Evaluating the Operational Efficiency and Cost Structures of Wide Row Sugarcane Production in Louisiana

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EXECUTIVE SUMMARY

Sugarcane row width has been studied for its potential to improve field efficiency and increase yields of raw sugar in Louisiana. Growers have experimented with the cultivation of eight foot rows to reduce farm input costs and improved yields compared to the traditional row width of 1.8 meters. The potential input cost savings and increased net returns to the farming operation associated with wide row sugarcane production, improved field efficiency can correspond to a reduction in the cultivation cost per acre. However, the replacement strategy of combine harvester becomes key in the grower's decision making process of wide row adoption. Therefore, this research considers that replacement strategy for the representative farm dictates that a harvester is scheduled to be replaced through investment of a new machine as the grower considers adopting eight-foot row width production. For a base yield of 7,500 pounds per acre, the additional amount of raw sugar produced per acre would have to be between 149 and 450 pounds per acre to offset the machinery costs associated with the adoption of wide row sugarcane production. When the investment costs are compared to improved field efficiency and potential increases in raw sugar yield, this research suggests that positive economic gains can be realized from the investment of widened row width systems by as much as $29.68 per acre.

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There is growing interest in incorporating increased row width in sugarcane production. Although producer-specific, most sugarcane farms in Louisiana have traditionally used a row width of six feet (72 inches). The adoption, or conversion to a wider eight foot (96 inch) row width calls for either modification of existing six foot equipment and/or purchase of additional farm machinery specifically designed to accommodate these new production practices. Therefore, farm operators will need to decide between investing in new equipment, modifying existing farm machinery, and/or on some combination of the two (modification/purchase). Farm operators will have to tailor their needs to that option which best fits their overall farm business plan.

With increased row width, the literature suggests a yield advantage anywhere from between three to ten percent under an eight foot (96 inch) row sugar production system (Richard and Gravois, 2016; Mintz, 2019). Other work in Louisiana has documented increased sugar yields ranging from between four to six percent. Engineering specifications from John Deere also suggest increased per acre fuel efficiency with their newer eight foot harvester, theoretically requiring less diesel fuel per hour, per acre of operation.

Some producers in Louisiana have used the positive economic and environmental aspects of eight foot rows as reason for considering this type of production while others have followed the line of reasoning that increasing the linear feet of a planted furrow will increase yield (Richard and Gravois, 2016). Richard and Gravois go on to say that while there are more row feet per acre of planted cane furrow, there are fewer row feet to travel on a per acre basis. There are 7,260 linear row feet per acre with six foot rows but only 5,445 linear row feet per acre on eight foot rows. When it comes to travel distances in an acre, this amounts to a 25% reduction in travel distance and fewer turns for farm machinery to make. This translates into a possible fuel savings for harvester and field operations. In addition to having the ability to reduce fuel and labor expenses, wide row sugarcane production has been shown as a tool in helping manage soil compaction in Australia (Garside, Bell, and Robotham, 2009). The authors state that "results suggest that controlled traffic can be adopted in the Australian sugar industry by changing from a 1.5-meter single row to 1.8-meter dual row configuration without yield penalty."

The combination of mismatched wheel and row spacing and heavy axle loads results in severe soil compaction, not only in the inter-row but also in the area adjacent to the row and even the row itself (Garside, Salter, and Kidd, 2008). By having controlled traffic with proper wheel and row spacing, some experts both in Australia and in the United States feel that less mud and trash would be introduced into harvested billets, thus, improving the commercial recoverable sugar (CRS) per ton of sugarcane.

Based on conversations with industry experts and Louisiana sugarcane growers, information was assembled to provide a preliminary economic overview of the potential gains from eight foot row adoption in Louisiana. From the outset of our research, it was evident that any consideration of switching row width would necessitate a farm maintaining six foot row capability (for a certain period of time) while simultaneously incorporating eight-foot row production practices (along with eight foot row equipment). This would continue until all farm acreage had been converted over to eight foot row production.

Switching row configuration involves capital investment in equipment, either through customized modification of existing equipment or the purchase of new equipment and is accomplished via modification/purchase of tractors (axle width), modification of planting wagons and cultivator/row packers, and adjusting sprayer booms. Based on conversations with project cooperators, the planting method of sugarcane (e.g. whole stalk or billet) is one factor in the degree of the modification costs necessary to facilitate an eight foot row width production system. Project cooperators indicated that machinery fabrication was done primarily on-farm when applicable. Depending upon the planting method, existing whole stalk planters require either a slight axle modification (~$8,000) or a custom fabricated planter tailored specifically for billet planting systems (~$85,000). Common to both billet and whole stalk planting systems, tractor wheel spacers (hubs) would need to be added at an approximate cost of $1,000, fertilizer rigs would need to be widened subsequently requiring new coulters, hoses, and pumps ($1,500); drums used to pack the rows would need to be widened ($5,000); and folding spray rigs would also have to be widened ($1,500). For whole stalk planting systems, cooperators purchased a row opener/packer implement at an estimated cost of $30,000. These sugarcane grower cooperators estimated that their cultivation equipment investment ranged between $75,000 and $178,000. However, through conversations with sugar industry professionals, the acquisition of custom fabricated new equipment would be estimated to fall somewhere between $85,000 to $250,000. The largest conversion expense would be the purchase of an eight foot combine harvester. It is noted that modifications can be made to existing six foot combine harvesters, but requirements for the specific conveyor guide extenders, shears, and frame adjustments needed in such a conversion are uncertain and highly variable. Through conversations with grower cooperators, this modification is estimated to total $90,000. Figures 1 and 2.

Figure 1. Whole stalk equipment modification performed by project cooperators. Clockwise: row cultivation implement, harvester modification to chopper, axel modification for planting wagon, and tractor wheel hub modification.

Figure 2. Billet equipment modification performed by project cooperators. Clockwise: folding boom sprayer modification, roller implement, row cultivation implement, and tractor wheel hub modification.

This preliminary range of costs for conversion is associated with those costs for modifying existing farm equipment for whole stalk/hand planting operations (lower bound) and billet planting systems (upper bound) that would require custom fabrication/purchase of a new planter. The decision whether to purchase a new eight foot harvester is considered later in the analysis and is contingent upon secondary assumptions regarding farm size and farm equipment replacement strategy.

This information was provided to the LSU Agricultural Center from independent project cooperators and it should be borne in mind that costs amongst producers will vary and are partially correlated to that producer's ability to modify/convert existing equipment on-farm as opposed to having any conversions/modifications contracted off-farm. Assuming a straight-line amortization rate of 5.25 percent for these modifications/ conversions, additional per acre costs range from $19.36 to $56.96 per acre over a five-year schedule on a 1,000 acre representative farm with harvest through third stubble. A five-year amortization period was adopted so as to capture attendant costs over one growing cycle. Annualized investment costs are treated as fixed costs and are considered an additional cost outlay in addition to machine ownership costs.

Total fixed costs for a representative six foot row sugarcane farm are estimated to be $155.77 per acre and include cultivation, planting, and harvest machinery costs. Of this $155.77 fixed cost, cultivation and planting machinery fixed costs are estimated to be $73.07 per acre while the remaining $82.68 are associated with harvest machinery. While initial conversion costs may have been inflated due to trial and error on the part of the initial adopters, the authors would like to reiterate that startup costs will vary, sometimes greatly. In addition to the above decision whether to modify or purchase new equipment (less harvester), an additional imposing decision for a producer that is considering switching row widths would be whether they should modify their existing six foot sugarcane harvester to accommodate eight foot rows or purchase outright a dedicated eight foot row harvester.

When considering a 1,000 acre representative sugarcane farm, the tractor size/capacity needed for each implement is ultimately one of the key factors in calculating fuel consumption and labor costs associated with a specific field activity. The representative farm methodology allows for the incurred production cost for each phase of the sugarcane crop to be weighted relative to the share of acres that correspond to fallow, planting, and stubble actives in efforts to calculate a weighted cost per rotational acre. This 1,000 acre farm grows sugarcane in a five year rotation with harvest occurring through third stubble (Deliberto and Hilbun, 2020). This does not imply that the average sugarcane farm size in Louisiana is 1,000 acres; rather, this selected acreage size (1,000 acres) is used as an illustration to identify the percent of acres in commercially harvestable sugar.

The adverse prevailing labor wage rate of $11.83 per hour for Louisiana along with a diesel fuel price of $2.44 per gallon were used. With eight foot row production, it is hypothesized that there are certain efficiency gains in terms of both fuel and labor (variable cost) savings of approximately $5.00 per acre that could be realized by a sugarcane producer. This savings of $5.00 per acre is weighted to reflect the varying stages of production on a 1,000 acre representative sugarcane farm. Tables 1 and 2. When examining eight foot row field operations, assumptions as to labor and fuel savings were grouped by field activity (coupled with the number of field passes) and range anywhere, depending on the operation, from $2.40 to $4.80 per acre (unweighted). Table 3. Each operation of sugarcane cultivation was referenced from Deliberto and Hilbun, 2020. The listing of field activities corresponds to standard production practices and engineering assumptions prevalent in the sugarcane industry in Louisiana. As no two farms are identical in their field activities, practices and field passes contained in Table 3 vary in terms of soil type, weather conditions throughout the production year, and the previous year's harvest time traffic field conditions.

Table 1. Cultivation equipment and the required number of field passes on modified equipment.

Equipment/Implement	Fallow	Planting	PC	1S	2S	3S
Row Marker	1	--	--	--	--	--
Hipper	5	2	5	4	4	4
Plow	1	--	--	--	--	--
Row Opener	--	1	--	--	--	--
Row Cover	--	1	--	--	--	--
Offbar	--	--	1	4	4	4
Number of field passes will vary farm to farm. Field passes are based on representative farm analysis employed in this research.						

Table 2. Operational acreage distribution for 1,000 acre farm converting to eight foot rows (shaded boxes denote eight foot row configuration).

Field Activity/Crop Stage	Year 1	Year 2	Year 3	Year 4	Year 5
Fallow	**200**	**200**	**200**	**200**	**200**
Seedcane Exp.	**3.3**	**3.3**	**3.3**	**3.3**	**3.3**
Planting Ops.	**196.7**	**196.7**	**196.7**	**196.7**	**196.7**
PC	**200**	**200**	**200**	**200**	**200**
1s	**200**	**200**	**200**	**200**	**200**
2s	**200**	**200**	**200**	**200**	**200**
3s	**200**	**200**	**200**	**200**	**200**

Table 3. Labor and fuel costs savings associated with eight foot modification.

Crop Phase	Efficiency Gains (unweighted)	Efficiency Gains (weighted)
Fallow	$4.20	$0.84
Whole Stalk Hand Plant	$2.40	$0.09
Mechanical Plant	$2.40	$0.47
Plant Cane Field Operations	$3.60	$0.72
First Stubble	$4.80	$0.96
Second Stubble	$4.80	$0.96
Third Stubble	$4.80	$0.96
Total	$27.00	$5.00

In attempting to model performance rates along with estimated fuel and labor costs for sugarcane equipment, the formula that was used for calculating the acres per hour (APH) coefficient (Equation 1) followed those recommendations of the American Society for Agricultural and Biological Engineers (ASABE) and is expressed mathematically as:
Equation 1. Acres per hour (APH) coefficient.

$$APH = \frac{FS \ x \ MW \ x \ FE \ x \ 5{,}280}{43{,}560}$$

Where APH is a measure of the acres per hour; FS is a measure of field speed (miles per hour); MW measures the width of the farm machine (feet); FE is a measure of field efficiency (%); 5,280 is a measurement of the amount of feet per mile; and 43,560 is the measure of square feet per acre.

In comparing any potential gains between a six foot row traditional sugarcane production and that of an eight foot row, any gains in harvest efficiency would be significant as harvesting costs constitute a significant share of total direct farm costs (28.8% on a 1,000 acre representative farm). In this analysis, we compare scales of efficiency between a traditional six foot row sugarcane harvester and an eight foot row sugarcane harvester. We calculated both the ownership, operating, and capital costs for both machines (Kay, Edwards, and Duffy, 2016). We then calculated the potential savings resulting from gains in increased efficiency that an eight foot harvester could potentially offer. Both machines (six foot and eight foot) were assumed to have a ten-year useful life, an amortization rate of 5.25 percent, a farm diesel unit price of $2.44 per gallon, and a $15.30 per hour operator labor rate (Deliberto and Hilbun, 2020). An eight foot harvester purchase cost of $450,000 and a six foot harvester purchase cost of $370,000 were also assumed from conversations with project cooperators. Based on engineering assumptions, performance rates of 2.04 acres per hour for the six foot harvester and 1.53 acres per hour for the six foot harvester were assumed. The difference in the assumed performance rates for the two production systems equates to an efficiency gain of 33 percent for the eight foot harvester. Efficiency gains were classified as less running time for the eight foot machine as opposed to the six foot machine. In our analysis, we assumed an annual usage rate of 750 hours for the six foot machine (Deliberto and Hilbun, 2020) and 500 hours for the eight foot machine. Table 4.

Table 4. Basic ownership/operational assumptions for six and eight foot harvesters.

Parameter	6 Foot Harvester	8 Foot Harvester
List Price	$400,000	$478,000
Purchase Cost	$370,000	$450,000
Salvage Value	$48,000	$57,360
Average Value	$209,000	$253,680
Ownership Life (years)	10	10
Estimated Annual Use (hours)	750	500
Interest Rate (cost of capital)	5.25%	5.25%
Price of Fuel (per gallon)	$2.44	$2.44
Labor Cost (per hour)	$15.30	$15.30
Performance Rate (acres per hour)	1.53	2.04

In evaluating ownership costs for both machines, costs associated with depreciation, interest, taxes, insurance, and housing were calculated to obtain total annual ownership costs for both. Annual ownership cost for an eight foot machine was calculated to be $56,387 and $46,308 for a six foot machine. These annualized ownership costs were then applied over the expected hours of annual use for each machine (500 hours for the eight foot machine, 750 hours for the six foot machine) in order to obtain a per hour cost of ownership. The per hour cost of ownership for the eight foot machine equates to $113 per hour and $62 per hour for the six foot machine. A larger capital cost along with reduced annual usage equates to the eight foot machine's higher per-hour ownership cost. Table 5.

Table 5. Ownership cost assumptions for six and eight foot harvesters.

Parameter	6 Foot Harvester	8 Foot Harvester
Depreciation	$32,200	$39,264
Interest	$10,973	$13,318
Taxes, Insurance, Housing	$3,135	$3,805
Total Annual Ownership Costs	$46,308	$56,387
Ownership Costs per Hour	$62	$113

In calculating the operating costs for both machines, projected repairs, fuel cost, lubrication cost, and labor cost were calculated for both machines using standardized engineering formulae. For purposes of this study, horsepower differences between both machines were taken into account in the calculation of the above operational cost parameters. The annualized cost of operation was calculated to be $65,899 for the eight foot machine and $85,176 for the six foot machine, equating to a per hour operating cost of $132 per-hour for the eight foot machine and $114 per-hour for the six foot machine. Table 6.

Table 6. Operating cost assumptions for six and eight foot harvesters.

Parameter	6 Foot Harvester	8 Foot Harvester
Repairs	$40,200	$32,026
Fuel Cost	$27,135	$21,472
Lubrication	$4,070	$3,221
Labor Cost	$13,770	$9,180
Total Annual Operating Costs	$85,176	$65,899
Operating Costs (per hour)	$114	$132

We then calculated a total cost per acre for both machines which takes into account the sum of both the ownership and operating costs divided by that machine's performance rate. The calculated total costs per acre were calculated to be $119.89 and $114.58, for the eight foot machine and six foot machine, respectively. Although there is disparity in both the purchase price and, subsequently, total ownership cost, the advantage in the performance rate of the eight foot machine over that of the six foot machine is one factor that closes the gap between total cost per acre between both machines. Tables 7 and 8.

Table 7. Total per hour operating cost assumptions for six and eight foot harvesters.

Parameter	6 Foot Harvester	8 Foot Harvester
Ownership Costs (per hour)	$61.74	$112.77
Operating Costs (per hour)	$113.57	$131.80
Total Costs (per hour)	$175.31	$244.57

Table 8. Total per acre operating cost assumptions for six and 8 foot harvesters.

Parameter	6 Foot Harvester	8 Foot Harvester
Ownership Costs (per acre)	$40.36	$55.28
Operating Costs (per acre)	$74.23	$64.61
Total Costs (per acre)	$114.58	$119.89

Under our assumptions, the labor and fuel savings associated with non-harvest field operations nearly off-set the increased total costs incurred with buying an eight foot harvester. However, as annual use (in hours) are increased, total costs per hour would decrease as the larger eight foot machine is able to harvest 0.51 acres per hour more than the six foot machine. In our analysis, however, harvestable acres of sugarcane are held constant for both eight and six foot systems. Thus, the economic benefit in switching to eight foot row production cannot solely be determined from a machine ownership perspective due to the narrow gap between the cost per acre between both eight and six foot machines.

As some sugar mills offer custom harvesting operations to its growers, this opportunity can represent a substantial cost savings to the grower if they do not wish to purchase an eight foot harvester. Custom harvest group rates vary but are typically based on a dollar per-ton equivalent (e.g. $5.00 per ton of harvested can per acre).

The above discussion does not account for any potential gains from increased yields or the net economic benefits resulting from reduced soil erosion and/or reduced soil compaction/rutting as more efficient field cultivation practices utilize fewer rows. From the perspectives of both agronomics and field engineering, more detailed information is needed that is specific to eight foot row sugarcane production in order to further extend and quantify the economic advantages eight foot row production potentially offers versus traditional production practices.

If there *is* an increase in yield, experts suggest increases of yield of one, three and five percent as most realistic. For calculation purposes, assuming a raw sugar price of $0.26 per pound, a base sugar yield of 7,500 pounds per acre and a corresponding 50.8 percent grower's share of raw sugar production, a grower could potentially see additional revenues of $9.91, $29.72, or $49.53 per acre in an eight foot row production system, respectively.

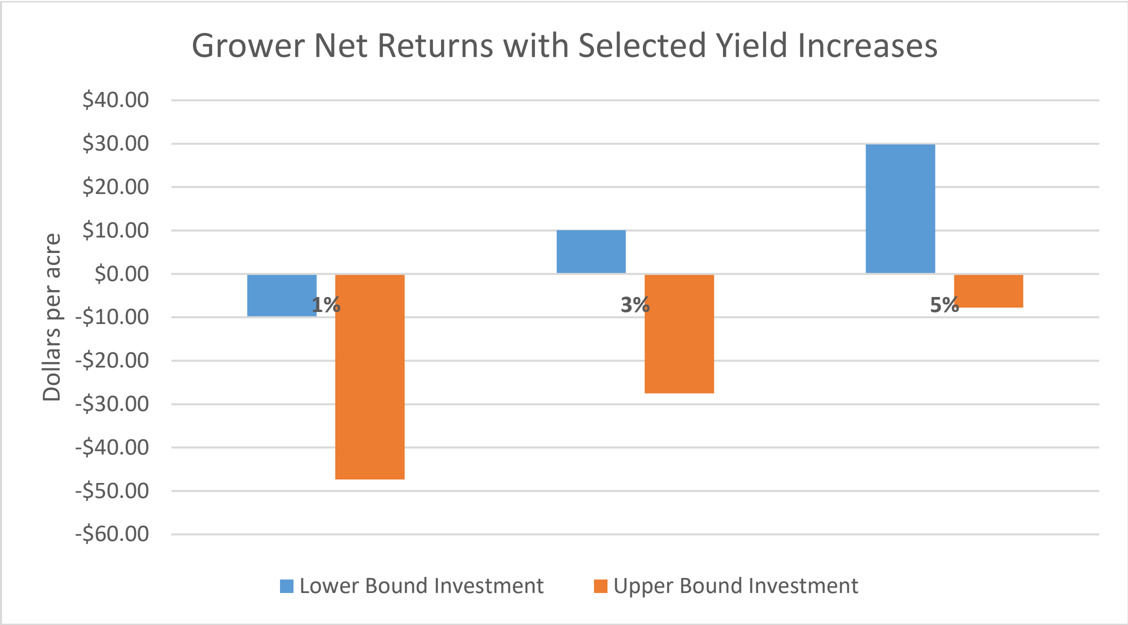
Overall, when a producer is considering switching over to wide row sugarcane production there are many factors to be considered. There are potential cost savings, potential increased yields and *also* potential increases in capital costs. While one might be inclined to base their decision for or against wide row adoption upon one of the potentials listed above, it must be said that all potentials together should factor into a producer's decision making process. A summary of this research is presented is Table 9, those values that are positive/negative are to be viewed as a net positive/negative to a grower's bottom line (per acre).

Table 9. Summary of the potential cost savings and revenue from eight foot sugarcane production.

Production System	Field Cultivation Costs	Investment Amortization	Harvesting Ownership Cost	Harvester Operating Costs	Crop Revenue
8 Foot Rows	+$5.00	- $19.36 to - $56.96	-$14.93	+$9.62	+$9.91 to +$49.53

The price of raw sugar received (cents per pound) also influences the breakeven amount of sugar warranted to cover the machinery amount that is outlaid in a non-revenue generating phase of the crop cycle. Increases in the price of sugar to the producer (50.8% grower share) can impact the pounds of sugar needed to offset a cost increase. Figure 3 incorporates potential efficiencies gained in eight foot row sugarcane production to a grower's net revenue (GNR). When these efficiencies are coupled with potential increases in yield that exceed 1.98% of our assumed base yield of 7,500 pound of raw sugar per acre (50.8% grower share), conversion would appear to be economically beneficent. Assuming an $85,000 conversion investment in Table 12 given a 1%, 3%, or 5% yield increase. At the upper bound of conversion cost ($250,000 investment), the representative farm would need increased yields upwards of 6% to approach economic beneficence under the same set of economic assumptions. Alternatively stated, the additional amount of raw sugar needed to make switching row configuration economically beneficent at the lower bound (1.98%) would be 148.5 pounds per acre. As the grower incurs additional costs of conversion, the increase in additional raw sugar needed at the upper bound (6%) would be 450 pounds per acre. Conversely, this additional amount of raw sugar required could be interpreted as the breakeven yield increase to offset conversion costs. Figure 3.

Figure 3. Potential per acre changes in GNR with eight foot row adoption across competing investment levels.



Costs associated with either modifying or purchasing new wide row sugarcane equipment (less harvester) were calculated first. We then compare purchasing (new) a traditional six foot row harvester with an eight foot row harvester. The performance rates for both machines were compared and assumptions as to gains in efficiency for the eight foot machine were calculated. Following suggestions from the literature of increased, sugar yields from wide row sugarcane production, sugarcane yields were increased by one, three, and five percent. Assuming a base sugar yield of 7,500 pounds of sugar per acre along with a sugar price of $0.26 per pound, additional revenue (grower's share) was then calculated. When one combines the above modification/purchase costs, harvester gains, and increased revenues, producers would need to realize an increase of 1.98 percent at the lower bound of modification costs ($85,000) and 6.00 percent at the upper bound of modification costs ($250,000) for eight foot row production to be feasible. Although, the investment of cultivation equipment modification and harvester purchase represent a significant sum of money, positive economic gains can be realized through the adoption of eight foot rows. Results from this study suggest that increases in the amount of raw sugar produced per acre from 149 to 450 pounds per acre in excess of the assumed base yield of 7,500 pounds per acre are needed to offset the increased costs of machinery modification necessary for wide row production.

In closing, eight foot row sugarcane production provides an interesting alternative to the traditional six foot row for Louisiana sugarcane production. Even though wide row sugarcane production may not be for everyone, several farming operations in Louisiana are making the new eight foot row system work. As more data becomes available, increased insight into the benefits and challenges that come with wide row sugarcane production will be more apparent. Hopefully, this information will prove beneficial to a dynamic sugarcane industry eager to maximize both profitability and operational efficiency.

REFERENCES

American Society of Agricultural and Biological Engineers (ASABE). 2006. *ASABE Standards*. St. Joseph, MI.

Deliberto, M. and B. Hilbun. 2020. *Projected commodity costs and returns for sugarcane production in Louisiana*. LSU Agricultural Center Department of Agricultural Economics and Agribusiness. AEIS Report No. 345.

Garside, A.L., B. Salter, and J. Kidd. 2008. *Soil compaction is a major issue operating against the development of sustainable sugarcane cropping systems*. Proceedings of the Australian Society of Agronomy 14.

Garside, A.L., M.J. Bell, and B.G. Robotham. 2009. *Row spacing and planting density effects on the growth and yield of sugarcane: 2 strategies for the adoption of controlled traffic*. Crop and Pasture Science, 60, 544-554.

Kay, R.D., W.M. Edwards, and P.A. Duffy. 2016. *Farm Management. Eighth edition.* New York, New York.

Mintz, M. 2019. *Doubling down raising cane*. John Deere's *The Furrow*.

Richard, C. and D. Gravois. 2016. *A Preliminary look at 8 foot rows in Louisiana*. Sugar Journal. Vol. 78, No. 8.

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The information within this manual has been compiled for general purposes only. All examples in this manual are hypothetical fact situations, used for explanation purposes only, and should not be considered investment advice.

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