Report for 2003CO72B: Canal Modernization for Addressing Salinity Issues in the Arkansas Valley, Colorado

- Water Resources Research Institute Reports:
  - Siegrist, Robert L., 2002, Water Quality Protection Provided by Onsite Wastewater Systems, in Proceedings of the 13th Annual South Platte Forum, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, Colorado, Information Series No. 94, p. 16-17.
- Conference Proceedings:
  - DeJong, Kathleen E., Robert L. Siegrist, Larry B. Barber, and Abigail L. Wren, 2004, Occurrence of Emerging Organic Chemicals in Wastewater Effluents from Onsite Systems, In: Proceedings of the Tenth National Symposium on Individual and Small Community Sewage Systems, American Society of Agricultural Engineers, Sacramento, California, p. 400-407.
- Other Publications:
  - DeJong, Kathleen E., 2004, Occurrence of Emerging Organic Chemicals in Wastewater System Effluents, Presentation at the 1st WEF/AWWA Student Conference, Rocky Mountain Region, May 18, 2004, Colorado School of Mines, Golden, CO.

Report Follows

Problem and research objectives:

The problem was to identify methods to assist canal companies in the Arkansas Valley to modernize their canal infrastructure, and to better understand factors influencing the desire to invest in further agricultural production, by way of improvements in canal systems. Canal modernization is needed to address both water conservation and salinity problems in the valley.

Research objectives included organizing workshops, study tours and feasibility studies on various approaches to canal modernization. In addition, several discussions were conducted with growers throughout the Arkansas Valley.

Utilizing the grant, the researchers were able to interest one city with two large irrigation canal companies passing through its annexed area to apply for a grant from the Colorado Water Conservation Board to conduct a feasibility study on modernizing these two canals while developing a pressurized secondary water system for the city, using shares of stock the city owned in the two canal companies. The researchers then collaborated with a private sector firm, Aqua Engineering, Inc., of Fort Collins, Colorado to conduct the feasibility study (see listed publication below).

In addition, the researchers were able to conceptualize the issues surrounding canal modernization by hypothesizing a set of key factors influencing the desire to continue farming in the Arkansas Valley. This hypothetical model is discussed below.

Methodology

Formal presentations on canal modernization:

City of Lamar Water Board, Colorado 5/1/03
Catlin Canal Board of Director, Colorado 5/12/03
The Town of Swink, Colorado 5/12/03
City of Lamar Water Board, Colorado 5/22/03
Catlin Canal Board of Directors, Colorado 6/9/03

Organized study tours:

City of Lamar Water Board – visit to canal companies in Utah undergoing modernization 10/3/03 to 10/5/03

Principal findings and significance

The are many economically viable opportunities for canal companies in the Arkansas Valley to improve their water delivery systems. These include improved water delivery recordkeeping through greater use of computers, including the use of computerized accounting of well augmentation plans within the service areas of canal systems; improvements in canal structures, such as canal check structures, gates, flumes and weirs; the use of SCADA (automated supervisory control and data acquisition) for both

monitoring of water supplies and for controlling structures, and; canal modernization through the provision of secondary water for lawns and gardens to surrounding rural communities and rural subdivisions. The presentations given at meetings on these technologies, as well as the study tour organized to visit canal modernization in Utah involving the use of technologies, were favorably received by those attending the sessions.

However, major constraints to the adoption of these technologies include insufficient income from farming, and the increased opportunity costs of farming due to the rapidly rising value of farm assets (i.e., land and water) for urban uses. Urbanization in the region, and the impact this urbanization is having on the value of water in the Arkansas Valley for uses other than for farming, appears to be resulting in a growing feeling of impermanence about future opportunities in agriculture. The continued desire to farm in the area appears to be primarily affected by the following key factors:

Modeling the Desire to Farm Under the Influence of Urbanization

$$C_d = f(W_s, Y_p, Y_f, L_p, G_{al}, I_s) + t$$

Where:

C_d = farm household desire to farm

W_s = water right
Y_p = present income (combined on-farm and off-farm)
Y_f = anticipated future income
L_p = price of land for non-agricultural uses
G_{al} = farm household pursuit of alternative lifestyles
I_s = feeling of impermanence
t = technology (affordability, rate of adoption)

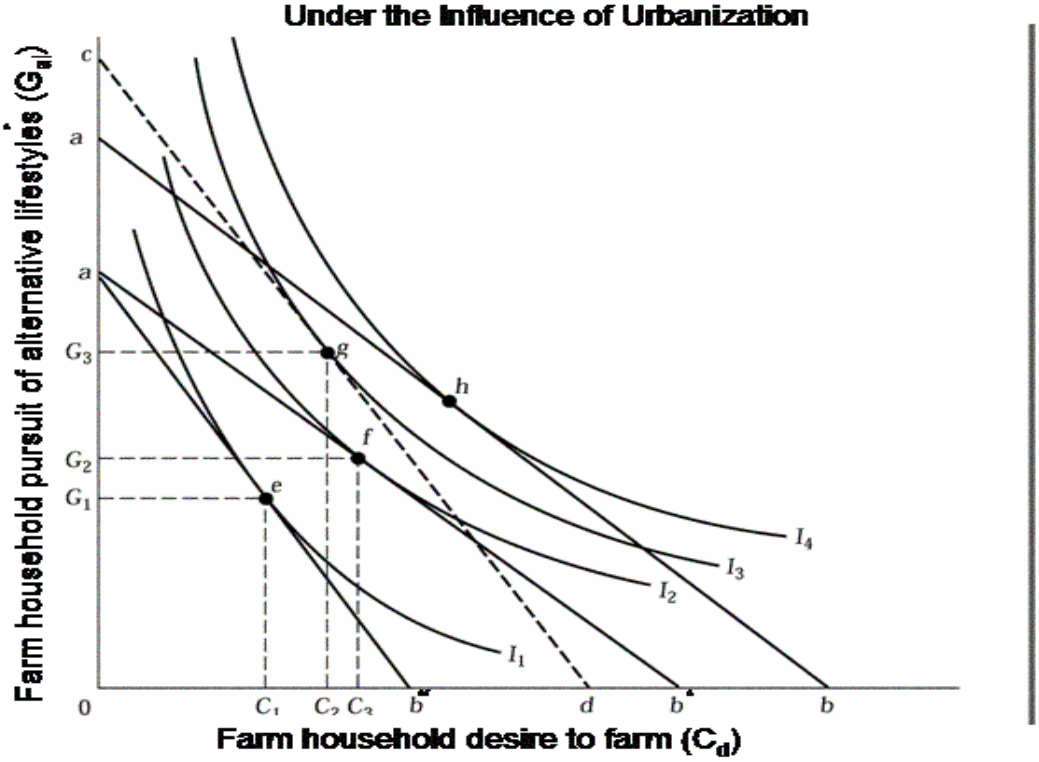
These factors are believed essential to understanding the process of technology transfer in agriculture as well, whether the issue is improvements in methods of farming, the exploration of new commodity markets, or the use of climate data for production purposes. The opportunity costs of continuing to farm in the Arkansas Valley have increased dramatically in recent years with the demand for agricultural water for out-of-basin urban uses. This demand has coincided with efforts to interest farmers in water banking, forbearance contracts, and other market mechanisms designed primarily to divert water from agricultural use.

Additional research is needed to arrive at a better understanding of important social trends in agriculture and how these new institutional market mechanisms may affect the overall production decision-making and rate of technology adoption by growers, whether for on-farm production needs or for canal modernization. The following is an initial conceptualization of the relationship between market demands for land and water for uses other than for agriculture. This conceptualization is based on discussions with growers, the presentations on canal modernization and the Utah study tour.

Figure 1 provides a simple portrayal of the influence of urbanization on the desire to farm, expressed through indifference curves or isoquants for all possible combinations of (1) the household desire to farm, C_d, on the horizontal axis, and (2) the pursuit of alternative lifestyles, G_{al}, on the vertical axis. The farm household desire to farm is represented by the cost of purchasing goods and technologies for farming, while the farm household's pursuit of alternative lifestyles is represented by the cost of purchasing non-farming related consumer goods.

The farm household's ability to select combinations of alternative lifestyles and/or continuing in farming is shown by the farm budget constraint line, *ab*. All combinations on or below line *ab* (within the triangle area 0*ab*) would be financially attainable by the farm household, based on its perceived income prospects represented by the slope of the *ab* budget constraint. Also, the steeper the slope of the budget line, the higher the cost of farming relative to the cost of competing alternative lifestyles (i.e., *ab"*).

Figure 1 – Theoretical Options to Continue Irrigation Farming Under the Influence of Urbanization



According to this hypothesized demand-based theory of irrigation farming while under the influence of urbanization, the farm household chooses from among all attainable combinations the one combination of alternative lifestyle costs and farming costs that maximizes household satisfaction. Diagrammatically, this optimal combination is represented by point *f*, the tangency point between the budget constraint, *ab*, and indifference curve I_2.

A rise in farm household income, represented by the outward shift of the budget line from *ab* to *a'b'*, would enable the farm household to attain a higher level of satisfaction (point *h* on curve I_4); this higher satisfaction represented by consuming more of both alternative lifestyle goods and farming goods.

An increase in the cost of farming goods, or increased opportunity costs of farming resulting from dramatically increased values of farm assets (i.e., land and water) resulting from urbanization, relative to the pursuit of alternative lifestyles, will cause farm households to substitute the pursuit of these alternative lifestyle costs for the desire to farm costs. In other words, other factors being constant, a rise in the relative cost (or opportunity cost) of farming causes the household utility-maximizing consumption combination to occur on a lower indifference curve, as shown by the movement of the equilibrium point from *f* to *e* when the budget line rotates around point *a* to *ab*".

Another scenario is a simultaneous increase in household income and farming as a result of, say, expanded off-farm employment opportunities, along with perhaps increased liabilities associated with farming on the urban fringe. In this case, there would be both an outward shift and downward rotation of the budget constraint line to the dashed line *cd*. This represents a shift to a new utility-maximizing combination with the relative increase in the cost of farming (whether brought about directly by liability issues or indirectly by increased feelings of impermanence).

The importance of this theoretical model is to show the potential relationship between (1) the effect of the current popular public policy of looking to agriculture for urban water supplies and (2) potential changes in the economic assessment of growers toward farming in general. The market for water in conjunction with urbanization, represented through new institutional mechanisms, such as water banking and forbearance contracts, has unleashed a tremendous and compelling force on the grower not to continue farming, due to increased value of key farm assets (land and water) and associated opportunity costs of farming, given current levels of farm income.

In addition, this may be leading to a greater feeling of impermanence regarding the future of farming in the region, and may make the adoption of new technologies for farm improvements and water conservation of minimal value to the producer, particularly when future income anticipated from these improvements is perceived by the grower to be unlikely, given increasing economic pressures to sell the land and water assets of the farm.

Relative to issues surrounding canal modernization, based on recent studies of what is occurring in other areas of the Rocky Mountain region, it is believed that canal companies being affected by land and water sales should explore new profit centers, such as providing pressurized secondary water for rural community and rural subdivision landscape use. This involves the canal company purchasing canal company stock when it is placed on the market by growers, transferring that stock to traditional canal treasury stock, and then utilizing this water in a pressurized secondary system for residential outdoor use (i.e. for rural communities and rural subdivisions). This would provide canal

companies with some new revenue sources to help modernize their irrigation infrastructure, while ensuring that the water decree of the canal company has at least a fighting chance of remaining viable and attached to the local area. Further research is needed to assess these strategies.