Dairy Production and Center-Pivot Irrigation Systems

Center pivots are historically known for their role in row-crop production but have more recently been considered for their application in livestock operations. Dairy producers in New Zealand have started using center-pivot irrigation systems to reduce heat stress as well as increase their forage yields. Because of their success in New Zealand, these practices are now being adopted and researched in the United States.

Mississippi State University's Bearden Dairy Research Center has used a center-pivot system with its grazing herd since 2015. The pivot system has reduced drought risk on the associated pastures. During the drought of 2016, the MSU grazing herd was able to start grazing ryegrass in the beginning of October 2016 and continued to graze irrigated pastures until the end of May 2017. Producers without irrigation are sometimes forced to delay or prolong grazing, depending on environmental conditions in their area. Irrigation lessens these impacts and allows for a more controlled grazing season.

This publication will review some of the reasons for production loss in Mississippi dairies and evaluate the costs and benefits of a center-pivot irrigation system on a dairy operation.

Dairy Production Loss

Common reasons for production loss within the dairy industry include:

- Poor nutrition
  - Restrictions to feed and water can cause decreases in milk production. A shortage or insufficient amounts of water can cause drastic drops in milk yield. Feed imbalances can reduce milk fat and protein percentages.
- Calving interval
  - Research has shown that a shorter calving interval can increase milk production and profitability. Twelve months is ideal.
- Chop size and length of cut
  - When the chop size or length of cut is too small, cows will chew less. Less chewing lowers their rumen pH, causing them to produce lower amounts of fatty acids that aid in milk production. Longer chop length will increase effective fiber in their diet and help keep them chewing.
- Heat stress
  - When a cow's environment gets above 68 THI (temperature humidity index), production levels can decrease by as much as 25 percent. When cows are heat-stressed, fertility rates decrease; elevated body temperature influences ovarian function, reduces oocyte health, and reduces embryonic development.

Potential Benefits of Center-Pivot Systems

Some possible benefits that could result from installing a center-pivot irrigation system are:

- Improved forage program
  - Consistent and timely irrigation allows forages to respond quicker to harvest events than just relying on rain.
- Reduction in forage yield variability
  - A reduced risk of drought could cause less variability in the dry matter yield of forage being produced.
- Extended grazing periods
  - With the ability to irrigate pastures in addition to rainfall, forage crops can reach optimal grazing heights sooner and recover faster.
- Reduction of the 10–25 percent production loss during summer months
  - With cows being cooled under the sprayers of the center pivot, heat stress will be less likely to affect production.

Cost of Installation

Installing a center-pivot irrigation system depends on the specifics of each operation. Some of the main differences will be:

- Land characteristics
  - Certain soils are not favorable for irrigation because of drainage and runoff. Soil characteristics should be determined before installation.
  - It might be necessary to level or form land to make the center pivot able to move with ease.
- Access to water
  - The need to install an irrigation well can be up to 25 percent of total installation costs.
- Cost of establishing electricity

The estimated costs for establishing a center-pivot irrigation system for a 42-acre field are displayed in **Table 1**. These costs do not represent any specific operation but are representative of the average costs for a typical operation. Costs will vary depending on each farm's specific characteristics. This information can be used as a guide for anyone considering installing a center-pivot system. Fixed costs could be reduced if some installation materials are already available or if a well is already established. We assume that center pivots have a 20-year useful life expectancy and an interest rate of 4 percent per year. Further, we assume for this example that the center pivot will have zero salvage value at the end of the 20-year period. If the center pivot is used for the full 20 years, the annual fixed cost per acre would be $129.21.

Note that the fixed costs per acre shown in **Table 1** are very sensitive to changes in the size of the irrigated area. Fixed costs per acre will likely drop substantially as irrigated area increases because the investment in the well, pump, motor, and electrical components is not likely to increase significantly for an irrigated area up to 128 acres. While the center-pivot investment will increase as the size of the irrigated area increases, that increase will not negate the economies of size generated by the other components. Therefore, it is important to budget for your specific size of operation.

Table 1. Average installation costs and annual fixed cost per acre for a 42-acre field and a 20-year useful life expectancy.

Item	Cost
Center pivot (sprinklers & gun)	$40,000
Well	$16,250
Pump, motor, and electrical	$17,500
Total investment	$73,750
Salvage value	$0
Average years of life	20
Interest rate	4.00%
Annual fixed cost per acre	**$129.21**

Table 2 shows the operating costs of a typical center-pivot irrigation system per year for a 42-acre grazing pasture. Water cost and use is an important factor in center-pivot operating costs. The estimates below assume that water is freely available and that increasing use only affects the cost of electricity. During drought years, more water will be used to keep the fields optimally irrigated and, therefore, more electricity will be used. These costs can also change with increased maintenance requirements or increased electrical usage. The annual operating cost is estimated to be $83.24.

Table 2. Operating costs and total annual costs per acre for a 42-acre field.

Item	Cost
Repair and maintenance	$996
Electricity	$2,500
Total operating costs per year	$3,496
Annual operating costs per acre	**$83.24**
Annual fixed and operating costs per acre	**$212.44**

Combining the $129.21 annual fixed cost with the $83.24 annual operating cost brings the total annual cost to $212.44 per acre. This is the cost that must be offset by either gains in revenue or a reduction in other costs of production. It is important to note that additional costs associated with forage production are not included here. It is possible that producers will spend more on forage management practices, but, for this scenario, we assume that the addition of the irrigation system is the only change.

Profitability Scenarios

There are multiple scenarios in which installing and maintaining a center-pivot irrigation system could be a profitable investment. Experimental data is not currently available to estimate the anticipated benefits for a dairy operation in Mississippi. The ability to monitor and reduce water deficits can lead to improved forage production, causing a reduction in costs associated with other feeding programs. The ability to reduce feed costs will be directly related to the current forage and feeding systems. The

level that forage programs can improve with more control over water application also depends on the type of forages grown, soil characteristics, and other management practices.

Because we do not have experimental data to estimate expected benefits, we will consider the benefits that would be required to make the center pivot profitable. Scenario 1 examines the amount that milk production would have to increase as a result of heat-stress abatement. We also discuss the reduction of feed costs that would be needed to offset the increased cost of irrigation. If either of the scenarios or a combination of the two can be obtained, then a center pivot could be a profitable investment.

Scenario 1. Increased Milk Production

This scenario evaluates a 4 percent increase in milk production per cow due to a reduction of heat stress. During the summer months, producers can commonly see up to a 25 percent decrease in milk production. Cows can be heat stressed for up to 6 months out of the year in the South. If the production loss in the summer months were to be lowered to 10 percent, annual production could be increased by as much as 7.5 percent. To offset the cost of the center-pivot system, a 4 percent increase in milk production would be required. Using the assumptions in **Table 3**, this would raise the total annual benefit per cow to $5.98. Milk-quality bonuses and extra costs for increased forage were not considered in these assumptions.

Table 3. Hypothetical production and revenue impact.

		Your farm's values
Production per cow (lb)	16,500	
Price per cwt	$17	
Revenue per cow	$2,805	
Production per cow with a 4% annual increase (lb)	17,160	
Revenue per cow	$2,917.20	
Total annual benefit	$112.20	

Scenario 2. Reduced Feed Costs

Increased forage production could result in a $106.22 reduction in annual feed costs per cow ($0.64 per cwt of milk production). For dairy producers in Mississippi, feed costs are around $12.50 per cwt of milk produced. With a center-pivot installation, there would be a reduction in the amounts of hay, supplemental forage, and TMR feeding needed. Forage grown under a pivot can be a more consistent, higher-quality feedstuff. This, in turn, can reduce supplemental feedings and extend grazing periods.

Alternative Uses

A primary advantage of a center-pivot system is the potential alternative uses. This gives dairy producers more flexibility to switch to other production systems as practices and market forces change. Center-pivot irrigation systems have uses in other livestock-, hay-, and crop-production systems, among others. When compared to a freestall barn, a center-pivot system is less specific to only dairy production. If desired, you could disassemble and sell the system; on the other hand, freestall barns have limited alternative uses without significant alteration.

Conclusion

This publication explores factors that cause milk production levels to decrease and discusses how a center-pivot irrigation system could be advantageous to dairy producers. For approximately half of the year, Mississippi's dairy cattle are under heat-stress conditions. When dairy cattle are heat-stressed, their production levels tend to drop. The center-pivot irrigation system is an alternative to help increase production. The average installation cost for a center-pivot system can be offset by either an increase in milk production or a decrease in feed costs. While experimental data is not yet available, it appears that a combination of these two benefits could make an investment in a center-pivot system profitable.

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