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FINANCIAL ANALYSIS OF HAY PRODUCTION IN CONNECTICUT

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I. INTRODUCTION

Hay and grasses have lost their importance in commercial livestock operations because of substitution by various grains and oil crops like corn, sorghum, and soy. However, hay remains a primary feedstock for horses. The hay considered in this analysis is defined as dry hay in the form of small square bales. Furthermore, although hay can be made from a variety of grasses and legumes, this paper focuses on hay made from an orchard or timothy grass mix. This specific mix is a common choice among Connecticut hay producers and consumers because it is palatable for horses and is suitable for the growing conditions prevailing in much of the State.

From a broader policy perspective, hay could present an attractive option for land that is currently, or might potentially be, a part of the Connecticut Farmland Preservation Program (Connecticut Farmland Trust, 2015) but not used for farming. Therefore, understanding the financial returns associated with hay farming can provide valuable information to farmers, extension personnel, and policy makers.

The general objective of this report is to present a financial analysis for horse hay production in Connecticut using a representative farm model. The remainder of this report is organized into 5 sections. Section II provides a background concerning hay production. Section III explains the methodology used followed by the results in Section IV. The report ends with a summary and conclusion in Section V.

II. BACKGROUND

The importance of small square hay bales stems primarily from two factors. First, most of the hay in Connecticut is bought by horse owners, who are typically middle-aged women, who own one or two horses (Nadeau et. al., 2006). Secondly, the bale has to be easy to transport and handle; thus, our focus on small square bales that generally weigh between 40 and 60 pounds. Other types of bales can weigh upwards of a half a ton, requiring specialized equipment for handling, which is not commonly available in small horse operations.

In this study, we do not consider hay from alfalfa based on information gathered in the field. The farmers interviewed typically grew orchard or timothy grass combined with a variety of legumes like clover or alfalfa mixed in to boost the protein and nutritional content. Several reasons were given for not growing alfalfa as a single crop including high cost, relatively short life, and a limited market. In addition, the nutritional content of pure alfalfa hay can be too high for pleasure horses, which can be problematic if fed as a standard, forage crop (Kentucky, 2014; Standlee, 2017).

Although the market for horse hay is beyond the scope of this study, it is useful to have an overview of key variables that comprise this market. USDA census data for 2012 indicates that 1,018 operations produced hay (excluding alfalfa) in Connecticut. The 2017 USDA survey reported that 92,000 tons of hay were produced in the State on 40,000 acres. According to NASS, the median land operated by hay farmers ranges between 70 and 100 acres with an average of 73 (NASS, 2012; NASS, 2017).

The horse population in Connecticut is difficult to estimate with some precision. Horses are recorded in the Census and surveys only if they are a part of a farming operation, but horses are often held for recreation and not used for commercial purposes (Nadeau, et. al., 2006). The USDA 2007 Census reported the Connecticut inventory of horses and ponies at 11,510 while this number was 17,424 in the 2012 Census. In contrast, in 2006, Nadeau, et. al., utilizing veterinary records, estimated the horse population in the State at 43,000 horses. These statistics vary significantly over a short 6-year period; hence, a good estimate of the actual number of horses that can be used to get an idea of the hay requirements in the State is not readily available.

Here we try to provide a general idea of the hay needed for Connecticut horses. The daily hay consumption for an average horse that weighs 1,100 lbs is around 21.25 lbs or a total of 7,756.25 lbs per year (Undersander, 2002). Based on the estimated total of 43,000 horses from Nadeau, et al. (2006), the hay requirement would be 166,759 tons per year. By comparison, based on the 2012 USDA figure of 17,424 horses, the requirement would be 67,572 tons per year.

Taking into account the cattle and horse inventories together, we calculate that the total potential hay demand in Connecticut, based on the lower estimate of the horse population (17,424 horses), is 274,755 tons while the demand based on the upper estimate (43,000 horses) is 373,942 tons.[1] According to NASS (2017), the state produces 92,000 tons of hay and 18,000 tons of alfalfa per year (NASS, 2017) so, regardless of the horse number estimate used, local demand has the potential to be considerably higher than supply. Therefore, this data suggests that there is room to increase hay production. The shortage of locally produced hay is currently being fulfilled primarily from surrounding states, particularly New York. This information is summarized in Table 1.

III. METHODOLOGY

This section presents the methodology used to develop our analysis. We first discus the characteristics of the representative hay farm used. This is followed by the procedures applied to undertake the financial evaluation.

The Representative Farm

A representative farm model is developed based on information assembled from a variety of sources (CCRH, 1998; Cesaro et al., 2008). The intention is to model a farm that is *representative* of the typical situation present in the industry and location under analysis. These

[1] The hay demand for cattle is estimated at 207,179 tons assuming 19,000 head of dairy cattle and 6,000 head of beef animals. The annual per head consumption of dairy cattle is 18,665 lbs and 9,955 lbs for beef cattle.

types of models are particularly useful in examining *a priori* the impact of different assumptions, such as alternative technologies, yields, and prices (CCRH, 1998; Herbst, 1996). According to Köbrich et al. (2003), the Representative Farm Model is a valuable tool for prospective investors and producers recognizing that every firm has its own set of unique characteristics and challenges.

Our representative hay farm is constructed based on information gathered from the literature, statistical information from USDA censuses and surveys, and interviews with Connecticut hay farmers. Below we present the specific characteristics and assumptions made and how the figures were derived, followed by a summary of the base case situation (see Table 2).

Base Case Assumptions

Farm Size: The representative farm has a total of 70 acres, 30 owned and 40 rented. This acreage is consistent with Connecticut's data reported by the Census (2012) and the data gathered in the farm interviews.

Hay Bales: 50lbs per bale, 40 bales per ton.

Hay Prices[2]*:* The Base Case prices are set at $6.50 per bale for the first cutting and $7.50 per bale for additional cuttings (see Table 4 for Annual Cash Inflows). This pricing scheme is consistent with information given by the farmers interviewed. Hay prices fluctuate during the year for a number of reasons but primarily from yield variability associated with weather conditions. We acknowledge that some farmers deliver hay to some customers at a higher price per bale but here the analysis is at the farm gate.

It is also assumed that prices, in real terms (adjusted for inflation), remain constant over the 12-year period analyzed in the study. The evidence shows that real hay prices experienced limited annual growth at 0.3% over the 27-year period from 1989 to 2015 (see Figure 1).

Yields[2]: The yields used come from two alternative sources. First, we calculated a 30-year average yield of 2.0 tons/acre using USDA Survey and 2012 Census data. Second, interviewed farmers indicated significantly higher yields ranging from 3.0 to 5.4 tons/acre including all cuttings, and this clearly depends on grass type, and field and soil conditions. To reflect the two sources of yield data, we assume a base yield of 3.3 tons/acre during the revitalization period (see below) and 3.9 tons/acre thereafter.

Land, Fields, and Values: We assume that the land that is owned remains as such throughout our 12-year planning horizon. The rented land is assumed to have a cost of $60 per acre per year over the period of analysis, which corresponds to the average figure reported by the farmers interviewed.

At the beginning of the planning horizon, the land used is suitable for hay production, but we assume that all land, owned and rented, is revitalized in years 1 through 5. Revitalization is defined as the operations needed to replant or improve a field to get the desired species and

[2] Further discussion of prices and yields can be found in Appendix A-2.

productivity. The revitalization process is site specific and can include a variety of methods. According to our field data, the methods commonly used to revitalize a field are: 1) Till and harrow; 2) No-till reseeding; 3) Chemical treatment and seeding; or 4) Over seeding only. The estimated cost for revitalization is $160 per acre for 14 acres/year for a total of 70 acres, based on costs gathered from the field data.

Equipment: The new equipment cost information was obtained from established agricultural equipment suppliers (Table 3). The sizing of the equipment was done using the information provided by the farmers interviewed. The hours and usage for the equipment were calculated using both the information gathered from our field data and field efficiency formulas provided by the Iowa State University Extension and Outreach modified to reflect Connecticut conditions (Iowa, 2017). To determine the number of hours required to perform the different field operations, we used the field efficiency, field capacity, and daily operating use of each implement (see Appendix A-3).

Labor: The estimated labor expense incorporates one unskilled worker at $12.50/hr and one skilled worker at 14.25/hr. These wage rates are derived from the Bureau of Labor Statistics for Connecticut Agricultural workers and some adjustments are made from our field data. For the harvest component, labor is calculated at 120% of baling time.

Fertilizer: The cost of fertilizer is based on the average cost per acre collected from the field multiplied by the acres farmed. The equipment used for the application is assumed to be rented. Fertilizer is applied twice per year.

Fuel: The fuel cost is estimated by taking the consumption per hour for the different field operations (mowing, tedding, baling, fertilizing, etc.) multiplied by the time it takes to complete each operation. This category also accounts for oil, lubricants, and fluids used.

Machinery Maintenance: Estimates for the maintenance of the equipment include tune-ups, basic maintenance, repairs to fix breakdowns, and an annual allowance for miscellaneous items.

Soil Testing: This is a standard cost to test field fertility levels. This allows the operation to efficiently use fertilizers and other chemicals.

Miscellaneous: This cost category captures any costs that are left out of the above categories such as: baling twine; chemicals; additives; preservatives; hitches; small tools; compressors; etc.

Fixed Cash Outflows: This includes insurance, equipment storage, and taxes on all equipment, liability insurance, property taxes, and rent. The itemized list can be found in Table 5.

Financial Analysis

The following three indicators are used to determine the financial viability of hay production for our representative farm: Net Present Value; Internal Rate of Return; and Payback Period.

Net Present Value: The Net Present Value (NPV) is the difference between the present value (PV) of cash inflows and cash outflows, i.e., the PV of net benefits. When NPV is used correctly it consistently provides the right answer. The equation for NPV is as follows:

$$NPV = \sum_{0}^{t} \frac{NB_t}{(1+r)^t} = -\mathrm{I}_0 + \sum_{1}^{t} \frac{NB_t}{(1+r)^t}$$

NB_t is the Net Benefits of the project in time period ***t***, **I_0** is the initial investment in time period zero, and ***r*** is the interest rate. The decision rule for NPV is as follows: NPV = 0, the investor would be indifferent; NPV > 0, invest; NPV < 0, do not invest.

Internal Rate of Return: The Internal Rate of Return (IRR) is the interest rate at which the NPV equals zero. In other words, the IRR represents the discount rate where the PV of Benefits (B) equals the PV of Costs (C). The formula for the IRR is as follows:

$$IRR \Rightarrow \sum_{t=0}^{n} \frac{B_t}{(1+IRR)^t} = \sum_{t=0}^{n} \frac{C_t}{(1+IRR)^t}$$

The decision rule for the IRR is as follows: IRR = rR, indifferent; IRR > rR, invest; IRR < rR, do not invest. The term ***rR*** is the required rate of return which is determined exogenously.

Payback Period: The final indicator used is the Payback Period (PP). The PP is the amount of time periods (usually years) that it would take to recover the initial investment. The PP is calculated as:

$$PP = \sum_{t=0}^{P} NB_t \geq 0$$

The decision rules for Payback Period are as follows: PP = PPD, indifferent; PP < PPD, invest; PP > PPD, do not invest. **PPD** is the **P**ayback **P**eriod **D**esired.

It is important to note that the impact of an investment or project needs to be analyzed by comparing the situation with and without such an investment. In other words, what is being analyzed are the incremental cash flows that can be attributed to the project compared to a *status quo* case (i.e. without project). In this analysis, the without project situation assumes that owned land (30 acres) would be rented out at $60 an acre per year or $1,800 total (Table 6).

IV. RESULTS

Below we first present the results of the base case scenario for the 70-acre representative hay farm based on the assumptions described above and summarized in Table 2. We then discuss the results of a sensitivity analysis on NPV, IRR, and PP.

The sensitivity analysis is performed by keeping all assumptions as in the base case scenario except for the following changes (one at a time): 1) 25% decrease in price per bale; 2) Varying rented land to 10, 20, 30 and 55 acres; 3) 10% drop in yield per acre; and 4) Purchasing used equipment instead of new. As we note below, the base case scenario generates attractive financial results; therefore, the sensitivity analysis focuses primarily on adverse situations.

The results of the analysis are found in Table 7.

Base Case: The Base Case reveals an NPV (at 6% interest rate) of $117,255; an IRR of 12.16%; and a Payback Period of approximately 8 years.

Scenario 1: A 25% decrease in the price/bale, i.e., an average of $4.88/bale for first cutting and $5.88/bale for second and third, generates the following results: NPV ($2,144); IRR 5.88%; and a PP of around 10 years. Thus, the results show that with a significant drop in hay prices the project does not remain financially viable compared to the Base Case.

Scenario 2: Varying farm size by renting different amounts of land. Here we assume that rented land changes from the base case of 40 acres to 10, 20, 30, and 55. The results indicate negative financial returns when rented acres are equal to 10, and marginal profitability at 20 rented acres, while returns remain positive in the other two cases (see Table 7).

Scenario 3: 10% Yield Reduction. Yield volatility is a common source of risk that an operation will experience and thus an important variable to include in the sensitivity analysis. The results here indicate that with a 10% yield reduction, the NPV (6% discount rate) drops to $74,469, or by $42,756, compared to the Base Case of $117,225. The IRR drops to 10.11% and the PP to 8 years.

Scenario 4: Used equipment instead of new. This option decreases the startup cash outflows, which might be appealing for operators with limited financial resources or dairy farmers seeking alternative uses for their land and who already have the required equipment. Machinery maintenance is increased by 15% to reflect the higher associated costs for used equipment.

Operating with used equipment reduces the initial investment by $65,000 from $263,000 to $198,000. This scenario exhibits an NPV (6% discount rate) of $177,585, an IRR of 17.36%, and a PP of 6 years.

Break-Even Analysis: To determine a Break-Even price per bale, we take the PV of all outflows incurred over the 12-year planning period ($253,828) and divide that figure by the total bales produced (114,576). In the Base Case Scenario, the estimated cost per bale is $2.22. The results for the sensitivity scenarios range from a cost per bale of $1.91 (Scenario 4) to $3.30 (Scenario 2, 10 acres rented).

V. SUMMARY AND CONCLUSION

The objective of this study was to examine the financial returns of a hay operation using a representative farm model. We use various sources of information to develop a base case situation as well as several scenarios to evaluate the sensitivity of the financial results. The analysis supports the conclusion that hay production, using small square bales for horse consumption and potentially other livestock species, can be a viable financial undertaking in Connecticut.

Table 1. Potential Hay Demand

Livestock Type	Population	Consumption Per Year (lbs)	Demand (Tons)
Horse (Upper Est.)	43,000	7,756.25	166,759
Horse (Lower Est.)	17,424	7,756.25	67,572
Cattle (Dairy)	19,000	18,665	177,317.5
Cattle (Beef)	6,000	9,955	29,865

Table 2. Itemized Base Case Assumptions for the Representative Farm

Item	Assumption	Comments
Hay bales	50 lb bales	40 bales in a ton
Prices	$6.50 First Cutting $7.50 Second & Third cutting	Price remains constant over project length
Yields	3.3 t/a – Year 1-5 3.96 t/a – Year 6+	Revitalization period Yields remain constant
Land	70 acres total farmed	56 acres in the first 5 years to revitalization, 70 acres for the remaining length of the project
	30 acres owned 40 acres rented	Acreage remains constant
Rent	$60 an acre	
Equipment, Machinery, and Buildings	Valued new at $263,000 at the beginning (year 0)	
Labor	Unskilled $12.00/hr Skilled $14.25/hr	Hours are billed at 120% of baling time
Variable Expenses	Fuel, labor, fertilizer, maintenance, soil testing, miscellaneous	Expenses are generally a function of acreage, time, or reported amounts
Fixed Expenses	Insurance, taxes, rent	

Table 3. Average New Machinery and Equipment Costs per Hour for a Representative 70-acre CT Hay Farm

Machinery and Equipment	Purchase Price	Salvage Value	Useful Life	Annual Use (hours)	Operating Cost per Hour
Tractor, 85hp	$51,000	$14,790	12	~187	$9.86
Mower-Conditioner	$31,000	$7,750	12	~32	$11.39
Tedder	$9,500	$1,805	12	~48	$9.37
Rake	$10,000	$1,900	12	~23	$7.39
Small Square Baler	$34,000	$7,140	12	~75	$30.35
Truck, 1-ton, gas	$41,500	$9,130	12	Yearly	-
Hay Wagon, x3	$14,000	$3,500	12	~75	-
Storage Building: 10,000 Bale Capacity	$72,000	$17,500	20	Yearly	-
Total	$263,000	$63,515			

Table 4. Total Annual Inflows-Base Case

Year 1-5 (56 acres)	Average Yield ton/A	Price Per Bale	Bales/Ton	Price/ Ton	Average Bale Count	Inflows
First Cutting	2	$6.50	40	260	4480	$29,120
2nd & 3rd Cutting	1.3	$7.50	40	300	2912	$21,840
Total Annual Inflow	3.3				7392	$50,960
Year 6+ (70 acres)						
First Cutting	2.4	$6.50	40	260	6720	$43,680
2nd & 3rd Cutting	1.56	$7.50	40	300	4368	$32,760
Total Annual Inflow	3.96				11088	$76,440

Table 5. Annual Outflows

Item	Year 1-5	Year 6+	Item		Year 1-5	Year 6+
Operating Cash Outflows			Fixed Cash Outflows:			
Revitalization Cost (14 acres a year)	2,240	-	Insurance, Taxes, Housing (ITH)			
Fertilizer, x2	3,400	3,400		Tractor	329	329
Fuel	4,000	4,000		Mower	194	194
Labor	2,600	2,600		Tedder	57	57
Machinery Maintenance	2,900	2,900		Rake	60	60
Soil Testing	50	50		Baler	206	206
Miscellaneous	1,300	1,300		Truck	253	253
				Wagons	88	88
				Building	448	448
			ITH Total		1,633	1,633
			Rent (40 acres)		2,400	2,400
			Umbrella Liability Insurance		550	550
			Property Taxes on Land (30 acres)		880	880
Total Operating Expenses	16,490	14,250	Total Fixed Expenses		5,463	5,463

Table 6. Net Cash Flows and Payback Period

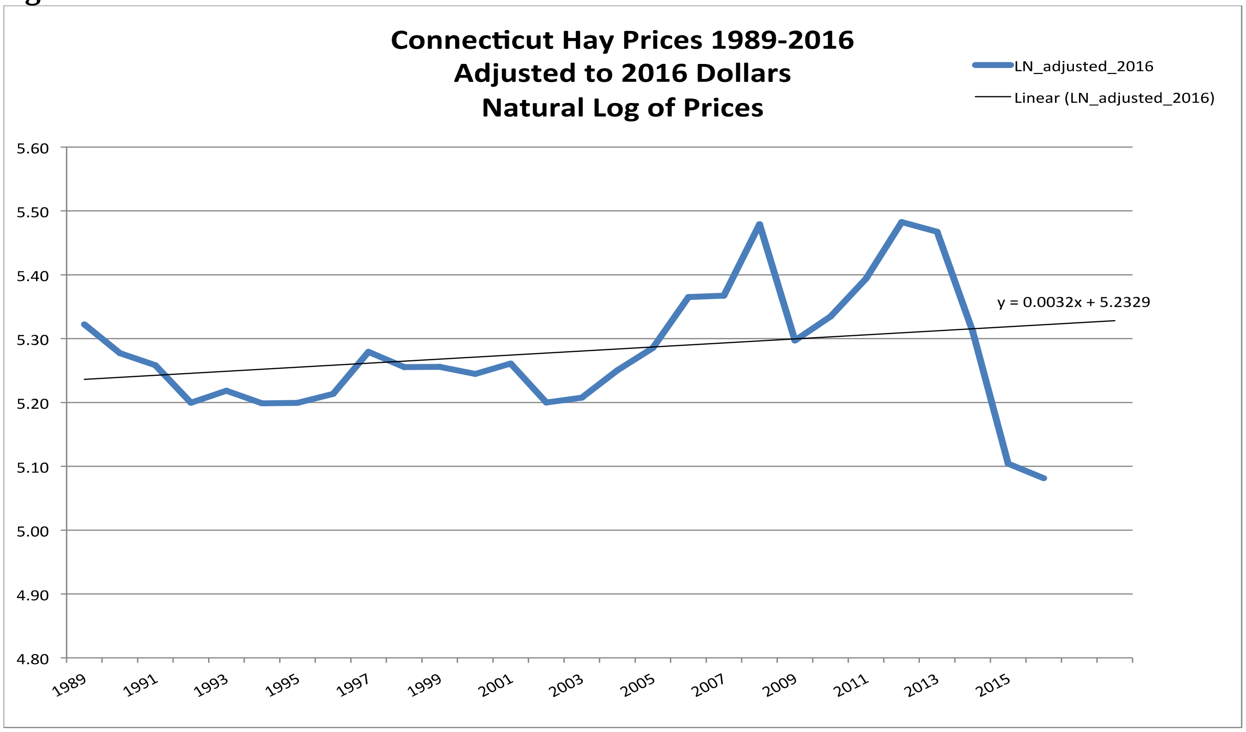
	With Project		Without Project			
Year	Cash Inflow	Cash Outflow	Cash Inflow	Cash Outflow	Incremental Cash Flow	Payback Period
0	-	263,000	-	-	(263,000)	(263,000)
1	50,960	21,953	1,800	1,430	28,637	(234,363)
2	50,960	21,953	1,800	1,430	28,637	(205,725)
3	50,960	21,953	1,800	1,430	28,637	(177,088)
4	50,960	21,953	1,800	1,430	28,637	(148,450)
5	50,960	21,953	1,800	1,430	28,637	(119,813)
6	76,440	19,713	1,800	1,430	56,357	(63,455)
7	76,440	19,713	1,800	1,430	56,357	(7,098)
8	76,440	19,713	1,800	1,430	56,357	49,259
9	76,440	19,713	1,800	1,430	56,357	
10	76,440	19,713	1,800	1,430	56,357	
11	76,440	19,713	1,800	1,430	56,357	
**12	139,955	19,713	1,800	1,430	119,872	
Net Present Value @ 6%					$117,255	
Internal Rate of Return					12.16%	
Payback Period					< 8 years	

** See Appendix Table A-1 for explanation of Yr. 12 values

Table 7. Sensitivity Analysis: All Cases

Category	Situation	NPV @ 6%	IRR	PP
Base Case	70-acres	$117,255	12.16%	Year 8
Scenario 1: Price per Bale	Price -25%	($2,144)	5.88%	Year 10
Scenario 2: Acres Rented	10-Acres	($48,479)	3.11%	Year 12
	20-Acres	$7,222	6.41%	Year 10
	30-Acres	$61,890	9.38%	Year 9
	55-Acres	$199,850	16.01%	Year 7
Scenario 3: Lower Yields	10% Reduction	$74,469	10.11%	Year 8
Scenario 4: Equipment Type	Used Equipment	$181,045	17.57%	Year 6

Figure 1.



Source:
NASS QuickStats

Appendix

Table A-1. Detailed Cash Inflows, Outflows, and Net Flows: Base Case

Inflows					Outflows				Net Flows
Year	First Cutting	Second &Third Cutting	Salvage Value	Total Inflows	Machinery and Equipment	Operating	Fixed	Total Outflow	
0					263,000	-	-	263,000	(263,000)
1	29,120	21,840	-	50,960	·	16,490	5,463	21,953	29,007
2	29,120	21,840	-	50,960	·	16,490	5,463	21,953	29,007
3	29,120	21,840	-	50,960	·	16,490	5,463	21,953	29,007
4	29,120	21,840	-	50,960	·	16,490	5,463	21,953	29,007
5	29,120	21,840	-	50,960	·	16,490	5,463	21,953	29,007
6	43,680	32,760	-	76,440	·	14,250	5,463	19,713	56,727
7	43,680	32,760	-	76,440	·	14,250	5,463	19,713	56,727
8	43,680	32,760	-	76,440	·	14,250	5,463	19,713	56,727
9	43,680	32,760	-	76,440	·	14,250	5,463	19,713	56,727
10	43,680	32,760	-	76,440	.	14,250	5,463	19,713	56,727
11	43,680	32,760	-	76,440	·	14,250	5,463	19,713	56,727
12	43,680	32,760	63,515	139,955	·	14,250	5,463	19,713	120,242

Operating Outflows are equal to the sum of: revitalization cost (until yr. 6), fertilizer, fuel, labor, machinery maintenance, soil testing, and miscellaneous cost.

A-2. Prices and Yields

Prices in the field often differ from the figures used to prepare the analysis. The price depends on distance to the market, consumer type, and perceived quality. Prices also vary from season to season primarily based on weather conditions. The key point is that the price of hay for horses can vary considerably and reliable official price data is not readily available.

Official hay prices, according to a conversation with James Johanson, the National Hay Statistician at the National Agricultural Statistics Service, are calculated twice a year based on voluntary reports and average prices reported by producers. These prices include all hay types at various quality levels, which makes it difficult to readily obtain the price of a horse quality hay. Mr. Johanson confirmed that, according to field offices, horse quality hay receives a higher price over other types of hay on the market.

Reported yields also complicate matters. Similar to how the prices are reported, yields for all hay types are recorded at the same time, including single yield hay species. The issue results in a miss-timing of the calculation of yields and not allowing all of the information to be incorporated.

A-3. Field Capacity and Hours for Completion: Base Case

Equipment Type	Width (ft)	Safe Operating Speed (MPH)	Field Efficiency	Field Capacity Acres/Hr	Acres Completed (Seasonally)	Total Hours Used**
Square Baler*	6	5	0.625	2.86	210	74.7
Mower	9.13	9	0.65	6.47	210	32.4
Rake	13.8	8.5	0.65	9.24	210	22.7
Tedder	13	8.5	0.65	8.71	420	48.2
Fertilizing	-	-	-	15	140	9.3
Tractor	-	-	-	-	-	187.4

* Square baler Field Capacity is reported as average of 3 cuttings

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