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FINAL PROJECT REPORT

Using Farmer-Based Water Technology Farms to Implement New Irrigation Technologies to Sustain the Rural Economy

Kansas State University

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PROJECT SUMMARY

The High Plains Aquifer underlying western Kansas supports more than a third of the state's total agricultural revenue. Because of a rapidly changing climate, current drought conditions, and overuse, the aquifer is being depleted faster than it can recharge, with many experts predicting that large portions will run dry within 50 years. To cope with limited water supply and to sustain the agricultural industry in western Kansas, producers are seeking new methodologies and technologies to limit economic decline and to extend the useable aquifer life; this includes improved water conservation technologies, more efficient irrigation applications, and the use of deficit irrigation management strategies. Recognizing the need for change, several farmers adopted new irrigation technologies in their farm operations. Together with Kansas Water Office (KWO), K-State Research and Extension (KSRE), and other public and private partners, a network of three "Water Technology Farms" was established in 2017. Today, this network has grown to 21 farms across Kansas (Figure 1).

One of the technologies farmers are implementing is mobile drip irrigation (MDI), a system that combines the efficiency of subsurface drip irrigation (SDI) technology with the lower cost and easier maintenance of a center pivot (CP) irrigation system. In the early stages of crop development, our studies show that MDI attained 35% less soil water evaporation compared to a typical spray nozzle. In addition, the reduced soil evaporation and improved infiltration from MDI manifests as increased yield – particularly in wells with reduced capacities (150-400 gpm).

However, positive results are meaningless unless the technology can be implemented and managed by farmers in their own operations. While the hydrologic and agronomic performance of MDI is promising, many farmers participating in the Water Technology Farm network found MDI management and performance challenging. One of the major hurdles facing farmers is having to plant high-profile crops (such as corn and sorghum) in a circular pattern. This pattern maximizes the effectiveness of MDI and reduces wear and tear on irrigation component hardware.

Over the project period, MDI was evaluated based on suitability, efficiency, management, cost, and longevity. This information was shared with other farmers, stakeholders, water managers, policy makers, and more. Despite some challenges, including changes within the project team members, substantial information dissemination activities were delivered, not only within Kansas but also internationally.

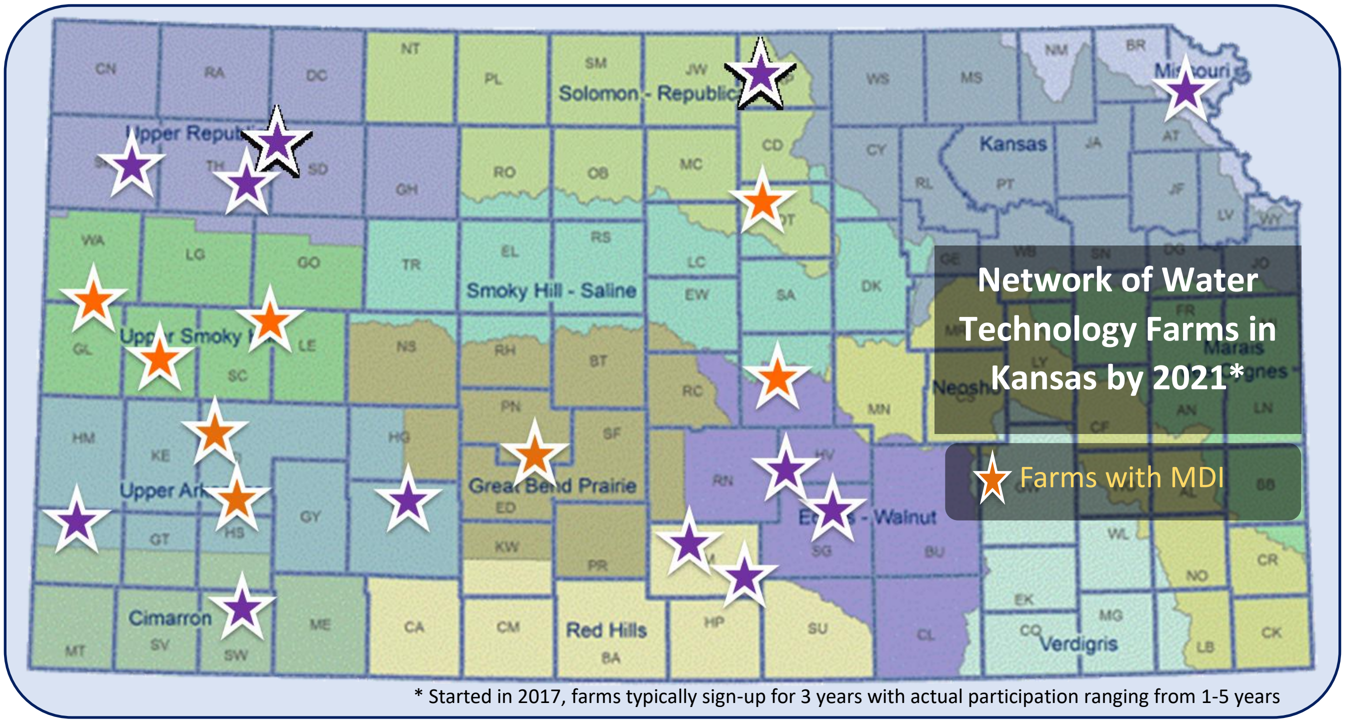

Figure 1. Map of the Network of Water Technology Farms in Kansas. Not all these farms were operating simultaneously since farms can shorten or extend their participation from the initial 3-year commitment.

IMPACT

The project paved the way for better understanding of the MDI system as well as similar technologies through a combination of data and observations from the research plots to the farmers' fields. This information was shared in various local, regional, and international forums with at least 40 presentations reaching more than of 2,000 people. The network of Water Technology Farms expanded to 21 farms by 2021 partly due to the template created by this project on the original three farms.

METHODS

This project capitalized on using the established, farmer-based Water Technology Farms to validate field research and to make additional observations on the MDI system's operation. The network of Water Technology Farms created an opportunity to expand the research being done on K-State's Southwest Research and Extension fields, and to validate findings on farms managed and operated by the farmers themselves. It also allowed the team members to use farmers' fields as an outreach platform for field days and field visits for neighboring farmers and other interested producers across the state.

CHALLENGES

Since the MDI system is still undergoing improvements, the team faced some unplanned changes in the operation and components of the system. This is a challenge evaluating MDI in the future since the system itself is continuously redesigned and improved. So far, with good management and maintenance, the driplines can last for seven years. There is no confirmed study yet to guarantee how long these systems could last. Farmers will also be doing a significant financial decision when transitioning to this system. While the advantage of this system seems to be more evident in low well capacity systems, investing in this system should balance within the economic viability of the irrigated farm.

One of the biggest challenges in this project was working with farmers to gather the data from the field. There were instances when our desired set-up was altered because of changes in a farmer's operation. At one time, due to scheduling and weather conditions, the team was racing against a silage chopper to collect samples for the treatment.

Figure 2. Precision mobile drip irrigation design by Netafim installed in a farmer's field in Southcentral Kansas.

RESULTS

FACTORS TO CONSIDER WHEN CONVERTING CENTER PIVOT SPRAY NOZZLES TO MDI

There are two mobile drip irrigation systems in the market, Mobile Drip Irrigation by Dragon-Line and Precision Mobile Drip Irrigation by Netafim. Each of these systems are installed and designed differently in the field. These lists are general considerations regardless of the MDI system.

Application and Water Use Efficiencies

1. MDI has better water use efficiency than spray sprinkler nozzle packages, approaching that of an SDI system. The application efficiency is closely comparable to a LEPA sprinkler package.
2. Before the crop canopy fully covers the ground, there is documented 35% less soil water evaporation on MDI than on spray nozzles.
3. Since only a portion of the soil surface is wet during irrigation, rainwater capture is improved.
4. MDI can reduce over-application of water typically found in the first 2-3 spans of center pivots.

5. In some years, soil water evaporation savings and improved rainwater capture are translated into almost an inch more water in the soil profile after harvest.
6. For heavier textured soils, 60-inch spacing of drip lines are sufficient to allow equal root access to water for crops such as corn, sorghum, alfalfa and wheat.
7. There is notably less soil surface encrustation in MDI irrigated soil compared to spray sprinkler nozzle packages which translates to better infiltration rate.

Management

1. In general, MDI requires less critical management than an SDI system but management is comparatively more tedious than with spray nozzles. Farmers that manage SDI would find it easier to adopt to MDI than farmers that manage center pivot systems.
2. To maximize the efficiency potential of MDI, crops should be planted in a circular pattern relative to the center pivot path.
3. To protect the hoses and driplines during off- or winter season, these materials should be lifted from the ground and fenced off if producers plan on grazing livestock in the field.
4. Drip lines should be protected from clogging by having an appropriate filter system and regular flushing activity and chemical treatment should be done.
5. Be mindful of fertigation mixes as the potential for clogging is higher for MDI than spray nozzles.
6. Check the lines regularly as leaks from driplines, hoses and connections are difficult to detect based on changes in water pressure and flow meter readings, or from looking from a distance.
7. Check the alignment of the lines in relation to the crop rows. Some lines might require adjustments depending on the uniformity and accuracy of planting the rows.
8. In some situations, installation of spray nozzles interspersed within the MDI manifold is necessary to achieve uniform seed germination and to apply herbicide and insecticide through the irrigation system. Occasional manual redirection of water using valves within the manifolds may be needed.

Suitability

1. MDI would perform better in field with flat to slightly undulating topography. The slope on which MDI can safely operate is determined by the structural dimensions of the towers. The center of gravity is slightly shifted to the back opposite the center pivot direction. The magnitude of shift can be substantial if the drip hoses are not freely traversing in between crop rows.
2. Irrigation systems with higher well capacity tend to mask yield advantage of MDI over spray nozzles. However, as the well capacity drops, spray nozzle systems show lower yield than MDI.
3. MDI has noticeable advantage in fields with problematic wheel track ruts. The characteristic of MDI to leave minimal soil wetting pattern in the field favors the prevention of wheel truck rutting. This feature can substantially reduce this problem’s associated maintenance and repair costs.
4. Keeping the driplines on the ground can allow MDI to be used in fields with salt or mineral deposition issues on crop foliage. MDI can avoid leaving salt and unwanted minerals on top of the leaves.
5. MDI tends to favor low profile crops since much of the hardware for this system struggles when passing through sturdier plant materials typically found in tall row crops such as corn and sorghum.

Cost

1. Conversion cost for MDI is about five times more expensive than upgrading into new spray nozzles on an existing center pivot. The cost for MDI conversion is less than one-fourth of the cost of a new SDI system.
2. Savings from repair and maintenance expenses can be gained by MDI over spray nozzles if the center pivot is in a location where wheel track ruts are a problem.
3. Based on simulation analysis, growing higher water use crops would be able to recover the costs of the conversion to MDI through increased water use efficiency quicker than producers growing medium and lower water use crops.

Longevity

1. Management and suitability will be the two main factors determining if the MDI system lasts longer.
2. Time will tell how long MDI components will last in the field. The MDI hoses with K-State have been in the field for longer than seven years, with only minor maintenance issues.

NEXT STEPS

MDI has some promising features warranting further investigations. Though this project was able to answer most of farmers' most pressing questions, there are additional questions that emerged through the research and demonstration.

Fertigation There is very little information on or demonstration of MDI's fertigation capability. One of the Water Technology Farms attempted fertigation using MDI and it created clogging on the emitters. With water going through metal and plastic components before leaving through drip emitters, MDI fertigation will be a little tricky compared to typical spray nozzles or SDI systems. Additional study and investigation are needed.

System Modifications Since MDI is relatively new in the market, there are still installation techniques, design parameters and product components being improved. During this project, the MDI system at K-State was modified twice for its connections, three times for end caps and three times for the drip hoses. Most of these modifications were addressing issues found with existing version. It is expected that further modifications will be implemented to improve the overall performance, operation and maintenance of MDI. As such, complete evaluation of the MDI needs to be updated as these modifications are implemented.

Figure 3. A hybrid winch system of Dragon-Line's product. The winch system is the key to move horizontally and vertically the hoses. Photo from dragonline.net.

Learn more at:
KSRE's Mobile Irrigation Lab
www.milab.ksu.edu

K-State Southwest Research-Extension Center
www.southwest.k-state.edu/program_areas/water_management

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