Impacts of the Irrigation Service Fee Policy on On-farm Irrigation Management, Agriculture Productivity and Household Economy

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Abstract

Irrigation Service Fee (ISF) has been adopted worldwide as an effective tool to improve water use efficiency in irrigated agriculture for a major water user especially in the context of climate and water scarcity. ISF has been applied across Vietnam for decades, but the policy on ISF has changed to subsidize for farmers since 2008. Impacts of this policy at on-farm irrigation management and household economy have been not documented clearly. Using the impact evaluation method, which is difference in difference, this study investigates the effects of the current ISF policy at on-farm water management, agriculture productivity and household economy in a site and across the 44,600 ha of Cau Son irrigation and drainage system in the Red River Basin.

The impact analysis found that the ISF exemption, after one year of implementation, had both disadvantage and advantage at the household level. On-farm irrigation performance presented via flexibility, reliability and equity indicators had negative and significant impact with p value <0.01. In terms of agriculture productivity, cultivation labor and rice yield had no significant difference in the study area. While total income, cultivation income of the sample households were not affected by the existing ISF subsidy, only net income from cultivation had positive effect. For the whole Cau Son system, about 26% of the total irrigated area was likely and similarly influenced. In the perspective of improved water use efficiency in irrigated agriculture, the current policy on ISF exemption is recommended to revise and follow the service-oriented management approach.

Key words: ISF, agriculture, productivity, household, impact
Introduction

Globally, water used for agricultural production accounts for 70% of total freshwater withdrawals [Faurêsa et al., 2003]. In Vietnam, this figure is reported as 80% [KBR., 2009; MARD, 2004]. While competition of water demand among different users is increasingly and widespread occurred, more and more water requirement for food production leads to the challenge for agriculture sector in terms of water use. Thus, water use in this sector is often considered as a major factor relating to the water scarcity issue. In practice, to address this issue, water pricing mechanism has been adopted as a primary mean many in many countries to manage irrigation water consumption [Robert, 2000].

In Vietnam, water fee (incl. ISF and non-ISF) was adopted since 1962 and stipulated in a numbers of Decrees as: 66/CP in 1962, 112/ND in 1984, 43/2003/ND-CP in 2003 by the Government. The ISF encourages the service-oriented mechanism for irrigation management in Vietnam. Revenue from the ISF, though was still low, formulated a significant budget for the operation and maintenance (O&M) of irrigation and drainage schemes [MARD, 2014]. Thanks to this budget the irrigators including irrigation and drainage companies (IDMCs) - state-owned enterprises - and water user organizations (WUOs), could pay for the major expenditures of their O&M activities. A research by Molle and Berkoff [2007], indicated that IFS in the Red River Delta covered between 70% and 85% of O&M costs, which was a substantial contribution to cost recovery. The accountability and responsibility in irrigation services of the irrigators had been improved through the ISF system. Meanwhile, the awareness of water users in terms of water saving were enhanced. Therefore, the irrigation services were improved leading to the higher water efficiency in the irrigation and drainage systems [MARD, 2007; Tiep, 2007].

However, since 2008, ISF policy in Vietnam has changed significantly through a number of Decrees by the Government of Vietnam. The ISF, which is separated into 2 components: on-farm irrigation fee and headwork irrigation fee, has been exempted the headwork fee part. Under this policy, the Government has paid the headwork irrigation fee for irrigators as the subsidy for farmers and water users
have now only paid for the on-farm irrigation fee. This policy intends to increase fund for O&M of irrigation and drainage system, and to reduce the cost burden in production for farmers, whose income is quite low in comparison with others [Quang and et al., 2008].

A number of issues related to the ISF policy has emerged both negatively and positively. Cook et al. (2013), suggested that under the exemption of ISF, farmers on average could save 2% of their annual income. Nevertheless, the policy presses an increasing burden of the state budget and leads to constraint of the service-oriented functions and incentives of irrigators in water management [MARD, 2014]. Removing the ISF reduces the incentive for farmers to use water efficiently and also let to less participatory irrigation management [Tiep, 2009]. It has weakened the link between farmers, WUGs and IDMCs in managing the resource [OECD, 2015].

So far, there have been number of studies tried to evaluate the impact of ISF exemption after 2008 as Cook et al. [2013], Huyen [2013], [MARD, 2014]. Most of studies applied the conventional approach in impact evaluation of the policy at broad level (national, province and scheme). Also, the results of quantitative impacts of the policy are not clearly identified, especially at the on-farm irrigation management and household level.

The objective of this study, therefore, is to evaluate and document the impacts of the policy on ISF exemption on the on-farm irrigation performance, agriculture productivity and household economy as part of an on-going research on the impacts of ISF policy in the RRB.

Scope and Methodology

1. Selection of the study area

The study was carried out in Cau Son irrigation and drainage area (CS area), which is located about 70 km north-east Hanoi in Cau river sub-catchment in the mid-land of the Red River Basin (RRB) in Vietnam (Fig. 1). The Red River Basin is the second largest river basin in Vietnam and plays an important role in
providing water sources for socio-economic development in Vietnam. This system is situated within one of 30 irrigation and drainage polders in the Red River Basin and is characterized as a typical irrigation and drainage system in the basin because it combines both Cau Son gravity canal scheme and pump schemes. The Cau Son irrigation scheme was constructed in 1907-1909, first rehabilitated in period of 1966-1973 [Nippon, 2003] and has been upgraded under the Vietnam water resources assistance project funded by the World Bank including canal lining.

Figure 1. Study area (Lang Son - LS) in Cau Son irrigation and drainage area with sub-catchments in the Red River Basin, Viet Nam

This study utilizes data available in recent research conducted by Chinh and Jensen[2014]. Thus, a sub-scheme E of about 2,350 ha (Fig. 1) was selected in the CS area for in-depth study of the impact of the ISF policy on the on-farm irrigation management and farming household’s economy. The investigation was conducted in LS area in sub-catchment E. The LS area covers about 733 ha irrigated by 3 pump stations, including Lang Son, Non Tuong and Dau Nui.
2. Surveys and data analysis

Surveys focused on status of the on-farm irrigation management and household economy before and after the implementation of the policy on ISF exemption. The study period for in-depth analysis was composed of 2 years 2008 and 2009, which year 2008 presented for baseline period (before implementation of the ISF exemption) and year 2009 presented for the follow-up period.

The performance of on-farm irrigation management was presented in terms of flexibility, reliability and equity indicators as defined by MASSCOTE approach [Renault et al., 2007]. These indicators were surveyed in LS area and measured with the scale of 5 levels ranging from 0 to 4. The household economy survey also was undertaken in the LS area coinciding with samples in the on-farm irrigation management survey. The economy questionnaire covered: (i) socio-demographic characteristics like household size, gender and education level; (ii) inputs and outputs of agricultural production such as labor, seeds and crop yield; and (iii) non-agricultural business activities. These surveys were conducted in 2010 under a research on drainage water reuse in the RRB by Le [2012] with a publication in 2014 by [Le and Jensen]. Furthermore, some information on on-farm irrigation performance was collected by additional survey in 2015.

The sampling strategy of the on-farm irrigation management and household economy surveys was exactly the same. About 100 households were sampled in all hamlets of the site with the number of samples in each hamlet proportional to its irrigated area of the site. The households were then selected randomly from the hamlet’s list of households. These samples provide a confidence interval of about 10% at a confidence level of 95% [Le and Jensen, 2014]. Data analysis was performed using MS Excel and STATA [Stata Corp., 2011].
3. Impact evaluation method: Difference in Difference Method

The impact of the policy on ISF exemption on on-farm irrigation performance, agricultural productivity and household economy was evaluated using the Difference in Difference (DD) method developed by Khandker et al.[2010]. The DD estimation method is commonly used to measure the effects of a treatment, such as an education program or a policy, based on the behavior of those who have received the treatment. A comparison of outcomes is made both before and after treatment and with a control group of similar people not benefiting the treatment. In our case, the treatment is the application of ISF exemption (policy), which was started to apply in 2009 in the study area under the Government’s Decree 115/2008/ND-CP.

The key issue in impact analysis is to estimate the counterfactual for the difference in outcome for the treatment group by calculating the change in outcome for the comparison group. This method allows taking into consideration any changes between the treatment and comparison groups that are constant over time.

The DD estimation technique, using panel data, usually includes two periods: base line and follow up. For our study, baseline is year 2008 and follow up is year 2009. The DD essentially compares treatment and comparison groups in terms of outcome changes over time relative to the outcomes observed for a pre-intervention baseline. That is, given a two-period setting where \( t = 0 \) before the program, and \( t = 1 \) after program implementation, letting \( Y^T_t \) and \( Y^C_t \) be the respective outcomes for a program beneficiary (treatment) and non-treated (control or without the treatment) units in time \( t \), the DD method will estimate the average program impact (DD) as follows:

\[
\text{DD} = E(Y^T_1 - Y^T_0 \mid T_1 = 1) - E(Y^C_1 - Y^C_0 \mid T_1 = 0)
\]

In this equation, \( T_1 = 1 \) denotes treatment or the presence of the program at \( t = 1 \), whereas \( T_1 = 0 \) denotes untreated areas.

When baseline data are available, impacts can be thus estimated by assuming that unobserved heterogeneity is time invariant and uncorrelated with the treatment
over time. And we must assume that, in the absence of the treatment, the outcome in the treatment group would have moved in tandem with the outcome in the comparison group. In this study, the treatment group consists of 60 households in Lang Son pump scheme benefited from the policy on ISF exemption since 2009. The control group is composed of 40 households in Non Tuong and Dau Nui pump schemes, which were still not subsidized ISF in the year 2009.

The effect of the treatment is estimated by using the *diff* procedure in STATA under linear regression. The command requests the specification of the outcome variable. The initial required option is the period, which contains a dummy variable indicating the baseline (*period*=0, year 2008) and a follow-up (*period*=1, year 2009) period. Additionally, the option treated is need, containing a dummy variable with the indicator of the control (*treated*=0, without exemption of ISF) and treated (*treated*=1, with exemption of ISF) individuals.

We used on-farm irrigation performance, agricultural productivity and household economy indicators as outcome variables for the impact evaluation. The performance variables were flexibility, reliability and equity. The productivity variables were: rough rice yield aggregated across all plots of the household and labor for cultivation. Because of the household-level scale of the surveys, the outcome variables such as e.g. yield were aggregated across the household’s plots. Indicators for household economy include cost and income of cultivation, total income and net income of the household.

## Results and discussion

### 1 Sample characteristic

According to surveyed data, the sample household’s characteristics on socio-demography were quite similar between the control and treatment group. As shown in Table 1, the average household size, gender, education and experience of household’s headman were almost the same between the 2 groups. Also, these features were near-constant during the study period. This indicated that there was a similarity in socio-demography of the sample selected.
Table 1: Household’s socio-demography

<table>
<thead>
<tr>
<th>Variables</th>
<th>Unit</th>
<th>Baseline (2008)</th>
<th>Control (40)</th>
<th>Treated (60)</th>
<th>Follow up (2009)</th>
<th>Control (40)</th>
<th>Treated (60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household headman's age</td>
<td>years old</td>
<td>51.18</td>
<td>51.18</td>
<td>55.07</td>
<td>55.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household headman's education</td>
<td>Years</td>
<td>0.732</td>
<td>0.732</td>
<td>0.732</td>
<td>0.733</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household headman</td>
<td>male</td>
<td>55</td>
<td>55</td>
<td>76</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household's persons</td>
<td>Persons</td>
<td>4.83</td>
<td>4.83</td>
<td>4.62</td>
<td>4.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Persons</td>
<td>2.60</td>
<td>2.60</td>
<td>2.38</td>
<td>2.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Persons</td>
<td>2.23</td>
<td>2.23</td>
<td>2.23</td>
<td>2.23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources: the survey in 2010
Table 2. Household’s agriculture production and economy

<table>
<thead>
<tr>
<th>Variables</th>
<th>Unit</th>
<th>Baseline (2008)</th>
<th>Follow up (2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Control (40)</td>
<td>Treated (60)</td>
</tr>
<tr>
<td>Irrigated area</td>
<td>sao=360m²</td>
<td>10.97</td>
<td>9.88</td>
</tr>
<tr>
<td>ISF</td>
<td>103 VND</td>
<td>590.1</td>
<td>300.7</td>
</tr>
<tr>
<td>Labor cultivation</td>
<td>Manday</td>
<td>139.6</td>
<td>100.4</td>
</tr>
<tr>
<td>Rice yield</td>
<td>kg sao-1</td>
<td>179.8</td>
<td>185.3</td>
</tr>
<tr>
<td>Cultivation cost</td>
<td>103 VND</td>
<td>4,700.7</td>
<td>3,967.1</td>
</tr>
<tr>
<td>Cultivation income</td>
<td>10³ VND</td>
<td>18,800.0</td>
<td>13,900.0</td>
</tr>
<tr>
<td>Total income</td>
<td>10³ VND</td>
<td>55,400.0</td>
<td>37,200.0</td>
</tr>
<tr>
<td>Total net income</td>
<td>10³ VND</td>
<td>18,700.0</td>
<td>7,891.2</td>
</tr>
<tr>
<td>Ratio of ISF to cultivation income</td>
<td></td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Ratio of ISF to total income</td>
<td></td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Ratio of culti. to total income</td>
<td></td>
<td>0.40</td>
<td>0.47</td>
</tr>
<tr>
<td>Flexibility</td>
<td></td>
<td>1.99</td>
<td>2.23</td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td>1.99</td>
<td>2.20</td>
</tr>
<tr>
<td>Equity</td>
<td></td>
<td>2.03</td>
<td>2.19</td>
</tr>
</tbody>
</table>

Sources: the survey in 2010 and 2015

In terms of household’s economy and agriculture production, it could be concluded that, the average size of irrigated agriculture land of the sample was not quite different between the control group (10.97 sao) and treatment group (9.88 sao) (Table 2). Also, cultivated land of all households in both treatment and control groups were irrigated by pumping. Income from cultivation activity was significant in both groups accounting from 34%-40% of total household’s income for the control group and from 42%-47% for the treatment group. Also, there was the similar tendency of increased costs but decreased incomes of the sample households.
2 Impacts of the policy on exemption of ISF

2.1 On-farm irrigation performance

Flexibility and reliability both measure the adequacy of field irrigation scheduling (time and amount), with flexibility emphasizing on timing and reliability on amount. Equity measures the fairness of the distribution of water at the on-farm level [Le and Jensen, 2014].

According to results of the impact evaluation method (Table 2), the performance of on-farm irrigation management was adversely affected by the ISF exemption policy. All features including flexibility, reliability and equity were very significant (p<0.01) and negative. It was shown that in the control group, mean value of these 3 indicators was reduced about 5% (Table 1), however, in the treated group, these values were quite considerably decreased by 16%, below the average level (2). This indicated that the ISF exemption has made lower water use efficiency at on-farm level since the ISF exemption was applied. This confirmed with other studies [Cook et al., 2013; OECD, 2015] that water losses and low irrigation efficiency were reported in many irrigation schemes.

Table 3. Impacts on on-farm irrigation performance

| Outcome variables | Diff-in-Diff | Standard error | T     | p>|t| |
|-------------------|-------------|----------------|-------|-----|
| Flexibility       | -0.258      | 0.051          | -5.07 | 0.000*** |
| Reliability       | -0.258      | 0.051          | -5.02 | 0.000*** |
| Equity            | -0.248      | 0.061          | -4.06 | 0.000*** |

* Means and Standard Errors are estimated by linear regression

**Inference: *** p<0.01; ** p<0.05; * p<0.1

It should be noted that this situation was at the on-farm level, where the relationship between farmers and IDMCs or WUOs existed. Thus, it illustrated the weak cooperation between IDMCs and/or WUOs with farmers in irrigation management. The effect of ISF exemption indicates the disadvantage of the existing subsidy on ISF, which reduces the incentives of both providers and users in saving irrigation water. As a result, the water use efficiency at the system level also could be negatively influenced.
2.2. Agriculture productivity and household economy

Based on impact analysis, the agriculture production and the economy of the sample households have not robust significant different. In terms of agriculture productivity, the ISF policy did not influence on rice yield ($p>0.1$, Table 3). Any impact on productivity of the ISF policy could also be expected to be difficult to identify given the very small variability of rice yields at household level within and between years and sites. In fact, rice yield was estimated by aggregation of yields across plots of different groups. Furthermore, once the basic field water requirement is met, yield variability is more determined by soil fertility and crop management practices than by water. Thus, in a somewhat similar application of the impact evaluation method, Rejesus et al. [2011], Le and Jensen [2014] found no impact of adoption of irrigation technology on rice yields.

Table 4. Impacts on agriculture productivity and household economy

| Outcome variables       | Diff-in-Diff | Standard error | T    | $p>|t|$ |
|------------------------|--------------|----------------|------|--------|
| Rice yield             | 7.750        | 7.396          | 1.05 | 0.296  |
| Labor for cultivation  | -5.057       | 9.110          | -0.56| 0.579  |
| Cultivation income     | 1.20E+06     | 8.70E+05       | 1.34 | 0.183  |
| Cultivation cost       | -3.80E+05    | 3.80E+05       | -0.99| 0.324  |
| Net cultivation income | 1.50E+06     | 7.20E+05       | 2.12 | 0.035**|
| Total income           | 8.60E+05     | 6.70E+06       | 0.13 | 0.897  |
| Total net income       | 3.00E+06     | 4.00E+06       | 0.77 | 0.445  |

* Means and Standard Errors are estimated by linear regression

**Inference: *** $p<0.01$; ** $p<0.05$; * $p<0.1$

The impact on cultivation labor was not significant implying that farmers did not change their labor on farming practice under the context of the ISF exemption. Given the fact of similar conditions for farming practice including soil, weather and irrigation technology during study period, this means that farmers to some extent spent similar labor on farming practice. It seems contradictory that farmers could use more labor for on-farm irrigation management in the treatment group because of lower field irrigation performance as discussed in the
section 3.2.1. However, it also could be explained by the fact that in the study area, labor for cultivation was aggregated from many activity components including field irrigation, land preparation, weeding, fertilizing, harvesting, transplanting.

Except the net income from cultivation, other outcome variables (cultivation income, cultivation cost, total income and total net income) had the p value > 0.1 (Table 3.) This study found that the total amount of ISF of the household accounted for 1-2% of total annual income, which was quite similar to the findings by Cook et al.,[2013]. This amount of ISF seemed quite small compared with the total income of the household and thus have no impact on the household economy.

While average irrigated area of the 2 groups was unchanged, and the average rice yield was lightly increase (1-5%), the decrease of cultivation income (about 22% in both group, Table 1) could be explained by the substantial reduction in rice price in the local market in Vietnam during the study period (2008-2009) [Le and Jensen, 2014]. However, the variability of rice price influenced both the control and treatment groups. In the meantime, average cultivation cost of the treatment group was reduced possibly because of ISF exemption. Therefore, the impact on net cultivation income of the household could be mainly made by the ISF exemption.

It should be noted that rice was a main crop for the study area, accounting for about 90% of cultivated area and of crop production[Le, 2012].

3 Scaling up to the Cau Son area

There were 109 pump stations in the Cau Son area, serving an irrigated area of 4961 ha, accounting for 26% of total irrigated area of the Cau Son area. At present, all performances of these dynamic irrigation schemes have been under the policy of the ISF exemption. Based on the analyzed results of the study, it could be concluded that the on-farm irrigation perform of the dynamic irrigation schemes were influenced negatively by the exemption of ISF. While net income of cultivation was positively affected, other outcomes from agriculture productivity and household economy seemed not impacted by the change of ISF policy.
Conclusion & Recommendation

This study documents the impacts of the ISF exemption on the field irrigation performance, agriculture productivity and household economy in the (pump) dynamic irrigation schemes in the Cau Son area. Results of the study indicate that the ISF exemption policy has both negative and positive impact on irrigated agriculture at household level.

Impact analysis demonstrated that the implementation of ISF exemption was unsuccessful in improving the on-farm irrigation performance by reducing flexibility, reliability and equity but without compromising rice yields. Under the implementation of ISF exemption, farmers in 109 dynamic irrigation schemes covering an area of 26% of the total irrigated area in Cau Son irrigation system was likely faced with a considerable effect at on-farm irrigation performance.

This low on-farm irrigation performance to some extend reflects the weak the cooperation between farmers and irrigation management units. In the existence of the ISF exemption, labor for cultivation activity was not demanded though low on-farm irrigation performance was illustrated. The ISF exemption enhances net income from cultivation activity by reducing partly input costs for irrigated agriculture production. However, because reduced ISF accounted for small part of the total household income, no effect of the ISF exemption on the household economy was found. The complexity of the household economy’s structure, in which the share of cultivation business accounted for smaller part (34-42%) of total income, may affect the robustness of this impact analysis on the household economy.

The disadvantage of the policy on ISF exemption on field irrigation performance just one year of the policy enforcement as indicated by this study implied that the ISF exemption has been likely sensitive to the quality of irrigation service in the Red River Basin. This somehow follows the on-going trend that, the application of water pricing or ISF mechanism in irrigation service has been considered as an effective mean in improving water use efficiency. In the context of climate change and increasing water conflict among water users in the RRB, improving the water efficiency in irrigated agriculture becomes very essential in this region. Thus, the current policy on ISF exemption should be revised and follows the
manner of service-oriented management where, service providers and water users should be linked via service contract under the direct payment mechanism as previously. Also, form of subsidy for farmers by the Government should be changed accordingly.

A comprehensive impact evaluation of the ISF exemption including different levels of water management from on-farm, irrigation schemes and river basin for each region across the country may be needed for the sound revision of the current ISF policy. Also, at the on-farm level, further studies on the water volume of on-farm irrigation application may be required to assess the impact on irrigation saving to firmly confirm this analysis result.

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