

# **COLORADO CROP WATER ALLOCATION TOOL**

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## **Introduction**

Many farmers in Colorado face limited irrigation water supplies. Limitations are imposed by a variety of circumstances including declining groundwater levels, significantly higher energy costs, evolving water case law and decreasing return flows in river systems. Regardless of the circumstance, farmers face the same question: what is the “best” allocation of limited water resources?

This presentation assists farmers by examining limited irrigation’s impacts on asset efficiency, cost efficiency and debt management. A spreadsheet decision tool has been designed for Colorado farmers making limited irrigation crop allocation decisions. The spreadsheet allows farm managers to input their own business information and contrast potential limited irrigation strategies. Crops examined in the spreadsheet tool include corn, alfalfa, wheat, dry beans and sunflowers. A copy of the spreadsheet and a technical document describing its use can be found at: <http://limitedirrigation.agsci.colostate.edu/> under the resources tab.

## **A Farm’s Changing Financial Position**

Under full irrigation, farm managers purchase inputs and choose crops in order to maximize profits with existing resources. As available irrigation water decreases, the manager’s original input purchases and crop choices will not maximize profits. This is reasonable because when making a whole farm plan, the farm manager chooses equipment, land, and financial capital jointly, and all of these choices assume adequate irrigation supplies.

Farm managers shifting from full to limited irrigation need to reconsider strategic choices if facing perpetual water limitations. One approach to making these decisions is to consider the farm’s asset efficiency, cost efficiency and ability to use borrowed funds when maximizing profits.

## Limited Irrigation and Asset Efficiency

Farm profits rely importantly on the ability to generate revenues from the existing asset base. A convenient way to measure this ability is the asset turnover ratio (ATR):

$$(1) \text{ ATR} = \text{Gross Revenues} \div \text{Total Farm Assets}$$

where

$$(1a) \text{ Gross Revenues} = \text{Yield per acre} \times \text{Acres Cropped} \times \text{Crop Price}$$

The asset turnover ratio summarizes how well the farm's resource inputs (assets) generate gross revenues (output). Note that expenses are not included in the asset turnover ratio; rather only farm sales (gross revenues) are present.

Limited irrigation reduces the ATR of a typical farm by reducing the level of gross revenues. Gross revenues are the product of the farm's yield per acre times cropped acres times the selling price of the crop as indicated by equation (1a). Yields decrease as irrigation is limited because less water is available for consumptive use, and gross revenues fall with decreased yields. In equation (1), the gross revenues are decreased which makes the ATR smaller.

A lower ATR means the farm is less efficient in producing revenues from its existing asset base. The farm may adopt several strategies to mitigate this shortcoming. One strategy is to time irrigations in order to reduce the vegetative growth of a row crop saving water for the important grain fill period. This mitigates the impact of reduced yields for the fixed cropping area shown in equation (1a). The farm manager might also choose a crop whose price and yield combination are higher than other crops. The Colorado Crop Water Allocation Tool reduces gross revenues to reflect decreasing yields that follow limited irrigation. In addition, the spreadsheet user can adjust prices according to market conditions.

Alfalfa is an interesting alternative when mitigating ATR reduction. When alfalfa is stressed with insufficient water supplies, the relative feed value of the crop actually increases. The feed value is important to dairies and feedlots, and alfalfa with a greater relative feed value garners a higher price. As a result, farm managers can partially offset ATR reductions by marketing a hay crop's quality more effectively.

Long term water shortages may lead to using some assets more intensively and culling less productive assets. As an example, a farm manager may choose to fully irrigate a portion of the farm and allow the rest to lie fallow. This "rotational" fallow approach leaves other resources, namely equipment and farm labor, underutilized. Taking advantage of a slack resource, the farm manager can lease

the farm's equipment to another operation, or might consider performing custom work for other operations. Gross revenues are increased when slack resources are put to use, so the limited irrigation ATR will increase by using the same asset base more intensively.

Culling the least productive assets might also improve the ATR ratio. However, selling assets, such as underutilized equipment, reduces the opportunity for the farm to expand operations if circumstances change. Selling equipment might also alter the farm's cost structure as the manager may need to hire custom work or lease equipment occasionally.

### Limited Irrigation and Cost Efficiency

In the previous section, asset efficiency described the farm's ability to generate revenues from its available resources. The farm's efficiency in retaining these revenues as profits is its cost efficiency. Operating profit margin (OPM) measures cost efficiency and is calculated as:

$$(2) \text{ OPM} = \text{Operating Income} \div \text{Gross Revenues}$$

where

$$(2a) \text{ Operating Income} = \text{Gross Revenues} - \text{Operating Expenses}$$

In equation (2a), gross revenues become operating income once expenses have been differenced. Operating income represents the funds available for paying creditors and income taxes with the remainder compensating owners.

The OPM calculated in equation (2) can be no greater than 1.0; after all, operating income cannot exceed gross revenues. An increase in OPM implies improved cost efficiency because the farm is retaining more of its gross revenues as operating income. A reduction in farm's gross revenues, or a sudden increase costs, will alter the OPM.

Limited irrigation will reduce the gross revenues of the farm operation as discussed previously. Operating expenses will change too. Expenses that decline are those closely tied to production levels including harvesting costs, irrigation energy costs, and irrigation labor expense. Additionally, fertilizer rates are reduced to match a lower target yield, and managers may limit seeding rates of row crops like corn. Yet, herbicide and insecticide costs may increase under limited irrigation because a water stressed crop is more susceptible to pests.

In contrast, overhead expenses, such as general farm labor, depreciation and insurance, do not change even though irrigation amounts are reduced. For this reason, cost efficiency generally suffers when limited irrigation is compared to full irrigation under the same cropping pattern. Evidence of this effect is found in

equation (2), where OPM declines as operating income is reduced at a proportionally greater rate than gross revenues.

Changing the crop rotation might save irrigation water and alter the farm's cost structure. As an example, managers may seek to adopt a corn-wheat rotation in place of continuous corn to conserve water. The rotation also reduces costs significantly as wheat requires fewer inputs than corn.

The Colorado Crop Water Allocation Tool is designed so that the user can change the expected allocation to reflect differing input levels including fertilizer, chemical, seed and tillage operations well as differing crop rotations. The operating return per acre is calculated for each operation so that limited irrigation alternatives can be compared.

### Asset Efficiency, Cost Efficiency and Profits

Farm profitability is a direct result of the efficiency with which the farm uses its assets and manages its costs. Indeed, the following mathematical relationship is true:

$$(3) \text{ Rate of Return to Farm Assets (ROFA)} = \text{ATR} \times \text{OPM}$$

OR

$$(3a) \text{ ROFA} = \text{ATR} \times \text{OPM} = \text{Operating Income} \div \text{Total Farm Assets}$$

Operating income divided by total farm assets is the rate of return to farm assets (ROFA) as written in equation (3a). More simply, the ROFA represents the percent rate of return that a farm can generate with its assets – a percent that can be compared against similar farms. Those farms with higher ROFA's are said to be more efficient in deploying and using farm assets to generate operating income.

ROFA is a product of the farm's asset efficiency and cost efficiency as shown in equation (3). If a farm seeks to increase its profitability, it may adopt a strategy that generates a greater revenue stream from its resources (increases ATR) or improves its cost efficiency (OPM). Unfortunately, reduced water supplies typically decrease both ATR and OPM by reducing gross revenues and operating income. As a result, the ROFA of a limited irrigation farm declines.

A declining ROFA is especially problematic for a firm whose interest expense is relatively high. The operating income used to calculate the ROFA also represents the funds available to compensate the lender(s) for the use of borrowed capital. If ROFA consistently falls below the average interest rate on borrowed capital, then the farm will have to find another means in order to make payments to the lender.

The relationship between borrowed capital and limited irrigation is considered in the next section.

### Limited Irrigation and Borrowed Funds

Borrowed capital permits farmers grow their business more quickly and control a larger asset base than if the owner were to grow based solely on retained earnings. In order to secure borrowed capital, farms often pledge their land as collateral. Shifting from full to limited irrigation impacts the farm's ability to secure borrowed funds in two ways: it limits the ability to repay debt by restricting cash flow and it undermines the security of the farm's collateral by decreasing the market value of its assets. Each effect will be discussed in turn.

### Limited Irrigation and Repayment Capacity

Repayment capacity is an important measure of the cash available to make existing term debt payments and/or to seek additional financing. Lenders calculate repayment capacity according to:

$$(4) \text{ Repayment Capacity} = \text{Operating Income} + \text{Depreciation} + \text{Contributions}$$

Repayment capacity reflects the available cash in the farm operation; therefore, depreciation is added to operating income in equation (4). (Depreciation is a non-cash expense that is usually subtracted from gross revenues when calculating operating income). Likewise, off farm income might represent an important cash contribution to the farm operation, so it is added to operating income to reflect the ability to repay.

Operating income declines with limited irrigation reducing the funds available to repay scheduled principal and interest payments. Increasing off-farm contributions, custom farming and expanding the operation may enhance repayment capacity by increasing cash flow. Yet, declining repayment capacity will limit opportunities to buy or lease additional farm acres. Furthermore, limited irrigation reduces farm's collateral.

### Limited Irrigation and Loan Collateral

Market values for farmland change with expected profits – farmland that is more productive and profitable is in greater demand fetching higher prices and cash rents. A farm evolving from full to limited irrigation will experience a decrease in the market value of its land.

Land is often pledged as collateral for the farm operation. Lenders are acutely aware of circumstances that alter expected farming profits and may attach more stringent covenants to loans on land that adopts limited irrigation cropping in place of full irrigation. Example covenants include the use of crop insurance and

maintaining a specific working capital level in the farm business bank account. Farm managers should communicate frequently with their lender when examining limited irrigation alternatives.

## Conclusions

Farms transitioning from full to limited irrigation will find their financial position is altered. Assets, especially land and equipment, may not be used to their full potential so that gross revenues are reduced. The cost efficiency of the farm operation will suffer, in a large part because overhead costs remain the same but the revenues available to compensate are reduced. Farm managers may be able to improve efficiency by carefully examining and reducing inputs such as fertilizer and the seeding rate. Finally, farm managers adopting limited irrigation practice should recognize shrinking cash flows will limit repayment capacity, and the declining values of farm assets decrease opportunities to grow the business with borrowed funds. Farm managers can address the changes with a variety of activities that range from timing irrigations to expanding the farm operation. The Colorado Crop Water Allocation Tool is one resource to assist in choosing among limited irrigation alternatives.