PITFALLS OF EFFICIENCY IN IRRIGATION MODERNIZATION

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RESUMO

Increasing efficiency in resource use is a commonly accepted aim. It creates the possibility of solving the economic problem of scarce resource allocation in a way that generates more income and, potentially, increases welfare. However, it has long been clear that higher levels of efficiency in the use of specific resources do not necessarily lead to proportional increases in resource conservation, since there are rebound effects in consumption. Efficiency improvements might even encourage additional resource use, a situation known as backfire. Moreover, the existing literature covers specific resources, mainly energy and water, separately. In this paper we present a dynamic model of irrigation where efficiency in water use is considered, and we highlight the role played by energy use through pumping costs.

Palavras-Chave: Irrigation; Water-use Efficiency; Energy Use; Renewable Energy.

RESUMO ALARGADO

The word "efficiency" carries a positive tone in various contexts, from academia to policy. When applied to natural resource use, where scarcity constraints are increasingly recognized as a barrier to sustainability, eco-efficiency sounds like a winning proposition that everyone can agree with. Nevertheless, the pitfalls of relying on efficiency to reduce resource consumption have been pointed out in the literature numerous times. User decisions will adapt to circumstances: if a particular service requires less of a given resource, there might be an immediate decrease in use, but this can be partially or wholly overturned through various counteracting mechanisms that lead towards higher resource use.

Significant research has discussed efficiency and pointed out the possibility of rebound effects, especially within energy economics, where efficiency is usually defined as the ratio of useful work to energy input. In the field of water economics, and for irrigated agriculture in particular, similar definitions of efficiency are common: if less water is applied for the same amount of water effectively consumed by crops, then irrigation efficiency can be said to have increased, although alternative definitions of efficiency exist (Scheierling, Treguer and Booker, 2016). Notably, this type of application efficiency is a focus of policy efforts to reduce water use in agriculture through "irrigation modernization" programs. However, in water an additional effect turns up: the part which is applied but not consumed is mostly not "lost" nor "wasted", since it will tend to percolate back to water bodies as return flow (Dumont, Mayor and López-Gunn, 2013). Moreover, erroneously perceived water "savings" from irrigation modernization are often used to justify the expansion of irrigated land, a particularly harmful development from a basin-wide perspective. Perez-Blanco et al (2019) summarize a sample of nearly 240 papers dealing with water conservation technologies in irrigation and show that while applied water did generally fall, consumed water did not, generating measurable harms in environmental flows.

Many papers uncover the issues surrounding irrigation efficiency goals, but most do so without considering the resource stock evolution. In this paper, we present a theoretical model of groundwater management where improvements in water irrigation efficiency are included. We begin with a description of the theoretical setup for groundwater extraction for irrigation when water-use efficiency is considered, then compare the common property solutions with the optimal groundwater extraction for changing values of efficiency, assuming that there exists a large number of identical farmers pumping from an underlying aquifer. Assuming that an increase in irrigation efficiency increases the marginal cost of pumping, we find that it will decreases the steady-stock of groundwater, even if the impact on steady-state applied water is negative. The impact on effective water will generally depend on location characteristics.

We also remark on the threat of coupling the use of zero-marginal-cost renewable energy (such as solar panels) with highly productive irrigation systems based on deep wells, a trend that is appearing in many irrigation areas due to the lowering cost of solar panels and misguided subsidy policies. If the new pumping technology eliminates the possibility of internalizing the stock effect via the marginal cost of pumping, neither the price of the resource signals scarcity nor energy prices can be used to foster conservation, implying that the incentive to preserve the resource via those prices is lost. Policies for groundwater management must integrate incentives for water and energy conservation along with strategies to limit rebound and backfire effects of efficiency improvements.

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