An approach to estimating the potential production benefits from improved irrigation water management for rice

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Abstract. Production benefits of improved allocation of irrigation water are often difficult to measure. In situations of irrigated wet rice cultivation, both ex post estimates of such benefits and ex ante estimates of the maximum potential benefits of further improvements in allocation of a given water supply are possible using a conceptual framework which (1) functionally relates weekly water supplies to weekly measures of average water shortage on individual paddy fields; (2) aggregates the weekly water shortage measures into a seasonal water shortage index; and (3) relates, via a production function, the seasonal water shortage index to yields. An empirical application of this framework estimates the potential increase in production from further improvements in water allocation in one Philippine irrigation system to be negligible.

Introduction

Economic evaluation of efforts to improve the management of irrigation systems is often limited by the twin difficulties of identifying (1) the effect of the change in management procedures on the resulting pattern of irrigation water deliveries, and (2) the effect of changes in water deliveries on production. A common approach used to circumvent these difficulties is to compare yields before and after a change in management is made. Alternatively, comparisons of yields may be made between a project area and some nearby 'reasonably comparable' area. In either case, the difference in yields, perhaps adjusted for differences that can be attributed to variables not related to irrigation, are assumed to be due to the improvement in irrigation. Effects of unmeasured variables may cause a bias of unknown magnitude and direction in the resulting estimate of the effect of the irrigation improvement.

In this paper we present an alternative approach to dealing with the second of the two difficulties noted above. The approach, which is applicable where

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flooded paddy rice dominates the cropping pattern, also permits an *ex ante* estimation of the potential for increasing production through improvements in allocation of a given water supply. The results of our attempt to apply this approach to a Philippine irrigation system are reported.

**Conceptual framework**

The value of irrigation water can be conceptualized by means of a production function in which water is one of the inputs with a functionally defined effect on production. Translating this concept into operationally useful methods for evaluating actual irrigation projects requires both empirical estimates of the water-output functional relationship and field measurements of the amount of water input. Several researchers have investigated the nature of the production function for water for various crops (Hexem & Heady 1978; Hogg & Vieth 1977; Minhas et al 1974). But the ability to obtain appropriate measurements of the actual water input under the field conditions that prevail in most LDC irrigation projects designed for wetland rice production is severely limited.

These measurement problems are of two general types. First, several practical difficulties associated with the instrumentation necessary to obtain field measures of water flows limit the availability of such measurements to a small number of points within an irrigation system. The water that is measured at any one of these points serves such a large area that it is not possible to identify the amount delivered to any individual field for which data on other inputs and outputs are obtained.

The second type of measurement problem relates to the potential for the existence of large differences between the amount of water delivered to an individual paddy field and the amount of water available to the rice plants. Under field conditions, especially when significant amounts of rainfall may occur during the cropping season, a substantial proportion of the water delivered to an individual field may not be available to the plants because of surface runoff. In contrast to the situation with an input such as fertilizer, the amount of water which can be stored on the field for future use by the rice plant is very small relative to the total amount of the input which is needed for unstressed growth during an entire cropping season. Thus even if it were feasible to measure the amounts of water delivered to individual fields, these measurements would not necessarily correlate well with the actual water input into the biological production process.

Given these difficulties, much of the research dealing with functional relationships between water and yield has followed an approach that incorporates into the production function one or more variables reflecting the degree of moisture adequacy or moisture stress encountered by the crop (Herdt and Man-