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Too Much of Good Thing Causes Run-off Problems

Proper water application requires care

Center-pivot irrigation is used on about 550,000 acres in Idaho, and is growing in popularity because of its ease of operation. The majority of the 350,000 acres of Idaho potatoes are irrigated by center-pivot. The main problem with the use of pivots on Idaho's silt-loam soils and variable topography is their tendency to produce runoff.

Pivot Design Considerations

Most center-pivot systems are designed with net capacities near the weekly peak seasonal evapotranspiration rate, which in southern Idaho is about 0.32

in/da (8 mm/da) or 6 gpm/ac. Allowing for an application efficiency of 85 percent, the gross capacity should be about 7 gpm per acre. With low-elevation sprays, the assumed application efficiency can be increased to 90 percent.

Conventional impact-type sprinklers require nozzle pressures of about 60 pounds per square inch. Spray heads can be operated effectively at 20 psi nozzle pressure, usually in combination with pressure regulators. The pressure at the pivot must be about 15 psi higher than nozzle pressure to allow for friction losses.

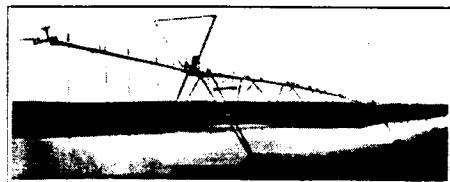
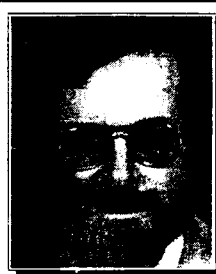


Figure 1.



Figure 2.



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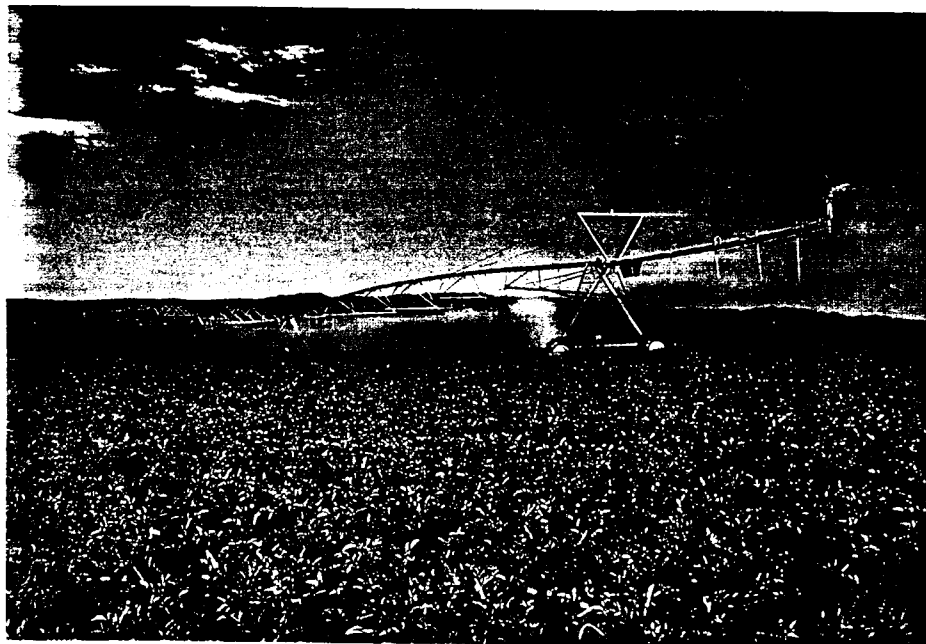
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Proper center-pivot irrigation means more than just turning on the system.

Figure 1 shows a pivot with spray heads mounted on drop pipes about 6 feet above ground. Figure 2 shows a pivot system with spraybooms. Pivots can achieve high-application uniformity if the nozzle spacing is limited to about one third of the sprinkler pattern width. Manufacturers have computer programs for design of their sprinkler packages. Application rates (and run-off potentials) are highest near the outer end of the lateral and are determined by the

system capacity and length of lateral. But the main factor is the width of the water-application pattern. *Table 1* gives average application rates near the outer end of a 1300-foot lateral.

Impact sprinklers are characterized by large-pattern widths but produce large drop sizes which tend to seal the soil surface. Smooth-plate spray heads produce small patterns and small drops. Other devices are available, such as rotating, serrated spray plates, which have characteristics intermediate between the impacts and sprays. However, there is no magic sprinkler package which will solve the run-off problem. It must be solved by a combination of system design and soil management.

Comparison tests have been made for the past several years between different sprinkler types. In most of these tests, the sprinkler type did not have a significant effect on crop yield, but there was a consistent tendency toward lower run-off under the sprayboom systems. The two main reasons for this were: 1) lower application rates as compared to sprayheads on drop pipes, and 2) small drop sizes which had less erosive and surface-sealing effects on the soil as compared to low-pressure impact sprinklers. Thus, the infiltration rates and effective surface storage tended to remain higher through the season with spraybooms.

Reservoir Tillage for Run-off Control

The strategy for controlling run-off has typically been to apply smaller amounts of water per rotation of the pivot (by increasing the rotation speed) and to use tillage, surface residue, and crop covers to enhance infiltration and surface storage. Reservoir tillage consists



Figure 3—reservoir tillage operation on potatoes.

of a subsoiler or ripper shank pulled at a depth of about one foot, followed by a paddle wheel which penetrates to the depth of the shank, forming pits with small dikes between the pits. This increases infiltration rates and creates additional surface-storage capacity. *Figure 3* shows a reservoir tillage machine (Dammer-Diker, manufactured by Ag. Engineering and Development Co., Tri-Cities, WA) in operation after potatoes have been planted and hilled on 36-inch-row spacing.

A five-year study was conducted on commercial center pivots using conventional and reservoir tillage. In many cases, run-off was eliminated by the use of reservoir tillage. Where run-off was not eliminated, it was primarily due to overtopping and washout of the dikes; this usually occurred on the steeper slopes. Run-off control was most successful where the tillage was done when the soil water was 60 to 80 percent of field capacity. Sandy soils exhibited some surface sealing and, as a result, run-off was as high on sandy soils as on silt

loams. Therefore, run-off for all soils was averaged for each crop in *Table 2*. Run-off for potatoes and corn averaged about percent with conventional tillage (CT) and less than 5 percent with reservoir tillage (RT). Beans, with closer row spacing (and more reservoirs per unit area) had less run-off.

Run-off is averaged for three ranges of slope in *Table 3*. On slopes less than 5 percent, the reservoir dikes generally remained intact and run-off was nearly eliminated. On the steeper slopes, where dike failure was more common, reservoir tillage considerably reduced run-off. Soil water was usually higher in reservoir-tilled plots than in the conventional plots due to reduced run-off (*Table 3*).

Crop Yield and Quality

The effect of reservoir tillage on crop yield was variable depending on the crop and the amount of run-off from the check plots. Where run-off from conventionally tilled plots was less than 10 percent, there was usually little affect on yield. In cases such as water-short years or temporary system breakdowns, a small reduction in run-off may have a significant affect on yield or quality. Over the five-year period on one farm, potato yields were increased an average of 15 percent and average percent No. 1 tubers was increased from 63 percent for conventional plots to 65 percent for reservoir-tilled plots.

Reservoir tillage should be the last field operation before harvest. On row crops, herbicide can be sprayed behind the tillage implement. Where mechanical weed control is used reservoir tillage can be done after the last cultivation. The increased surface roughness can cause a problem for harvesting some crops. The use of dual wheels reduces the effective roughness, and a furrow-smoothing device can be pulled ahead of the wheels.

The tillage process of creating additional surface roughness can also create additional soil clodiness, a problem for potato harvesting. This can be minimized by not letting the soil get too dry before harvest. ■

Table 1

Typical center-pivot sprinkler types and application rates for a design capacity of 7 gpm per acre.

Sprinkler Type	Pressure		Pattern width		Application rate	
	psi	kPa	ft	m	in/hr	mm/hr
High pressure impact	60	414	100	30	1.3	33
Low pressure impact	30	207	65	20	1.9	49
Sprayboom	20	138	65	20	1.9	49
Spraydrop	20	138	35	10	3.9	98

Table 2

Average percent run-off and yield for different crops.

CROP	run-off %		Yield, ton/ac	
	CT	RT	CT	RT
Potato	14	4	19.2	20.1
Corn	16	5	.7	5.9
Beans	8	0	1.2	1.2
Grain	23	5	3.5	3.5

Table 3.

Average percent run-off and soil water increase with reservoir tillage for three slope ranges.

Slope Percent	No. fields	run-off %		Soil Water Increase inches per foot
		CT	RT	
0-1	16	9	1	0.17
1-5	8	16	4	0.24
5	8	25	9	0.12