Economics of Cooperative Irrigation District in Oklahoma Panhandle

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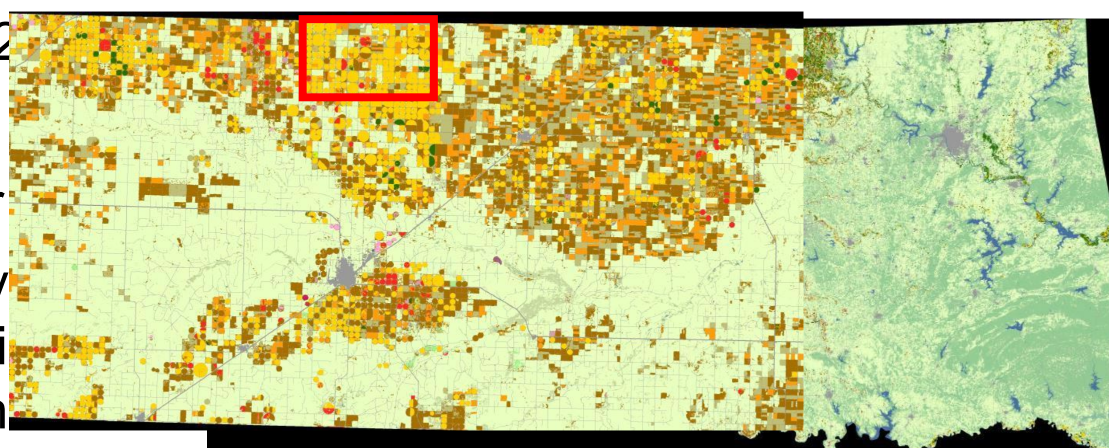
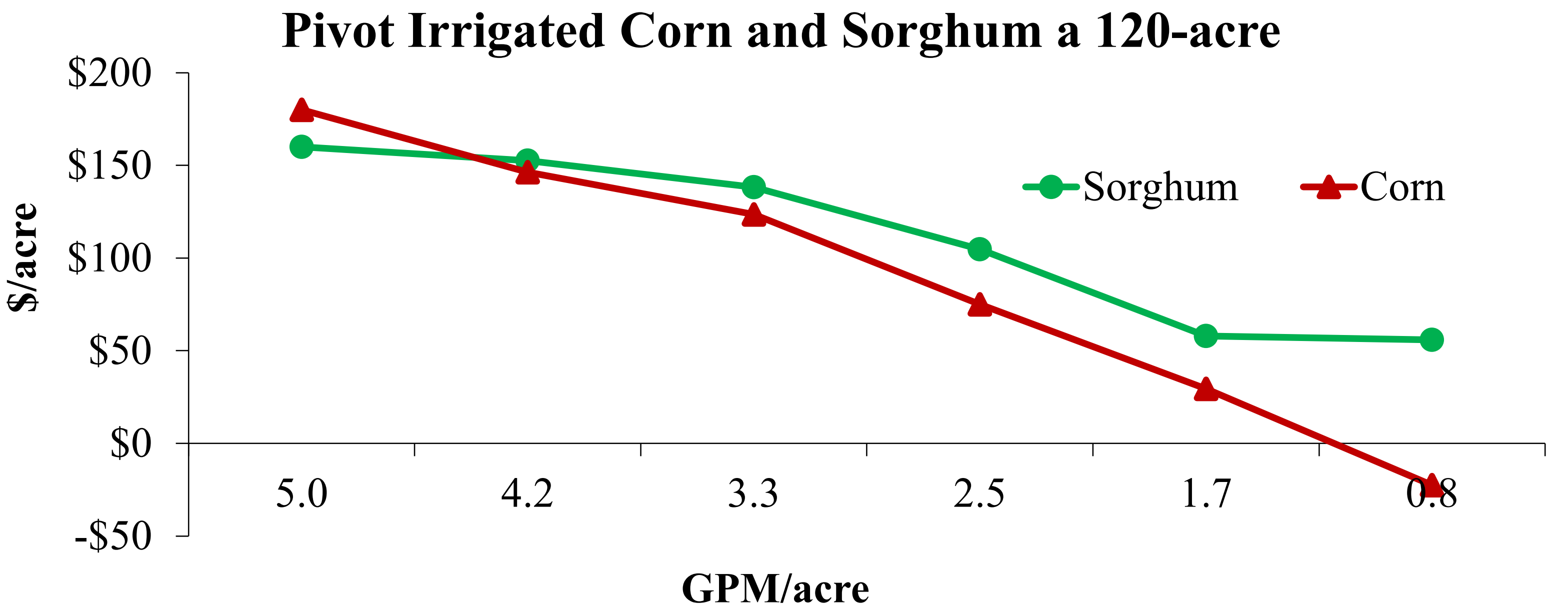
Background

- In Oklahoma, irrigation accounts for 86 percent of total groundwater use from Ogallala aquifer (OWRB, 2012)
- Water-levels in OPA have been falling steadily by 1 to 3 feet annually
- Unfortunately, groundwater recharge in Oklahoma Panhandle area (OPA) overlying the Ogallala aquifer is almost zero
- The major irrigated crops in OPA (Census of Ag, 2012)
  - ➢ corn 106,240 acres
  - ➢ sorghum 19,450 acres
  - ➢ winter wheat 64,670 acres
- OPA has 2
- Hydraulic
- Range for nt
- Average y . Station)
  - ➢ Corn i
  - ➢ Sorgh nch



Previous Studies

Warren et. al, 2015 (OKWRC report)

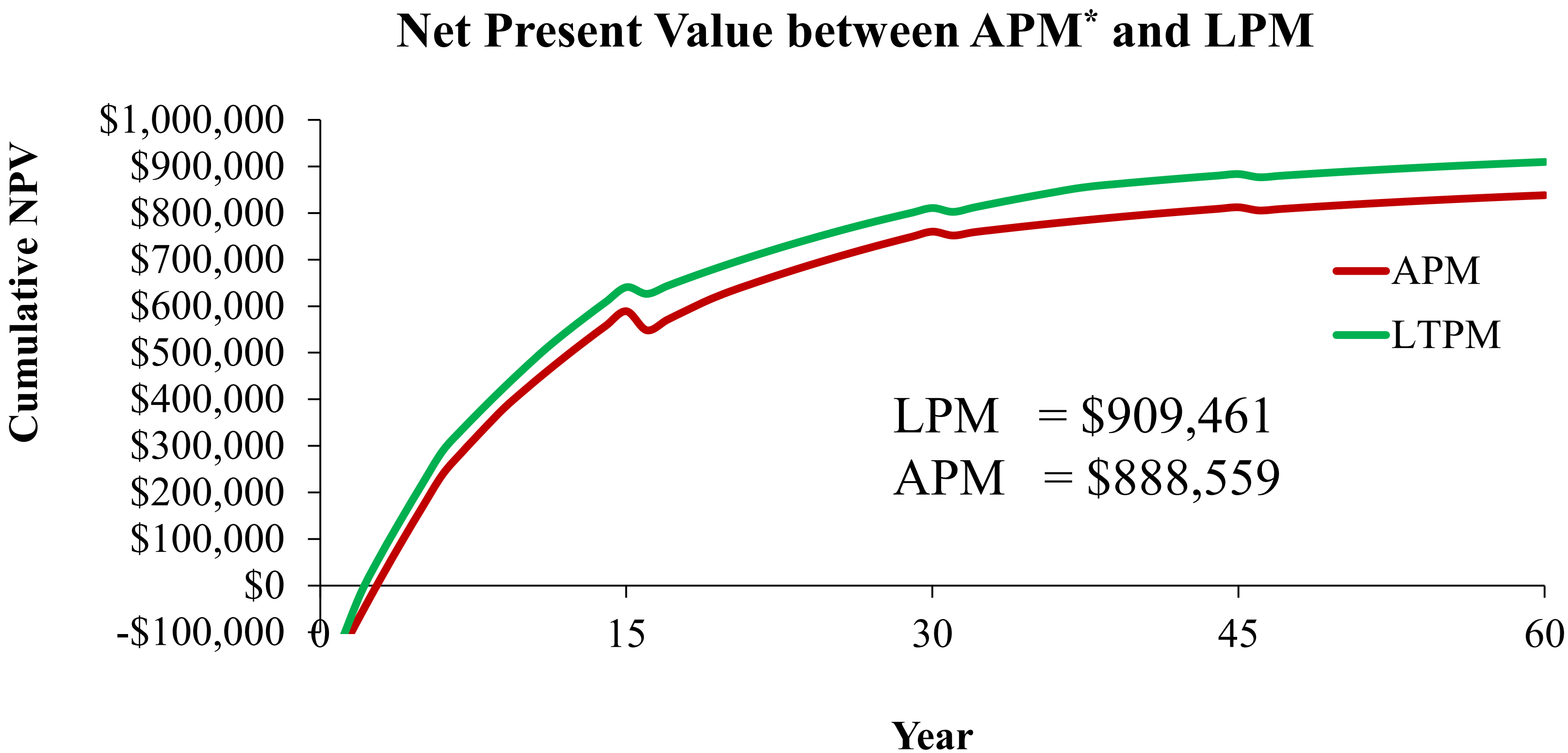


- Irrigated corn gives greater net returns than sorghum when well capacities are above 5 GPM per acre
- Irrigated sorghum gives greater net returns than corn if well capacities decline below 5 GPM per acre

Previous Studies

Ramaswamy, 2016 (M.S. Thesis, OSU Library)

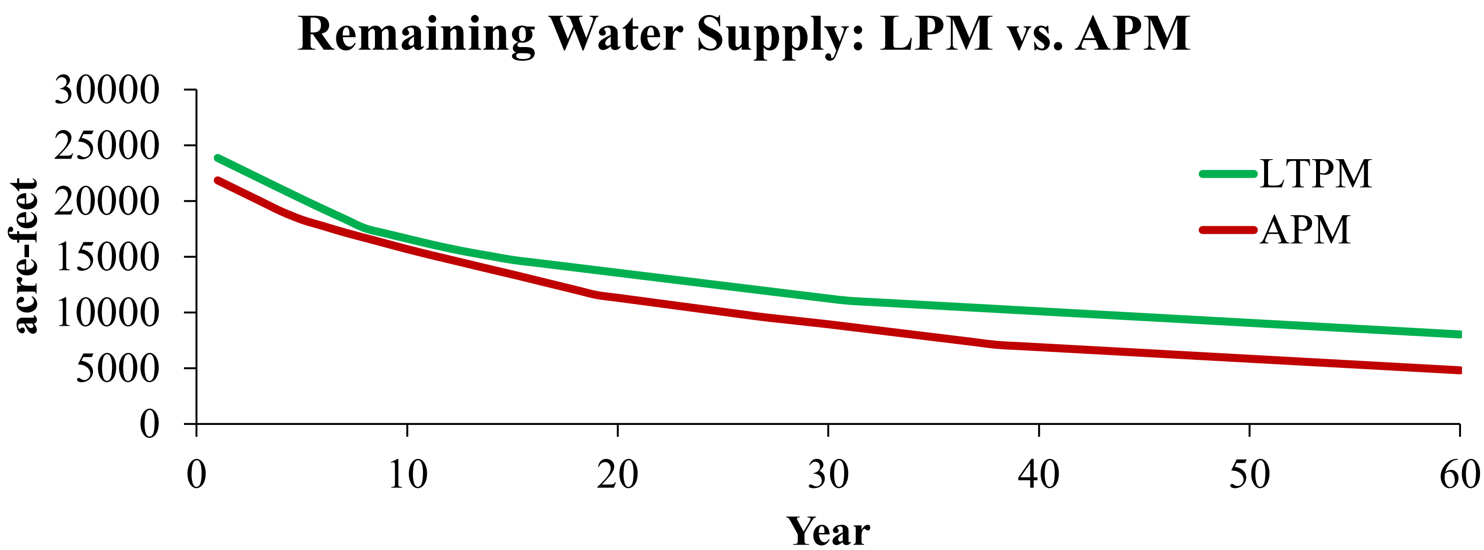
- It is more profitable to follow long-term profit maximizing (LPM) strategy by replacing irrigated corn with grain sorghum



*APM is Annual Profit Maximization

Motivation of this Study

- In LPM strategy, a producer would use less water and irrigate for more years than the annual profit maximizing (APM)



- LPM producers will fear that any water saved for the future use will migrate toward and be used by an adjoining APM neighbor

- However, it is expected the proportion of lateral groundwater loss from a contiguous group of LPM producers would be less than from a single LPM producer.

Objective

The overall objective of this research is to determine groundwater migration and observe the benefits of constructing a CID for planning periods of 30 or more years

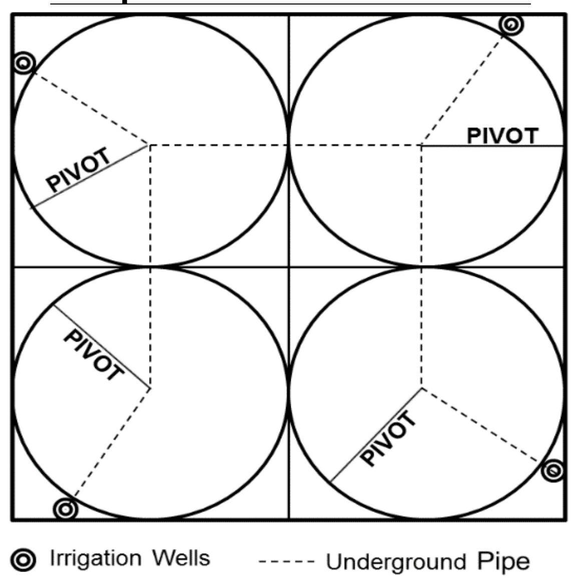
Specific objectives test hypothesis

- To estimate well interference through lateral flows for different sized groups (1, 4, 9, 16, etc., 640-acre sections) of LPM in a CID surrounded by APM producers
- To quantify the effect of different hydraulic conductivities on the lateral movement of groundwater from each size of CID surrounded by APM producers
- Determine the optimal contiguous size of land area that must be controlled or agreed upon by the producers to follow LPM strategies

Methods

- Each individual producer (LPM or APM) is assumed to have a 640-acre field with four wells

Representative farm

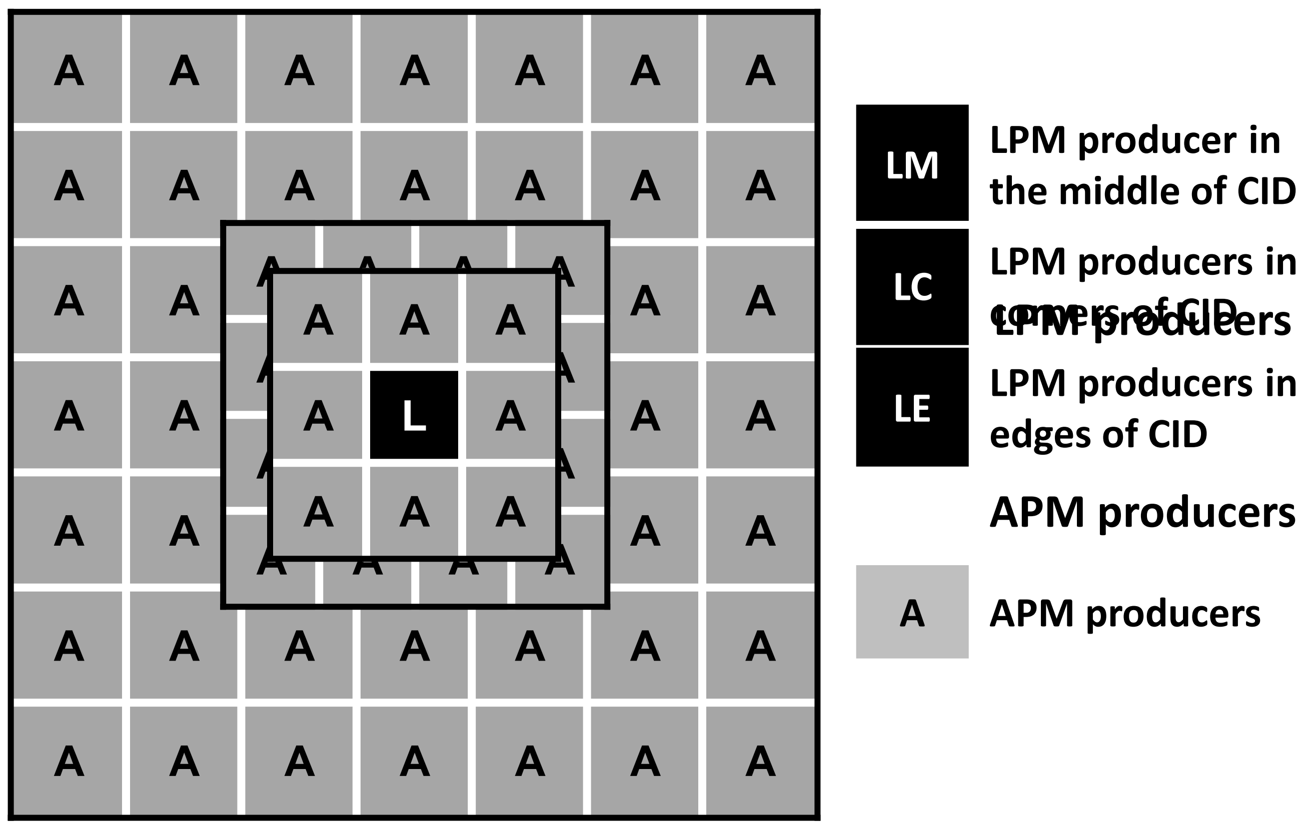


- The APM group chooses crops (grain sorghum or corn) and irrigation levels that give maximum annual profits
- The LPM group chooses same crops and irrigation levels that maximize the net present value (NPV) from the remaining groundwater for the planning horizon

Methods (cont.)

Four LPM producers surrounded by 12 APM producers

One LPM producer surrounded by 8 APM producers



Methods (cont.)

- The hydrology parameters from USGS and OWRB were collected and entered into the MODLOW model
  - ►Hydraulic conductivity 25 feet per day
  - ►Specific yield 0.175
  - ►Saturated thickness 83 feet (with 35 feet of safety zone)

- The optimal water use for LPM strategy is determined by a multi-period mixed integer programming model
- The APM optimal water use strategy is determined by a recursive linear programming model

Expected Annual Water Use of LPM and APM producers with four wells on a 640 acre for 30 years

	Acre-feet per year																
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17-30
LPM	461	461	321	185	185	185	185	185	217	238	238	213	209	209	209	230	104
APM	462	462	462	462	457	431	405	352	352	284	206	206	206	206	206	104	104

Methods (cont.)

- Groundwater interaction analysis are done in MODFLOW for contiguous land sizes and well locations

For each year

- The head values are noted from the MODFLOW
- The amount of groundwater flow from the CID producers to the surrounding APM producers is calculated

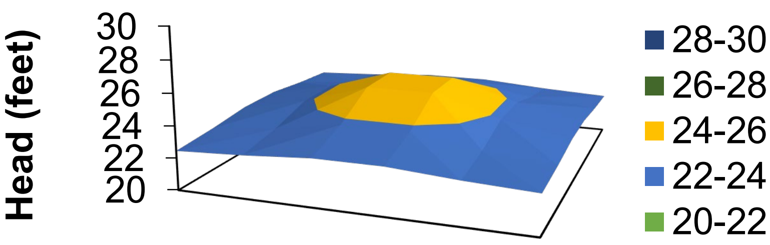
For the planning horizon (30 years)

- Each size of CIDs lateral flow to the surrounding APM producers is compared to potential returns if all producers adopted the LPM strategy

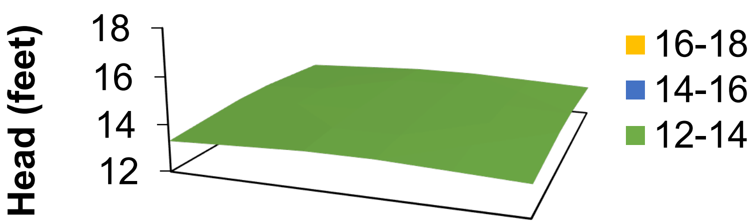
Principal Findings

One LPM surr. by 8 APM's

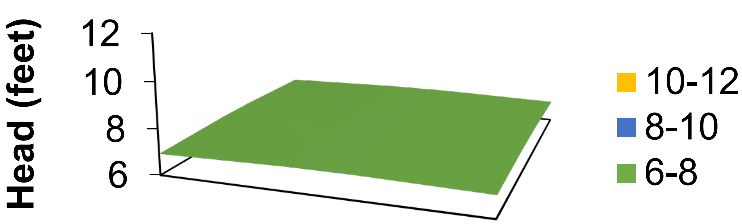
Year 10



Year 20

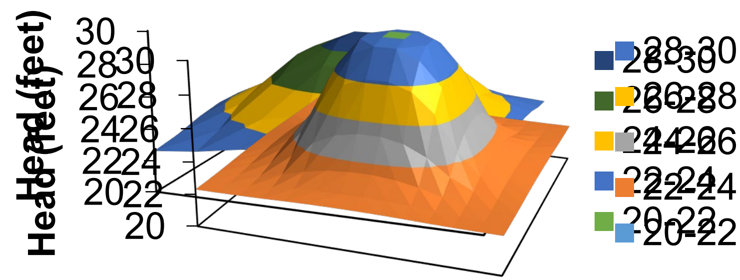


Year 30

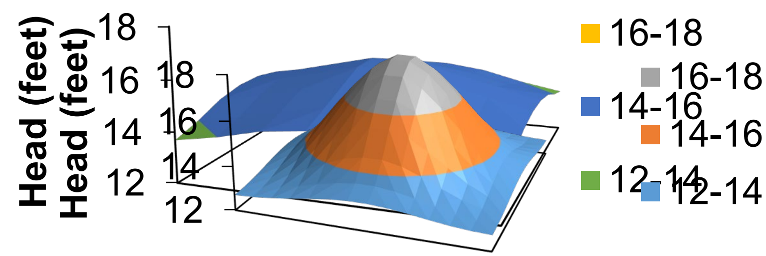


Nine LPM surr. by 40 APM's
Four LPM surr. by 12 APM's

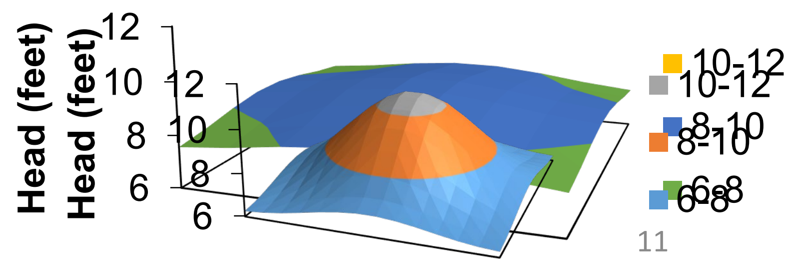
Year 10



Year 20

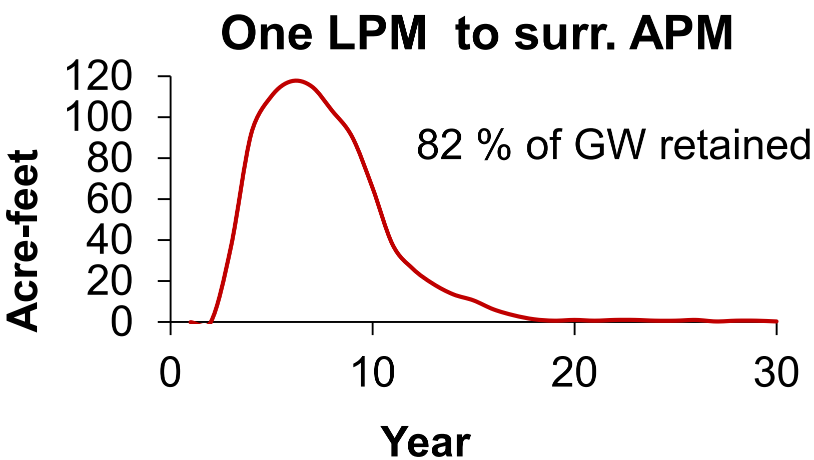


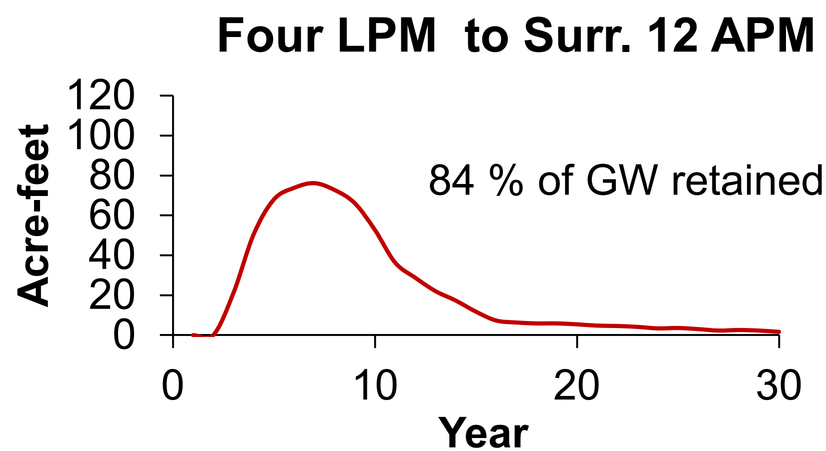
Year 30

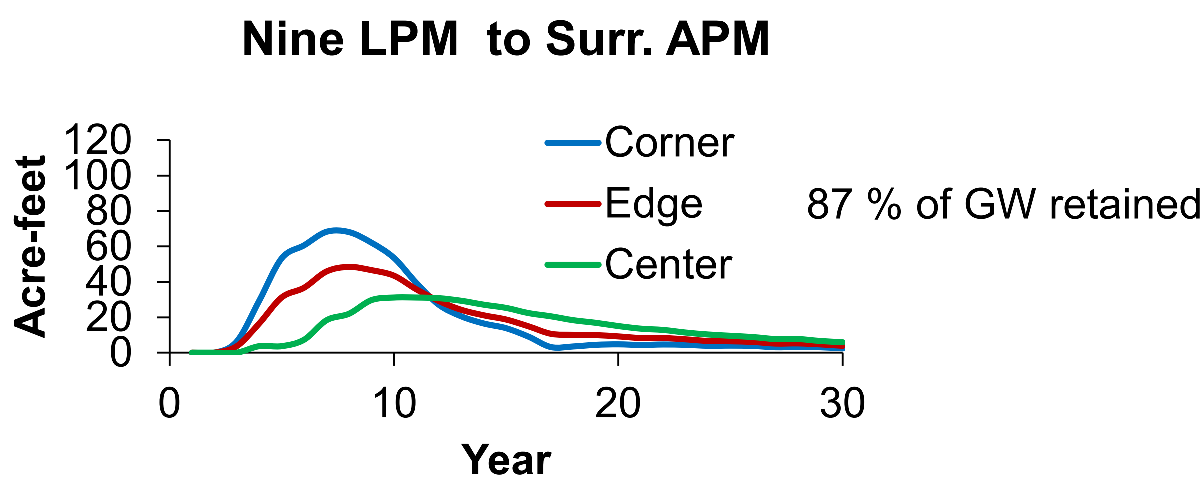


Principal Findings (cont.)

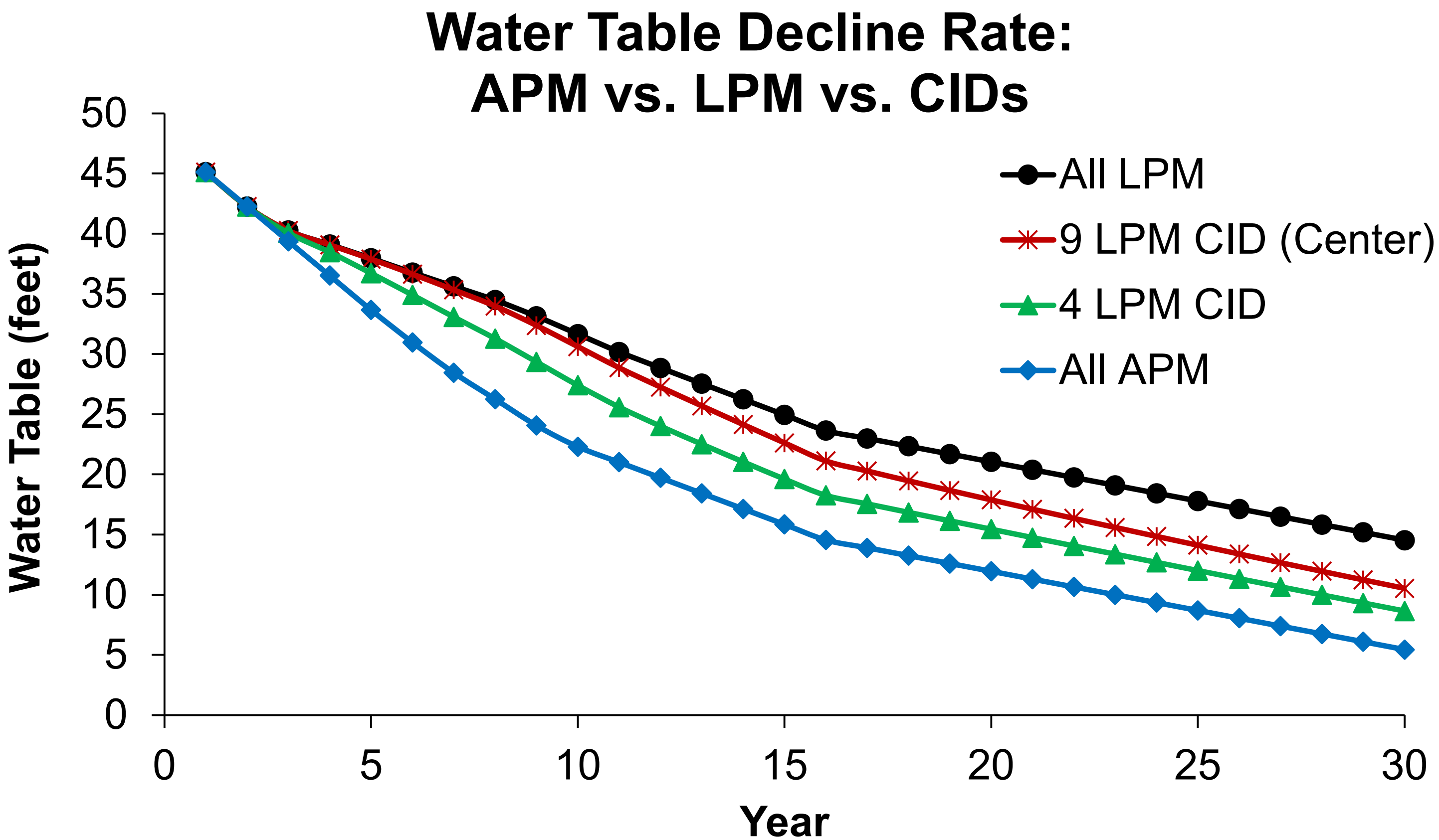
Amount groundwater (GW) migrated from each LPM producer in CID to surrounding APM producers







Principal Findings (cont.)



Research Progress

- Maximize the value of the water by satisfying the pumping rates subject to uniform head stress levels for all the LPM producers in CID

- This can be done using GWM MODFLOW-2000
 (Developed by Ahlfed. D, University of Massachusetts, Amherst)

- Determine the CID for other regions of OPA by testing
    - Hydraulic conductivity 50, 75, and 100 feet per day
    - Specific yield 0.12 to 0.22

- Determine the most optimal CID size for OPA, and that will increase the grain production in long-run

Kansas Water Law (Golden and Guerrero, 2017)

- The 2012 Kansas Legislature passed Senate Bill 310 making Local Enhanced Management Areas (LEMAs) a part of Kansas Law.

“Knowledge that in the future groundwater saved through conservation will be available to the conserving producers and should increase conservation benefits”

Thank you

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