renting, and the purchase of agricultural insurance (see table 7).

*Empirical Strategy:*

While the descriptive analysis based on simple tabulation is informative, it requires multivariate regressions to identify the multiple factors that can jointly determine farmers' outsourcing decisions. As discussed in the previous section, all factors that potentially affect the benefits and costs of outsourcing or not should be included as the determinants of farmers outsource decisions. Discrete choice model (either probit or logit) is a standard model to analyze farmers decisions to outsource or not and the literature used either one of the two models. We adopt the logit model in our analysis.[7]

The logit model is to model the probability of a particular farmer to outsource as a function of all the factors that potentially affect the farmer's outsource decision, specifically, we will have

$$P(y = 1|X) = F(\beta_0 + \beta_1 X_1 + \beta_1 X_1 + \cdots + \beta_k X_k) = \frac{1}{1+e^{-(\beta_0+\beta_1 X_1+\beta_1 X_1+\cdots+\beta_k X_k)}} \qquad (1)$$

Where the dependent variable Y is a binary variable (=1 if outsourcing, =0 otherwise), F(.) is a cumulative logistic distribution function, and $X_1$, $X_2$, …, $X_k$ are the explanatory variables that are expected to influence Y. $\beta_0$, $\beta_1$, …, $\beta_k$ are coefficients of the explanatory variablesto be

[7] We also estimate a pobit model for robustness check, it is not surprising that the results are highly consistent with those from the logistic model.

estimated.Specifically, the explanatory variables include farmers' demographic characteristics, land characteristics, governmental police, and regional economic conditions, etc.

We first estimate equation (1) for farmers' decisions to outsource any production task at any stage of the production. Then we also estimate equation (1) for the farmer's decision to outsource one of the three mostly frequently outsourced agricultural tasks(i.e., plough service, plant protection service and harvest service). Thefact that the three tasks cover both labor-intensive tasks and technique-intensive tasks allow us to examine how differently these factors affect farmers' decision to outsource tasks of very different requirementsdifferently.

## 5. Results and Discussions

The logit model results for outsourcing any task(column 1) as wells as for outsourcing one of the three most frequently outsourced individual tasks (columns 2-4) are reported in table 9. As shown in table 9, the determinants of farmers' outsourcing decisions vary with tasks serviced.We focus our discussion around the variables that are statistically significant.

First, considering the determinants for farmers' decisions to outsource any task (column 2), the coefficients on the number of agricultural machines owned, farm scale, land fragmentation, and number of subsidies received are all statistically significant (at either 5% or 1%) and have the expected signs. Consistent with our hypothesis, farmers with more agricultural machines are less likely to outsource any task because holding everything else equal, farmers with more machines have higher working ability to perform some or all the tasks by themselves.Large farmers are more likely to outsource any production task, which is expectedbecausea larger production scale is not only associated with a lower cost of outsourcing services due to the economies of scale effect, but also is more likely to be constrained by labor or technical requirements. Land fragmentation reduces the likelihood for rice farmers to outsource, which is also expected because land fragmentationincreases the cost of outsourcing services. The positive effects of subsidies received on farmers' decisions to outsource suggest that the government subsidy matters in promoting outsourcing services.

The positive coefficients on number of working members (16 years or older) and the average price of outsourcing service are somewhat puzzling. On the one hand, we would expect farmers with more working members to use fewer outsourcing services. But on the other hand, more working aged members may also mean that the farmer has higher ability to learn and

accept new knowledge such as outsourcing services. Another possible explanation is that more working members of a farm household may allow farmers to expand production at an early phase, which in turns demand more labor in the later phase when some of the members are not available. In order to have a better understanding of this point, regressions of decisions to outsource individual tasksare necessary. Finally, the positive effect of outsourcing price on propensity to outsource is not expected, but the magnitude is small.

Columns 2-4 report the results on farmers' decisions to outsource individual tasks. The positive and significant coefficient on years of planting rice in the plant protection equation (column 3) means that farmers who planted rice for long time tend to have plant protection done by others. Farmers who have grown rice for a long time are likely to beelder farmers. Holding other things constant, it is not surprising that an elder farmer is more likely to outsource plant protection because plant protection is both labor-intensive and technique-intensive.On the other hand, more experienced farmers are able to advise/monitor the service providers to apply pesticide more scientifically. Compared to plant protection, the techniques for ploughing and harvesting are much less complicated so the supervision is less important. The number of working members (16 and above) reduced the likelihood of a farmer to outsource plant protection, which is as expected.

The number of agricultural machines have positive and significant effects on farmers' decisions to outsource both ploughing and harvesting activities, which is surprising as we would expect the opposite. However, there are fewpossible explanations for these unexpected results. First, the abundant supply of outsourcing services for ploughing and harvesting and high labor demand to perform these activities make outsourcing of these tasks popular regardless of how many machinesa farmer owns. Second, without other wealth variables on the right hand side of the equation, agricultural machinesserve as good proxy for wealth so wealthy farmers are more able to afford these outsourcing services. And third, this could be related to data problems. For example, the machine variable is an aggregated variable, we are not able to relate the type of machines to the type of task performed.

Average local wages havea significant influence on farmers' outsourcing behavior in plant protection. Plant protection is both labor-intensive and technique-intensive. It is rational for a farmer to outsource plant protection when he/she can earn more money from working on non-farm employment than the cost of outsourcing services. The positive and significant coefficient

on GDP per capita of a countyin both the ploughing and plant protection models suggest that farmers in wealthier regions are more willing to outsource labor-intensive and/or technique-intensive activities.Finally, whether a village is located in aRPFZ has positive and significant effects on farmers' decisions to outsource ploughing. This is not surprising as farmers are likely to benefit from the supply of services provided by the agricultural cooperatives which are promoted and subsidized by government. Among the three types of tasks, the likelihood to outsource harvesting is the least influenced by the factors, which is expected as harvesting is the most outsourced task than any other task.

## 6. Conclusion

China's rapid urbanization and industrialization will continue to create increasing pressure on its agricultural sector. How to achieve food security under this extremely challenged situation will be a top priority of Chinese government's development policy in the coming years. China's agricultural sector has proved to be quite resilient in the past as its total grain production has increased for the past 11 consecutive years. While many factors have contributed to the sustained growth of grain production, agricultural outsourcing as a newly emerged institution is believed to have played an important part.

In this paper, we analyzed the factors affecting farmers' decisions to outsource any production task or a specific task using data from rice farmers in Zhejiang Province. We find the number of working age members, farm size, fragmentation, number of machines, service prices, and subsidies received are all important factors affecting farmers' decisions to outsource any task. In terms of decisions to outsource any specific task, the determinants vary from task to task. While service prices has the expected negative effect on the likelihood to outsource plant protection, the effect on the propensity to outsource ploughing (or harvesting) is positive (or insignificant). While more experienced (elderly) farmers are likely to outsource plant protection which is both labor- and technique- intensive, experience plays no role in ploughing and harvesting. While farmers in richer counties (high GDP) are more likely to outsource both ploughing and plant protection, it has no effect on harvesting. A farmer who is located in a RPFZ is more likely to outsource ploughing, but whether a farmer is located in a RPFZ has no significant effect on his decision to outsource plant protection and harvesting.

The econometrics results allow us to draw a number of important implications. First, the fact that the small scale and fragmentation are two key land related constraints that prevent farmers from using outsourcing service for any task point toward the need to consolidate land to increase farming scale. One way to increase the farming scale is through land rental market. Local government should remove any restrictions toward free land rental and guarantee security if the land is rented out to others. It is also advisable to reduce fragmentation if an opportunity is presented to local leaders to reallocate land during the new titling process. Second, subsidy is an effective mechanism to promote agricultural outsourcing. However, it should target to the activities (tasks) that are less adopted and more responsive to subsidy or price. For example, price and subsidy is likely to be more effective to promote the take-up of plant protection outsourcing than harvesting outsourcing. In fact, outsourcing harvesting task need the least assistance from government.

We would like to acknowledge some caveats with the current study. First, the relatively small sample size prevented us from exploring farmers' outsourcing behaviors for more production tasks. Second, the aggregation of some key variables prevent us from linking outsourcing of different tasks (labor-intensive, technique-intensive, etc.) to the task-specific machines or labors. For example, we would like in the future to be able to separate machines used for different tasks (e.g., plough, tractor, seedling transplanter, sprayer, and harvester, etc.). Doing so would allow us to have more accurate estimation on the effect of machinery on task-specific outsourcing decisions. Similarly, we would like to the future labor data to allow us to separate agricultural labor from potential non-agricultural labor (e.g., those with migration experience).

## References


Chen, C. and H.W. Huang 2012. Outsourcing behavior of rice producers from perspectives of specialization—survey from three counties in Jiangsu Province (in Chinese). Economic Problems vol (9): 87-92.

Cheng, D.Z. 2006. The increase, structure change and its influence of China's modern service development. Financial Economics vol 10. 68-71.

Gong, D.G. 2000. General theories of agricultural services and its adoptions in farmers' choice behavior. Observation of China's Countryside vol 6. 25-34.

Li, Yinqiu. and Hongfang, Shen. 2015. Research on supply of outsourcing behavior of agricultural production link in east China – take rice industry as an example. Journal of Agricultural Management Institute of Ministry of Agriculture (in Chinese). Vol 18, 17-23.

NBSC. 2011. "The release of the Sixth National Census Data of China." http://www.stats.gov.cn/tjsj/zxfb/201104/t20110428_12707.html

Pei, C.H. Analysis of experience and theories of modern services development in China. Research Journal of China's academy, 2010 vol 1: 5-15.

Su, S., Z. Jiang, Q. Zhang, and Y. Zhang, Transformation of agricultural landscapes under rapid urbanization: A threat to sustainability in Hang-Jia-Hu region, China, Applied Geography, Vol31(2):439-449.

Teng, Y.F. 2012. Research on rice production specialization service under small scale production model. Mater thesis, Yangzhou University. (in Chinese)

Yang, J., Z. Huang, X. Zhang, and T. Reardon. 2013. "The Rapid Rise of Cross-Regional Agricultural Mechanization Services in China." American Journal of Agricultural Economics 95(5):1245-1251.

Zhang, X., J. Yang and T. Reardon. 2015. "Mechanization Outsourcing Clusters and Division of Labor in Chinese Agriculture." IFPRI Discussion Paper 01415. Washington, D.C.

Zhou, W.S. 2003. Typologies and situations of agricultural services. Private journal of communist party of Sichuan Province. Vol 2: 12-15.

Wang, Z.G., Hongfang, Shen and Xiyuan, Liao. 2011. Industrialization of Agricultural Production – Starting from outsourcing production, taking rice production as an example. China Agricultural Economics (In Chinese). Vol 9, 4-12.

Acknowledgement

Hereby, the authors appreciate the National Natural Science Foundation of China Projects (No. 71333011, 71473218) for funding the research.

Table 1. Sample data distribution in ten counties

| City | County | Sample amount | Percentage (%) |
|---|---|---|---|
| Jiaxing | Jiashan | 25 | 9.22 |
| Huzhou | Nanxun | 24 | 8.86 |
| Hangzhou | Xiaoshan | 16 | 5.90 |
| Ningbo | Yinzhou | 20 | 7.38 |
| Shaoxing | Zhuji | 27 | 9.96 |
| Quzhou | Jiangshan | 42 | 15.50 |
| Li'shui | Jinyun | 31 | 11.44 |
| Wenzhou | Pingyang | 30 | 11.07 |
| Taizhou | Wenling | 28 | 10.33 |
| Jinhua | Wucheng | 28 | 10.33 |
| Total | Total | 271 | 100 |

Table 2. Demographic characteristics of sample farmers

| Characteristics | Items | Sample amount | Percentage（%） |
|---|---|---|---|
| Age | Under 35 | 6 | 2.6 |
| | Between 35-45 | 47 | 20.1 |
| | Between 45-55 | 83 | 35.5 |
| | Between 55-65 | 79 | 33.8 |
| | Above 65 | 19 | 8.1 |
| Education | Primary School unfinished | 20 | 8.5 |
| | Primary school graduated | 72 | 30.6 |
| | Middle school graduated | 100 | 42.6 |
| | High school graduated | 29 | 12.3 |
| | University education | 14 | 6.0 |
| Experience | Working in non-agriculture sector | 71 | 30.3 |
| | Running own business | 38 | 14.0 |
| | Work as government staff | 91 | 38.9 |
| | Member of socialism party | 88 | 37.4 |
| Family members number | Under 3 | 80 | 34.2 |
| | Between 3-5 | 103 | 44.0 |
| | More than 5 | 51 | 21.8 |

Table 3. Rice producer types and their scale

| Scale | Sample Amount | Percentage (%) |
|---|---|---|
| Small scaled farmers (scale $\leq$ 20mu) | 96 | 40.9 |
| Big rice producer (20< $scale \leq 100mu$) | 57 | 24.3 |
| Commercialized-farm rice producer (scale> $100mu$) | 82 | 34.9 |

Note: 1mu$\approx$ 0.0667 hectare

Table 4. Percentage of different principals outsourcing agricultural service in each link of rice production process (%)

| Principal / Link | Small rice producer | Big rice producer | Rice producer with commercialized farm |
|---|---|---|---|
| Plough | 72.73 | 58.49 | 65.75 |
| Seeding | 37.5 | 45.28 | 41.1 |
| Rice transplanting | 37.5 | 56.6 | 49.32 |
| Plant protection | 60.23 | 62.26 | 68.49 |
| Harvest | 88.36 | 86.79 | 80.82 |
| Drying | 12.5 | 41.51 | 58.9 |
| Transportation | 15.91 | 24.53 | 46.58 |
| Stocking | 2.27 | 9.43 | 13.7 |
| Processing | 19.32 | 7.55 | 9.59 |

Table 5. Percentage of principals who provide agricultural services in different links (%)

| Principal / Link | Relative and friends | Big rice producer | Rice production cooperative | Agricultural service companies | Village-level community | Agricultural technology department of government |
|---|---|---|---|---|---|---|
| Plough | 3.07 | **44.79** | **36.20** | 4.91 | 6.13 | 4.91 |
| Seeding | 0.96 | 11.54 | **70.19** | 2.88 | 4.81 | 9.62 |
| Rice transplanting | 2.52 | 19.33 | **65.55** | 2.52 | 3.36 | 6.72 |
| Plant protection | 2.60 | 9.09 | **72.08** | 0.65 | 3.90 | 11.69 |
| Harvest | 4.02 | **46.23** | **43.72** | 2.01 | 2.01 | 2.01 |
| Drying | 1.08 | 10.75 | **63.44** | 16.13 | 4.30 | 4.30 |
| Transportation | 9.21 | **55.26** | 31.58 | 1.32 | 0.00 | 2.63 |
| Stocking | 7.69 | **26.92** | **53.85** | 3.85 | 3.85 | 3.85 |
| Processing | 47.22 | **19.44** | 16.67 | 13.89 | 2.78 | 0.00 |

Table 6.Percentage of different principals' service demand, supply and gap in different links (%)

| Demand \ Link | | Plough | Seeding | Rice Transplanting | Plant Protection | Harvest | Drying | Transportation | Stocking | Processing |
|---|---|---|---|---|---|---|---|---|---|---|
| Small rice producer | Service Demand | 82.28 | 58.23 | 51.90 | 68.35 | 82.28 | 32.91 | 20.25 | 11.39 | 27.85 |
| | Current supply | 72.73 | 37.50 | 37.50 | 60.23 | 86.36 | 12.50 | 15.91 | 2.27 | 19.32 |
| | Gap between demand and supply | 9.55 | 20.73 | 14.40 | 8.13 | **-4.09** | 20.41 | 4.34 | 9.12 | 8.53 |
| Big rice producer | Service Demand | 64.00 | 54.00 | 64.00 | 68.00 | 86.00 | 48.00 | 28.00 | 18.00 | 22.00 |
| | Current supply | 58.49 | 45.28 | 56.60 | 62.26 | 86.79 | 41.51 | 24.53 | 9.43 | 7.55 |
| | Gap between demand and supply | 5.51 | 8.72 | 7.40 | 5.74 | **-0.79** | 6.49 | 3.47 | 8.57 | 14.45 |
| Rice producer with commercialized farm | Service Demand | 67.16 | 49.25 | 56.72 | 68.66 | 85.07 | 65.67 | 47.76 | 22.39 | 25.37 |
| | Current supply | 65.75 | 41.10 | 49.32 | 68.49 | 80.82 | 58.90 | 46.58 | 13.70 | 9.59 |
| | Gap between demand and supply | 1.41 | 8.16 | 7.40 | 0.16 | 4.25 | 6.77 | 1.19 | 8.69 | 15.78 |
| Rice producer cooperative | Service Demand | 75.00 | 70.00 | 75.00 | 85.00 | 80.00 | 60.00 | 40.00 | 40.00 | 40.00 |
| | Current supply | 88.00 | 72.00 | 80.00 | 84.00 | 84.00 | 60.00 | 52.00 | 36.00 | 32.00 |
| | Gap between demand and supply | **-13.00** | **-2.00** | **-5.00** | 1.00 | **-4.00** | 0.00 | **-12.00** | 4.00 | 8.00 |

Table 7. Rice producer with different scales demand for various types of government subsidy (%)

| Subsidy \ Rice Production Principal | Small rice producer | Big rice producer | Rice producer with commercialized farm |
|---|---|---|---|
| Rice production direct subsidy | 80.21 | 78.95 | 67.07 |
| Good seed cultivation subsidy | 62.50 | 54.39 | 42.68 |
| Subsidy on agricultural raw materials purchasing | 75.00 | 54.39 | 41.46 |
| Subsidy on agricultural machine purchasing | 17.71 | 21.05 | 31.71 |
| Subsidy on land renting | 10.42 | 29.82 | 50.00 |
| Subsidy on agricultural insurance | 19.79 | 28.07 | 25.61 |
| Others | 7.29 | 5.26 | 3.66 |

Table 8. Descriptive analysis result of farmers' outsourcing behavior

| Variables | Value and explanation | Medium | Standard Deviation |
|---|---|---|---|
| Dependent variables | | | |
| Outsource in one of the nine tasks | No=0，Yes=1 | 0.89 | 0.31 |
| Outsource in Ploughing | No=0，Yes=1 | 0.34 | 0.47 |
| Outsource in Plant Protection | No=0，Yes=1 | 0.39 | 0.49 |
| Outsource in Harvesting | No=0，Yes=1 | 0.20 | 0.40 |
| Independent variables | | | |
| 1.Demographic Characteristics of Farmers | | | |
| Yeas of producing rice | Unit: year | 24.66 | 13.92 |
| Householder Experience | Without experience in working in cities/run own business/staff in village government/being communist party member=0<br>With experience in any one of the above=1 | 0.64 | 0.48 |
| Percentage of rice production income accounts for whole family income | Unit：% | 53.68 | 34.80 |
| Numbers of Agricultural machines that a family owns | | 2.29 | 4.14 |
| 2. Land Characteristics | | | |
| Land acreage | Unit：mu | 135.87 | 238.29 |
| Level of how lands are scattered | Land acreage/Land Numbers，<br>Unit：Mu/numbers | 2.29 | 4.14 |
| 3.Outsourcing Price | | | |
| Average Price | (outsource price of plough+ outsource price of plant protection+ outsource price of harvest) /3 | 114.26 | 20.09 |
| Outsource price of ploughing | Unit：yuan | 98.09 | 20.58 |
| Outsource price of plant protection | Unit：yuan | 129.94 | 41.79 |
| Outsource price of harvesting | Unit：yuan | 114.74 | 32.54 |
| 4.Benefits enjoyed from government | | | |
| Whether belongs to a "Rice Production Functioning Zone" | Yes=1，No=0 | 0.68 | 0.46 |
| Subsidies from Government | Number of types of subsidies that farmers get from government | 4.33 | 2.02 |
| 5. Regional Economic Level | | | |
| Average price of hiring a worker/day | Unit：yuan | 124.63 | 30.29 |
| GDP per capita in each county | Unit：10000 yuan | 5.7202 | 2.5928 |

Table 9. Logistic Model Results

| Variable | Any of the nine tasks | Ploughing | Plant protection | Harvesting |
|---|---|---|---|---|
| Years of planting rice | -0.011 | 0.001 | 0.037*** | 0.013 |
| Householder Experience | 0.885 | -0.262 | -0.139 | -0.741 |
| Rice production income that accounts for the whole family income | 0.000 | 0.012** | -0.003 | 0.007 |
| Agricultural machines that a family owns | -0.316*** | 0.127* | 0.044 | 0.124** |
| Land acreage | 0.005** | -0.002 | 0.000 | 0.000 |
| Level of how land are scattered | -0.005** | 0.001 | 0.000 | 0.000 |
| Outsourcing price of agricultural service | 0.029* | 0.044*** | -0.011** | 0.007 |
| Whether or not the village belongs to a "Rice Production Functioning Zone" | -0.350 | 0.674* | 0.399 | -0.126 |
| Subsidy that farmers enjoy from government | 0.365** | 0.010 | -0.119 | -0.135 |
| Average price of hiring a worker in cities | -0.009 | 0.004 | 0.017*** | 0.004 |
| GDP per capita of a county | -0.131 | 0.199*** | 0.222*** | 0.066 |

Note: "*"represents that it's significant on 10% level; "**"shows that it's significant on 5% level; "***"shows that the result is significant at 1% level.

Figure 1. Ten counties in Zhejiang Province selected as sample data

Figure 3. Small rice production farmers' percentage change from 2010 to 2012 in five counties Zhejiang Province

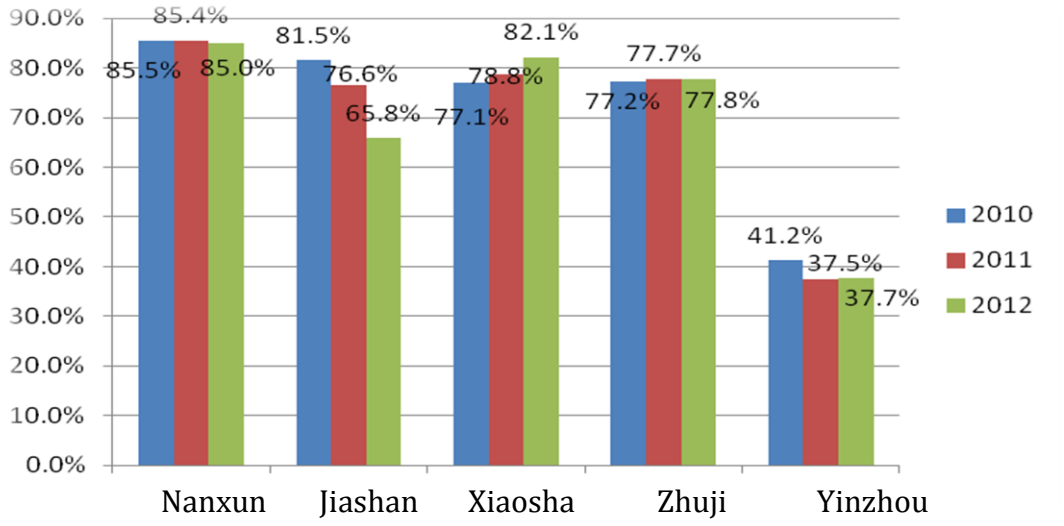

Figure 4. Big rice production farmers' percentage change from 2010 to 2012 in five counties in Zhejiang Province

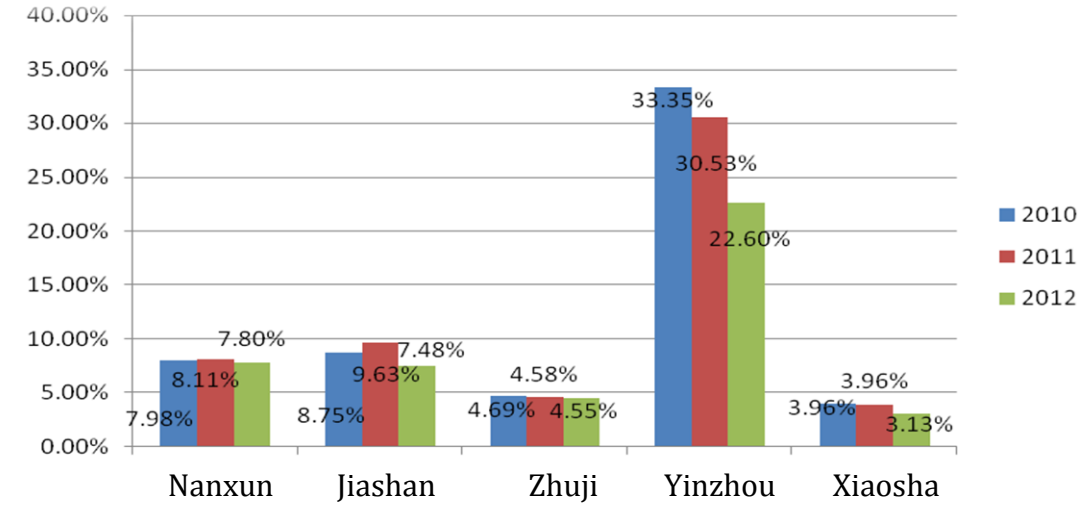

Figure 5. Rice producer with commercialized farmland percentage change from 2010 to 2012 in five counties in Zhejiang Province

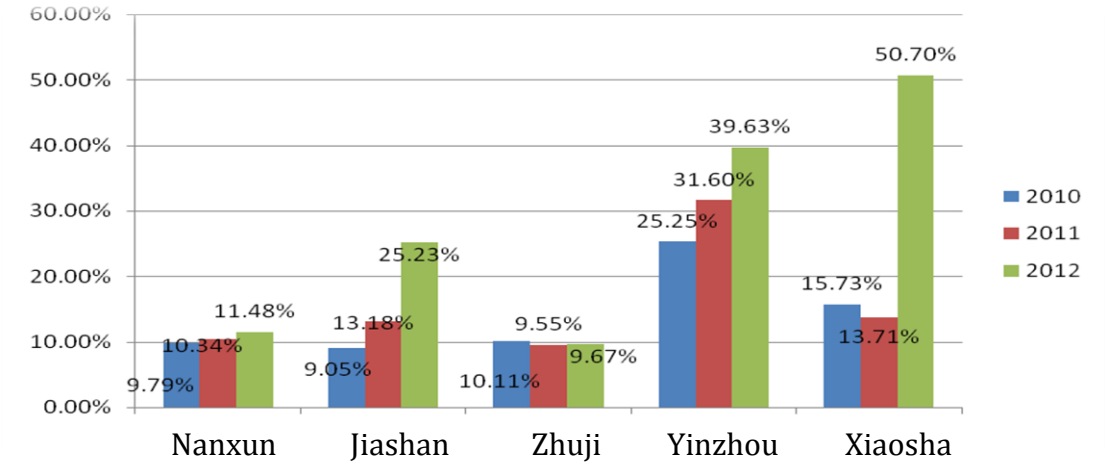

Figure 6. Rice production service outsource percentage in each link