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The economics of on-farm rice drying in Arkansas

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Cover Page Footnote
Clayton J. Parker is a May 2020 honors program graduate with a major in Agricultural Business. Lawton L. Nalley is a faculty mentor and Professor in the Dale Bumpers College of Agriculture, Food, and Life Sciences

The economics of on-farm rice drying in Arkansas

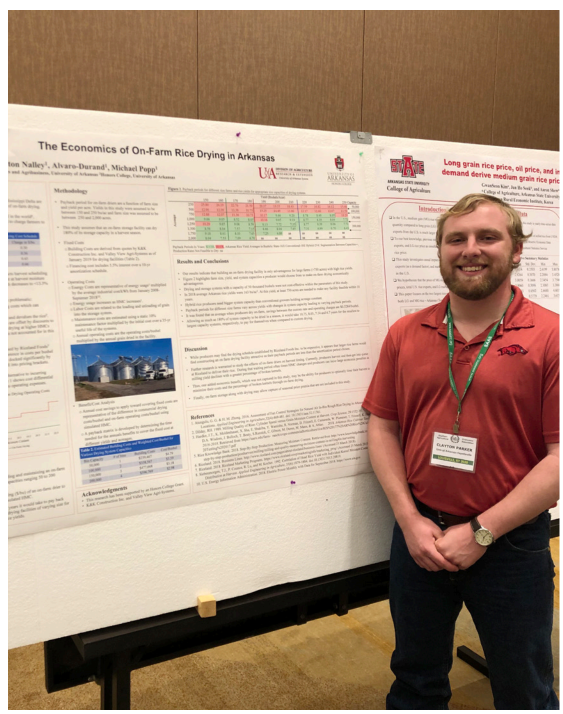
Meet the Student-Author

Clayton Parker

Living in a small town like Carlisle, Arkansas, agriculture was inescapable, even more so because I also lived on our four-generations old family farm. From riding the tractor with my father as a kid to walking the fields and working the land now myself, farming has always been a love in my life. After my high school graduation, it led me to pursue a bachelor's degree in agribusiness at the University of Arkansas. As an honors student, I have gained pertinent knowledge to succeed as a business person and leader in today's agricultural industry. The experiences in the classroom and as a researcher have helped me gain the tools to create what I hope are valuable tools for other farmers in Arkansas. Upon graduation, I plan to return home to the farm and start the fifth-generation of operation alongside my father and grandfather. My time at the University of Arkansas would not be the same without the friends and professors that have been there to support me along the way, and I am forever grateful for them. I would like to thank my mentor, Dr. Lanier Nalley, as well as my committee members Dr. Michael Popp and Dr. Alvaro Durand-Morat for their advice, expertise, and support in this process.

Research at a Glance

- Rice farmers are charged at buying points to dry their rice at rates that can represent a significant percentage of the cash price they receive for their grain.
- This research analyzes the potential benefit on-farm rice drying can provide Arkansas farmers by finding the feasibility of constructing and operating on-farm drying and storage facilities.
- The results of this research found that on-farm rice drying could be a viable long-term solution to high commercial drying rates for farmers who assume the risk of high initial investments to build the facilities.



Parker presented his research at the 2020 Southern Agricultural Economics Association annual meeting in Louisville, Kentucky.

The economics of on-farm rice drying in Arkansas

Clayton Parker and Lanier Nalley†*

Abstract

Globally, rice producers are faced with the temporal problem of deciding the optimal time to harvest rice. When harvested, paddy rice is typically at a harvest moisture content (HMC) between 15% and 22% and subsequently dried by the mill to a moisture content (MC) of 12.5%. Riceland Foods Inc., the largest miller of rice in the world, uses a stair-step pricing model to charge farmers to dry, which can complicate the timing of harvest as producers try to balance the tradeoff of minimizing drying costs by waiting to harvest at lower HMC vs. maintaining higher rice quality typically observed when harvesting at higher HMC. This study estimates the costs of on-farm drying as an alternative to commercial drying. This study estimates the total fixed and operating costs using current building, operating, insurance, and financing costs to establish and run an on-farm rice drying and storage facility with capacities between 1,750 and 7,000 m^3 for varying farm sizes (acres grown and yield observed), while drying from a simulated HMC range of 16% to 23%. A cost/benefit analysis compares on-farm operating costs to the current Riceland drying costs. This study finds an average savings of $16.38/ton within the simulated HMC range once payback has occurred. Payback periods when drying at full capacity ranged from 7.52 to 12.26 years, where the larger capacity systems had shorter payback periods compared to the smaller systems. The results of this study can provide rice farmers with important information when considering on-farm drying and storage systems in the Mississippi Delta region.

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† Lanier Nalley, the faculty co-mentor, is a Professor in the Department of Agricultural Economics and Agribusiness.

Introduction

Globally, rice producers are faced with the temporal problem of deciding the optimal time to begin rice harvest. Rice is unique in that producers are paid both by the quantity of rice produced as well as the quality (head rice yield, HRY) of the rice, which is not determined until after the milling process. Rice requires post-harvest processing, including drying to a 12.5% moisture content (MC) for storage and milling (Rice Knowledge Bank, 2018). Because the rice must be dried, commercial mills charge rice producers. The HRY is directly affected by the moisture content of the rice at harvest (HMC; Dilday, 1989). Rice that has a greater HRY receives a premium from buyers, while lower HRY receives a discount. This puts farmers in the predicament of deciding when to harvest, based on HMC. The greater the HMC, the higher the quality, but the higher the associated drying costs; whereas the lower the HMC, the lower the drying costs, but this can result in lower HRY and reduce potential profits.

Empirical studies have found that long-grain rice varieties in Arkansas experience losses in HRY when HMC deviates from the optimal range of 15% to 22% (Siebenmorgen et al., 1992). Compounding the problem is that there is a different optimum for each rice cultivar and type (long-, medium-, and short-grain). The respective HMC that maximizes HRY is different for each rice cultivar (Siebenmorgen et al., 1992). Further, the HMC, which maximizes the HRY, may not maximize profits as it does not account for drying costs.

Riceland Foods, headquartered in Stuttgart, Arkansas, is the largest rice mill in the world (Riceland Cares, 2019a). Riceland uses a stair-step model to price drying costs within ranges of varying HMC, presented in Table 1 (Riceland, Marketing Programs, 2019b). This stair-step pricing method can either lead to large cost savings or additions if a producer harvests close to the HMC at a stair step pricing point. Hence, the subsequent drying cost compounds uncertainty for rice producers.

Rice producers can potentially mitigate the uncertainties associated with the Riceland stair-step pricing method by drying their rice on-farm. Previous studies (Young and Wailes, 2002) analyzed the cost of on-farm drying, and other studies (Nalley et al., 2016) have analyzed the impact of HMC on the net value of rice (NV) through HRY. But to date, there is a void in the literature on the impact of on-farm drying on NV at varying HMC using on-farm drying costs. As such, the objectives of this study are to:

1. Estimate the cost (\$/0.035 m^3) to build and operate an on-farm drying and storage facility over an expected useful life.
2. Estimate payback periods when constructing and operating on-farm drying facilities at different capacities with varying rates of throughput.

This study is pertinent given the thin margins rice producers are currently experiencing. The results from this study should help determine the feasibility of on-farm drying, given farm size and expected yields.

Materials and Methods

This study utilized secondary data to estimate the relative profitability of on-farm drying in comparison to commercial drying. Assumptions were made for the following factors: energy usage and costs, labor costs, insurance costs, maintenance costs, building costs, lending costs, useful life, and yield. Risk was analyzed using @Risk (an Excel add-in program, Palisade, Ithaca, N.Y.) to simulate HMC (from historical HMC percentages in Arkansas), and energy costs (from U.S. Energy Information Administration industrial rates January 2008 to September 2018), as these two continuous variables are the main drivers of uncertainty for on-farm drying on an annual basis.

This study assumed storage systems with 14.63-m diameter bins and a capacity of approximately 1,750 m^3. The approximate total capacities ranged from 1,750 to 7,000 m^3, consisting of 1, 2, 3 or 4 bins, a dump, a 25.4-cm loop system, sweep augers, concrete necessary for the pad, and ramps, fan systems, and other required electrical hardware. Quoted 2019 prices from various contractors in Arkansas for these systems ranged from \$239,273 to \$617,570.

Lending information was provided by Farm Credit Services (G. Golleher, pers. comm., 12 August 2019). For this study, an estimated interest rate of 5.5% and an expected useful life of 35 years was assumed. Interest was equal to the sum of compounding interest payments found using the 2018 Microsoft Excel® Payment (PMT) function over a 10-year amortization period.

A static repair factor of 10% was assumed and used to determine the total value of repairs to the drying system.

Table 1. Riceland Foods 2019 rice drying fee schedule.

Harvest Moisture Content	Drying Costs
%	dollars/metric ton
Less than 13.5	13.50
13.6 thru 18.9	16.43
19 thru 21.9	19.35
Greater than 22.0	27.00

Total maintenance, in dollars, for the entire life of the drying facility was a product of building costs and the static repair factor. Annual maintenance was estimated to be total maintenance divided by the expected useful life. Annual maintenance per metric ton was estimated to be annual maintenance divided by the fixed storage capacity of a facility.

Insurance rates were assumed to be static at a rate of 0.55% of the book value of the asset. A salvage value of zero after a 35-year useful life was used to determine the average book value of the asset. Annual insurance costs were calculated by multiplying the average book value by the static insurance rate. Total insurance costs were equal to annual insurance costs multiplied by the expected useful life. Thus, the total fixed cost was estimated to be the sum of building costs, total maintenance, total interest, and total insurance.

Hypothetical HMCs were simulated 1,000 times using @Risk and a normal distribution truncated between 16% to 23%, representative of 1,000 potential loads of harvested rice brought into Riceland. The simulated HMCs were used to determine energy usage, and on-farm costs (per metric ton) and compared to the Riceland stair-step pricing in Table 1. Atungulu and Zhong (2016) provided the relevant equations to estimate the energy needed to dry each of the 1,000 simulated HMC down to 12.5% MC using the average national industrial energy cost/kWh from January 2008 to September of 2018, which ranged from \$0.0667 to \$0.071 per kWh (U.S. EIA, 2018).

Labor costs were subject to multiple assumptions within this study, and only additional labor to load and unload the system was accounted for. Labor varied by the capacity of the drying facility. Labor was not a function of HMC. The hourly wage was assumed to be \$10/hour. The total operating cost/t for each of the 1,000 HMC simulations was estimated to be the summation of the energy cost/t of each iteration and the labor costs/t.

Paddy yield and farm size were integral factors in this study, as they determine the throughput on a drier. Farm size was analyzed at 101.23-hectare increments, ranging from 101.23 to 809.72 ha. Yield intervals ranged from 7.56 to 12.60 t/ha at 0.50 t intervals. Yield intervals were based around state averages and variety trials done by Hardke et al. (2018).

For a comparison to be made between on-farm drying costs and commercial drying costs in Table 1, total drying cost/t and total savings/t (the difference between on-farm operating costs and the Riceland drying schedule) were estimated for each of the 1,000 HMC simulations. Annual cost savings were representative of the amount of money saved by a producer at a given rate of production, where it was equal to the total farm production multiplied by the average cost savings per bushel. The total benefit over the

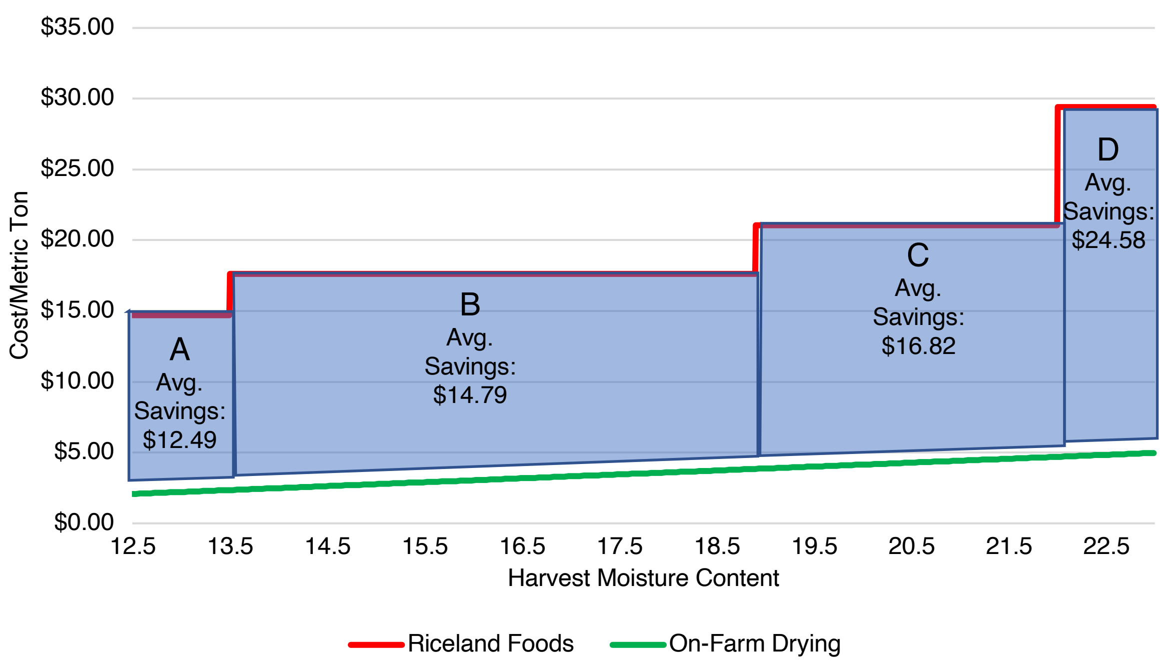

Fig. 1. The difference in on-farm drying operating costs and Riceland Foods, Inc.'s 2019 rice drying fee schedule once the on-farm drier has been paid back. Shaded portions are representative of the total savings throughout the range of harvest moisture content (HMC) between its on-farm operating costs and its respective Riceland cost once the on-farm drier has been paid back. The average savings is listed for each bracket: (A) HMC <13.5%, (B) 13.5% < HMC <18.9%, (C) 19.0% <HMC <21.9%, (D) HMC> 22%.

lifetime of the facility was estimated to be equal to the expected useful life multiplied by annual cost savings/1000 (which finds the average annual cost savings for all 1,000 HMC iterations).

The drying capacity of each drier was determined by the number of cycles each grain bin can run through in a harvest season. Drying capacities were determined by the initial HMC (more moisture results in lower capacity) for each iteration as well as the relevant drying functions provided by Atungulu and Zhong (2016). The study only analyzes the lesser of capacity or output (yield * farm size) to ensure consistency of the proportion of fixed capacity dried by each size drier.

Results and Discussion

When comparing the commercial (Riceland Foods 2019 cost schedule) and on-farm costs (Fig. 1), it was found that there were savings associated with on-farm drying across all HMCs from 12.5% to 23% after payback has occurred. The average savings associated with each bracket in the Riceland Foods 2019 cost schedule and the simulated HMC ranged from \$12.49/t to \$24.58/t, where the brackets increased in HMC (Fig. 2). In the 1,000 simulated HMC ranging from 16.0% to 23.0%, there was an average savings of \$16.38/t. These "savings" are relative comparisons to commercial driers only after the on-farm drier has been paid back. Thus, the payback period is of importance to producers.

While Fig. 1 illustrates the cost differences between on-farm and commercial drying once the on-farm drier has been fully paid back, Table 2 illustrates the payback periods of each capacity system. The payback period was equal to the number of years needed to pay back the total fixed cost of the facility using the annual savings at varying production rates. Each system was limited to drying 166.43% of its storage capacity in a 98-day harvest season, assuming 100% of the drying capacity was used to dry rice. This harvest season was taken from the 5-year average of Arkansas rice harvest progress from the National Agriculture Statistics Service (USDA-NASS, 2019). This historical harvest season length for Arkansas, may be too long for any individual farm. When drying at full capacity, the payback periods ranged from 7.52 to 12.26 years. The smallest capacity of 1,750 m^3 had a payback period of 12.26 years, while the largest capacity of 7,000 m^3 had the fastest payback period of 7.52 years. This seemed counterintuitive, but the larger throughput of the larger drier helps pay back the initial investment quicker. When considering that payback periods needed to be less than or equal to the 10-year amortization period to be advantageous to farmers, the 1,750 m^3 capacity system was not feasible. The Arkansas state average rice yield in 2018 was 8.21 tons/ha (Hardke et al., 2018); and at this yield, at least 404.9 ha of rice was needed for any facility to be feasible within 10 years. Higher yielding producers could potentially need a larger capacity and likely experience lower payback periods via higher throughput when holding acreage constant.

Conclusions

While the high initial costs of constructing a grain drying and storage system are a significant barrier to entry for many rice producers, on-farm drying could prove to be an attractive investment relative to high commercial drying costs. Larger capacity systems were found to be more cost-effective because of the lower payback periods that were estimated. Farmers with higher rates of production would see more benefit from on-farm storage, as shown by lower payback periods for larger capacities and production rates.

Table 2. Payback periods for various capacity on-farm drying systems under different farm sizes and rice yields.

Hectares	Yield (metric tons/hectare) 7.56	8.06[b]	8.57	9.07	9.57	10.08	10.58	11.09	11.59	12.09	12.60	Capacity
101.23	27.20[a]	25.50	24.00	22.66	21.47	20.40	19.43	18.54	17.74	17.00	16.32	1,750
202.43	13.60	12.75	17.78	16.79	15.91	15.12	14.40	13.84	13.14	12.60	12.09	3,500
303.64	13.44	12.60	11.86	11.20	10.61	10.08	9.60	9.16	11.63	11.15	10.70	5,250
404.86	10.08	9.45	11.80	11.15	10.56	10.03	9.56	9.12	8.73	8.36	8.03	
506.07	10.70	10.03	9.44	8.92	8.45	8.03	9.53	9.10	8.71	8.34	8.01	7,000
607.29	8.92	8.36[c]	9.82	9.27	8.78	8.34	7.95	7.58	na	na	na	
708.50	9.53	8.94	8.41	7.95	7.53	na	na	na	na	na	na	
809.72	8.34	7.82	na[d]	na	na	na	na	na	na	na	na	

[a] Payback periods that were greater than 10 years were highlighted in red. Payback periods that were less than or equal to 10 years were highlighted in green.

[b] Arkansas rice yield averages in tons/ha for 2018 were labeled to highlight the impact of yield and variety selection on payback periods: State 8.21 (green line), Conventional 9.12 (red line), and Hybrid 10.78 (blue line).

[c] Black lines in-between cells segment production rates within 166.43% of fixed storage capacity. All production rates above a segment were feasible but may not be optimum for that system capacity.

[d] Production rates that were outside the drying capacity of any dryer in the study were labeled as "na" for not applicable.

Other potential benefits to on-farm drying, which this study did not assess and warrant further research are: the impact on harvest timing and duration, effects on the marketing abilities of farmers, and enhanced quality preservation.

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