

A STATISTICAL ANALYSIS OF WHEEL RUT DEPTHS WITH CENTER PIVOT IRRIGATION SYSTEMS

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Wheel track rutting can be a problem with center pivot irrigation systems. Deep wheel ruts can cause systems to become stuck, shutting them down and causing irrigation delays. Deep wheel ruts can cause added farm machinery maintenance problems when crossing them at our present day operating speeds. Hay harvesting equipment is especially vulnerable.

A center pivot system with aluminum pipe and structural members was installed at the Carrington Branch Station in 1976 to compare wheel rutting resulting from its use to those of an all-steel system. The aluminum system was essentially of the same basic design as the steel system already at the station. The span lengths for the aluminum system were 123 feet with a 6-inch overhead mainline pipe. The span lengths of the steel system were 124 feet with a 6 5/8-inch overhead pipe. Working weight of the aluminum system was approximately 2700 lbs. per tower as compared to approximately 4800 lbs. per tower for the all-steel machine. Both systems have eight towers each and are mounted on 11.2 inches by 24 inches rubber tires. The systems are electrically driven and water pressure at the pivots is 75 PSI. The flow rate for both is 587 GPM.

Depths of wheel track ruts, amount of irrigation water applied, number of system revolutions, growing season precipitation, tillage practices and crops planted under the steel and aluminum systems were recorded for three irrigation seasons. Six replications were observed per system. Irrigations were scheduled to maintain soil moisture depletion levels between 30 and 50 percent. A checkbook-like water balance and soil probe were the irrigation scheduling techniques. Rut depth measurements were taken at the first six towers for both machines beginning at the pivot. Measurements were taken in the fall of the year after the irrigation season. The observations were replicated three times per crop.

Each circle was split between two crops. Corn, pinto beans, HRS wheat and durum were grown in rotation

on the resulting four fields. The row crops were cultivated as needed for weed control. The data were analyzed using the General Linear Model procedure in the Statistical Analysis System (SAS User's Guide, 1979 edition).

Results and Discussion

Three variables were found to significantly effect the depth of wheel ruts on a silt loam soil planted to annual crops. The variables were the year, system type and distance of tower from the center. Year one had significantly less rutting than each of the following two observation years. Wheel ruts from years two and three did not differ significantly from each other. When the data from year one was taken separately and compared to the following two years, it was found that tillage methods were relatively the same and crop rotation was not altered. However, the highest number of system revolutions occurred in year one. The average number of revolutions made by the two systems in years one, two and three were nine, eight and eight, respectively. Growing season precipitation was 8.86 inches for year one, 17.19 inches for year two and 11.38 inches for year three (Figure 1).

Figure 1.

	Mean System Revolutions	Mean Acre- Inches Applied	Growing Season Precipitation
Year 1	9	8.58	8.86 inches
Year 2	8	8.77	17.19 inches
Year 3	8	9.04	11.38 inches

Indications are that growing season precipitation and amount of irrigation water applied have a strong effect on wheel rut depths on silt loam soils but only as they relate to number of revolutions.

Significant rut depth differences were also noted between irrigation systems. Over the three-year period, the all-steel system had a mean rut depth of .31 feet while the all-aluminum systems' mean was .27 feet, the conclusion being the aluminum system will not rut as deep because it supports less weight per tower.

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The depth of the rut depended on the location of the tower from the pivot. Tower number 1 from the pivot had a mean rut depth for three seasons of .41 feet and was significantly different from all the towers. Tower number 2 had a mean rut depth of .30 feet and was significantly different from towers number 1 and 6. The depths of the ruts for towers 3, 4, 5 and 6 became shallower as the measurements moved away from the center of the machine but were not significantly different from each other. Mean depths of wheel ruts over three irrigation seasons for towers 1, 2, 3, 4, 5 and 6 were .41, .30, .26, .26, .25 and .24, respectively. These data suggest that the longer a tower remains in one place, the deeper the wheel rut will be since the innermost towers travel at a slower pace over the field.

Summary

Three variables were found to significantly affect the depths of wheel ruts with center pivot irrigation on silt loam soils. They were the year, working weight of the system and location of towers from the pivot point.

The wheel ruts in year one were significantly shallower than in years two and three. There was no difference in mean rut depths between years two and three. A statistical analysis suggests that the depths of wheel ruts were dependent on growing season precipitation and amount of irrigation water applied as they relate to number of revolutions. Lesser amounts of irrigation water and growing season precipitation were observed in year one. Tillage methods were relatively the same and the crop rotation was not altered between years.

The working weight of the systems used also statistically affected the depth of the wheel ruts. Three-year mean wheel rut depths were significantly different between the two types of systems but the actual measured difference for the period was only .48 inch.

The towers closest to the pivot point of the center pivot irrigation system make deeper ruts than those towers located outward (Figure 2). Theoretically, this is possibly due to the towers closest to the pivot point moving more slowly than towers located further outward. As a result, the longer the length of time a tower remains in one place, in saturated soil, the deeper the wheel ruts will be.

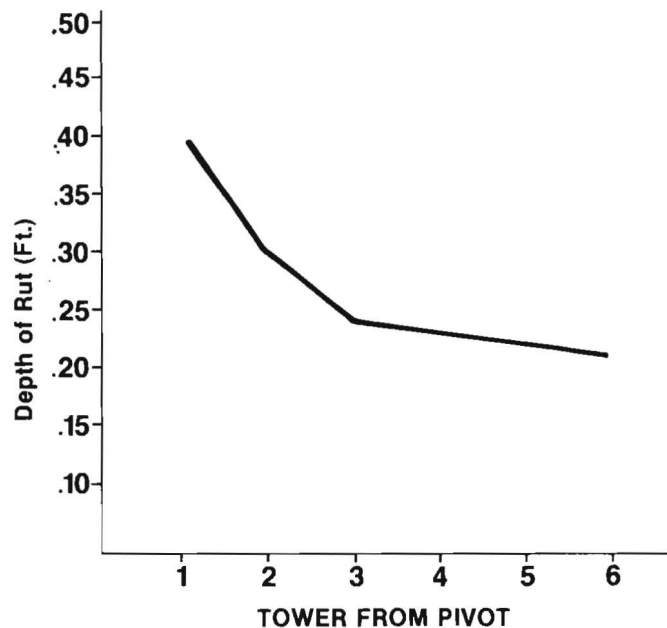


Figure 2. Mean Wheel Rut Depths for 3 Irrigation Seasons By Tower.

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bage dumped from international airliners at military or civilian air bases is an excellent method of introducing foreign diseases. Specialty meat products such as uncooked sausage find their way into this country in luggage. Hunting specimens headed for the taxidermy shop provide an additional method of introducing new disease. These are not theoretical possibilities; these instances have occurred in North Dakota. Fortunately no disease agents that we know of have been transmitted by these methods.

Another very real threat is the introduction of new or previously significant disease agents across our state borders from other states. Unfortunately these situations are often brought about by illegal entry of livestock and is often by intent rather than ignorance. In this category we can list such diseases as anaplasmosis, blue tongue, brucellosis, tuberculosis, and scabies.

What are we doing to cope with these present and potential disease problems? First of all we are very for-

tunate to have in North Dakota a cadre of dedicated, bright and experienced veterinary practitioners. These veterinarians form the first line of defense against animal disease. An extension of these veterinary practices is the accredited full service veterinary diagnostic laboratory at the Department of Veterinary Science. The information and materials flowing from the diagnostic laboratory are fuel to feed the fire of research in the department.

Much work needs to be done and is being done in our research areas to answer the disease questions in North Dakota, the region, and the nation.

It is simplistic to feel that solutions to all our problems will be forthcoming in the near future. However, we can be comfortably assured that the continuum in disease prevention, detection and treatment involving stockmen, veterinarians, diagnosticians, and research people will do its best to safeguard the health of our animals.