

# INDUSTRIAL & SYSTEMS ENGINEERING SEMINAR

Wednesday, December 7

3:15 PM – Refreshments before the seminar

3:30 PM – Graduate Seminar

Mechanical Engineering Room 4125 A & B



## Efficient Distribution of Water Between Head-Reach and Tail-End Farms in Developing Countries

**Professor Mili Mehrotra**

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The necessity of surface water for irrigation and its increasing scarcity in developing economies motivate the need for its efficient distribution. Surface water is distributed from its source to individual farms via simple canals, which are surface pathways dug through farms. The inequity in this distribution arises due to the relative physical locations of the farms. Head-reach (primary) farms are close to the source while tail-end (secondary) farms are relatively farther. The lack of physical infrastructure (that could securely connect each farm to the source) implies that water allocated to secondary farms must pass through primary farms. Left to their individual incentives, primary farmers use more than their fair share of water by denying its release to secondary farmers. Such an inequitable sharing results in significantly sub-optimal productivity of the farming community as a whole. This issue has been documented in several developing countries and the need for incentive schemes to ensure efficient, fair, and sustainable distribution has been highlighted by the World Bank. We propose two decentralized coordination mechanisms -- an internal payment scheme and a water guarantee scheme-- to achieve socially-optimal distribution of water for a farming community, under a choice of multiple crops. Under uncertainty in rainfall (low or high), the internal payment scheme is appropriate for risk-neutral secondary farmers while the water guarantee scheme is suitable for risk-averse secondary farmers. We also discuss a rainfall-contingent payment scheme for risk-averse secondary farmers. The first two schemes are then extended for the entire farming community. The internal payment scheme gives rise to a rate card, which specifies prices for potential water quantities that a secondary farmer could purchase from its primary counterpart. The water guarantee scheme generates a premium chart, under which a secondary farmer purchases an upfront (i.e., before the season) water-level guarantee from an administering authority; e.g., the government. In this scheme, the administering authority conducts the monetary transaction for the give-and-take of surface water between the primary and secondary farmers. Based on realistic data from field publications, we show that the two mechanisms can be efficiently computed and can closely approximate socially-optimal revenue of the farming community. We also highlight useful insights on (a) the improved sharing of surface water under the rate card, (b) behavior of the water levels sought under the premium chart, and (c) the movement of the price of water with the probabilities of the rainfall scenarios. Ideas that can help in administering the mechanisms are also briefly discussed.

Bio: Mili Mehrotra is an Assistant Professor of Supply Chain and Operations at the University of Minnesota's Carlson School of Management. She received her PhD in Operations Management in 2010 from the University of Texas at Dallas. Her research interests are in identifying sources of inefficiencies in supply chains and devising effective coordination mechanisms to remove or alleviate such inefficiencies. She is also interested in using discrete models for analyzing problems in service operations, production planning, and logistics.

**FOR MORE INFORMATION ON PROFESSOR MEHROTRA'S RESEARCH, please visit:**

<http://www.carlsonschool.umn.edu/faculty-research/faculty.aspx?x500=milim>