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Economic Cost of Augmenting Streamflows in the Republican River in Southwest Nebraska

by

Osei-Agyeman Yeboah

A Dissertation

Presented to the Faculty of
The Graduate College at the University of Nebraska
In Partial Fulfillment of Requirements
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Major: Agricultural Economics

Under the Supervision of Professors

Maurice Baker and Raymond J. Supalla

Lincoln, Nebraska

August, 1998

DISSERTATION TITLE

Economic Cost of Augumenting Streamflows in the Republican River in Southwest Nebraska

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Osei-Agyeman Yeboah

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GRADUATE COLLEGE
UNIVERSITY OF NEBRASKA

Economic Cost of Augmenting Streamflows in the Republican River in Southwest Nebraska

Osei-Agyman Yeboah, Ph.D.
University of Nebraska, 1998

Advisors : Maurice Baker and Raymond J. Supalla

There has been considerable discussion about the impact of groundwater irrigation development on streamflows in the Republican River in Southwest Nebraska. Groundwater levels in Southwest Nebraska have declined up to 30 feet or more and streamflows at the same guages have declined by nearly two-thirds.

Linear programming and simulation models were used to determine the least cost of reducing the impact of groundwater irrigation on streamflows in the Republican River. The groundwater water was constrained through successive reductions of both gross and consumed irrigation water.

The yield-gross water response function is curvilinear while that with consumed water is linear. Hence in the latter case, land is either irrigated or goes under dryland production.

When gross water is restricted, the optimum response was initially to keep all irrigated land in production but with a slight reduction in applied water and output. At higher restrictions, it becomes economic to shift irrigated land to dryland. In contrast, when consumed water is restricted, the optimal response is to reduce irrigated acres, rather than reduce applied water. The first land to shift to dryland in both scenarios is gravity on sandy soils. Continuous corn is the best irrigated crop under both scenarios, while the best dryland alternatives are wheat-corn ecofallow for silt soils and continuous grain sorghum for both the loam and sandy soils

Also, when costs are defined as the loss in net returns, the average cost per acre foot of reducing consumed water ranged from a high of $189.34 at a 20 percent reduction in gross application to a low of only $132.69 at 80 percent reduction.

On the other hand, if consumed water is restricted rather than gross water, the average cost per acre foot of reduced consumptive use is from a low of $109.93 to a high of only $129.37 with the same associated percent reduction of gross water.

Thus it is more cost effective to restrict consumed water directly than restricting gross water applications.

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Introduction

There has been considerable discussion about the impact of groundwater irrigation development on streamflows. This has intensified recently with Kansas arguing that Nebraska is failing to meet the terms of the Republican River Interstate Compact which allocates water between Colorado, Kansas and Nebraska. Kansas contends that irrigation wells are one of the causes for Republican River streamflow reduction to Kansas.

Irrigation is the main consumptive use of groundwater for irrigation within the basin, with relatively smaller amounts used for municipal, industrial, domestic, and stock watering purposes. Irrigated corn acres in Chase County for instance increased from 1400 in 1950 to 125,000 in 1994. Much of this growth took place in the 1970s, when irrigated corn acres nearly tripled, increasing from 38,000 in 1970 to nearly 111,000 by 1980. Most of this increase was from groundwater.

Well development has resulted in significant groundwater table declines because withdrawals for irrigation have exceeded natural recharge. The Frenchman Creek Basin is such an area. Groundwater levels within this area have declined up to 30 feet or more (Steele and Wigley, 1994).

A U.S. Geological Survey (U.S.G.S) report in 1989, predicted a steady decline in the level of the aquifer from 1989 to 2030 resulting from long term pumping at the current rate. The effect of the pumping scenario on streamflow was also noted. For example, the streamflow in French Creek near Imperial at the end of May 1989 was 32.6 cubic feet per second (cfs), while the simulated flow at the same location in May 2030 was only 10.2 cfs.