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**Where There's Muck There's Brass — Wastewater Irrigation near Faisalabad, Pakistan**

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## Introduction

Water scarcity is one of the most pressing problems for many arid and semi-arid regions. With regard to the need for a more efficient and sustainable use of the existing freshwater resources, one main focus should be on agriculture with its share of 80-90% of the global water consumption (UNEP and GEC 2004). The Indus Basin Irrigation System in Pakistan is the largest irrigation system in the world and the backbone of the country's economy (ALAM et al. 2007). However, because of an increasing demand for irrigation water and a lack of maintenance of irrigation infrastructure resulting in water losses, many farmers can no longer satisfy their irrigation water requirements with canal water. Beside the use of groundwater, another coping strategy is the use of wastewater for irrigation. This practice is not confined to Pakistan: worldwide, an estimated 200 million farmers irrigate 20 million hectares of land with wastewater (Raschid-Sally and Jayakody 2008). Among scientists and decision makers, a negative perception of wastewater irrigation prevails (CARR et al. 2004). Beside concerns about negative impacts on health and environment, various scholars have stated that wastewater irrigated agriculture might not be sustainable in the long term (PESCOD 1992, CHANG et al. 2002, ENSINK 2006). This study, which was part of a larger research project on wastewater irrigation (AMERASINGHE et al. 2009, WECKENBROCK et al. 2009), focuses on one aspect of agricultural sustainability: economic long-term impacts of wastewater irrigation in a periurban area of Faisalabad, Pakistan. In terms of inputs, the costs of irrigation water for groundwater and wastewater users are compared. In terms of outputs, the comparison is between the economic outputs of agriculture per area of the two groups.

## Study area

The comparative study was carried out in two periurban villages close to the city of Faisalabad in the Pakistani Province of Punjab. While farmers in Kehala village used predominantly groundwater to irrigate their fields, the groundwater in neighbouring Chakera was too saline for use in agriculture. Instead, farmers there used untreated wastewater diverted from the feeding canal of the nearby Wastewater Stabilisation Ponds.

## Material and Methods

Different methods were used, including semistructured interviews with 110 farmers in the research area. These interviews, in combination with data from the literature were the basis for calculating irrigation water costs. Spatial data gathered during detailed field mapping with GPS and satellite image print-outs were processed in ArcGIS 9.2. Besides, a main data source were *Khasra Girdawari* records kept by the local revenue tax department. These records provide information on crop types produced on all fields of the research villages in a high spatial (approximately 60 by 60 metres) and temporal (twice yearly) resolution. The *Khasra* data retrieved for the present study contain information on more than 2000 fields in each of the two research villages for 49 and 60 cropping seasons respectively between 1958 and 2006 (WECKENBROCK 2010). A further data source was the online FAOSTAT database (FAO 2009). FAOSTAT data on yields per area unit and producer prices for different crops for the period from 1991 and 2006 were used to calculate average economic outputs for different crops. For data processing and analysis, a PostgreSQL database, run with the administration tool pgAdmin, was used.

## Results and Discussion

*Lower irrigation water costs with wastewater*

The price of irrigation water for groundwater users was determined by several factors including installation and maintenance costs of tubewells, diesel prices and ownership of tubewells. Most tubewells used for groundwater extraction in Kehala were powered by diesel engines making groundwater using farmers vulnerable to diesel price increases like the one of more than 70% between February and July 2008 (JAVED 2008). Not all farmers could afford the installation cost of 1200 to 2400 US$ (WECKENBROCK 2010) and the annual maintenance cost of more than 100 US$ (QURESHI et al. 2003). Those farmers who did not have their own tubewells and depended on purchasing groundwater from tubewell owners paid twice as much for irrigation water than tubewell owners. Assuming an average cost of US$ 10 for irrigating one hectare once for tubewell owners (which is a conservative guess as it includes not only the costs of diesel but also of tubewell installation and maintenance) and twice this amount for farmers purchasing water from tubewell owners, the expenses for irrigating four major crops were calculated (see Figure 1). Irrigation water was the most expensive input for groundwater farmers amounting to up 50% of the crops' producer prices (WECKENBROCK 2010). In contrast, farmers in Chakera paid a flatrate of approximately 12 US$ per hectare per year to the local water and sanitation agency (ENSINK et al. 2008).

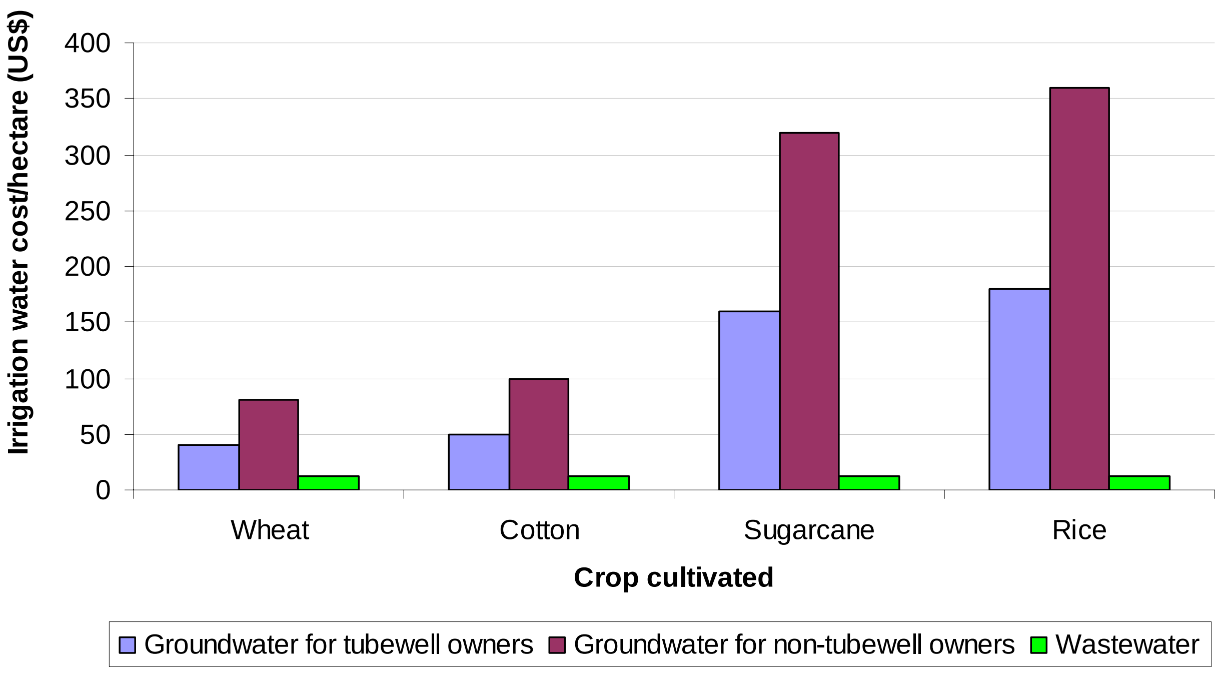


**Figure 1: Costs of irrigating different crops for groundwater and wastewater users.**

Figure 1 shows the irrigation water price per hectare for four main crops. For all crops groundwater users who did not own tubewells paid most and wastewater users paid least. Groundwater users without tubewells paid between 566% (for wheat) and 2900% (for rice) more for irrigation water than farmers irrigating their fields with wastewater.

*Higher economic outputs with wastewater*

Figure 2 shows the development of the average economic output (in terms of producer prices generated) per hectare over the last five decades[1]. In predominantly groundwater irrigated Kehala village, the average output remained constant between the 1960s and the 2000s. In contrast, the development in wastewater irrigated Chakera showed a steady increase in average economic output per area. In the early years of the new millennium, wastewater irrigating Chakera farmers generated more than 30% higher economic outputs per area than their groundwater irrigating neighbours in Kehala. The main factor contributing to this was the shift towards higher value crops, in particular vegetables, in Chakera (WECKENBROCK 2010). In terms of economic output per area of agriculture, wastewater using farmers thus seemed to have advantages over farmers irrigating their fields with groundwater.

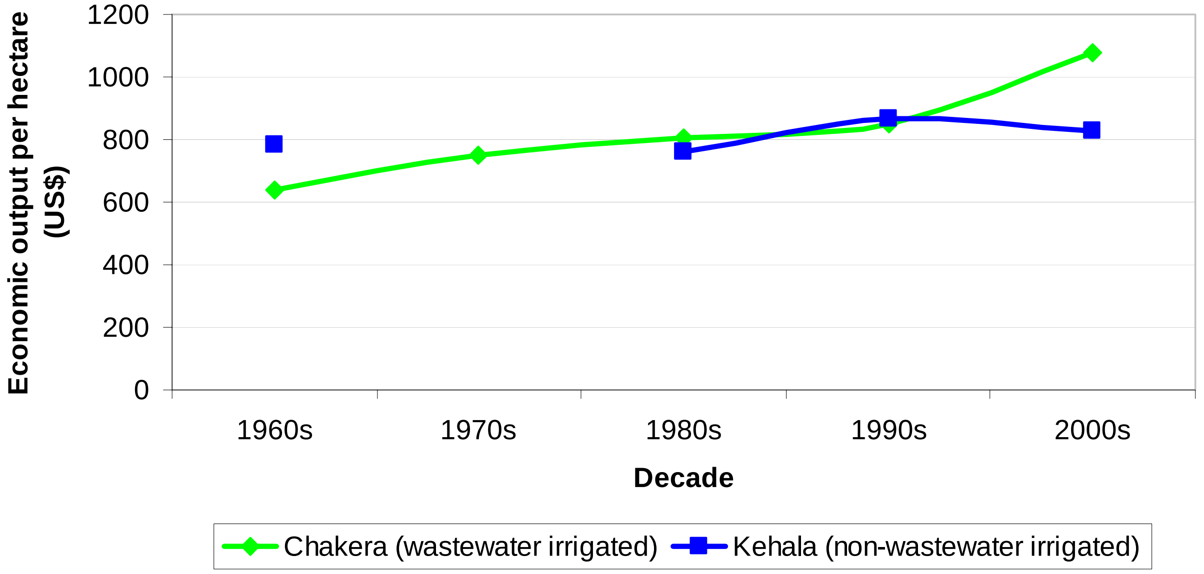


**Figure 2: Economic output of areas under irrigation with wastewater and groundwater.**

## Conclusion

Contrary to previous expectations, wastewater irrigation did not have negative impacts on economic sustainability indicators in the research area. Instead, wastewater using farmers had far lower irrigation water costs and higher economic outputs per area, in particular because of the production of high-value crops like vegetables. Thus, in economic terms, wastewater irrigated agriculture seemed to be more profitable than groundwater irrigated agriculture in the research area. This suggests that wastewater irrigation, if properly managed, has the potential of increasing small farmers' incomes.

[1] No data were available for Kehala village for the 1970s.

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