# Impact of Wastewater Use on Farm Households in Nam Dinh, Vietnam

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## Introduction

In many urban and peri-urban areas in Vietnam, irrigation and drainage canals receive wastewater which is then used for agricultural purposes and aquaculture. This is a common occurrence in many cities (Raschid-Sally et al., 2004). The impacts of such application on farming households in Vietnam, have never been investigated. The objective of this study was to understand wastewater farming practices in rice cultivation systems and their socio-economic, environmental and health impacts, through an in-depth quantitative and qualitative analysis.

## Methodology

The detailed study on the impact of wastewater use on farm households was conducted in the district of My Loc to the north of Nam Dinh city, Vietnam. The My Loc district has a capital town and 10 communes including the communes of My Tan (where farmers have plots in both wastewater irrigated and clean water irrigated locations) and My Trung (located next to My Tan, however having essentially clean water irrigated plots) from which the sample villages were selected. My Tan commune receives water from the Quan Chot pumping station which pumps wastewater from the wastewater drain serving the north-east catchment of the city, into the irrigation canal. My Tan commune has 79 ha of agriculture lands which 42 ha, where rice is the main crop. In addition the aquaculture ponds in the commune receive wastewater. My Trung has 478 ha of agricultural lands and gets irrigation water from Huu Bi pumping station that takes water from Red River. 95% of My Trung land gets clean irrigation water.

Based on the total numbers of non-agricultural and agricultural households in the study area, a sample of 288 households was selected randomly from 3 villages in the My Tan commune, and 250 from 3 villages in the My Trung commune which was equivalent to10% of the total population for each of the communes.

The survey was a one-off survey of the selected households using a pre-designed questionnaire. Prior to applying the questionnaire, a situation analysis was conducted using Participatory Rural Appraisal (PRA) tools at the commune and village levels with participation of commune leaders, representatives of local level organizations and local technical authorities.The pre-tested survey questionnaire was then applied to each of the households selected and information pertaining to the socio-economic characteristics of the users, history and pattern of wastewater usage, land holding, land use, cropping patterns, farm/plot sizes, farm inputs (water, fertilizer, pesticides) and outputs (yields or returns), comparative prices wastewater/non wastewater produce where available, and farmer perception of advantages and disadvantages, was collected. Information relating to aquaculture as impacted by wastewater and information on non-farm income was also gathered to quantify the contribution from different sources.

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## Results and Discussion

### i) Analysis of farmer households

The average family size of a household is 4.2 persons. 80-90% were agricultural households ie their primary source of income was from agriculture and 21 % of the households were female-headed. In both communes, there is a predominance of women in certain tasks like fertilizer application, transplanting and weeding. Irrigation and animal husbandry are also activities where women are in the majority. The average farm area per household varied between 0.21 and 0.28 ha in the two communes. Between 54 and 58 % of households in the two communes had ponds for aquaculture and the average pond area varied between 0.06 and 0.075 ha.

### ii) Analysis of wastewater and Clean water agriculture at plot level

Comparisons between clean water and wastewater agriculture were conducted through a plot level analysis and not at the household level. For the two communes studied the number of clean water plots was three to four times the number of wastewater plots, and plot distribution per household is shown in Figure 01. My Trung had few wastewater plots, so comparisons between the two types of plots were done mainly with data from the My Tan commune.

***Irrigation water use and Water depth:***

Data shows that irrespective of the growth period, water usage in the summer is higher than in spring in both clean and wastewater areas and the difference is significant (p= 0). Furthermore irrespective of season and growing period, wastewater plots show consistently higher water depths than clean water plots. This is explained by the fact that wastewater plots are in the lowest elevation areas in the respective locations. In the wastewater irrigated areas it is the lowest elevation plots which would be the most impacted by wastewater

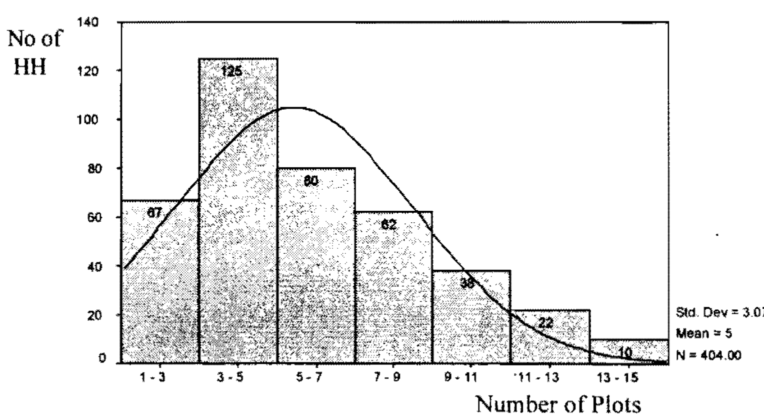


**Fig. 01. Plot distribution among households in both communes (MTA an MTU) in spring season**

***Rice yield differences***

Wastewater plots gave a significantly lower yield than clean water (p=0.011), but this yield reduction was still only 7%. In analyzing this difference further within a single commune (Table 01), the difference was significant only in the spring season yields.

**Table 01. Rice yield differences by season and water quality**

| | Spring yield Kg/sao | | P value | Summer yield Kg/sao | | P value |
|---|---|---|---|---|---|---|
| My Tan | Clean water | 174.9 | 0.03 | Clean water | 92.06 | 0.208 |
| | Wastewater | 164.3 | | Wastewater | 97.2 | |

In summer wastewater plots did not appear to be worse affected than the clean water plots in the commune. A possible explanation is that in wastewater areas, from the water depth analysis, summer season has higher water depths, so there is greater immersion in wastewater, but the quality is diluted due to the rains and therefore the overall effect is beneficial. The reduction in yield in the spring season for wastewater may be due to the excess application of nutrients (see Table 02) which shows that similar amounts of fertilizer and manure are being applied to the wastewater and clean water plots irrespective of inherent nutrients in the wastewater, or due to other inhibiting factors. There is a significant but small difference only in urea application.

Interestingly a farmer opinion tally of rice yield reduction in wastewater showed that 62% of the 190 respondents from My Tan commune felt there was a 20-30% reduction in yield in their wastewater plots compared to clean water. This is a gross overestimation of the actual yield reductions as described by the farmers themselves. It is possible that this is because the farmers compare the yield lost in the worst case scenario of wastewater, with normal clean water condition.

Furthermore, a comparison between My Tan wastewater yields and My Trung clean water yields for showed that in spite of poor water quality, yields from My Tan wastewater plots (131 kg/sao), were still significantly higher (p=0.007) than My Trung clean-water plots (127 kg/sao). This may be attributed to the overall lower application of fertilizer and manure in My Trung and to poor soil quality and the overall irrigation and drainage conditions.

***Use of Manure and Chemical Fertilizer as nutrients:***

Nutrient input data was analyzed for rice crop as being the predominant crop in both seasons. Nutrients used were manure, Nitrogen fertilizer (urea), Phosphate fertilizer (PO4), potassium (K) and in addition aggregate fertilizer (NPK). In general it can be stated that most farming households (66%) apply manure to their plots, both clean-water and wastewater, the reason being its value as a soil conditioner. 45% of clean water farmers used NPK in addition to using manure and other fertilizers.

Within the My Tan commune application of manure, urea and phosphate fertilizer in spring is significantly higher than in summer; but when a comparison was made between clean-water and wastewater plots, this difference is manifested significantly only in urea application (Table 2.0 and Fig. 2.0). The difference however is small (0.6kg/sao). Why wastewater farmers used less urea but apply other fertilizer in equal amounts is not clear. It is surmised that farmers, realizing that urea contributes to excessive leaf growth, avoid its application. In the case of chemical fertilizer application, fluctuations in levels of Phosphate (PO4) and Potassium (K) in wastewater or simply ignorance of their presence in wastewater may be leading farmers to continue to add these types of chemical fertilizer.

**Table 02. Differences in Fertilizer inputs, seasonally and by type of plot (My Tan commune)**

| Input (kg/sao) | Spring | Summer | P= | CW | WW | P = |
|---|---|---|---|---|---|---|
| PO4 | 19.5 | 18 | 0.051 | 18.5 | 19 | 0.462 |
| K | 4.7 | 4.4 | 0.138 | 4.3 | 4.7 | 0.109 |
| NPK | 19.5 | 18.9 | 0.451 | 19.3 | 19.2 | 0.954 |
| N (Urea) | 9.9 | 8.3 | 0 | 9.5 | 8.9 | 0.012 |
| Manure | 273 | 233 | 0 | 269 | 253 | 0.114 |

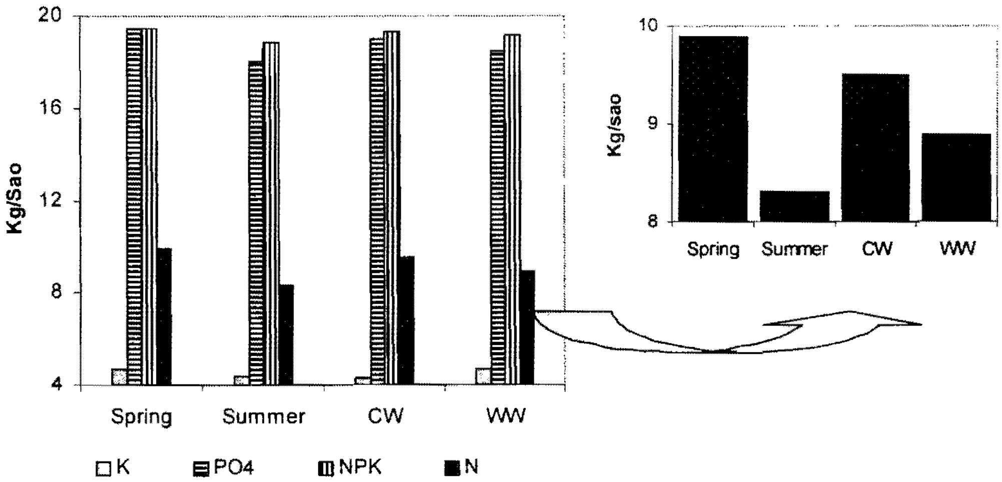


**Fig. 02. Differences in Fertilizer inputs, seasonally and by type of plot (My Tan commune)**

**iii) Aquaculture (fish and water birds):**

Data from 143 clean water ponds and 60 wastewater ponds was analyzed. Results from the two communes showed that clean water ponds were being used mainly for fish production, whilst in wastewater ponds, the predominant activity was breeding of fingerlings. Nearly 50 % of wastewater ponds bred fingerlings whereas this was only 20 % for clean water. The reason for this was explained as habits and tradition in the commune. However poor quality of fish produced in these wastewater ponds and lower prices, may also have been a deterrent. Farmers complained that wastewater bred fish smelt bad and their flesh was black and spoiled early. It was difficult without detailed study to generalize this to wastewater fish culture. Farmers with wastewater ponds avoided fish breeding and bred only fingerlings (which sold at the same price whatever the origin), to avoid loss of income. Overall income figures from aquaculture show no significant differences.

Data from a single commune (My Tan) was analyzed for differences between wastewater and clean water aquaculture production. There is no significant difference in production/sao between clean-water and wastewater ponds whether its fish or fingerlings being cultured (p values between 0.2 and 0.6). On an average whether from clean water or wastewater aquaculture (breeding or fish production), between 230-250 kg of fish, were sold annually by a household.

**iv) Household consumption of produce:**In general irrespective of quality of water used for production, 92-96% of households consumed 100% of their agricultural produce. With aquaculture, produce either in the form of fingerlings or fish was mostly sold and only 6% of households interviewed explicitly spoke of domestic consumption of up to 30% of their produce. 97 % of the households said they sold nearly all of their produce, indicating that fish was produced mostly for commercial purposes and not usually for domestic consumption.

**v) Reasons for using wastewater:**

In the My Tan commune, where wastewater use is predominant, 60% of the respondents used it because no alternatives were available. In effect the IDMC pumps wastewater into the irrigation canal in the wastewater areas because the clean irrigation water from the river does not reach these areas. 35% of the respondents said it was a dependable source when clean water was lacking. 15% appreciated the fertilizer value in it.

**vi) Share of production and loss of income:**

As shown earlier, 5 plots was the average per household and in the My Tan commune, 3 out of the 5 plots were irrigated with wastewater. Table 3 below shows that farmers from My Tan earned 11 million Vietnam Dong (VND)* compared to 9 million VND for My Trung. For households in My Tan having both clean water and wastewater plots, the share of household income contributed by the wastewater plots is only 22 % of total family income, but is as much as 50% of the total agricultural income. Wastewater contributes significantly to these farming households who have no other source of water for their plots.

**Table 03. Share of household income from wastewater**

| Commune | Cultivation, Fishery and water bird | | | Husbandry | Total agriculture | Other income | Total income |
|---|---|---|---|---|---|---|---|
| | *CW* | *WW* | *Total* | | | | |
| | % | % | % | % | % | % | 1000VND |
| My Tan | 17.5 | 21.7 | 39.2 | 5.9 | 45.1 | 54.9 | 11.253 |
| My Trung | 46.8 | 8.5 | 55.4 | 1.2 | 56.5 | 43.5 | 9.110 |

**Conclusions and Perspectives**

Almost all the cities in Vietnam, to some extent, use wastewater for agriculture or aquaculture or both. This brings significant income for poor farmers in urban and peri-urban areas.

In the communes studied wastewater use is related to the topography of the plots and its use is predominantly in the spring season when rainfall is scarce and plots require the most irrigation deliveries. Yield variations between wastewater and clean water plots was only significant in the spring crop but even such differences did not exceed 7%.

Farmers seem to recognize that wastewater contains nitrogen (urea) and so apply less urea fertilizer to their plots leading to some savings. However for all other types of fertilizer application there was no significant difference. It appears that they add fertilizer in spite of the presence of nutrients in wastewater, because they have no quantification of the levels and cannot control and regulate its application depending on plant needs. More optimal use of nutrients in wastewater would require well prepared extension services.

Tasks undertaken by women in relation to the crops cultivated may result in higher levels of exposure to wastewater and risks. In the case of rice culture, this requires standing in water when transplanting and weeding. They require special attention and awareness raising to minimize exposure and risk.

* 1 USD = approx 15000 Vietnam Dong in 2004

Whilst wastewater provides opportunities and greater cropping flexibility in water scarce regions (Van der Hoek et al 2002), wastewater may impose certain restrictions under specific conditions as is the case with aquaculture in Nam Dinh. Living in a monsoon region with abundance of water sources, farmers are unhappy with waste water and do not always appreciate its nutrient value. They use it because they have no choice of alternatives and because the authorities in a sense impose its use.

Household consumption of their own produce even of wastewater origin indicates that these products are not perceived as harmful. Other studies have shown that this is the case in many parts of the world where wastewater agriculture is practiced.

Under abundant water conditions, unplanned disposal of wastewater generated by cities is polluting irrigation water sources and impacting poor suburban farmers. Improved waste water disposal/management is necessary and should be enforced while alternative sources and other risk mitigation measures must be put in place in the short term (IWMI policy brief, 2006)

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