

BENEFITS FROM IMPROVING FLOOD IRRIGATION EFFICIENCY



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BENEFITS FROM IMPROVING FLOOD IRRIGATION EFFICIENCY¹

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ABSTRACT

Efficient use of irrigation water is particularly important in western Kansas, where the water supply continues to diminish. Water conservation practices can improve efficient use of the ground water supply, thereby prolonging the life of the Ogallala aquifer. These practices include better land development, water conveyance methods, and water recovery systems. An economic model was used to estimate benefits of improving the efficiency of flood irrigation. Efficiencies of 50, 60, 70, and 85 percent with several combinations of crop acreage and well yield were tested. The model selected a crop mix of either corn and wheat (above 500 GPM at all levels of efficiency) or grain sorghum and wheat (below 500 GPM at low levels of efficiency). Results of our study showed that the economic benefit from increasing the efficiency of flood irrigation by 10 percent is about \$8 per acre per year, under current price and cost conditions. From this benefit, the irrigator must subtract the annual cost of investment and increased operating costs. A worksheet and examples of its use are provided. Using the worksheet should help irrigators plan more water-conserving and economically sound operations.

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INTRODUCTION

Irrigators using the Ogallala aquifer realize that the water supply is diminishing and that improving the efficiency of water use can prolong the life of the aquifer and, thereby, extend their water supply. Planning an irrigation system to improve the efficient use of water requires knowing the cost of improvements and the potential benefits. This report will help irrigators estimate the benefits from increasing irrigation efficiency for a flood system.

Water conserving practices, like other farm operations, should be undertaken if they can be done successfully and at a profit. The benefits from irrigation should increase farm income enough to cover all costs of purchasing, installing, operating, and maintaining the irrigation system and provide a reasonable return from the owner's investment. These benefits are based on sound irrigation and cultural practices, and proper crop selection and management, resulting in using less water per bushel of crop and using water more productively. They are usually realized as annual income, whereas the costs may be in land development, purchase of depreciable equipment, or annual maintenance. Some of the costs, therefore, must be prorated over the life of the asset or included in the value of the land investment.

WATER CONSERVING PRACTICES

Some factors that influence water conservation are controlled by the irrigator and some are not. Soil texture, which greatly influences irrigation efficiency, is not changed appreciably by any action of the irrigator. Topography can be modified by land leveling and shaping within reason, but extensive land development may be too costly. Improving methods of water conveyance and water recovery is a management decision based on cost and return considerations.

Improving irrigation efficiency by land treatment, better pipeline distribution of water, a tailwater recovery system, and other techniques or practices requires investment of capital or increase in annual operating costs. Estimates of the cost of land leveling and shaping, pipeline, etc. can be gotten from engineers, Soil Conservation Service personnel, irrigation consultants, or dealers. Once the cost estimate is available, the next step is to estimate the annual benefits from improved efficiency.

Land Development

Land development can have a large effect on the efficiency of water use for flood irrigation. However, land shaping often requires a large, initial, capital investment. Obtaining the proper grade for a field may require moving large amounts of soil over a long distance. Removing high spots and filling in low spots provides for more efficient water use. Low spots may receive excess water, which will drown the crops, and high spots receive too little water, causing crop stress. Periodic maintenance and special treatment may be necessary to keep the surface slope uniform and of the proper grade.

Investment in land development will be affected by soil texture and topography. Keith, Richfield, Dalhart, and Ulysses soils are the principal

upland soils with irrigation suitability in western Kansas. They vary mostly from loamy fine sands to silt loam. Soils suitable for irrigation are deep and have adequate moisture-holding capacity. Their permeability is moderately rapid to moderate, and internal drainage is good. Most of these lands require leveling, so that the distribution of water can be uniform.

The Soil Conservation Service correlates several land development practices with their efficiency for flood systems (Table 1.)

Table 1. Condition of Irrigation System by Level of Irrigation Efficiency.

Farm Irrigation Efficiency	Irrigation System Condition
50 percent	Average system, no treatment.
60 percent	Partial treatment, i.e., land leveling or irrigation pipeline, etc.
70 percent	Land leveling, delivery pipeline, and drainage system to design standards.
85 percent	Tailwater recovery system with proper land leveling, delivery pipeline, and drainage system.

Source: Kansas Irrigation Guide, U.S. Department of Agriculture, Soil Conservation Service, Page 1-7.

Water Conveyance

The use of low pressure pipe for water conveyance to the field for gravity flow systems is common. Seepage and evaporation losses are eliminated when water is transmitted in a well constructed pipeline. The availability of relatively low cost, light-weight plastic pipe has made the investment in buried pipe reasonable for many irrigators. The initial cost of trenching and filling to lay buried pipes may be offset by avoiding the annual labor cost of moving pipe. Also, a buried pipe is subject to less damage by tillage or travel of vehicles or equipment. The use of buried pipe allows the irrigator to take the most direct route from the well to the field and to avoid weed problems and loss of productive land, because crops can be planted up to and over the pipelines. Portable surface pipe has an advantage over buried pipe because it can be moved and used in more than one location. If adequate labor is available, the portable systems can be removed while field work is in progress.

The advantages of a pipe conveyance system can be extended to infield distribution by using gated pipe instead of an earthen ditch. Water losses from unlined ditches by evaporation, infiltration, and transpiration from weeds and brush may be as high as 10 to 15 percent of total water conveyed. These losses may be reduced to 2 to 5 percent with a lined ditch and almost eliminated by a properly designed gated pipe system (2, p. 17). Gated pipe is

well suited for use in place of an intermediate head ditch on fields too long to be irrigated in one length of run. Irrigation efficiency can be improved by shortening the length of the run.

Water Recovery

A tailwater recovery system is a conservation practice that may significantly increase irrigation efficiency. Most gravity flow systems are difficult to regulate for good uniformity of application. Combinations of factors such as slope, soil infiltration rates, and water application rates often result in excess application, which runs off as tailwater. Typical, high intensity, growing-season rainfall may also produce excess runoff. A tailwater recovery pit is a means of capturing and reusing such runoff waters. Tailwater recovery systems can reduce application and rain-fall runoff losses up to 85 or 90 percent (2, p. 18).

A tailwater recovery system includes a water collection pit at the lower end of a field with a means for returning the collected water to the same field or delivering it to a different field. The return delivery system may include a pump and a pipeline. The tailwater recovery system has an initial investment in construction of the pit, return pipe, and pump and power unit, plus annual maintenance and operating costs.

STUDY PROCEDURE

Well yield, field size, and irrigation efficiency determine how much water will be available during the critical flowering and grain formation stages of crops. Increased irrigation efficiency can compensate somewhat for low well yield. The most difficult situation is one with low irrigation efficiency and low well yield. This combination will greatly reduce the acreage of water-sensitive crops that can be grown. If moisture deficit occurs during the critical stages, then crop yield per acre may be reduced. The adverse effect of low well yield and/or low irrigation efficiency can be reduced by storing some water in the soil from pre-season rainfall or irrigation. The soil texture and depth of soil determine how much water can be stored. A 5-foot soil profile with a silt loam texture can store a maximum of 21 inches (1.74 acre foot) of water, of which 11 inches (.9 acre foot) are available to growing plants. This is equivalent to two, 6-inch irrigations. However, water does drain from the soil, and the longer the storage time, the more will be lost to depths below the root zone. Also, evaporation of water will take place at the soil surface. Therefore, the 0.9 acre foot maximum for the silt loam soil will likely not be accomplished with the pre-season irrigation practice because of evaporation and drainage.

A linear programming model was used to estimate the annual benefits and the crop acreage adjustment needed to achieve specified levels of efficiency with a flood irrigation system on a 160-acre field. The model considered three irrigated crops; corn, grain sorghum, and wheat. There were several irrigation regimes for each crop; pre-season irrigation only, limited irrigation, and full irrigation. Water requirements during pre-vegetative, vegetative, flowering, grain formation, ripening, and post-ripening stages were considered for each crop. Different well yields at gallons per minute (GPM) were combined with

different irrigation efficiencies to estimate the most profitable crop mix for a specified efficiency.³

Some important assumptions of this model are:

1. Soil is a silt loam that stores about 4.17 inches of water per foot, of which 2.22 inches are available to plants.
2. The authorized amount of water for irrigation is 2 feet per acre.
3. The irrigation efficiencies for the flood system are 50, 60, 70, or 85 percent.
4. The field size for the flood system is 160 acres with an authorization of 320 acre feet of irrigation water.
5. Well yields are 1500, 1300, 1100, 900, 700, 500, or 300 GPM.
6. Rainfall is average for the year.
7. Natural gas is the power source.

Thus, the model considered net returns for combinations of seven different GPM amounts, four different irrigation efficiencies, and seven different crop mixes. The results are based on these 196 combinations and were summarized into one equation using the multiple regression method. This equation was used to construct a worksheet, which is used for examples and included at the end of this publication.

RESULTS

General Results with Model

The worksheet and examples of its use are provided to help an irrigator to plan an irrigated crop mix that provides the highest net returns and to evaluate the expected benefits from improving irrigation efficiency. The net return is the expected amount after paying operating cash expenses. The fixed costs, such as depreciation and taxes on well and equipment, and land taxes have not been subtracted out. So, the net return is that to the operator for his time and investment.

Net returns are based on current prices and costs of production. Commodity prices used are current government loan rates. The model selects the most profitable amount of water pumped based on the yield that is expected for each different irrigation regime. Fertilizer costs are based on the expected crop yield for each irrigation regime.

³For more details regarding the economic model, see Kansas Water Resources Institute Completion Rep. 258, Kansas State University, Manhattan, KS 66506.

The model considers the amount of labor required by the different crops and the amount available on farm. If additional labor is needed, it can be hired.

Commodity and input prices change frequently, as do costs among irrigators. These changes could alter the net returns of the irrigated crops. However, if the pattern in price changes continues much the same as in the past, then the percent changes among different plans may be affected little. So long as the price relationship among commodities remains fairly stable, the comparative advantage among crops will also remain stable.

The model was used to test many combinations of efficiency, crop acreage and well yield for their effects on net income. Table 2 provides a summary of these results. As efficiency is increased from 50 percent to 85, the acreage of corn increases as does the percentage of water pumped on corn. Conversely, the acreage of irrigated wheat and percent of water pumped decreases as irrigation efficiency increases. The profit for fully irrigated corn is higher than that for fully irrigated wheat or grain sorghum. But the authorization of 2 acre feet per acre limits the number of corn acres that can be fully irrigated. Therefore, the model selected a combination of crops. Above 500 GPM, the model selects combinations of wheat and corn for all levels of irrigation efficiency studied. Below 500 GPM and at low levels of irrigation efficiency, grain sorghum replaces corn in the crop mix. The combination of lowest GPM and efficiency shows wheat as the predominant user of cropland and water. By increasing the efficiency of irrigation and/or the GPM, water pumped to corn increases, replacing first grain sorghum and then wheat.

Table 2. Percent acreage and water use by crop, efficiency, and well yield.

GPM	Acres		Percent Efficiency			
			50	60	70	85
500 and greater	160	<u>% Acreage</u>				
		Corn	25	44	63	92
		Wheat	75	56	37	8
		Gr. sorgh.	0	0	0	0
		<u>% Water Pumped</u>				
		Corn	52	72	85	97
		Wheat	48	28	15	3
		Gr. sorgh.	0	0	0	0
		300	160	<u>% Acreage</u>		
Corn	0			32	41	54
Wheat	86			68	59	46
Gr. sorgh.	14			0	0	0
<u>% Water Pumped</u>						
Corn	0			60	69	79
Wheat	77			40	19	21
Gr. sorgh.	33			0	0	0

The results estimated by the economic model show that for each 10 percent increase in efficiency, net income increased annually \$1284 on 160 acres, which is \$8.03 per year per acre.

Estimating the Effect of Improving Efficiency

To use the worksheet, you must know the efficiency of the current and the proposed systems, the acreage irrigated by each well, the GPM of each well, the amount of water pumped per acre to each crop, and the acreage of each crop per field irrigated.

To work through an example, let's assume an irrigator is considering an improvement in the water distribution system that will increase irrigation efficiency from a current 60 percent to 70 percent. This situation is demonstrated in Table 3 for a 60 percent efficient irrigation system and Table 4 for 70 percent. The irrigated field size is 160 acres with well yield of 900 GPM. The irrigator plans on 70 acres of corn and 90 acres of wheat: water pumped is 2.7 acre feet per acre on corn and .8 acre foot on wheat. This information is recorded on lines 1, 2, 3, and 4 of the Table 3 worksheet. Next are the calculations to estimate net returns. On line 5 appears a negative constant value, which remains the same in all situations studied. Line 6 is the efficiency (in percent) times the value of 1 percent efficiency. Line 7 is the well yield in GPM times the value attached to a specific GPM. Line 8 is the calculation of water pumped on corn in total acre feet times the value of 1 acre foot of water on corn. The product is the net income associated with growing corn. Lines 9 and 10 are like 8, but for wheat and grain sorghum, respectively. Line 11 is the total net returns estimated for the 160 acres. Lines 12 and 13 are used to test if water applied exceeds the authorized limit.

In the example, total water pumped per acre for the field and for each crop is within the specified limits shown at the bottom of the worksheet. The water pumped is called the gross irrigation requirement. It is the amount pumped, not the amount used by the crop. To estimate the amount available to the crop, multiply the amount pumped by the efficiency (in decimal units) of the system.

The above calculations are for 60 percent efficiency. Next, consider the effect of improving irrigation efficiency to 70 percent. This example is shown on Table 4. Several numbers will change. On line 1, the 60 percent is changed to 70 percent. On line 6, change the 60 percent to 70 percent, thereby increasing the income attributed to efficiency from \$7701.60 to \$8986.20. Lines 5, 7, 8, 9, and 10 remain the same. Total income increases from \$6165 to \$7449. Thus, increasing efficiency from 60 to 70 percent is estimated to increase net income from \$6165 to \$7449, which is an increase of \$1284 or 21 percent.

Table 3: Example Worksheet for a 60 Percent Efficient Irrigation System.

- (1) Well GPM 900 Acres per field 160 GPM Per Acre 5.6 Efficiency = 60
 (2) Acres corn 70 Water pumped per acre of corn 2.7 Ac. ft.
 (3) Acres wheat 90 Water pumped per acre of wheat .8 Ac. ft.
 (4) Acres gr. sorgh. 0 Water pumped per acre of gr. sorgh. 0 Ac. ft.

Net Return Calculations

- (5) Constant -\$8564.10
 (6) 60 % efficiency * 128.36 = \$7701.60
 (7) 900 GPM * 1.43 = \$1287.00
 (8) 70 acres corn x 2.7 Ac. ft. pumped per acre = 189 x \$19.95 = \$3770.55
 (9) 90 acres wheat x .8 Ac. ft. pumped per acre = 72 x \$27.36 = \$1969.92
 (10) 0 acres grain sorghum x 0 Ac. ft. pumped per acre = 0 x \$23.36 = \$ 0
 (11) TOTAL = \$6164.97
 (12) 160 TOTAL ACRES 261 Total Ac. ft. pumped
 (13) TOTAL WATER PUMPED / TOTAL ACRES = 1.63 Ac. ft. per acre

Limits and restrictions on use of worksheet

1. For wells with GPM per acre of 3.1 or higher, do not exceed 2 acre feet per acre of water use.
2. For wells below 3.1 GPM per acre, do not exceed 1.5 acre feet per acre.
3. Range in water pumped on corn: 2-3 acre ft. per acre.
4. Range in water pumped on wheat: .5-1.5 acre ft. per acre.
5. Range in water pumped on grain sorghum: 1-1.8 acre ft. per acre.
6. Range in GPM: 300 to 1500.
7. Range in efficiency: 50% to 85%.
8. Minimum GPM per acre Corn:

50% efficient system,	8 GPM
60% efficient system,	6 GPM
70% efficient system,	5 GPM
85% efficient system,	3.5 GPM

Table 4: Example Worksheet for a 70 Percent Irrigation Efficient System.

- (1) Well GPM 900 Acres per field 160 GPM Per Acre 5.6 Efficiency = 70
 (2) Acres corn 70 Water pumped per acre of corn 2.7 Ac. ft.
 (3) Acres wheat 90 Water pumped per acre of wheat .8 Ac. ft.
 (4) Acres gr. sorgh. 0 Water pumped per acre of gr. sorgh. 0 Ac. ft.

Net Return Calculations

- (5) Constant -8564.10
 (6) 70 % efficiency * 128.36 = \$8985.20
 (7) 900 GPM * 1.43 = \$1287.00
 (8) 70 acres corn x 2.7 Ac. ft. pumped per acre = 189 x \$19.95 = \$3770.55
 (9) 90 acres wheat x .8 Ac. ft. pumped per acre = 72 x \$27.36 = \$1969.92
 (10) 0 acres grain sorghum x 0 Ac. ft. pumped per acre = 0 x \$23.36 = \$ 0
 (11) TOTAL = \$7448.57
 (12) 160 TOTAL ACRES 261 Total Ac. ft. pumped
 (13) TOTAL WATER PUMPED / TOTAL ACRES = 1.63 Ac. ft. per acre

Limits and restrictions on use of worksheet

1. For wells with GPM per acre of 3.1 or higher, do not exceed 2 acre feet per acre of water use.
2. For wells below 3.1 GPM per acre, do not exceed 1.5 acre feet per acre.
3. Range in water pumped on corn: 2-3 acre ft. per acre.
4. Range in water pumped on wheat: .5-1.5 acre ft. per acre.
5. Range in water pumped on grain sorghum: 1-1.8 acre ft. per acre.
6. Range in GPM: 300 to 1500.
7. Range in efficiency: 50% to 85%.
8. Minimum GPM per acre Corn:

50% efficient system,	8 GPM
60% efficient system,	6 GPM
70% efficient system,	5 GPM
85% efficient system,	3.5 GPM

In the example shown in Table 4, in which irrigation efficiency is increased from 60 to 70 percent, no change is made in the amount of water pumped per acre. The example shows 2.7 acre feet pumped on corn and .8 acre foot pumped on wheat for both levels of efficiency. What this means is that by pumping the same quantity of water but with higher efficiency, more water is available for crop use. With more water available for crop use, yield per acre is higher. So in the procedure used to summarize results, the benefit from increased efficiency that makes possible a higher yield per acre is included in the value attributed to the efficiency variable.

Suppose the irrigator wants to improve irrigation efficiency from 60 to 70 percent but also conserve on the amount of water pumped so that the amount available to the crop remains the same. This would result in the same yield per acre but with less water pumped. On the Table 5, the water pumped on corn is reduced 10 percent, from 2.7 to 2.43 feet per acre, and reduced 10 percent on wheat, from .8 to .72 acre foot. These reductions show that 10 percent less water is pumped because of the increase in efficiency. Now crop yields will be the same for the 60 and 70 percent efficiencies. These changes appear on the worksheet on lines 2, 3, 6, 8, and 9 and the change in total income on line 11. The calculations are: on line 6, $70\% \times \$128.36 = \8985.20 ; on line 8, $70 \times 2.43 \times \$19.95 = \3393.50 ; on line 9, $90 \times .72 \times \$27.36 = \1772.93 ; on line 11, the sum of the values on lines 5, 6, 7, 8, 9, and 10, which is \$6874.53. By increasing efficiency and reducing the amount of water applied so that yield per acre remains constant, income is estimated to increase from \$6165 to \$6875 for an increase of \$710 or 12 percent. This increase is a result of pumping less water, thereby reducing pumping costs.



Table 5: Example Worksheet for a 70 percent Efficient Irrigation System with 10 Percent Less Water Pumped.

-
- (1) Well GPM 900 Acres per field 160 GPM Per Acre 5.6 Efficiency = 70
 (2) Acres corn 70 Water pumped per acre of corn 2.7 Ac. ft.
 (3) Acres wheat 90 Water pumped per acre of wheat .8 Ac. ft.
 (4) Acres gr. sorgh. 0 Water pumped per acre of gr. sorgh. 0 Ac. ft.

Net Return Calculations

- (5) Constant -\$8564.10
 (6) 60 % efficiency * 128.36 = \$8985.20
 (7) 900 GPM * 1.43 = \$1287.00
 (8) 70 acres corn x 2.43 Ac. ft. pumped per acre = 170.1 x \$19.95 = \$3393.50
 (9) 90 acres wheat x .72 Ac. ft. pumped per acre = 64.8 x \$27.36 = \$1772.93
 (10) 0 acres grain sorghum x 0 Ac. ft. pumped per acre = 0 x \$23.36 = \$ 0
 (11) TOTAL = \$6874.53
 (12) 160 TOTAL ACRES 234.9 Total Ac. ft. pumped
 (13) TOTAL WATER PUMPED / TOTAL ACRES = 1.47 Ac. ft. per acre
-

Limits and restrictions on use of worksheet

1. For wells with GPM per acre of 3.1 or higher, do not exceed 2 acre feet per acre of water use.
2. For wells below 3.1 GPM per acre, do not exceed 1.5 acre feet per acre.
3. Range in water pumped on corn: 2-3 acre ft. per acre.
4. Range in water pumped on wheat: .5-1.5 acre ft. per acre.
5. Range in water pumped on grain sorghum: 1-1.8 acre ft. per acre.
6. Range in GPM: 300 to 1500.
7. Range in efficiency: 50% to 85%.
8. Minimum GPM per acre Corn:

50% efficient system,	8 GPM
60% efficient system,	6 GPM
70% efficient system,	5 GPM
85% efficient system,	3.5 GPM

The first change calculated on the Table 3 worksheet, that of an increase in irrigation efficiency from 60 to 70 percent, showed an increase in income from \$6165 to \$7449. This \$1284 increase is caused by having more water available for crop use, thereby increasing yield per acre. The change calculated on Table 5, that of reducing the amount of water pumped because of increased irrigation efficiency but with crop yields unchanged, shows an increase in income from \$6165 to \$6875. This \$710 increase is the result of reducing irrigation costs because less water is pumped.

CONCLUSIONS

The model selected crop mixes of wheat and either corn or grain sorghum.

As the efficiency of flood irrigation increased from 50 to 85 percent, the acreage of corn increased, as did the percent of total water pumped on corn. Conversely, with increasing efficiency, acreage of irrigated wheat and percent water pumped on wheat decreased.

Above 500 GPM, the model selected mixes of wheat and corn for all levels of efficiency. Below 500 GPM and at low levels of efficiency, grain sorghum replaced corn in the crop mix. The combination of lowest GPM and efficiency showed wheat as the predominant user of cropland and water.

The results estimated by the economic model showed that for each 10 percent increase in irrigation efficiency, net income increased \$1284 annually for a 160-acre, flood irrigated field. This is equivalent to \$8.03 per acre per year.

REFERENCES

1. Water for the Future of Kansas, Kansas State Water Plan Studies. 1971. Kansas Water Resources Board cooperating with U.S. Bureau of Reclamation.
2. "Agriculture and Water Use Management and Technology Assessments." 1982. Report for Six-State High Plains-Ogallala Aquifer Regional Study. Camp Dresser and McKee, Inc., Austin, Texas.



WORKSHEET

- (1) Well GPM _____ Acres per field _____ GPM Per Acre _____ Efficiency = _____
- (2) Acres corn _____ Water pumped per acre of corn _____ Ac. ft.
- (3) Acres wheat _____ Water pumped per acre of wheat _____ Ac. ft.
- (4) Acres gr. sorgh. _____ Water pumped per acre of gr. sorgh. _____ Ac. ft.

Net Return Calculations

- (5) _____ Constant \$-8564.10
- (6) _____ % efficiency * 128.36 = \$ _____
- (7) _____ GPM * 1.43 = \$ _____
- (8) _____ acres corn x _____ Ac. ft. pumped per acre = _____ x \$19.95 = \$ _____
- (9) _____ acres wheat x _____ Ac. ft. pumped per acre = _____ X \$27.36 = \$ _____
- (10) _____ acres gr. sorgh. x _____ Ac. ft. pumped per acre = _____ X \$23.36 = \$ _____
- (11) _____ TOTAL = \$ _____
- (12) _____ TOTAL ACRES _____ Total Ac. ft. pumped
- (13) TOTAL WATER PUMPED / TOTAL ACRES = _____ Ac. ft. per acre

Limits and restrictions on use of worksheet.

1. For wells with GPM per acre of 3.1 or higher, do not exceed 2 acre feet per acre of water use.
2. For wells below 3.1 GPM per acre, do not exceed 1.5 acre feet per acre.
3. Range in water pumped on corn: 2-3 acre ft. per acre.
4. Range in water pumped on wheat: .5-1.5 acre ft. per acre.
5. Range in water pumped on grain sorghum: 1-1.8 acre ft. per acre.
6. Range in GPM: 300 to 1500.
7. Range in efficiency: 50% to 85%.
8. Minimum GPM per acre of Corn:
 - 50% efficient system, 8 GPM
 - 60% efficient system, 6 GPM
 - 70% efficient system, 5 GPM
 - 85% efficient system, 3.5 GPM



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