*** Title Page with names and Institutions only (not sent to Reviewer)**

Evaluating the Impact of Tax-for-Fee Reform (*Fei Gai Shui*) on Water Resource and Agriculture Production in the Zhanghe Irrigation System, China

By

Shahbaz Mushtaq[1], Shahbaz Khan[1,2], David Dawe[3], Mohsin Hafeez[2], Mohammad Nadeem Asghar[1]

[1]Charles Stuart University (CSU), Wagga Wagga, NSW, Australia

[2]Commonwealth Scientific and Industrial Research Organization (CSIRO), Land and Water, Wagga Wagga, NSW, Australia

[3]Food and Agriculture Organization (FAO), Bangkok, Thailand

Contact Address

Shahbaz Mushtaq

Water System Analyst
Charles Sturt University (CSU),
Building 24, Boorooma Campus,
Wagga Wagga, NSW 2650
Email: smushtaq@csu.edu.au
Tel: (02) 6933 4934
Fax: (02) 6933 2647

March 2007

* Manuscript (no name or institution)

Evaluating the Impact of Tax-for-Fee Reform (*Fei Gai Shui*) on Water Resource and Agriculture Production in the Zhanghe Irrigation System, China

Abstract

This article questions the effectiveness and viability of Tax to Fee reform (*Fee Gai Shui*) on water resources and agriculture production. The *Fee Gai Shui* reform has been heralded as a possible solution for reducing the excessive fiscal burden on peasants. While the reform may achieve in relieving peasant' burden up to 30%, the initial impact of *Fee Gai Shui* on water resources and agricultural production indicate least satisfactory trends. The policy show profound effect on rice yield and area. It might also have profound effect on cropping pattern but it has yet to be seen. Dependence on local water resources show significant increase after *Fei Gai Shui* as it discouraged farmers to rely on regional water sources. Although the lower regional water use under *Fei Gai Shui* reduced the volumetric water fees paid by farmers, the savings were mostly offset by increasing pumping costs in accessing water from ponds. Without any adjustments, the *Fei Gai Shui* is likely to cause serious predicament in agricultural sector. It is visioned that local water resources such as water ponds will continue to play a more important role in sustaining agricultural production.

Key words: Tax to Fee reform, multiple regression, water ponds, irrigation costs, rice

1. Introduction

The importance of maintaining rural viability and stability has become a regular item in top Chinese leaders' policy over the last ten years. The precursor of these policy changes is the growing regime receptivity to peasants' frustration (Bernstien, 1999). Farmers in china have been required to pay agricultural fees. In addition, they also have to pay other fees for such things as public accumulated funds, public welfare, management, education, family planning and communications. Moreover, such fees are increasing more and more in some localities. Reiteration of these concerns result in three main responses at political, administrative and fiscal level. Politically, leaders have emphasized greater transparency of village administration, including further implementation of village elections and enhancement of financial accountability (Kevin and Li, 2000). Administratively, streamlining of rural bureaucracy has gained renewed momentum. In the past management of funds has been erratic in most cases. Under-reporting is common, as is illegitimate use of the funds for purposes other than those specified. Fiscally, Tax-for-Fee reform (*Fei Gai Shui*) that has been heralded as a possible solution to the cancer of excessive fiscal predation by local governments (Yep, 2004).

Fei Gai Shui (FGS) reform aims primarily at reducing peasants' fees burden. They intend to standardize farmers' duties and responsibilities to the state, and at the same time, standardize the administrative enforcement of the law (Zengke, H., 2000). The taxation department collect taxes according to the law. The burden on farmers is mainly embodied in supporting redundant township staff members. They also pay fees used in various economic and social activities and in education.

With the FGS reform, various types of irregular fees, fines and quota imposed on farmers are completely abolished. That is to say, farmers only pay an agricultural tax, and no other departments collect any other fees from farmers. The agricultural tax and overall burden, based on stipulations, do not exceed 8.4%. The basic aim is to reduce the burden on farmers by 25 to 30% (Zengke, H., 2000).

Fee Gai Shui (FGS) was implemented in Hubei province in 2002, along with ten other provinces. Hubei Province in central China north of the Changjiang (Yangtze) River, in which Zhanghe Irrigation District (ZID) is the main agricultural area. With in ZID, the Zhanghe Irrigation System (ZIS) was established with the construction of the Zhanghe reservoir between 1958 and 1966 on a tributary of the Yangtze River. The reservoir was designed for multipurpose uses of irrigation, flood control, domestic water supply, industrial use, and power generation.

A critical look at the FGS indicates that its complicated nature can provoke new issues for both local government and the farmer's sector. With the FGS, local governments experience a shortfall in the amount of funds collected for education and other social purposes. At the same time, increasing the agricultural tax might adversely affect agricultural production and consequently decrease farmers' incomes. It is possible for farmers to end up with a double burden, not only must they pay the new agricultural tax, they will still be asked to pay fees to the local government when the latter runs into financial difficulties (Yep, 2004).

With the implementation of FGS, farmers need to organize to request water from ZIS (rather than going through the village or township administration) and to pay all or a portion of the water fee in advance, in addition to increase in water prices. The operations of the main canals linked with ZIS reservoir were greatly disrupted by the sharp decline in irrigation water allocations and in the collection of water fees which they had relied on for operation and maintenance (Loeve et al., 2004). In 2002 and 2003, the ZIS irrigation releases were down sharply due to the introduction of FGS (Figure 1). As a result, rice production area and production was also declined, however, the decline was more in the dry year 2003 (Dong et al., 2004).

There are apprehensions that FGS will have major impact on water distribution, water conservation, and crop production (Mushtaq, 2004). Thus, a detailed analysis of the impact of FGS on all aspects, especially agriculture and agricultural production, is very crucial before expanding its area of implementation. In this aspect, the initial effect of FGS on water distribution and conservation, pond water use, irrigation costs, and agricultural yield is explored by this paper.

2. Methodology

2.1 Study Area

The study was conducted in the Zhanghe Irrigation District (ZID), which is located in Hubei Province, Yangtze River basin of China (Figure 2). The Zhanghe basin has an area of 7,740 km^2, including a catchment area of 2,200 km^2. The ZIS accounts for most of the irrigated area in ZID. It is one of the typical large-size irrigation systems in China. It is designed to irrigate an area of about 160,000 ha.

The ZID has a subtropical climate with temperature varying from a minimum of –19°C in the January to a maximum 41°C in the July. About 80% of the irrigated area lies in the hilly region. Average annual rainfall is 970 mm, although rainfall varies substantially from year to year depending upon the monsoon. This rainfall provides about 5.2 billion m^3 of water annually, with an average annual runoff of approximately 2.15 billion m^3. Rice is the major crop in summer, while rapeseed and wheat are the major crops in winter. Other important upland crops include beans, sesame, oil and sweet potato. Rice cultivation covers about 80% of the area.

The Zhanghe Irrigation System: The main water source in ZIS is the Zhanghe reservoir. The annual water supply from the Zhanghe reservoir is about 0.50 billion m^3, some 42% of which is allotted to agriculture, 45% to hydropower, and rest of the water for industry and municipalities. However, the water availability for irrigation is declining over time due to competition from the municipal and industrial water use. Hong et el. (2001) observed that there was 61% decrease in ZIS water supply to irrigation during last decade. Apart from this reservoir, there are thousands of medium and small reservoirs (ponds) supplying water to the irrigation system.

Water ponds and small size reservoirs: Ponds and reservoirs are located in irrigated areas that allow farmers to capture rainfall, store surplus water from the Zhanghe Irrigation System (ZIS), and conserve water from other sources. The small dots shown in Figure 2 are thousands of small to medium reservoirs (ponds) in the ZID. The role of the ponds in rice growing has become important since the reduction of irrigation supplies from ZIS. Aside from the Zhanghe reservoir, there are about 86,000 ponds and more than 300 medium and small size reservoirs supplying water for irrigation. These ponds and small reservoirs allow the users to obtain water on-demand because of its built-in flexibility to store water close to water users (Loeve et al., 2001). They are also helpful in reducing floods, recharging and providing drainage in high-rainfall periods (Anbumozhi et al., 2001). In Hubei Province, China, these ponds and small reservoirs essentially play an important role in agriculture by providing supplemental irrigation. The ZIS obtains one-fourth of its water from medium and small ponds to complement the supply from the main Zhanghe reservoir (Moya et al., 2001).

2.2 Sampling Procedure and Sample Size

Three sets of questionnaires were developed − one for the village level, the second for the pond management group, and a third for households. The goal was to gain insight regarding water distribution before and after FGS, water allocation, development of and construction of ponds, change in cropping pattern and cost of irrigation before and after FGS.

A multistage sampling methodology was used. In the first stage, 36 villages were selected at random from within ZID for village head interviews. Of the 36 villages, four were selected purposively for detailed characterization to represent different topographies (e.g. hilly, intermediate, flat) of the area. In the second stage, 100 ponds were selected at random (25 ponds from each of the 4 villages). Next, 100 households were selected randomly, one household from each pond, to capture the variation between ponds, as there is very little variation among farmers using a given pond. In the final stage, 38 pond managers/management groups, approximately 10 from each village, were selected on the basis of pond size, using stratified random sampling. Aside from selecting 100 farmers with ponds, 10 households without ponds were selected randomly. It was intended that data from a total of 40 households without pond be gathered, ten from each village. However, only a few households were found not using pond water.

2.3 Modelling Impact of FGS

2.3.1 Conceptual framework

Evaluation usually takes either a quantitative or qualitative approach, with the two approaches often viewed as alternatives. If carried out carefully, a quantitative approach provides measured outcomes with statistical tests that support the validity of the findings (Kerr and Chung, 2001). To the extent that it is feasible, quantitative evaluation attempts to attribute changes in various outcome variables to a project intervention and determine whether such effects are statistically significant. To evaluate the initial impact of FGS, before and after technique was implied. With this approach, the "before" scenario was used as a control against which the effects of the FGS was compared. This is fairly weak but feasible analysis (Campbell and Russo, 1999), since it involves the unlikely assumption that there have been no other causes of significant changes during the study period.

Figure 3 shows the theoretical model for the effect of FGS on crop area. Figure (3a) shows, initially, that demand (DW_{ZIS}) and supply (SW_{ZIS}) of ZIS water at equilibrium price (P_{EQ}) and quantity (QD_{EQ}). The effect of implementation of FGS, change in the water delivery policy by ZIS management committee and increase in price of water, is shown with the increase the price from P_{EQ} to $P_{FGS.}$ As a direct result of the policy the water demand (QD) decrease from QD_{EQ} to QD_{FGS}. The decrease in quantity demanded in the agricultural sector results access supply of water, which believed to be diverted to fast growing industries and city area. Figure 3(b) shows the effect of decrease in ZIS water after FGS the rice area under cultivation. The rice area decreases from RA_{EQ} to RA_{FGS}. This theoretical framework was empirically tested by developing regression model given in the next section.

2.3.2 Empirical Models

The choice of the relevant regression model depends on the type of dependent variable. The total cost of irrigation was calculated by adding all water fees paid by respondents, which mainly include water fees paid to the village, the ZIS irrigation bureau, fuel cost, pumping cost, operation and maintenance cost, and basic water fees. Due to the nature and type of variable, total cost of irrigation was treated as continuous variable. Similarly, pond water use frequency, rice area and yield were considered as continuous variables.

If the dependent variable is continuous and influenced by more than one independent variable, multiple regression analysis to predict the net effect of all independent variables on dependent can be used (Green, 2000). The assumption of multiple regression analysis is that the dependent variable is a linear function of a series of independent variables $X_1, X_2, \ldots, X_k$ and an error term ε_i. The empirical models to determine the impact of ponds on cost of irrigation, rice area and yield are given by the equation 1-4.

$$PONDWTR = \beta_0 + \beta_1 DFGS + \beta_i \boldsymbol{Xi} + \varepsilon_i \quad (1)$$

$$IRRCOST = \beta_0 + \beta_1 DFGS + \beta_i \boldsymbol{Xi} + \varepsilon_i \quad (2)$$

$$RICEAREA = \beta_0 + \beta_1 DFGS + \beta_i \boldsymbol{Xi} + \varepsilon_i \quad (3)$$

$$RICEYLD = \beta_0 + \beta_1 DFGS + \beta_i \boldsymbol{Xi} + \varepsilon_i \quad (4)$$

where *PONDWTR* stands for pond water use, *IRRCOST* for total costs of irrigation, *RICEAREA* for rice area, *RICEYLD* for rice yield, FGS for *Fee Gai Shui*, ***Xi*** for vector of exogenous variables affecting the dependent variables, β_0 is constant, βi is a vector of unknown parameters and error term εi. As before and after technique is used, therefore, a dummy variable (0 and 1) was used for FGS. A FGS rating of 0 means before FGS, which will serve as control, and a rating of 1 implies after FGS. Similarly, *PONDWTR, IRRCOST*, *RICEAREA* and *RICEYLD* use was measured before and after FGS.

2.3.3 Definitions and Measurement of the Variables

The variables used in the empirical study are defined and explained below in alphabetical order. Descriptive statistic of these variables is given in Table 1.

AGE. This refers to the age of the household head. The age factor is considered as a proxy for experience and position of an individual in society, viz., older the age means higher societal status. This was measured in terms of years since birth.

AWDSCORE. This refers to alternate wetting and drying score. *AWDSCORE* was calculated based on soil conditions. It ranges from 0 to 1. A score of 0 implies that the respondent's irrigation practice is continuous flooding, that is, he irrigates while the field has standing water. On the other hand, a score of 1 implies that the respondent allows the field to dry before irrigation. A score between 0 and 1 indicates that farmers follow a practice intermediate between continuous flooding and drying of soil before every irrigation.

DSTANCE. This refers to distance from the pond to the main plot. This was measured in meters. It is expected that distance will influence rice area and yield.

DPOND. This refers to dummy for pond access. If a respondent was having access to pond water than *DPOND* = 1; other wise 0.

DVILAGE. This refers to dummies for four villages. Specific characteristics of the study site may greatly influence the dependent variable. For example, if the observation is from village Shungbie than *DVILAGE* =1; otherwise 0.

EDUCATON. This refers to educational experience of the household head. Education could increase the farmer's ability to obtain, process, and use information efficiently. It was measured in terms of number of years of schooling.

ELEVAT. This refers to the elevation of the plot. The terrain was divided into three categories, i.e. high, medium and low. Elevation of the plot affects irrigation management practices. It will be defined at *ELEVAT* = 1 if the plot is located at higher elevation, *ELEVAT* = 2 if the plot is located at medium and *ELEVAT* = 3 if the plot is situated at lower elevation.

FARMEXP. This refers to experience of the household head in farming. With experience, the household learns the advantages and disadvantages of difference technologies. This was measured in terms of numbers of farming years.

FARMSIZE. This refers to total cultivated area of the farmer. This is defined as the total area of all the parcels owned by the farmers excluding the area this is rented in. This was measured in *mu* (A Chinese unit of land, 1ha = 15 *mu*).

FGS. This is refers to the policy *Fee Gai Shui*. FGS was used as a dummy variable. It was defined as FGS = 1, after the policy FGS, and 0, if before FGS

IRRPOND. This refers to number of irrigations made from ponds.

IRRZIS. This refers to number of irrigations made from the ZIS reservoir.

IRRCOST. This refers to total cost of irrigation. Total cost of irrigation includes water fees paid to the village, ZIS and ponds, fuel cost, pumping cost, operation and maintenance cost, and basic water fees. This was measured as total cost of irrigation ¥/*mu*/year (1 US$ = 8.2 ¥ as of December 2004) before and after FGS.

LANDQLTY. Farmers were asked to subjectively rate the quality of their plots as good, average, or poor. The quality of the land is included as a control variable because it might influence input use and management practices. It was defined as *LANDQLTY* = 1, if the land is poor, *LANDQLTY* = 2 if the land is average, and *LANDQLTY* = 3 if the land is of good quality.

PONDACCS. This refers to number of ponds accessed. An individual respondent can have access to one or more ponds, depending on the area, and quantity of ponds in each village. Numbers of ponds accessed is expected to influence collective action, area, and yield. This was measured in numbers.

PONDSIZE. This refers to size of the ponds. Pond was divided into three categories, i.e., small, medium and large, based on the storage capacity. Small ponds have a storage capacity less than 1,000 m^3, medium ponds have a storage capacity between 1,000 to 10,000 m^3, and large ponds have a storage capacity over 10,000 m^3.

RICEAREA. This refers to area devoted to rice cultivation. Information regarding rice area was collected for before and after FGS. Rice area was measured in *mu*.

RICEYLD. This refers to rice yield. Information regarding rice yield was collected for before and after FGS. Rice yield was measure in kg/*mu*.

WEALTH. This refers to wealth status of the household. It was used as a proxy of income. Wealth status was self-reported by the farmers according to their standing in the society. Wealth status was divided into three categories, i.e. top 1/3, middle 1/3 or bottom 1/3. A score of 1, 2 and 3 was then assigned to lower, middle, and top level of wealth status, respectively.

3. Results and Discussion

Fee Gai Shui was imposed only in 2002, however, almost everyone in the study area such as farmers, managers and village leaders, were fully aware of this policy during the time of the survey. This demonstrates the broadness and significance of the policy on rural life. The main advantages of FGS, as reported by the farmers, were elimination of many taxes and responsibilities to the village. Changes in the ZIS policies for water distribution and increase unit price of water from ¥0.004/m^3 to ¥005/m^3 were reported as major disadvantages.

3.1 Effect of FGS on water use

The demand for ZIS water sharply decreased because of increase water prices, and changes in ZIS policy. According to a ZIS official, the new ZIS policy requires farmers to submit a group request in order to demand water from ZIS. An individual farmer cannot alone request for water. The quantity of water demanded should be large enough before ZIS would deliver water in that area. In addition, the group organization requesting for the ZIS water has to pay fees for the requested water in advance. Due to the above policy, most of the farmers were unable to organize in to groups to file a combined request for ZIS water. During the survey period, ZIS officials admitted that their own agricultural income has sharply decreased because of lack of demand for ZIS water.

The results of change in water use from the ZIS revisor and ponds are given in Table 2. Almost half of the respondents reported an increase in the pond water use after FGS, at 44% in the management level survey, and 42 percent in the farmer level survey. On the other hand, 70% decrease in ZIS water was reported. The farmer level survey revealed that increase in pond water used mostly happened in Sundian (55%) and Wuba (40%) as compared to Shuangbie (37%) and Huangyan (28%). As the latter two villages are relatively far from the ZIS canals, there is little reliance on ZIS water even before FGS, thus there was less increase reported on pond water use.

Frequency of water application on rice crop from each source before and after FGS is presented in Table 3. The result showed that over all the frequency of irrigation decreased (0.44) significantly at $P<0.01$. Also, it is evident from the table that frequency of irrigation from ZIS has decreased substantially, while the frequency of irrigation from the ponds has been increased. Both of these changes were statistically significant at $P<0.01$. However, frequency of irrigation from reservoir and irrigation remained unchanged before and after FGS.

The FGS policy shows major impact on water pond development. It has discouraged farmers to rely on regional water sources, which led to increase in local water resources such as ponds. Although farmers started constructing ponds since 1960s, or even before, the bulk of the ponds were constructed in late 1990s and early 2000. In the sample data, 20 percent of the ponds were constructed in 2002, it was due to water shortages, decreasing water supply from the ZIS, and as an effect of the FGS. The farmers reported that they were successfully able to increase the quantity of pond water (44%) after FGS due to: enlarging the ponds to hold more water; use less pond water for other activities like laundry and drinking.

3.1.1 Empirical findings for the effect of FGS on pond water use

Multiple regression analysis was used to estimate the effect of FGS on pond water use frequency. Pond use frequency, number of times pond water used, before and after FGS, was treated as continuous variables. It was hypothesized that FGS have a significant impact on pond water use.

The result showed that with a few exceptions, most of the coefficients were significant with *a priori* expected signs. The model was overall significant; the F value (3.8) was significant $P<0.001$ (Table 4). The values of R^2 (0.20) and adjusted R^2 (0.15) were low; however, this is not unusual for cross section data.

The coefficient of FGS (0.918) was found positive and significant at $P<0.001$. The relation could be explained by the fact that the introduction of FGS in the area caused pond water use to increase significantly. FGS caused an increase in the per unit price of ZIS water, as a result farmers avoided using ZIS water and relied more on pond water for irrigation.

Among other variables, the coefficient AWD score (*AWDSCORE*) show negative but significant at $P<0.01$. This implies that with the increase in AWD score, the number of irrigation decreases. The results are consistent with the aim of AWD, which is to reduce the amount of water used for irrigation. The results were consistent with Palis et al. (2004), who concluded that AWD practices saved 16-24% of irrigation water in Tarlac, Philippines.

The coefficients of dummy variables for Shuangbie (*DVILAGE1*), Huangyan (*DVILAGE3*) and Sundian (*DVILAGE4*) were negative and significant P <0.001. This indicated that Shuangbie, Huangyan and Sundian were less using pond water compared to Wuba. This is true, because Wuba farmers rely mainly on pond water for irrigation as compared to other villages, which relies equally on pond and ZIS water for irrigation.

The coefficients of rests of variables did not show any significant results; however, they showed expected signs.

3.2 Irrigation costs after FGS

Excluding the labor cost, farmers' irrigation costs consists of: payment to ZIS management to cover the cost of supplying water; payment to the village for the construction and maintenance of local water irrigation infrastructure; basic water fees, which has been progressively introduced in major irrigation districts since the late 1990s (Yang et al., 2003); pumping cost, which includes operation & maintenance, fuel and electricity expenses; and other costs, which include payment to small reservoirs.

The total cost, before and after FGS, is shown in Table 5. On an average, the current cost was about 155/*mu* as compared ¥166/*mu* before FGS. Results of pair wise t-test showed that there was average ¥10/*mu* decrease in total cost of irrigation, was not statistically significant. There was significant decrease (¥61/*mu*) at P <0.001 in the irrigation cost to the village, which was mainly due to decrease in the demand for water and change in the ZIS policy for water distribution. Farmers reported that they are not paying money to the village for buying water from the ZIS, which was the norm before FGS. On the other hand, there was significant increase at P<0.001 in fuel/electricity (¥21.85/*mu*) and pump/rental cost (¥28.45/*mu*) after FGS; this simply show that importance of ponds after FGS. A significant increase at P<0.05 was also noticed in the operation & maintenance of ponds after FGS, this was because the extensive used and enhanced the management activities of the ponds.

3.2.1 Empirical findings for the effect of FGS on cost of irrigation

Multiple regression model was used to test the null hypothesis that FGS has a significant impact on cost of irrigation. The dependent variable, total cost of irrigation (¥/*mu*) was treated as a continuous variable. The results are shown in Table 6. The coefficients estimated in the model were in accordance with the theoretical expectations, other than one instance, distance of pond from the field (*DSTANCE*), where the coefficient was found negative but not significant. The F value (3.345) was significant at $P<0.001$. The values of R^2 and adjusted R^2 were 0.26 and 0.18, respectively. R^2 (0.26) means that 26 % of the variation in cost of irrigation was explained by the variables included in the model.

The coefficient of FGS (-11.93) was found negative but insignificant, which implies that with the introduction of FGS, there was no significant change observed in the total cost of irrigation. However, the result showed that even though the total cost of irrigation remained the same, the cost structure has been changed, which we can clearly see from 5. Furthermore, a detailed understanding of the result revealed that although the overall cost of irrigation did not change significantly, the quantity of irrigation before and after FGS has significantly decreased, which we can clearly check in Table 3. It implies that farmers were paying almost same amount of money before and after FGS, but for a significantly lower quantity of water. Hence, as a result, we can say that the cost to the farmers have increased after FGS. The important implication of this might be that Chinese government was able to introduce policies, which forced farmers to reduce water demand.

The coefficient of dummy for Shuangbie (*DVILAGE1*) was negative and significant at $P<0.05$, while dummy for Huangyan (*DVILAGE3*) and dummy for Sundian (*DVILAGE4*) were positive but not significant. Shuangbie has always benefited from its proximity to the ZIS reservoir as compared to the other villages. Thus, their irrigation costs were relatively less as compared to other villages. The irrigation costs of Huangyan and Sundian were higher compared to Wuba, but the difference was not significant. The apparent reason was the dependability of ponds and ZIS water. Wuba totally relied on pond water for irrigation whereas Huangyan and Sundian equally relied on ponds and ZIS water. Pond water is cheaper than ZIS water, thus the cost of irrigation in Huangyan and Sundian were relatively higher compared to Wuba.

The coefficients of rests of variables did not show any significant results; however, they showed expected signs.

3.3 Cropping pattern after FGS

In the study area, there was no significant change observed in terms of crop diversification, but, both at farmers and village level, there was noticeable reduction in the irrigated area, especially areas grown with rice. There were no significant changes observed in terms of crop diversification because FGS was implemented only two years ago, and it might take sometime before the farmer will adjust cropping patterns according to FGS. In this regard, farmers also reported that they were still in the process adjusting their cropping pattern in response to FGS. In terms of cropping pattern, over 92 percent of farmers reported follow the same cropping pattern before and after FGS.

3.3.1 Rice area and yield after FGS

Both village level and farmer level data were used to analyze the effect of FGS on rice area and yield. Based on pair wise t-test, the mean irrigated area per village decreased by187.3 *mu* (8.32%), which was significant at $P < 0.001$ (Table 7). The average decrease in rice area per village was 98.70 *mu* (3.69%), which was significant at $P < 0.00l$, and average decrease in rice area per farmer was 0.16 *mu* (1.45%), which was significant at $P < 0.005$. On the other hand, the average increase in the summer crop area per village was 67.9 *mu* (81.12%) significant at $P < 0.005$.

The data on yield showed that the average decrease in rice yield at village level was 115.7 kg per mu (26.9%), and farmer level was 146.9 (32.8%) kg per mu. Both of these decreases in the areas were statistically significant at $P < 0.01$.

Based on the results, it appeared that the contraction in the rice area was greater than the substitution in summer crop. Therefore the total effect, contraction + substitution effect, of FGS was found negative on the area. These results implied that the introduction of FGS caused a significant decrease in rice yield. However, this is true only if our assumption, that there have been no other significant changes during the study, is also true. Weather changes from year to year, and this along with pests and diseases, could also be responsible for the fall in rice yield.

3.3.2 Empirical findings for the effect of FGS on rice area and yield

To evaluate the impact of FGS on rice area and yield multiple regression models were used. Dependent variables, rice area and yield, were both treated as continuous. The estimates of effects of FGS on rice area and yield have been presented in Tables 8 and 9. Both models fitted the data very well. In addition, the values of R^2 and adjusted R^2 were also high.

In case of rice area, the coefficient of FGS (0.16) was negative and significant at $P<0.005$. In case of rice yield, the coefficient of FGS (146.9) was also negative and highly significant at $P<0.001$. This implies that the introduction of FGS caused a significant decrease in rice area and yield. However, this is true only if our assumption, that there have been no other significant changes during the study, is also true.

The coefficient of AWD score (AWDSCORE), in case of rice area, was positive and significant at $P<0.001$. This positive result was expected, as AWD practices saves around 20 percent of water, therefore, as a result this saved water, crop area should increase. On the other hand, the coefficient of AWD score, in case of rice yield, was found negative but not significant. This relation can be explained by the fact that, by adopting AWD practice yield might decline, but that decrease in the yield was not statistically significant. This result was consistent with the findings of Canbagon et al, 2001, Moya et al, 2001 and Palis et al, 2004 who concluded that AWD practices have no significant effect on yield.

The coefficient of farm size (*FARMSIZE*), in case of rice area, was also positive and significant at $P<0.001$. It implies that increase farm size will result in a higher yield perhaps due to economies of scale and better management practices. The coefficient of experience (*FARMEXP*), in case of rice area, was negative and significant at $P<0.01$. This finding appeared little puzzling, but it can be interpreted by the fact that after FGS, those who have a good deal of experience were not growing rice, perhaps they found it not feasible, either due to high cost of irrigation or lack of water.

In case of rice area, the coefficients of dummy for Shuangbie (*DVILAGE1*) and Huangyun (*DVILAGE3*) were found highly significant and positive at $P<0.001$, and dummy for Sundian (*DVILAGE4*) was also found positive but significant at $P<0.005$. The result indicated that rice area in Wuba was comparatively more affected by FGS compared to the other villages, perhaps due to the shortage in water. The data regarding Wuba showed that after FGS, ZIS water delivery was almost negligible, which, most probably, resulted in larger reduction in rice area compared to other villages.

In case of rice yield, the coefficients of dummy for Shuangbie (*DVILAGE1*) and Huangyun (*DVILAGE3*) were found highly significant and negative at $P<0.001$. Dummy for Sundian (*DVILAGE4*) was found positive but not significant. These results indicated that yield in Shuangbie and Huangyun was significantly effected as compare to Wuba, it maybe because these two villages were relying mainly on ZIS for irrigation, and as a result of FGS, their yield was significantly affected. Shuangbie was found to be severely affected by FGS perhaps because it failed to divert pond water for irrigation as they were also using these for fish harvesting. However, there was no statistically significant difference observed between yield decrease in Wuba and Sundian.

4. Conclusion and Recommendations

The implementation of *Fei Gai Shui*, in 2002 shifted the responsibility for receipt of water deliveries from the village to the farmers. This led to a sharp decline in Zhanghe Irrigation System water deliveries in 2002 and 2003 resulting in a greater dependence on ponds. In some instance new ponds were constructed and existing ponds were improved and expanded. Due to the broad nature of the *Fei Gai Shui* policy, the results do not show the complete picture of the real effects of *Fei Gai Shui*, however, it certainly described at least satisfactory initial trends on water resources and agriculture production in future. *Fei Gai Shui* might have profound effects on cropping pattern but it has yet to be seen. Over time it might also affect the cropping pattern of the area. Although the lower use of Zhanghe Irrigation System canal water under *Fei Gai Shui* reduced the volumetric water fees paid by farmers, the savings were mostly offset by increasing pumping costs in accessing water from ponds.

The empirical results show that *Fei Gai Shui* had a positive effect on pond water use but negative effect on rice area and yield. Although *Fei Gai Shui* had no effect on over all irrigation cost, the cost per unit of water used has certainly increased. Pond water played important role in sustaining agricultural production despite sharp decrease in Zhanghe Irrigation System water deliveries. Results show that the presence of ponds cushioned the impact of *Fei Gai Shui* in the study areas. The empirical results indicated that access to pond water has made positive impact on yield and area and helped to reduce the irrigation cost. It is assumed that in future, and especially after the implementation of *Fei Gai Shui*, ponds will continue to play a more important role in sustaining agricultural production.

Reference

Anbumozhi, V., Matsumoto, K., Yamaji, K. (2001). Sustaining Agriculture Through Modernizing of Irrigation Tanks: An Opportunities and Challenge for Tamil Nadu. Agricultural Engineering International: CIGR Journal of Scientific Research and Development, Manuscript LW 01 002. Vol. III

Cabangon, R. J,. E. G Castillo,. G. Lu,. G. H Wang,. Y. L Cui,. T. P. Tuong,. B. A. M. Bouman,. Y. H, Li,. C. D. Chen and J. Z. Wang. 2001. Impact of Alternative Wetting and Drying Irrigation on Rice Growth and Resource-Use Efficiency. Water Saving Irrigation for Rice: Proceedings of an International Workshop held in Wuhan China. Baker, R., R. Loeve, Y. H. Li and T. P. Tuong (eds.). Colombo, Sri Lanka: International Water Management Institute.

Campbell, D. T. and M. J. Russo, 1999. Social Experimentation. Thousand Oaks Sage Publications, California, USA.

Dong, B. D.Molden, R.Loeve, Y.H.Li, C.D.Chen, and J.Z.Wang, 2004, Farm level practices and water productivity in the Zhanghe Irrigation System In Randolph Barker, Guest Editor, Paddy and Water Environment. Vol. 2, No. 4. Dec. 2004

Green, W.H., 2000, Econometric Analysis, Prentice Hall, Upper Saddle River, New Jersey.

Kerr, J. and K. Chung. 2001. Evaluating Watershed Management Projects CAPRi Working Paper No. 17. International Food Policy Research Institute.

Kevin O'Brien and Lianjiang Li, "Accommodating 'democracy' in a one-party state: introducing village elections in China," The China Quarterly, No. 162 (June 2000), pp. 465–489.

Loeve, R. L. Hong, Dong, B., Chen, C. D., Dawe, D., Barker, R.2004, Changes in long term trends in intersectoral water allocation and crop productivity in Zhanghe and Kaifeng, China. In Randolph Barker, Guest Editor, Paddy and Water Environment.

Loeve, R., Dong, B., Zhoa, J. H., Zhang, S. J., Molden, D. 2001. Operation of Zhanghe Irrigation System. Water Saving Irrigation for Rice: Proceedings of an International Workshop held in Wuhan China. Barker, R., Loeve, R., Li, Y. H., and Tuong, T. P. (Eds.). Colombo, Sri Lanka: International Water Management Institute.

Moya, P., Hong, L., Dawe, D., Chen, C. D. (2001). Comparative On-Farm Water-Saving Irrigation Techniques in Zhanghe Irrigation System. Water Saving Irrigation for Rice: Proceedings of an International Workshop held in Wuhan, China. Barker, R., Loeve, R., Li, Y. H., and Tuong, T. P. (Eds.). International Water Management Institute, Colombo, Sri Lanka.

Mushtaq, S. 2004. An Assessment of the Role of Water Ponds in Sustaining Crop Production and Adoption of Water Saving Irrigation Practices in China. Ph.D Thesis. University of the Philippines at Los Banos, Laguna, Philppines.

Palis, F. G., P.A. A. Cenas, B. A. M. Bouman, R. M. Lampayan, A.T. Lactaoen, T. M. Norte, V. R. Vicmudo, M. Hossain and G. T. Castillo. 2004. A Farmer-Participatory

Approach in the Adaptation and Adoption of Controlled Irrigation for Saving Water: A Case Study in Canarem, Victoria, Tarlac, Philippines. International Rice Research Institute (IRRI), DAPO Box 7777, Metro Manila, Philippines.

Thomas Bernstein, “Farmer discontent and regime responses,” in Merle Goldman and Roderick MacFarquhar (eds.), The Paradox of China’s Post-Mao Reforms (Cambridge, MA: Harvard University Press, 1999), pp. 195–219.

Yang, H., X. Zhang and A. J. B. Zehnder. 2003. Water Scarcity, Pricing Mechanism and Institutional Reform in Northern China Irrigated Agriculture. Agricultural Water Management 61 (2003) 143–161.

Yep, R. 2004. Can “Tax-for-Fee” Reform Reduce Rural Tension in China? The Process, Progress and Limitations. The China Quarterly

Zengke, H., 2000. Corruption, Governance and Good Governance in Transitional China. China Social Science Quarterly (Hongkong), vol.31: 107-115.

Table(s)

Table 1 Summary statistics for variables used in the regression analysis

Variable code	Variable name	Measurement	Mean	S.D.
AGE	Age of the household head	Year	44.97	9.72
AWDSCORE	Alternate wetting and drying score	Number	0.81	0.15
DSTANCE	Distance of the main plot from the pond	Meter	100	163.93
DPOND	Dummy for pond water	If pond access = 1, otherwise = 0	0.90	0.30
DVILAGE1	Dummy variable for Huangyan	If village Huangyan = 1, other wise 0	0.23	0.42
DVILAGE3	Dummy variable for Sundian	If village Sundian = 1, other wise 0	0.23	0.42
DVILAGE4	Dummy variable for Shuangbie	If village Shuangbie = 1, other wise 0	0.23	0.42
EDUCATON	Education level of the HH head	Numbers of schooling years	7.45	1.99
ELEVAT	Elevation of the plot	If high elevation = 1, if medium = 2 and if low = 3	2.09	0.64
FARMEXP	Farming experience of HH head	Year	26.76	10.51
FARMSIZE	Size of the farm	*Mu*	11.54	5.07
FGS	Dummy variable for FGS	After FGS = 1, before FGS = 0	200	0.50
IRRPOND	Number of irrigation from ponds	Number	110	3.21
IRRZIS	Number of irrigation from ZIS canals	Number	110	0.60
IRRCOST	Total cost of irrigation per year	¥/*mu*/year	164	161.70
LANDQLTY	Land quality	If good quality = 1, if average = 2, if poor = 3	1.97	0.68
PONDACCS	Number of pond access to an individual respondent	Number	110	1.81
PONDSIZE	Size of the pond	If small pond = 1, if medium = 2, and if large = 3	100	1.88
RICEAREA	Rice area	Percent of rice area to the total cropped area.	89.05	46.61
RICEYLD	Rice yield	Kg/*mu*	506.0	114.19
WEALTH	Wealth status of the household	If top level =1, if middle= 2, and if low =3	2.24	0.63

**1US$ = 8.2 Yuan (¥) on December 2004
1 ha = 15 *Mu*
These data were collected in a random sampling, and consists of 100 household having access to 100 small, medium and large ponds, 10 household without pond access, 38 pond management groups in 36 villages (4 villages for detailed characterization) in the Zhanghe Irrigation System, China, during 2003 and 2004.

Table 2 Percentage change in water use after *Fei Gai Shui (*FGS)

Village	Percentage increase in pond water use			Percentage decrease in the Zhanghe Irrigation System reservoir water use		
	N	Mean	S.D			
Farmer Level						
Shuangbie	12	37	14	18	61	25
Wuba	20	40	24	23	99	6
Huangyan	7	28	19	15	42	11
Sundian	14	55	22	18	67	25
Overall[a]	53	42	22	74	70	28
Overall[b]	87	25	27	93	56	38
Manager Level						
Shuangbie	2	50	00	–	–	--
Wuba	2	50	25	–	–	--
Huangyan	3	43	12	–	–	--
Sundian	8	44	19	–	–	--
Overall[a]	18	44	18	–	–	--
Overall[b]	37	21	25	–	–	--

[a]Based on the respondent, who said that pond water use is increased and Zhanghe Irrigation System is decreased after FGS

[b] Based on the overall manager (38) and farmer (100) level sample

-- Not applicable.

Table 3 Number of irrigations for rice from difference sources of water before and after *Fei Gai Shui* (FGS)

Sources of irrigation	Before FGS			After FGS			Mean difference[a] (%)
	N	Mean	S.D	N	Mean	S.D	
Zhanghe Irrigation System reservoir	100	2.04	1.41	100	0.61	0.69	-1.43***
Pond	100	2.62	1.29	100	3.53	1.57	0.91***
Local reservoir	100	0.01	0.10	100	0.08	0.56	0.07[NS]
Irrigation well	100	00	0.10	100	0.01	00	0.01[NS]
Total	100	4.67	1.94	100	4.23	1.69	-0.44***

[a] refers to the mean difference between before and after FGS.
*** and ** refers statistical significance at 1% and 5%, respectively, and [NS] refers to non significant at 10%.

Table 4 Regression results for the effect of *Fei Gai Shui (*FGS) on pond water use frequency

Variable	Coefficient	STD. Error	P Value
INTERCEPT	4.789***	1.047	0.000
FGS	0.918***	0.196	0.000
PONDACCS	0.133	0.097	0.141
PONDSIZE	0.120	0.140	0.393
DSTANCE	0.0003	0.001	0.534
FARMSIZE	0.022	0.021	0.307
LQUALITY	0.247	0.159	0.123
AWDSCORE	-1.514*	0.844	0.075
EDUCATON	-0.069	0.054	0.198
FARMEXP	-0.001	0.010	0.890
DVILAGE1	-1.163***	0.346	0.001
DVILAGE3	-1.002***	0.345	0.004
DVILAGE4	-0.952***	0.338	0.005
F Value			3.805***
R-square			0.20
Adjusted R-square			0.15
Number of observation			196

***, ** and * indicate the significance at 1, 5, and 10 percent probability levels, respectively.

Table 5 Total cost of irrigation (¥/*Mu*) before and after *Fei Gai Shui* (FGS)

Source of irrigation	Before FGS			After FGS			Mean difference[a]
	N	Mean	S.D	N	Mean	S.D	
To village for water	96	61.12	90.92	96	0.26	2.55	-60.87***
To ZIS for water	97	11.35	22.64	97	16.11	44.38	4.76[NS]
To pond	99	0.09	0.64	99	0.84	7.08	0.74[NS]
Fuel/electricity	90	34.05	69.07	90	55.90	84.37	21.85***
Pumping cost	95	45.95	114.84	95	74.41	124.95	28.45***
Operation & maintenance	100	2.56	11.36	100	4.92	16.23	2.36**
Basic water fee	100	1.58	0.99	100	00	00	-1.58**
Others	100	0.45	4.50	100	1.15	8.28	0.70[NS]
Overall	82	166.74	173.63	82	156.65	154.69	-10.09[NS]

[a] refers to the mean cost difference between before and after FGS.
*** and ** refers statistical significance at 1% and 5%, whereas [NS] means non significant.

Table 6 Regression results for the effect of *Fei Gai Shui (*FGS) on total cost of irrigation (¥/*Mu*)

Variable	Coefficient	STD. Error	P Value
INTERCEPT	179.35	136.33	0.190
FGS	-11.93	16.35	0.365
PONDACCS	-24.72*	14.18	0.083
PONDSIZE	-7.34	16.72	0.661
DSTANCE	-0.005	0.046	0.916
IRRPOND	4.33	9.71	0.656
IRRZIS	-10.58	10.63	0.321
FARMSIZE	4.84*	2.59	0.064
LQUALITY	19.40	19.74	0.327
ELEVAT	11.77	28.41	0.679
AWDSCORE	-69.69	104.58	0.506
EDUCATON	10.48	6.71	0.121
FARMEXP	0.98	1.37	0.475
DVILAGE1	-94.11**	43.39	0.032
DVILAGE3	85.77*	46.55	0.067
DVILAGE4	74.88	57.69	0.196
F Value			3.345***
R-square			0.26
Adjusted R-square			0.18
Number of observation			160

***, ** and * indicate the significance at 1, 5, and 10 percent probability levels, respectively.

Table 7 Comparison of area (*Mu*) and yield (kg/*Mu*)before and after *Fei Gai Shui (*FGS)

Area	before FGS			After FGS			Mean [a] difference	Percent change
	N	Mean	S.D	N	Mean	S.D		
Irrigated area, village level	24	2675.4	718.9	24	2577.6	717.7	-98.7***	-3.69
Rice area, village level	24	2289.3	877.3	24	2098.8	848.2	-190.4***	-8.32
Other summer irrigated crops, village level	24	66.2	246.6	24	119.9	227.7	53.8**	81.12
Rice area, farmer level	100	11.04	4.70	100	10.88	4.59	-0.16**	-1.45
Yield								
Rice yield, village level	28	546.4	66.1	28	430.6	78.2	-115.7***	26.89
Rice yield, farmer level	584	594.9	74.9	584	448.0	86.8	-146.9***	32.79

[a] refers to the mean difference between difference irrigated, rice, other summer crops area, and rice yield before and after FGS.
*** and ** refers statistical significance at 1% and 5% level levels, respectively.

Table 8 Regression results for the effect of *Fei Gai Shui* (FGS) on rice area (*Mu*),

Variable	Coefficient	STD. Error	P Value
INTERCEPT	-2.42	1.69	0.154
FGS	-0.16**	0.32	0.042
PONDACCS	0.02	0.16	0.912
PONDSIZE	-0.35	0.23	0.126
DSTANCE	-0.0001	0.001	0.788
FARMSIZE	0.78***	0.03	0.000
AWDSCORE	5.94***	1.32	0.000
EDUCATON	-0.03	0.09	0.696
FARMEXP	-0.03*	0.02	0.070
DVILAGE1	2.21***	0.56	0.000
DVILAGE3	2.03***	0.56	0.000
DVILAGE4	1.26**	0.55	0.023
F Value			59.15***
R-square			0.78
Adjusted R-square			0.76
Number of observation			200

***, ** and * indicate the significance at 1, 5, and 10 percent probability levels, respectively

Table 9 Regression results for the effect of *Fei Gai Shui* (FGS) on rice yield (kg/*Mu*)

Variable	Coefficient	STD. Error	P Value
INTERCEPT	650.15***	54.13	0.000
FGS	-146.95***	9.95	0.000
PONDACCS	2.38	5.07	0.639
PONDSIZE	3.98	7.29	0.585
DSTANCE	0.01	0.02	0.515
FARMSIZE	-0.62	1.08	0.566
LQUALITY	4.77	8.07	0.555
ELEVATION	-2.70	10.57	0.798
AWDSCORE	-32.86	43.27	0.449
EDUCATON	-1.78	2.71	0.512
FARMEXP	0.41	0.54	0.447
DVILAGE1	-112.28***	17.72	0.000
DVILAGE3	-67.04***	17.42	0.000
DVILAGE4	13.24	19.72	0.503
F Value			24.11***
R-square			0.64
Adjusted R-square			0.61
Number of observation			194

***, ** and * indicate the significance at 1, 5, and 10 percent probability levels, respectively

Figure(s)

Figures

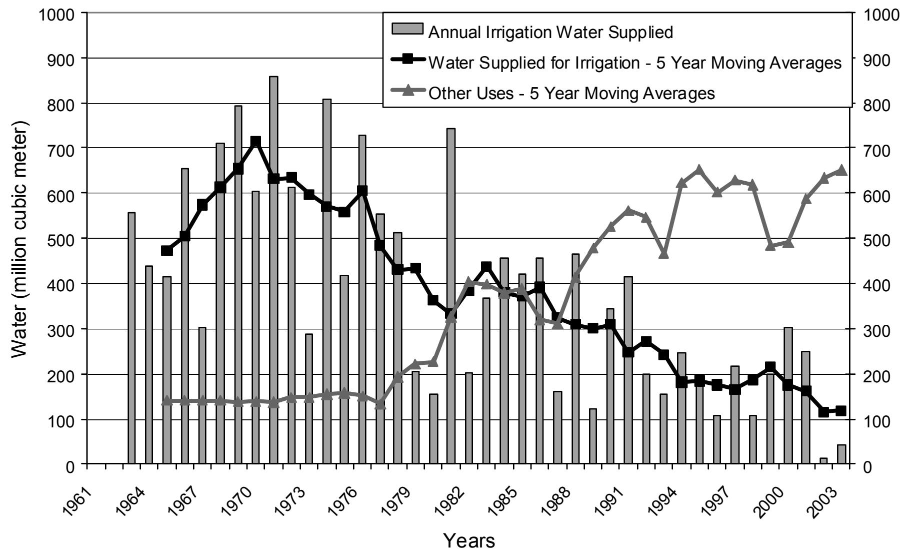


Figure 1 Zhanghe Irrigation System, Hubei, China: Annual water Allocations for irrigation and other uses, 1965-2003

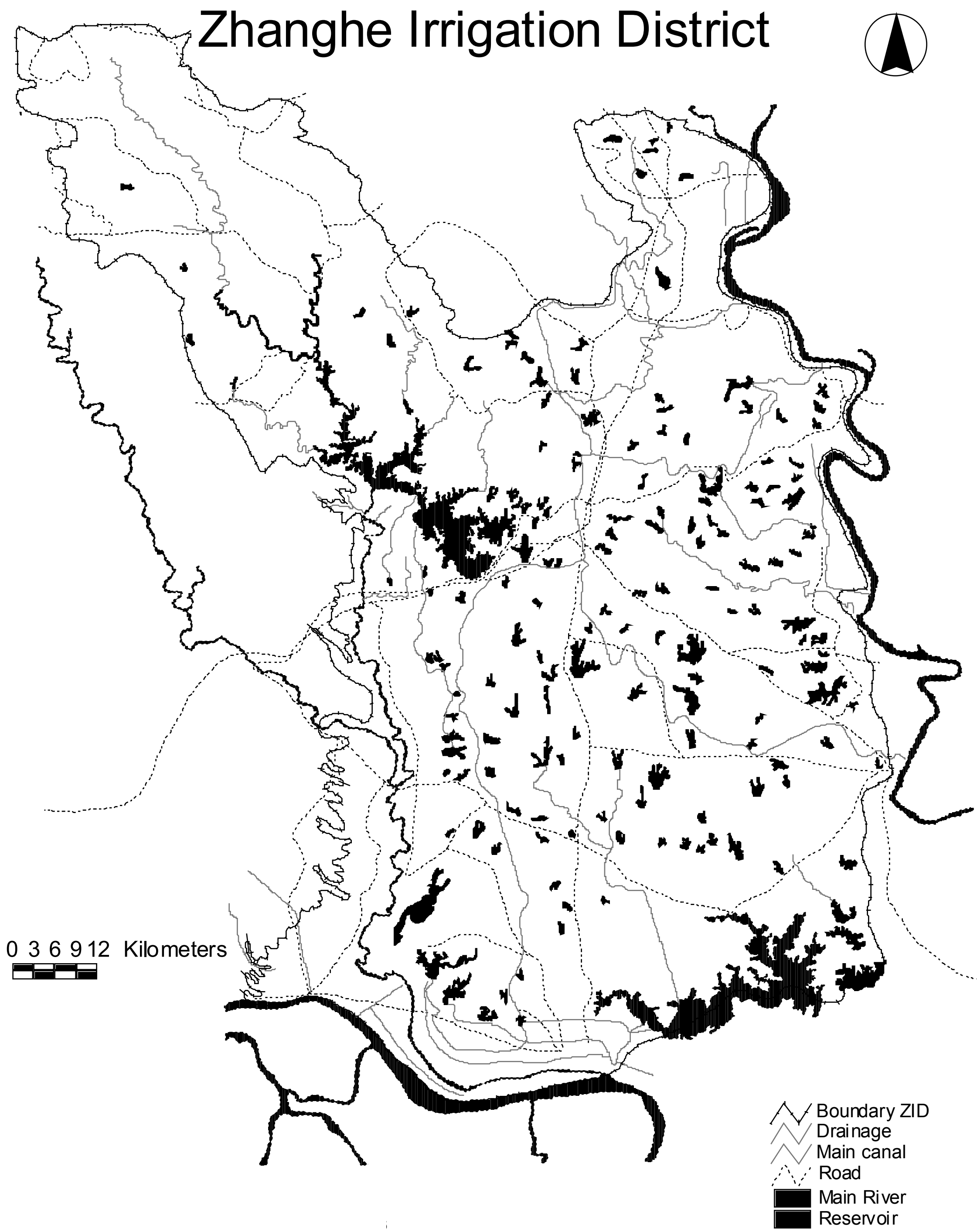
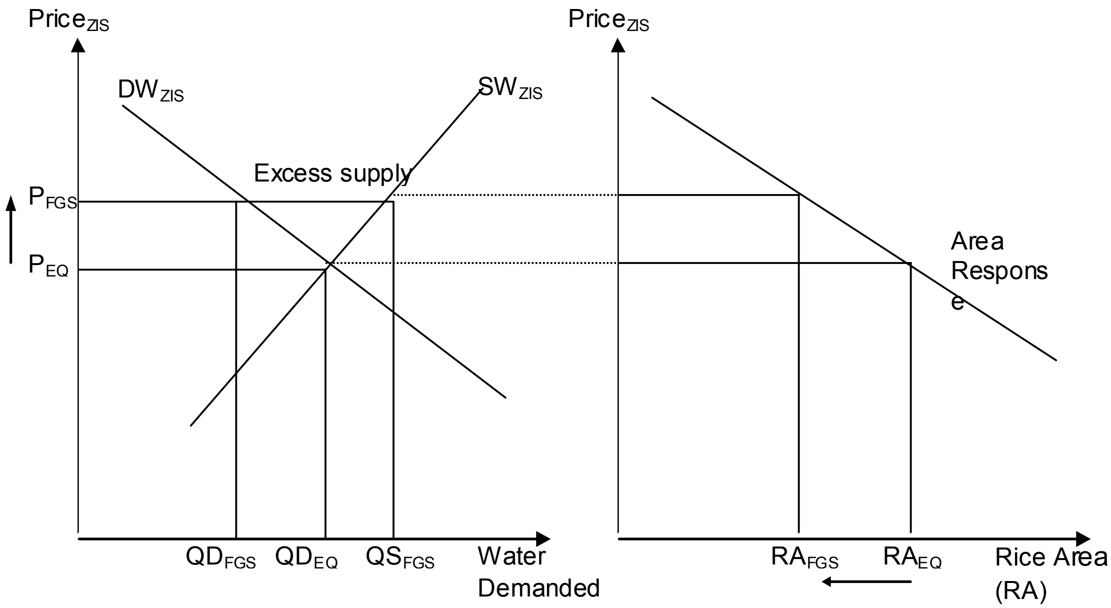


Figure 2 Area served by the Zhanghe Irrigation System (ZIS)



(3a) (3b)

Figure 3 Theoretical framework of the effect of *Fei Gai Shui* on rice area