Figure 1: Front-mounted Senix sensor system implemented on ATV for measuring pasture height. Sound waves from the sensor reflect off the forage. The time difference between the tare value (zero) and forage indicate forage height in mm.

Figure 2: Calibration of crabgrass. Forage height is first measured using the ATV sonic sensor. Forage is then harvested with machine above which measures forage wet weight and distance covered in harvest. Forage is dried and applied to sensor height to develop a predictive equation for the forage.

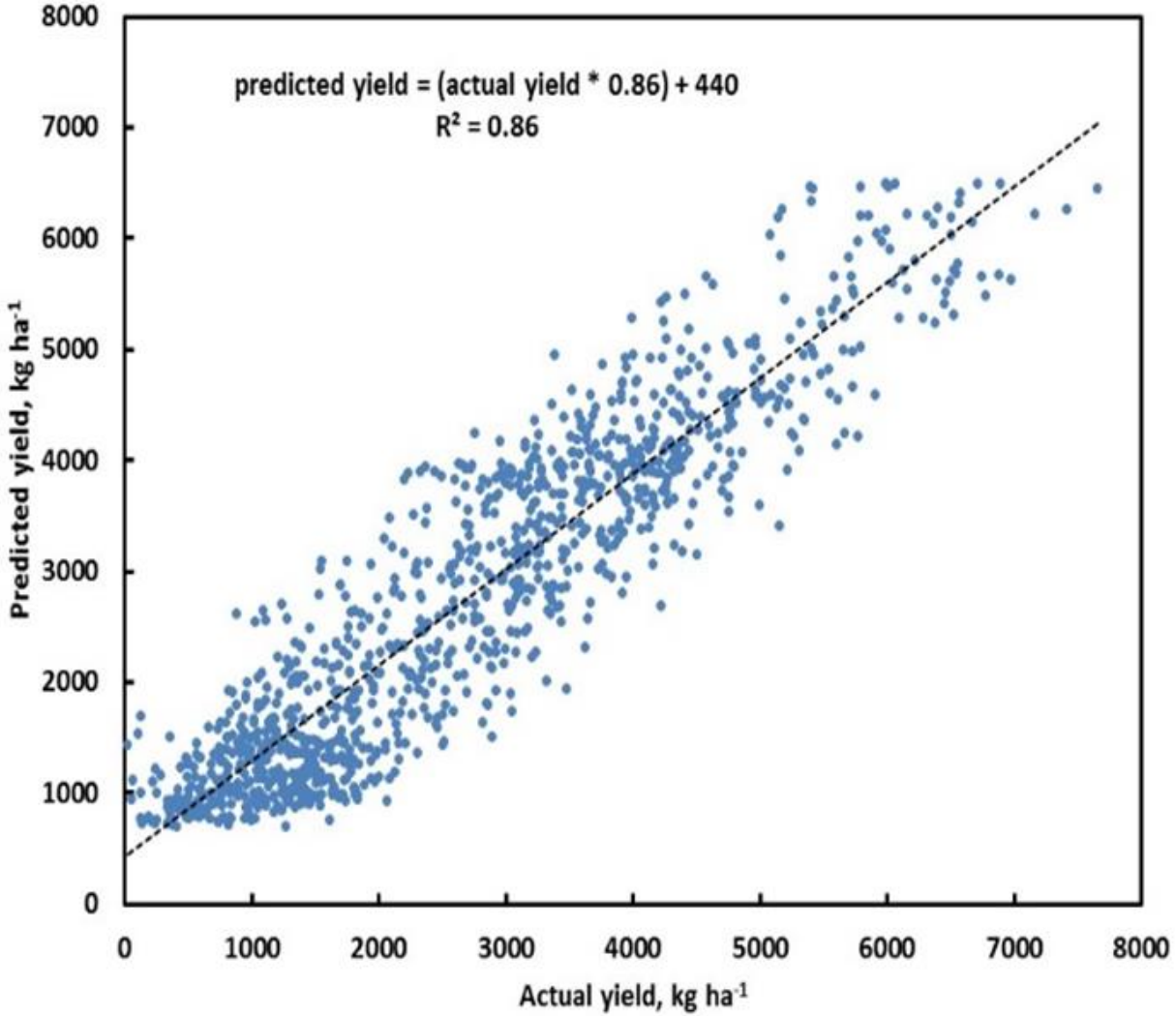
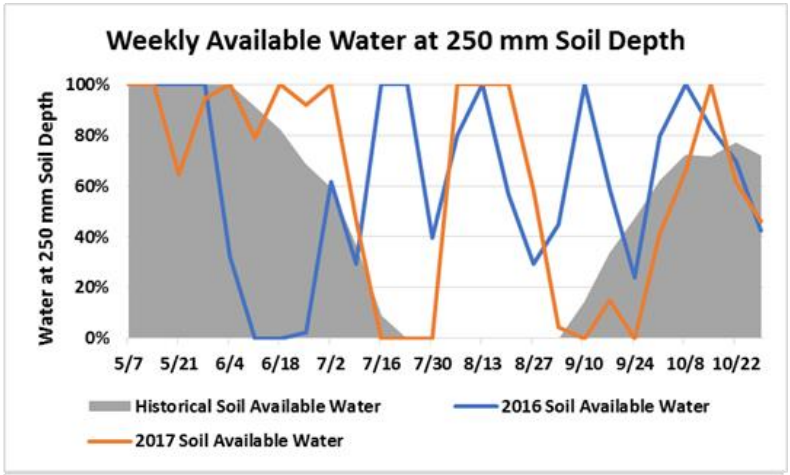
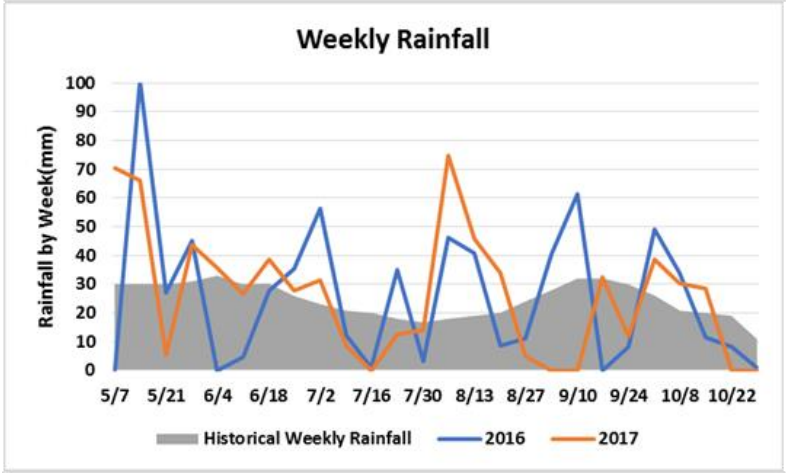


Figure 3. Linear relationship between actual forage yield and that predicted by the ultrasonic sensor modeled with other environmental parameters. Data collected over 19 site-years provide the basis for introducing this technology on farms.





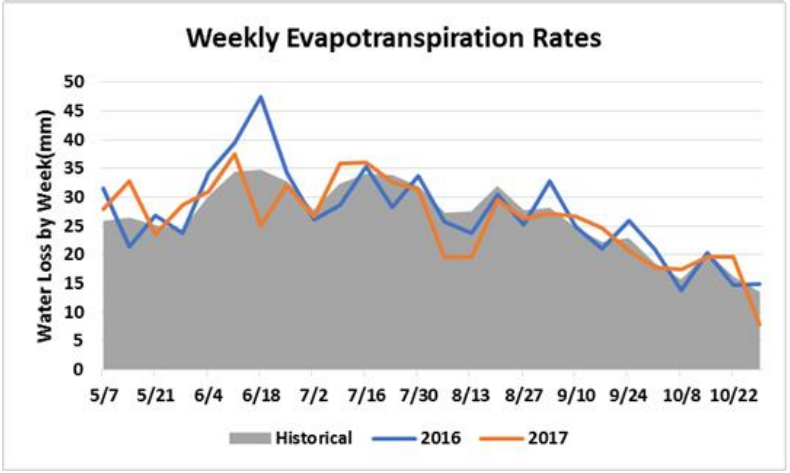


Figure 4: Five Year versus study years of 2016 and 2017 averages of soil available water at a 10 inch depth (top panel); weekly rainfall (middle panel) and weekly evapotranspiration rates (bottom panel)

Figure 5: Pod type low-pressure irrigation system (K-line). Pods and line are pulled in a pattern across the field after desired amount of water is applied. Typically 8-12 hours required for each set in this producer's system.

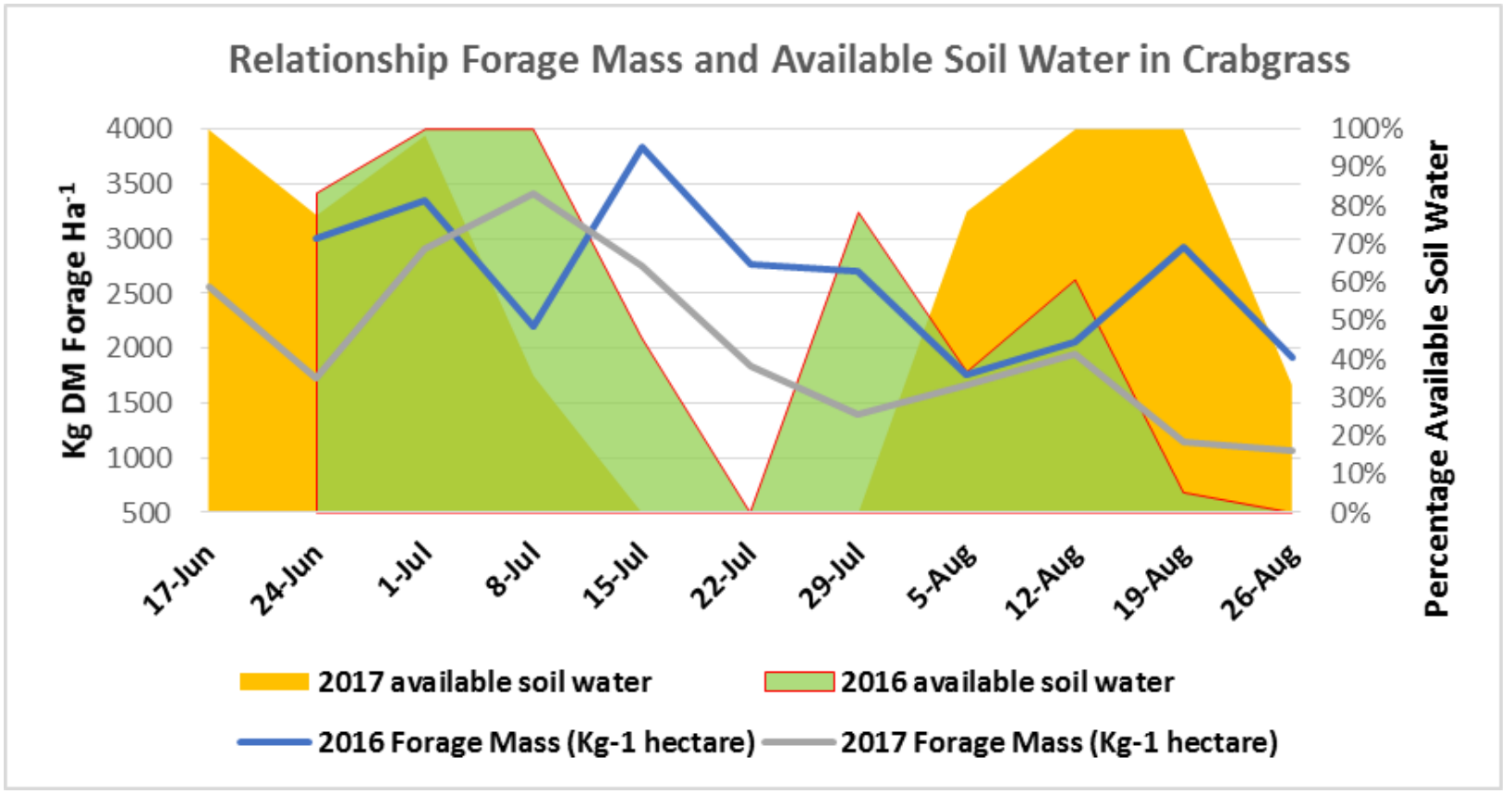


Figure 6: Average dry matter forage mass per hectare and percentage of soil water availability for crabgrass in 2016 and 2017

Figure 7: Annual ryegrass irrigated with K-Line system (right) compared to annual ryegrass non-irrigated (left).

Figure 8: Pre-grazing alfalfa irrigated with Spider type system.

Figure 9: Low-pressure traveling gun (Spider). Irrigator is pulled across the paddock via a cable and ratchet powered by water pressure turning the arms. The water line is puled behind the irrigator. This can limit the type of forage species irrigated due to the water line

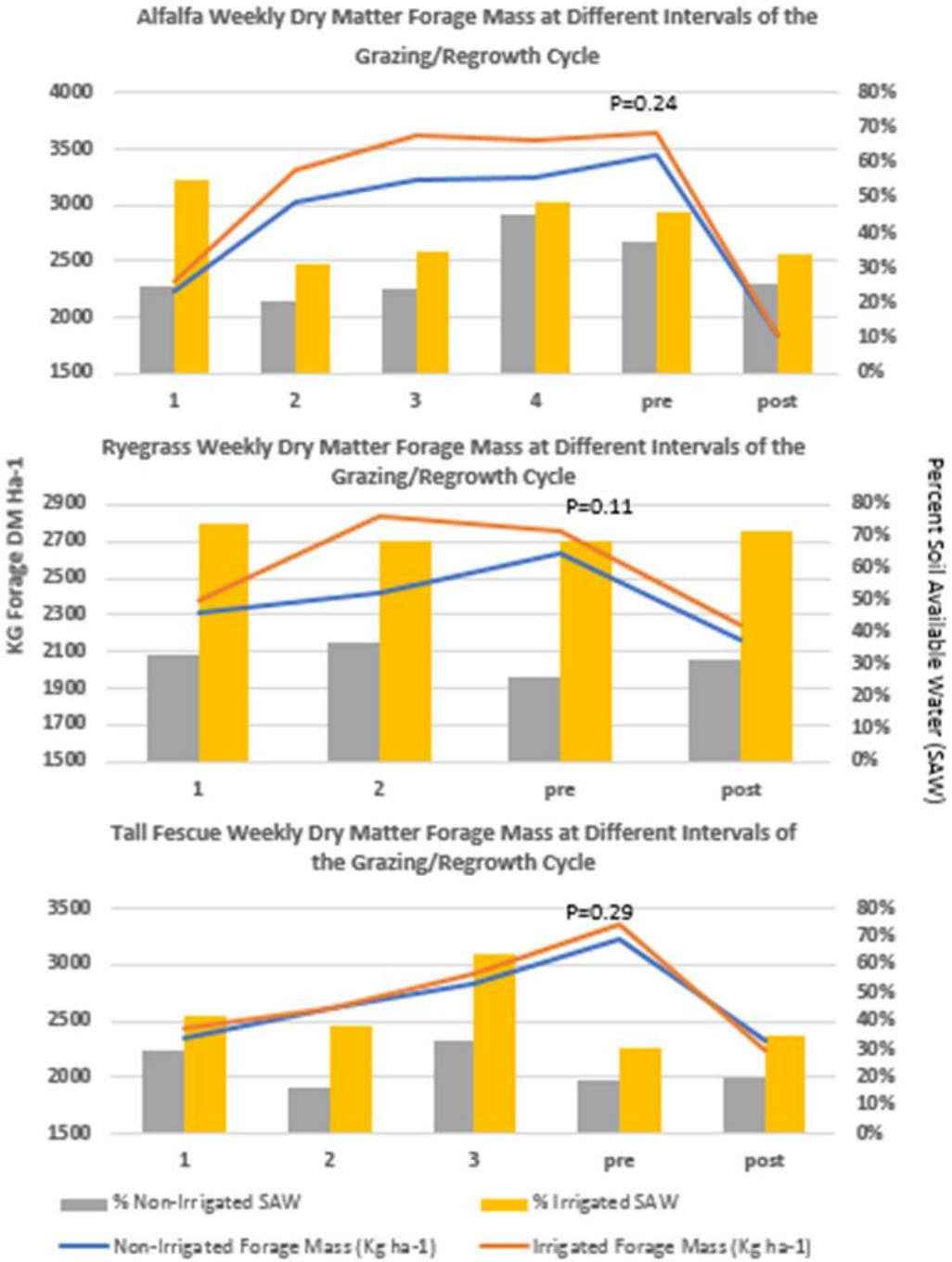


Figure 10: Weekly Dry Matter Forage Mass (Kg ha^{-1}) for Alfalfa (top panel), Perennial Ryegrass (middle panel) and Tall Fescue (bottom panel). Horizontal axis represents the weekly measurement of the growth phase of the forage after a prior grazing event. Numbers equal the week(s) after a grazing event, Pre equals the week the next grazing event occurs and Post the week measured after a grazing event. The primary vertical axis is forage mass measured (Kg ha^{-1}) and secondary vertical axis is percent of soil available water at 250 mm depth

Figure 11: Depiction of alfalfa being fully irrigated with 33 mm water (picture with hat on right) compared to alfalfa with no water applied to alfalfa (hat on left). These were taken on same day and in same paddock. The alfalfa on the right measured 217 mm compared to 69 mm on the left.

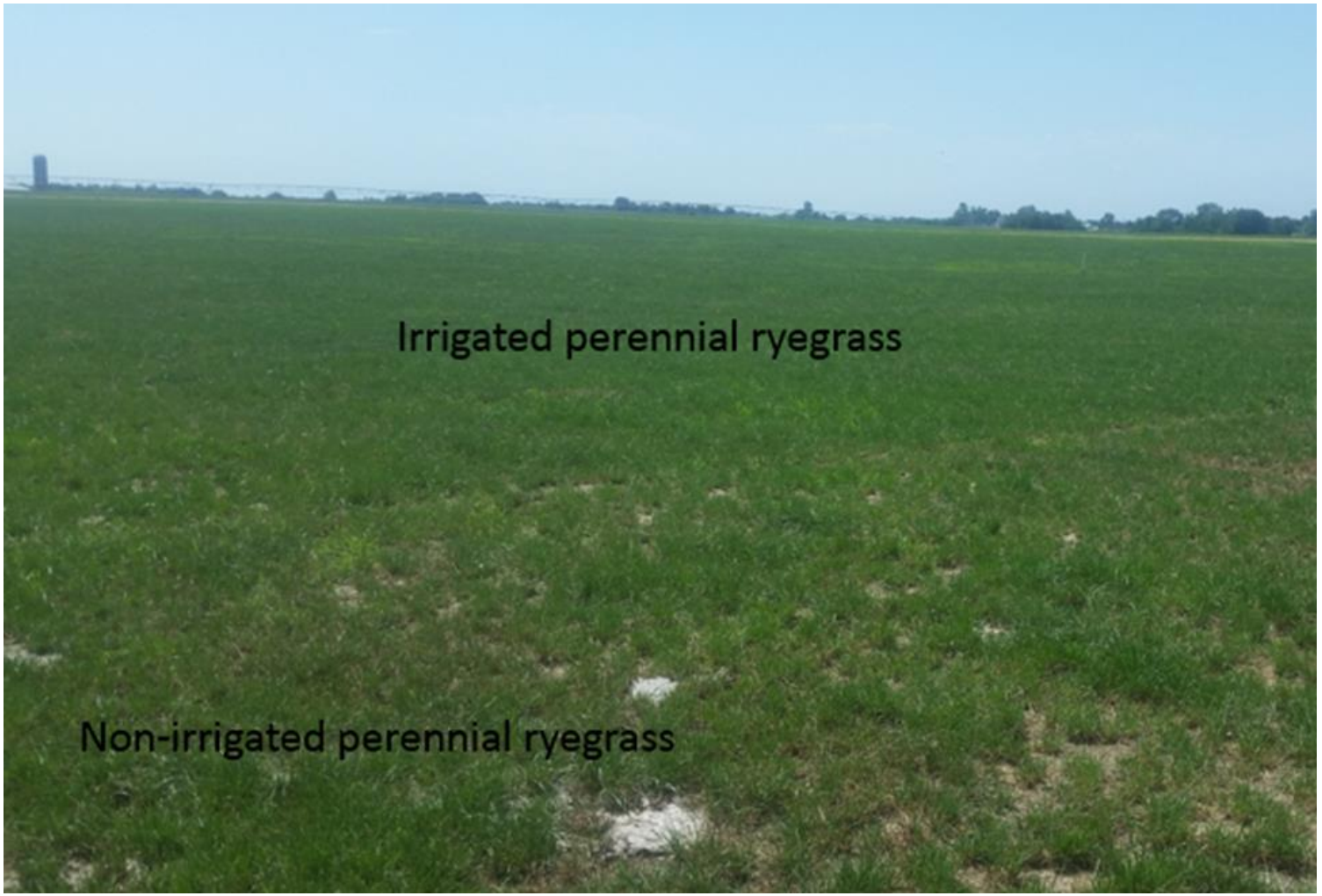


Figure 12: Center pivot irrigated and non-irrigated perennial ryegrass in the same paddock.

Figure 13: Use of center pivot irrigation on perennial ryegrass and tall fescue pasture. Additional benefit is the use of misters to cool cows during inclement weather during the summer.

	Investment/hectare	Cost/hectar
Irrigation of Alfalfa		
Low Pressure Traveling Gun (Guns, water line, misc)	$450	$22
Low Pressure Traveling Gun(well and pump-47 hectares)	$2,141	$107
repairs		$17
labor		$4
Power for 76 mm irrigation		$30
Total cost per hectare		$182
Additional DM Forage Mass grown (Kg ha-1)		927
Cost/DM Kg pasture produced above non-irrigated forage		$0.20
Irrigation of Perennial Ryegrass		
Center Pivot (towers, water line, misc)	$2,890	$144
Center Pivot (well and pump-182 hectares)	$815	$41
repairs		$12
labor		$2
Power for 254 mm irrigation		$153
Total Cost per hectare		$353
Additional DM Forage Mass grown (Kg ha-1)		831
Cost/DM Kg pasture produced above non-irrigated forage		$0.43
Irrigation of Tall Fescue		
Center Pivot (towers, water line, misc)	$2,609	$130
Center Pivot (river source and pump-65 hectares)	$587	$29
repairs		$12
labor		$2
Power for 114 mm irrigation		$34
Total cost per hectare		$209
Additional DM Forage Mass grown (Kg ha-1)		706
Cost/DM Kg pasture produced above non-irrigated forage		$0.30

Table 1: Basic irrigation costs for the three forage species measured with final estimated cost per kilogram of dry matter forage above the non-irrigated forage.

Figure 14: Use of center pivot irrigation in establishment of new perennial ryegrass pasture. Obvious differences in earlier germination, top of pasture, compared to lower portion where ryegrass is just beginning to germinate.

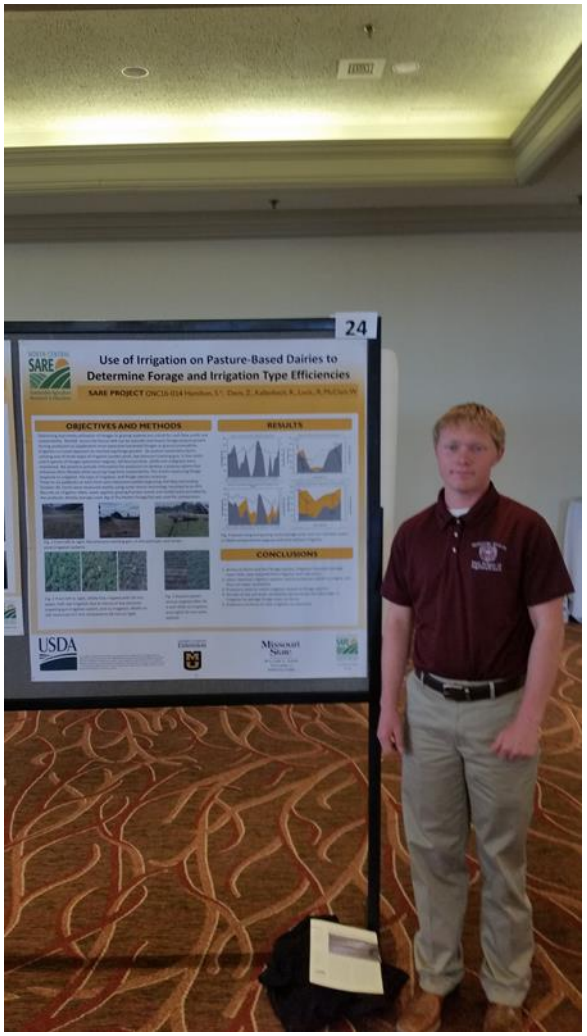


Figure 15: Zach Davis, Missouri State master's candidate presenting data at the NC SARE conference in St. Louis on the efficiencies of irrigation on pasture.