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### Mismatched Equipment Creates Bottlenecks

*From Hay & Forage Grower Magazine*

- In an article written by Amanda Smith, she brings to light the inefficiencies created when pieces of equipment within your fleet are not properly matched. Decreased efficiency and increased man hours ultimately means profit loss in more ways than one. Not only does it incorporate the increased risk of nutrient loss in your hay crop due to variability in weather, but also the opportunity costs involved with being able to do more with your time. Equipment matching to build the most efficient fleet for your operation is the first step to increasing your Return on Investment. "In a hay making system, each piece of equipment needs to match the size and field efficiency of the other pieces. Even if just one piece is not as efficient as the others, it can create a bottleneck. Such slowdowns elevate the risk for rain damage, lower forage quality and elevate costs per ton." (Smith).

**CASE IH** March 30th, 2019 - High Efficiency Hay Production

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### Chapter 1: Improving Your Fleet, One Piece at a Time

#### The Right Tools for the Job: Evaluation and Selection Criteria

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### Starting with the Tractor

Equipment Matching

- The majority of the time, the most expensive part of your fleet is the tractor. It is also considered the most important due to it usually being asked to perform multiple tasks.

Key Tractor Specifications	
Engine Horsepower	Generally, if you have enough PTO HP then you will have sufficient engine HP. However, terrain may be a factor that could require more power than the implement spec calls for.
PTO Horsepower	Always pay attention to PTO HP requirements of implements. Under powered tractors can result in not being able to run a machine, excessive wear, and reduced capability.
Weight	Often times, implements such as balers can be very heavy. It is important, especially on hills, to ensure that your tractor is heavy enough to handle it.
Hydraulics	Number of remotes and hydraulic flow has the potential to influence every implement you own. How many remotes do you need to operate each function on the machine? Could increased hydraulic flow decrease my tailgate cycle time, ultimately improving efficiency?

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### Laying it Down

Equipment Matching

- Mowers are one of two implements that often drive the PTO horsepower requirements of your tractor. More importantly, cut width and windrow width are determining factors for the equipment that completes the jobs that follow.

Key Mower Specifications	
PTO Horsepower Requirement	What came first, the tractor or the mower? PTO horsepower requirements can determine tractor size, just as tractor size can determine mower size.
Cut/Windrow Width	Cut width and windrow width are two critical specifications in their own right, but even more so when looked at as one. Cut width combined with speed can determine acres per hour. Windrow width can influence dry down time. Combined, they can determine the working width requirements of your tedder and/or rake.
Conditioning Systems	Conditioning systems have a direct effect on dry down time and crop quality. If selecting a mower with a conditioner, be sure to know pro and cons of each style and what would be best suited for your crop type(s).


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### A Fork in the Field

Equipment Matching

- After mowing your hay, there are various routes you can take before you get to your baler depending on what you are trying to make. Baling wet hay? Often times this can be accomplished by windrowing it straight out of the mower and skipping any steps in between. Making dry hay in a short window? Maybe adding a tedder to your fleet could prevent profit loss due to mold or rain damage. Need to turn your windrows? Could combining windrows increase your tons per hour and decrease your baling time? A rake can be a crucial asset to any operation, with any crop type, wet or dry. Determining the intentions of your operation will determine the units you need, but don't forget that it may pay to have that extra piece in your wheel house when you need it.




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### Tedding

Equipment Matching

- Tedding has become a more and more popular practice over recent years, despite crop types. Working widths are the key specification, with things like number of baskets or tine design that can affect the quality of spread the machine is capable of. The key to successful tedding is creating an even cover of material while being efficient yet careful on crops, primarily legumes. When selecting widths, take into consideration your total number of acres, how many windrows you want to ted in one pass, and the cut and windrow widths of your mower.




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### Forming your Windrow

Equipment Matching

- With multiple types and sizes, how do you know what rake fits your operation? Rakes can often be the limiting factor of your fleet because the requirements are affected by both the capacities of the implements used before and after.

Key Rake Specifications	
Style	How do you know whether you want a rotary, wheel, or basket rake? These decisions are often based on price, preference and what you're pulling it with. Terrain and field sizes can also be determining factors.
Working Width	Working widths and capabilities on rakes becomes very crucial. With a lot of options, it can be difficult to decide what machine can optimize your capabilities. Do you want to turn one, two, three or more rows at a time? These are all things you need to know before selecting the rake that is best for you.




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### Rolls or Squares? Baler Options

Equipment Matching

- Balers, where do we even begin? Chances are you know what kind of baler fits your operation. With small and large square balers, round balers and a multitude of options within them, there is something for everyone. When feeding cows is your primary focus, round balers are the most cost efficient machines to package your crop. It again comes down to key features and specifications to help guide your decision.

Key Baler Specifications and Features	
PTO Horsepower Requirement	Possibly your mower and baler have similar power requirements, or maybe one is significantly higher than the other. Be sure you know what implement requires the most power and have the tractor capable of handling it.
Type and Size	In relation to PTO horsepower, it is directly correlated to the type and size of baler you want to run. Upgrading from a 4x5 dry hay configuration to a 5x6 silage? You better be prepared with a tractor capable of producing the adding horsepower required.




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### Rolls or Squares? Baler Options

Equipment Matching

Key Baler Specifications and Features	
Wet or Dry Hay	The most important piece of information here is not to expect a machine intended for dry hay to perform like it needs to in high moisture situations. If you are baling wet hay, silage balers tend to fair better than just balers with silage kits. How much baling you plan on doing will determine the configuration you need.
Features	Wet or dry hay and intended use both play a part in the baler features that can save you time and money. Are you grinding hay? Precut knives or bale slice systems can dramatically decrease grind time, just be aware they may increase the power requirement of that machine. Same goes for wet or dry hay. Pick up systems, debris solutions and more can increase capacity in wet conditions.
Intended Hay Use	Are you feeding or selling? Hauling long distance or down the road? When it comes to feeding cows, you can beat the efficiency and cost effectiveness of a round baler. If your are selling, everything depends on customer demands and your market.




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### Storage A Key Component to Minimizing Loss

Equipment Matching

- Too many times do people consider the job done once the bales are made. Proper storage is a key part in minimizing loss and maximizing feed efficiency. Bale density is the most important factor to protecting your bales from weather and aging. With sheds, we can become limited on space. When storing outside, we become more susceptible to loss due to climate and damage. Increased bale density allows for you to get the same tonnage in less bales. This saves trips in and out of the field, as well as space in your barn. Increased bale density can also decrease the ability for oxygen and water to infiltrate the bale, resulting in better hay preservation. Wrapping wet hay to seal out oxygen and allow for proper fermentation is a huge benefit when trying to capitalize on the capturable nutrient amount in your hay. It can also be cost effective to wrap dry hay to prevent damage from the elements and preserve color, which can be worth a premium at the time of sale.



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## Chapter 2: To Manage, You Must Measure

### Interpretation: Matching Equipment Specifications and Outputs

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## Power Units

### Equipment Matching

- Rule of thumb, PTO horsepower is equivalent to 86% of total engine horsepower. For the following calculations, we will use this rule.

Engine Horsepower	PTO Horsepower
50	43
75	64
100	86
125	107
150	129
175	150

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## Mowers

### Equipment Matching

- A lot of factors play a part in the horsepower requirements needed for your mower. Things such as implement weight, cut type, mounted or trailed, and conditioning systems are all factors. Sicklebar machines tend to require less horsepower than disc mowers. These are specs from Case IH mowers. *NOTE: This data will fluctuate based on manufacture and conditioning systems.*

All Case IH sicklebar conditioners have 60 PTO HP requirements.

Cutterbar Width	Minimum PTO Horsepower Required
5'6"	35 – Economy Mounted
6'8"	45 – Heavy Duty Mounted (40 – Economy)
7'10"	55 – Heavy Duty Mounted (50 – Economy)
9'2"	65 – Side Pull Conditioner (60 – HD Mounted)
10'4"	80 – Side Pull Conditioner
13'	90 – Center Pivot Conditioner
16'	100 – Center Pivot Conditioner

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## Rake/Tedders

### Equipment Matching

- In order to figure your needed working widths for rakes and tedders, you must know the cut width and windrow width of your mower along with how many windrows you want to cover at once. The working width calculations are as follows:
  - Total Swath = Cut Width x Number of Passes
  - End Gap = Cut Width – Windrow Width
  - Required Working Width = Total Swath – End Gap
- Take into account that rake requirements can vary based on tedding as well as rake styles. For instance, a rotary can require more total working width than a wheel rake.

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## Rakes/Tedders

### Equipment Matching

Windrow Width	Cut Width	Number of Windrows	Total Swath	End Gap	Required Working width
3'	5'6"	1	9'2" x 3 = 27'6"	9'2" – 6' = 3'2"	27'6" – 3'2" = 24'4"
3'6"	5'6"	2			
4'	6'8"	3			
4'6"	7'10"	4			
5'	9'2"				
5'6"	10'4"		13' x 2 = 26'	13' – 4' = 9'	26' – 9' = 17'
6'	13'				
6'6"	16'				
7'					

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## Rakes/Tedders

### Equipment Matching

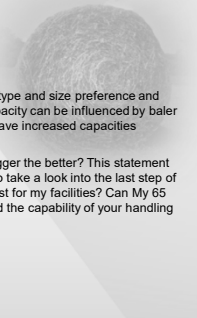
- While working width is most important on the front side to ensure you can gather enough crop to fill your windrow, it is also important to think about the dimensions and shape of the windrow behind the rake. Forming a windrow consistent and full windrow that will maximize your balers capacity is extremely important to your success in the next step. Keeping your baler full all the time and at maximum capacity will increase your bales or tonnage per hour and decrease the time spent on your final pass through the field.

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## Balers

### Equipment Matching

- The decision making behind balers is generally derived from baler type and size preference and configuration needs as stated in chapter one. Changes in baler capacity can be influenced by baler size, type, and even year as often times newer generation balers have increased capacities relative to their older counterparts.
- So if increased efficiency is dependent upon increased size, the bigger the better? This statement is far from true. When thinking about potential bale size, we need to take a look into the last step of the process. That last step is handling and storage. What works best for my facilities? Can My 65 HP tractor handle a 5x6 round bale? Bale size should never exceed the capability of your handling equipment.




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## Chapter 2: To Manage, You Must Measure

### Understanding Variables by Applying Numbers: The “What If’s” of Hay Production



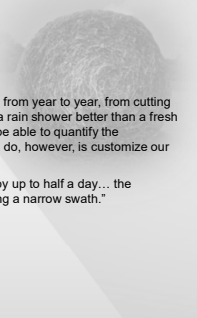
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## Windows and Weather

### The Unpredictable

- Hay making windows will vary from North to South or East to West, from year to year, from cutting to cutting, day to day and even hour to hour. (Nothing encourages a rain shower better than a fresh cut hay field). No matter how precise we want to be, we will never be able to quantify the uncontrollable variables involved in the hay business. What we can do, however, is customize our fleet to be ready to adapt to the changes involved.
- “The stirring or fluffing of forage typically reduces field-curing time by up to half a day... the average field curing time is reduced up to 2 days compared to drying a narrow swath.” (Rotz, Pg. 4)



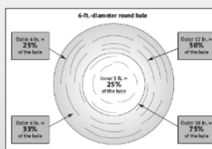
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## Storage Losses

### Associated Costs

- Storage techniques and bale density can drastically reduce storage losses, keeping money in your pocket. Softer bales are more permeable to water meaning there is a higher chance of damage due to rain water penetration. Take your percent loss multiplied by your bale cost, then spread that across your total number bales and the dollars wasted add up quickly.



6-ft. diameter round bale

- Top 1/2 in. = 25% of the bale
- Inner 1/2 in. = 25% of the bale
- Outer 1/2 in. = 33% of the bale
- Center 1/2 in. = 16% of the bale
- Center 1/2 in. = 25% of the bale

Source: Haag, E. Baling Strategy Cuts Losses. Angus Journal October 2007, pg 282-285.

Bale Diameter	Outer Layer Depth			
	2 in	4 in	6 in	8 in
4 ft	16%	31%	44%	56%
5 ft	13%	25%	36%	46%
6 ft	11%	21%	31%	40%
7 ft	9%	18%	27%	34%
8 ft	8%	16%	23%	31%

Source: Hundtloff, E. B. 1965 Cornell Univ. Agric. Engineering Ext. Bull. 364, Ithaca, NY.

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## Chapter 2: To Manage, You Must Measure

### Technology: It's place in the Hay Field



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## Hay Harvesting Technology

### Taking efficiency to the next step

- Does auto-guidance have a place in the hay field?
  - Mowing, fertilizing, aerating – minimize overlap, fewer passes in the field = less time and money on the task
- Data
  - On-board moisture sensing – real time data to make harvest decisions
  - On-board scales can be installed onto loaders to sell by the ton, straight out of the field
- Applicator systems
  - Constant or variable rate with auto shut-off

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## Hay Harvesting Technology

Taking efficiency to the next step



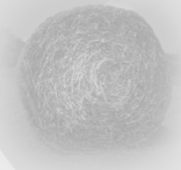
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 Round Baler Automation – When equipped:
  - Baler tells tractor to stop when desired bale size reached
    - Tractor stops with no operator interaction
  - Auto net-wrap (just like with traditional baling)
  - Baler tells tractor to open tailgate
    - Tailgate raises
    - When bale exits ramp, baler tells tractor to close tailgate
  - Operator shuttles into forward, tractor returns to pre-set speed




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## Hay Harvesting Technology

Benefits




- Make most out of the day
  - Get the most acres covered in a day
- Less fatigue
- Make the right decisions
  - Density
  - Storage
  - Handling



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## Chapter 3: Wrapping it Up

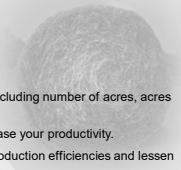
Summary: How Your Decisions on the First Day can Affect Your Value on the Last




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## Day One to Day Fed

Impacts of Efficiency

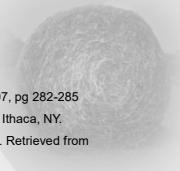


- Haying equipment needs to be properly sized for your operation, including number of acres, acres per field, and transport considerations
- Properly matched equipment in your hay making system can increase your productivity.
- Agricultural equipment technology for hay growers can increase production efficiencies and lessen operator fatigue.




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AGRICULTURE  
RETHINK PRODUCTIVITY

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