

Cowpea Potential in Dryland Cropping Systems

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Introduction In Eastern Colorado, introducing alternative pulse crops (grain legumes) into crop rotations to counter the rising costs and management complexities of fallow has potential to increase farm profitability and improve soil health while minimizing environmental impact. Many pulse crops have low water and nutrient requirements, provide soil nutrient cycling benefits, and can provide risk-reducing options, as they can be used for forage or grain. At the USDA – Central Great Plains Agricultural

Standard:	Wheat	Corn	Fallow
Alternative 1:	Wheat	Corn	Millet
Alternative 2:	Wheat	Corn	Cowpea

Research Station in Akron, our research team is evaluating environmental and economic outcomes for 3-year crop rotations including a standard fallow rotation along with alternative rotations with millet or cowpea as a fallow replacement. It is part of a USDA Pulse Crop Health Initiative (PCHI) project.

We are conducting in-depth evaluations of environmental outcomes by measuring water use efficiency, soil health metrics including nitrogen cycling and soil organic matter, and total resource use from farm to plate. Additionally, economic viability of each rotation is being assessed by comparing profitability of rotations that contain pulse crops to standard rotations using break-even analysis. Here, we present some initial economic comparisons of cowpeas as a rotation crop as a replacement for fallow or millet.

Project Highlight: *Break-Even Analysis for Cowpea as a Rotation Crop*

Break-even analysis is a tool that can help dryland wheat farmers evaluate whether they should replace fallow with a rotation crop and which crop to choose. This “project highlight” shares results of a simplified comparative break-even framework applied to dryland wheat in Eastern Colorado. We work through two break-even analysis examples which assess the potential for cowpea to (1) replace fallow in a Wheat-Corn-Fallow (W-C-F) rotation and (2) replace millet in a Wheat-Corn-Millet (W-C-M) rotation.

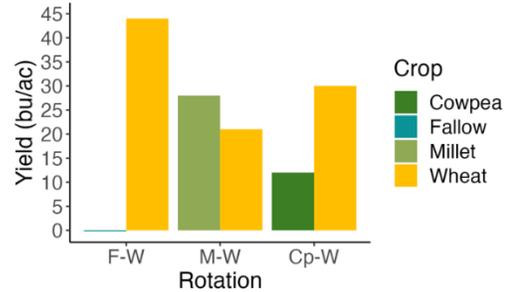
Comparative break-even analysis shows how relative changes in yields, prices, and/or costs for alternative options (fallow, millet, cowpea, etc.) affect the profitability of a cropping rotation. In addition, it considers the effect of those alternatives on subsequent wheat yields. When fallow is replaced with millet or cowpea, there is a wheat yield penalty due to less available soil moisture. Corn yields may also be affected within these rotations, as outlined in the full report. The impact of a change in rotation on a farmer’s “bottom line” is summarized by a metric called *incremental profit*.

Incremental profit is interpreted as the expected *change* in profit, relative to a baseline or status quo scenario. Incremental profit is calculated as “total positive changes” minus “total negative changes.” Positive changes can include increased revenues or decreased costs. Negative changes can include decreased revenues or increased costs. Partial budgets are the economic tool that we use to calculate incremental profits for a proposed change in cropping rotation. A positive value for *incremental profit* indicates the proposed change is expected to improve a farmer’s bottom line, whereas a negative *incremental profit* indicates the farmer is likely better off without making the change.

Yield Assumptions

Complete yield data from the PCHI field trials are not yet available, so we drew values from several different sources for this analysis. The expected crop yields in the examples (wheat after fallow, wheat after millet, millet after corn) are set to the long-run average yields for these crops in the USDA-ARS Akron experiment station dryland rotation field trials (1994-2017). The cowpea yield values are from performance trials conducted by CSU Crops Testing (<https://csucrops.org/bep/>).

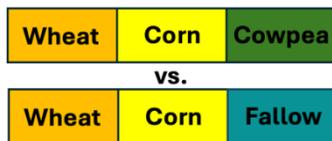
The expected wheat yield after fallow is 44 bu/ac, while the expected wheat yield after millet is 21 bu/ac, for a yield penalty of 23 bu/ac. The expected wheat yield after cowpea is 30 bu/ac, for an expected 14 bu/ac yield penalty as compared to fallow. Consistent with emerging results from USDA-ARS trials, wheat following cowpea appears to have a lower yield penalty by about 7-10 bu/ac compared to wheat following millet.



Price and cost assumptions

The price and cost assumptions are highly simplified. Wheat and millet price ranges are from the USDA NASS Colorado Agricultural Statistics bulletin. Millet prices approximate recent prices observed in Eastern Colorado. Wheat costs come from the CSU Crop Budgets. For simplicity, we assume fallow costs are 10% of wheat costs based on the University of Nebraska crop budgets. We assume costs for millet are 80% of wheat costs and cowpea costs are 120% of wheat costs.

Example #1: Potential for cowpea to replace fallow in a W-C-F rotation



We begin with the question, “Is it profitable for cowpea to replace fallow, if the expected cowpea yield is 12 bu/ac and the expected wheat yield penalty is 14 bu/ac?” For this to hold, the incremental profit for replacing fallow with cowpea in a W-C-F rotation must be positive. The incremental profit is positive when cowpea revenues plus decreased fallow costs are greater than the forgone value of the wheat yield penalty plus cowpea production costs.

fallow costs are greater than the forgone value of the wheat yield penalty plus cowpea production costs.

Partial Budget for Example #1 (Potential for cowpea to replace fallow in a W-C-F rotation)

Increased Revenue		Decreased Revenue	
	\$/ac		\$/ac
Cowpea Production (\$0.50/lb x 12 bu/ac x 60 lb/bu)	\$360	Wheat Yield Penalty ((\$6/bu x Wheat yield penalty = 14 bu/ac)	\$84
Decreased Cost		Increased Cost	
	\$/ac		\$/ac
Fallow Cost Savings	\$14	Cowpea Production Costs (Assumed to be 120% of Wheat Production Costs)	\$196
Total Positive Changes (\$/ac) =	\$374	Total Negative Changes (\$/ac) =	\$280
		Incremental Profit (\$/ac) =	+\$95

To evaluate how sensitive the result is to prices, we show the incremental profit for several combinations of cowpea prices and wheat prices below. Positive entries are shown in black and imply that replacing fallow with cowpea is profitable, given the assumed yields, prices, and costs.

Sensitivity of Incremental Profit to Cowpea and Wheat Prices

(Cowpea Yield = 12 bu/ac, Wheat Yield Penalty = 14 bu/acre)

		Wheat Price (\$/bu)				
		\$4.00	\$5.00	\$6.00	\$7.00	\$8.00
Cowpea Price (\$/lb)	\$0.30	(\$21)	(\$35)	(\$49)	(\$63)	(\$77)
	\$0.40	\$51	\$37	\$23	\$9	(\$5)
	\$0.50	\$123	\$109	\$95	\$81	\$67
	\$0.60	\$195	\$181	\$167	\$153	\$139
	\$0.70	\$267	\$253	\$239	\$225	\$211

Main takeaway: In cases where the assumed yields, prices, costs, and yield penalty effects approximate the value for your farm, replacing fallow in a W-C-F rotation with cowpeas might be profitable. The values for your farm, however, may differ markedly from those shown in the case study example and this same exercise should be repeated with more accurate values. Other limitations are discussed below.

Example #2: Potential for cowpea to replace millet in a W-C-M rotation

Wheat	Corn	Cowpea
vs.		
Wheat	Corn	Millet

Next, suppose you already replaced fallow with millet, but wonder whether cowpea might be a more suitable rotation crop. We ask the question, “Is it profitable for cowpea to replace millet, if the expected cowpea yield is 12 bus/ac, the expected wheat price is \$6/bu, and the expected wheat yield gain is 9 bu/ac for cowpea compared to fallow?” For this to hold, the incremental profit for replacing millet in a W-C-M rotation must be positive. The incremental profit is positive when the sum of cowpea revenues, increased wheat revenue, and millet cost savings are greater than the forgone millet revenue and cowpea production costs.

Partial Budget for Example #2 (Potential for cowpea to replace millet in W-C-M rotation)

<u>Increased Revenue</u>		<u>\$/ac</u>	<u>Decreased Revenue</u>		<u>\$/ac</u>
Cowpea Revenue		\$360	Forgone Millet Revenue		\$210
(\$0.50/lb x 12 bu/ac x 60 lb/bu)			(\$0.15/lb x 28 bu/ac x 50 lb/bu)		
Wheat Revenue (Smaller yield penalty)		\$54			
(\$6/bu x 9 bu/ac increase)					
<u>Decreased Cost</u>		<u>\$/ac</u>	<u>Increased Cost</u>		<u>\$/ac</u>
Millet Cost Savings		\$130	Cowpea Costs		\$196
			(Assumed to be 120% of Wheat Costs)		
Total Positive Changes (\$/ac) =		\$544	Total Negative Changes (\$/ac) =		\$406
			Incremental Profit (\$/ac) =		+\$139

The combinations of cowpea price and millet price that make replacing millet with cowpea profitable, given the assumed cowpea yield, wheat yield, and wheat price, are shown in black below. Entries in the table are increased overall returns to the rotation per acre. Entries that appear red and are enclosed by parentheses imply a negative incremental profit and switching to cowpea would not be profitable.

Sensitivity of Incremental Profit to Cowpea and Millet Prices

(Cowpea Yield = 12 bu/ac, Wheat Yield Gain = 9 bu/ac, Wheat Price = \$6/bu)

		Millet Price (\$/lb)				
		\$0.05	\$0.10	\$0.15	\$0.20	\$0.25
Cowpea Price (\$/lb)	\$0.30	\$135	\$65	(\$5)	(\$75)	(\$145)
	\$0.40	\$207	\$137	\$67	(\$3)	(\$73)
	\$0.50	\$279	\$209	\$139	\$69	(\$1)
	\$0.60	\$351	\$281	\$211	\$141	\$71
	\$0.70	\$423	\$353	\$283	\$213	\$143

Main takeaway: In cases where the assumed yields, prices, costs, and yield effects approximate the value for your farm, replacing millet in a W-C-M rotation with cowpeas might be profitable. Similar to Example #1, however, the values for your farm may differ markedly from those shown in this case study example and this same exercise should be repeated with more accurate values.

Further Information A full report will be available at the CSU Crops Testing website, along with a customizable Excel decision aid that will help you calculate break-even prices for these two examples based on values specific to your farm. Although this “study highlight” shows potential benefits to cowpeas as a fallow replacement, there are other limitations that must be considered. Markets for cowpeas are limited and producers should have a suitable contract with a processor. Non-yield effects (weed control, soil health, corn yield effects, etc.) should also be considered. The examples assume that the necessary equipment is available to farmers and only consider changes in variable costs. Implications for cash flow, risk position, crop insurance, or inflation are not considered but also important to the decision.



Link to Full Report and Continuing Cowpea Research:

<https://csucrops.org/bep/>