Estimating the Value of Ontario's Forage Industry

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Summary:
The forage industry is a key sub-sector of the primary production industry in Canada. Forage provides feed to many animals, is used as pasture, and can be part of a crop rotation system. Increasingly, forage will be in demand as part of the bio-fuel phenomenon. Yet, the value of forage is difficult to define within the conceptual notion of quantity multiplied by price. Due to the fact that little of the forage produced in Ontario enters the market, the value of the industry cannot be measured by usual economic measurements (price sold in the market). Thus, a forage study was carried out in an attempt to calculate the monetary value of forage in Ontario.

A voluntary online survey was conducted that asked farmers to input their forage production data for the year 2007. The survey asked specific questions related to the production of forage, price, storage, and cost. The final number of pertinent records was 612.

The value of all forages (grasses and legumes) in Ontario during 2007, for agriculture purposes was estimated at $746M, making it the second largest crop produced in Ontario next to corn.

The Problem:
Forage is defined here as grasses and legumes; harvested dry, wet, or as pasture. Ontario produced approximately 4,563,000 tonnes of tame hay in 2005 (Agriculture and Agri-food Canada, Table 1, 2007). It should be noted that although price and quantity are reported by AAFC for hay production, the value of hay is not reported. The total economic value of hay production is difficult to measure because price can vary widely, and hay sales represent only a fraction of total production. The remainder of forage is home-fed and difficult to value. Pastures should not be ignored because studies have found that it has economic value. In a recent study on the price of grazing permits in the U.S.:

> "The fact that permits have market value proves that the fee is less than the value of the forage. The permit's value represents the capitalized value of expected future difference between the fee and the value of the forage." (Torell et al, 2006).[1]

The goal of this study, therefore, is to put a monetary value on the entire forage production in Ontario.

Objective:
The main objectives of the study were to collect and analyze data pertaining to the following:

1. Quantity, yield, and price of forage production by type.
2. Storage method by quantity (silage, dry hay or pastured).
3. Value of forage sold off-farm within province, outside province, and outside Canada.
4. Value of forage purchased.
5. Value of the seed, fertilizer, herbicides, plastic and twine, and inoculants used in the production of forage crop.

Literature Review:
According to Statistics Canada (2006), there are 1,862,387 acres of pasture including both tamed and natural land, and 2,500,000 acres of tame hay in Ontario.[2] With an average yield of 2.70 tonnes per acre, the quantity of the Ontario forage production is relatively straightforward to calculate. The price per unit of forage is, however, difficult to determine. The majority of Canada's forage production is used on-farm, while off-farm sales represent only 10-15% of the total production (Agriculture and Agri-food Canada, 2007).[3] The price of forage represented by this marginal market overstates the price when if all forage crops were traded in the market.

Quality of forage also determines the unit value of forage. "Forage quality is defined as the sum total of the plant constituents that influence an animal's use of the feed…factors affecting quality are maturity, species, harvest and storage methods" (Cherney & Hall).[4] Nutritional values are reflected by the quality and these values may be used to determine the forage price. "Three key nutritional value indicators of forage are energy, protein and fibre". (Agriculture and Agri-food Canada, 2007)

Indirect economic benefits of forage are very difficult to measure, and are beyond the scope of this study. Forage and pasture crops are used in rotation for the conservation of soil and can be valued for carbon sequestering. For example, Bouton (2006) estimated that the amount of nitrogen fixed by growing a legume-grass mixture (at a current nitrogen price of $0.88/kg) would potentially result in a savings of US$98 per hectare per year in fertilizer costs.[5]

There are several methods to put a price on forage inventory despite the difficulties.

Component Approach
Value of forage can be estimated by a comparison of nutrient contents found in substitute feeds and then valuing the components found in forage. When forage and a crop of a known value substitute perfectly, then value for forage can be derived by:

$V = P * (ME_F / ME)$ where V = dollar value/ kg for forage, P = dollar value/kg for its substitute, ME_F and ME = energy concentration in forage and alternative feed ($MJ\ kg^{-1}$ DM) (Doyle & Elliot, 1983).[6] However, this formula ignores inherent attributes of forage that make it intrinsically less valuable than grain, such as handling and storage costs and it is naïve to assume perfect substitution between the two. A similar approach

was applied by Fisher et al (1999) who estimated the value of pearl millet and grain sorghum grains.[7] In their study, the evaluation was based on the content of net energy of lactation (NE_L), crude protein (CP), and phosphorus (P). The best equation was derived by performing regression analysis on these three nutrient contents.
Price = -49.83 + 53.12 * NE_L + 0.46 * CP +216.05 * P

Peterson's Equations are widely recognized and used to calculate the value of other feeds based on their protein and energy contents in comparison to the nutritive value and cost of corn and soybean meal. Rodenburg (1997) evaluated feedstuffs with Peterson's Equations using grain corn as the standard energy feed and soybean meal as the standard protein feed.[8] Using similar ideas, Stevens and Garret (1994), applied simultaneous equations as a method by using cracked corn, 48% soybean meal, limestone, and dicalcium phosphate to calculate the unit value of net energy of lactation, crude protein, calcium, and phosphorus.[9] By imputing these values on the nutrient content of a forage crop such as alfalfa, its unit value can then be calculated.

Substitute Approach

It is also recognized that the forage and its substitute feeds share similar inputs. Thus, to obtain an extra unit of forage, a certain amount of capital, such as a piece of land, must be used. Certain potential benefits of growing other feeds from the same capital will be lost. This is commonly referred to as opportunity cost. The opportunity cost of the extra unit of forage varies depending on the amounts of other products using the same inputs. This relationship makes the development of iso-cost map possible.

Development of an iso-cost map (Lin, 2003) is appropriate to determine the relationship between forage and its substitute.[10] An iso-cost map shows the combination of forage and its substitute at a given cost. Such maps reflect whatever degree of competitiveness may exist in the production of forage and one of its substitutes. Once the cost relationship is mapped between forage and its substitute, the marginal cost of forage can be determined by knowing the marginal cost of its substitute. In a price taker industry, such as agriculture, marginal value is equal to marginal cost in the long term. The marginal value of forage may be determined this way. The iso-cost method was first suggested to be used on forage by Lowell Hardin and Glenn Johnson (1955).[11]

Contribution Approach

Forage can be seen as an intermediate product that adds value to the livestock. It will be making contribution to the value of the livestock over the years regardless of the way forage is transferred in the market (i.e., sold, purchased, or used on farm). A procedure called 'residual imputation' can be used to determine the value of an intermediate good (Houk et al, 2007).[12] The total value product is calculated; in this case, it is the revenue from the livestock sales including beef, dairy, etc. The accounting costs of all inputs, except feed cost of using forage, are subtracted from the revenue. The residual, what is left, is the value attributed to the amount of forage production used in that year. This method was first mentioned by Nelson et al (1957) to be used on forage.[13] This method has also been used to evaluate grass:

"Grass is not a traded commodity and its value as a feed has to be imputed from its contribution to livestock production. Since the value placed on grass is estimated from the residual profits after the deduction of all other costs…" (Doyle & Elliott, 1983)

Pricing Approach

The market price of hay is the marginal value of the small percentage of forage traded on the market, as opposed to the average value of forage including inventory. This framework had been developed by Lowell Hardin and Glenn Johnson (1955) to best estimate the value of forage:

1. Not less than the highest net price realizable through off-farm disposal or salvage value. Some examples of off-farm disposal are cash receipts from renting pasture out and cash receipts from the sale of hay.
2. Not more than the cost of acquiring, by the most economical means available, the same quantity and type of feed units or their equivalents. Some examples of acquisition include off-farm acquisition price, on farm acquisition cost, cost of emergency crops, and opportunity cost to convert lands to pasture.

The marginal value can be either of the two values discussed above depending on the individual farm. If a farmer values his forage above the cost of acquiring, he would acquire more until the marginal value equals the cost. If a farmer values his forage below the salvage value, he would dispose more of his forage until the marginal sale equals the salvage value. The marginal value of forage can also fall between the limits of the first and second situations above and can be approximated by individual farmer assessment.

Each approach to value has its advantages and disadvantages. The component approach is easy to compute but other intrinsic characteristics affect the outcome. The substitute approach is easy to compute, but is subject to imperfect substitution. The contribution approach is very difficult to calculate due to the complexity of cost-of-production. The pricing approach assumes the marginal value is between the salvage value and acquisition cost. Thus it is less reliable, but easy to obtain from farms.

Methodology:

Data collection for this study was conducted through a survey of farmers using the website SelectSurvey.NET, a web-based tool for creating and deploying online surveys. Thanks are due to the DFO, OCA, OSA, OSCIA, OFA, and OFC[1] for facilitating the conveyance of the surveys. The survey (Appendix 1) asked farmers to voluntarily input data regarding their use of forage in the year 2007. Data was collected through a link to the survey website distributed through producer association email lists. Producers were asked a total of 18 questions which can be broadly categorized into identification questions, livestock questions, forage information questions, and storage and cost

[1] Dairy Farmers of Ontario, Ontario Cattlemen's Association, Ontario Sheep Association, Ontario Soil & Crop Improvement Association, Ontario Farmer's Association and the Ontario Forage Council.

questions. Records came from every region and farm sector that uses forage in Ontario. The initial survey produced a response of 1218 records, including records that were blank and incomplete. Records left blank after answering only the first four questions were removed. The final number of pertinent records amounted to a total of 612.

Component Approach
The component approach is based on a comparison of close substitute crops that provide similar nutrients to forage. Nutrient contents of substitutes including corn, corn silage, oats, oatlage, barley, barlage, soybean meal, brewer grain, and distiller grain were obtained from the feed testing laboratory of Agribrands Purina Canada Inc. for 2006. As well, nutrient contents for forages including alfalfa hay, grass hay, alfalfa-grass hay, alfalfa haylage, grass haylage and mixed haylage were similarly acquired (Figure 2). Regression analysis was used to develop a modelling equation that provided a 'good fit' for a component pricing equation. In this fashion a value for forages is estimated.

Contribution and Substitution Approaches
The contribution approach was not applied to the survey in the context of residual value, however it needs to be recognized that forages have an intrinsic contribution to the farming operation that is difficult to ascertain. Some of this intrinsic value is seen in the difficulties experienced in the component approach, as we tried to find a regression equation that provided a statistical fit with value. A very high R-squared value can be easily found to value a grain to other grains ($R^2 = .98$), however not so to value a forage to other grains ($R^2 = .85$). This is because forage has intrinsic properties such as being valuable in crop rotations; is bulky and does not transport long distances well; is of different quality and variety (not homogeneous); and is difficult to store. Pasture has its own intrinsic attributes as it does not store (use it or lose it). Thus for many surveyed, the value of pasture is attributable to the replacement or opportunity value of stored forages for the pasture season; i.e. a substitution approach.

Pricing Approach
The survey used the pricing approach by directly asking farmers how they would value their forages. Included in the survey were questions to determine the value of forage depending on its quality, as well as the average quantity of forage purchased and sold; and at what price. Data collected included the price of forage sales, purchases, and inventory; all dependant on quality.

Data Analysis
The equation to estimate the overall value of forage in Ontario is essentially: quantity × price = value. In order to arrive at a final value, several methods could be used to aggregate the data, including: extrapolating from the entire data set to the province, extrapolating by each of the identified industries (beef cattle, dairy cow, equine, sheep, and cash crop), or extrapolating by agricultural region. Only the first aggregating method was used as aggregating by industry and/or by region would require a very large sample.

Random Sample
A random sample is defined as one chosen by a method involving an unpredictable component. Random sampling is important when conducting research because a random sample allows a known probability that each unit will be represented. In the case of random samples, mathematical theory is used to assess the sampling error, and determine how well the sample represents the rest of the population. Although sampling can be a valuable and informative method of gathering information, it is important to consider how representative the sample is of the general population in order to draw accurate conclusions. In order to determine how well the survey results reflected that of the general population, the regional data was correlated with census information for each industry and region, and compared to the total population to provide a percentage of the sample size.

R Squared
In statistics, the coefficient of determination (R squared) is the proportion of variability in a data set that is accounted for by a statistical model. An R squared of 1.0 (100%) indicates a perfect fit. In the case of linear regression, R^2 is the square of a correlation coefficient. The coefficient of determination is a statistic that will provide information about the goodness of fit of a model. In regression, the R^2 is a statistical measure of how well the regression line approximates the real data points.

Covariance
In probability theory and statistics, covariance is the measure of how much two variables change together. If two variables tend to have similar variances, then the covariance between the two will be positive. Similarly, if one variable tends to be above the expected value and one variable tends to be below, then the covariance is said to be negative.

Results:

Randomness

Surveying people makes randomness more difficult to achieve than say, having blue and red marbles in a jar. Challenges in identifying the target population, the availability of financial records, access to the whole group and non-responders makes randomness very difficult to obtain. In this survey we conducted a computer survey, launched it through producer associations, and asked some financial questions. Therefore, all our respondents were those who had computers, who were members of one of the producer associations, and who had financial records. The challenge is to assess how well the sample represents the farming industry in Ontario.

The survey did ask some identifier questions, i.e. region of Ontario and type of production. In Table 1 the top rows identify surveyed farms in each of the five regions of Ontario that had each type of livestock and land. Corresponding to this, the census data is identified as closely as possible. As can be seen the percent of the farming population included in the survey ranges from a low of 1.48% for beef cow/calf to a high of 9.50% for sheep.

Table 1: Sort by Region

	Beef Cow/Calf (total # of cows)	Beef Feedlot (total # of head)	Dairy (total # of cows)	Dairy heifers and calves	Sheep (total # of ewes)	Equine (total # of horses)	Cultivated Crop Land (total # of acres)	Native Pasture (total # of acres)
Eastern Ontario	53	20	90	125	23	38	159	113
Southern Ontario	35	24	70	88	31	41	148	88
Western Ontario	45	35	84	93	30	25	148	76
Central Ontario	12	6	17	21	10	12	37	26
Northern Ontario	19	7	10	19	3	11	32	21
Total of Farms with…	**164**	**92**	**271**	**346**	**97**	**127**	**524**	**324**

Census Data	combined beef cows and feedlot	combined dairy cows and heifers	Sheep	Equine
Eastern Ontario	2203	1373	174	627
Southern Ontario	1341	929	206	1093
Western Ontario	4535	1849	417	1455
Central Ontario	2221	615	188	949
Northern Ontario	752	171	36	173
Total of Farms with…	**11052**	**4937**	**1021**	**4297**

% Of Total Population Surveyed				
Eastern Ontario	2.41	6.55	13.22	6.06
Southern Ontario	2.61	7.53	15.05	3.75
Western Ontario	0.99	4.54	7.19	1.72
Central Ontario	0.54	2.76	5.32	1.26
Northern Ontario	2.53	5.85	8.33	6.36
Percent of Farms	**1.48**	**5.49**	**9.50**	**2.96**

How closely does this sample represent the distribution of farms in Ontario? Postal code data was used and sorted to segregate information into each corresponding agricultural region. Table 2 shows reasonable correlations of farms by farm type (bottom row) for beef, dairy and sheep. The correlation for equine is low at 0.34 showing that the equine industry was not well represented in the sample. The correlation of data by region (right hand column) is not as good. The distribution of producers by region in our sample is not as representative of the population as is the distribution of farmers by type.

Table 2: Correlation by Region and by Farm Type

	Beef + Feedlot	Dairy + Heifers	Sheep	Equine	Total	Correlation
Eastern Ontario	73	215	23	38	**349**	0.436
Southern Ontario	59	158	31	41	**289**	0.225
Western Ontario	80	177	30	25	**312**	0.256
Central Ontario	18	38	10	12	**78**	-0.026
Northern Ontario	26	29	3	11	**69**	0.592
	256	**617**	**97**	**127**	**1097**	0.226
Census Data						
Eastern Ontario	2203	1373	174	627	**4377**	
Southern Ontario	1341	929	206	1093	**3569**	
Western Ontario	4535	1849	417	1455	**8256**	
Central Ontario	2221	615	188	949	**3973**	
Northern Ontario	752	171	36	173	**1132**	
	11052	**4937**	**1021**	**4297**	21307	
Correlation	0.601	0.853	0.748	0.336	0.613	

Table 3: Number Analysis

1	Number of complete surveys	612	
2	Number of full-time farm responses	426	
	Number of part-time farm responses	149	
	Number of hobby farm responses	37	
3	Number of beef farms ....and then number of farms reporting beef stockers	167	93
	Number of dairy farms	276	
	Number of sheep farms	99	
	Number of horse farms	130	
	Number of farms with crops only	31	
	Number of farms with no crops	85	
4	Number of conventional farms	519	
	Number of organic farms	32	
	Number of transitioning farms	28	
	Number of other definition farms	33	

Table 3 presents some of the collected data from survey respondents. In total 612 complete surveys were collected. Full-time conventional farms dominate the survey data, with dairy being the prevalent farm type.

The 'big picture' is seen in Table 4, which summarizes three different values for the forage industry in Ontario.

- First the census reports total corn and forage acreage for 2006. If an estimated price of $500 per acre of corn and $200 is used for forage then a ball-park census estimate of these two industries for Ontario is about $949.3M and $512.5M respectively.
- Within the survey, producers reported $19.1M of pasture. Sales outstripped purchases at $168.7M versus $75.0M but sales included forage destined for U.S. and out-of-province sales. Total forage production at reported prices totaled

$1,240.1M which overstates the value because farmers tend to report inventory price to reflect sale price.

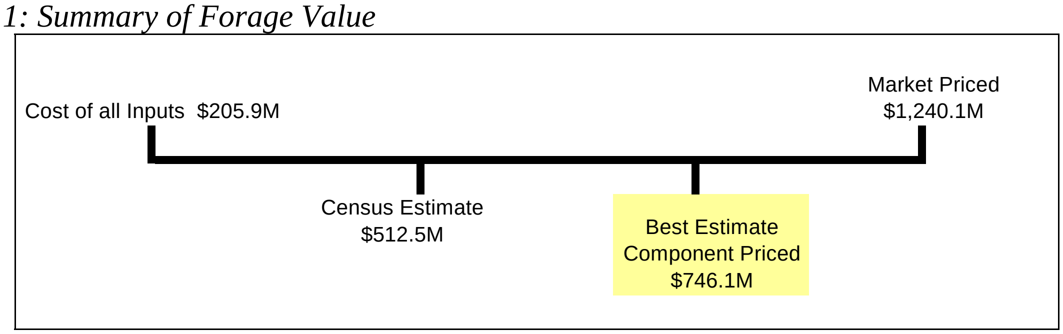
- The last column in Table 4 uses an imputed price for dry and silage forages. This is the best estimate for the total value of forage in Ontario, at $746.1M in 2007.
- And then for reference, the cost of all inputes identified was $205.9M.

Table 4: The Big Picture

			Estimate at survey value	Fisher's imputed value
Census 2006				
All Corn imputed @$500 per acre	949,310,500			
All forage imputed @ $200 per acre	512,527,400		$1,240,133,603	$746,096,032
Fisher				
Pasture $value			$19,052,067	$19,052,067
Dry Grass and Legume				
All Purchases	$1,579	per farm x 47537	$75,041,655	$75,041,655
All Sales	$3,548	per farm x 47537	$168,654,107	$168,654,107
Ontario Sales			$106,446,544	$106,446,544
Silages				
All Purchases	$102.57	per farm x 47537	$4,875,921	$4,875,921
All Sales	$50.99	per farm x 47537	$2,423,727	$2,423,727
Dry Hay Production	5,688	per farm x 47537	$270,396,981	68,028,843
Legume Hay Production	9,480	per farm x 47537	$450,664,368	113,478,806
Silage Hay Production	1,724	per farm x 47537	$81,970,721	83,685,028
Silage Legume Production	8,794	per farm x 47537	$418,049,466	357,766,282
Total Expenditure on Inputs	4,332	per farm x 47537	205,940,087	

Figure 1 summarizes the range of values identified. At one end of the range the value at cost stands at $205.9 million; the Ag Canada census value is $512.5 million; and on the extreme there is the value at market price identified from our survey at $1.2401 billion. The best estimate from this research imputes a price for hay and silage inventory, and estimates a value of $746.1M.

Figure 1: Summary of Forage Value



Imputing Price

Figure 2 is a regression analysis of known grain prices on unknown forage prices. The figure has five areas. In the upper left corner, forages are identified with their known component analysis for calcium, crude protein, net energy, phosphorus, and total digestible nutrients. Also, DHI (Dairy Herd Improvement[2]) price is identified. Beneath forages is a corresponding component analysis for known grains including barley, corn, oats, wheat, corn silage and mixed grain. The grain DHI price is identified.

Two regression analyses are calculated in Figure 1. Analysis #1 is a regression of nutritional components within the grains onto DHI price for grains. The R^2 is 0.86 which is a very good fit, and so when nutritional component coefficients are used to recalculate an estimated price, grain prices range from $138 to $132 for barley to mixed grain respectively. In a similar fashion, Regression #2 is a regression of forage nutritional components onto DHI forage prices and the R^2 is 0.87; also showing a good fit for market value. Using these component coefficients to recalculate forage DHI price the range is from $74 to $89 for hay-grass to hay-mixed respectively. This regression is merely demonstrating that the DHI prices identified for grains and for forages independently are relatively well suited when traded into the market. The survey data reported prices of $103.34 per tonne for grass hay and $139 per tonne for alfalfa hay; and $46.04 for grass silage and $54.92 for alfalfa silage per tonne. Our survey was overpriced on dry forage and under the DHI prices for silages.

Figure 2: Regression Analysis Showing Estimate of Imputed Forage Prices

Avg As Is	Ca	CP	Neg-Mcal/k	P	TDN	Per tonne DHI - 2007 Market Price	Forage Components Estimated Price	If this were grain, then Grain Components Estimated Price	If this were forage then grain component Estimated price
Hay - Grass	0.61	10.31	1.15	0.2	51.6	**75**	**74**	213	26
Hay - Legume	1.19	15.62	1.16	0.22	51.74	**100**	**97**	275	35
Haylage -- Grass	0.4	7.38	0.69	0.15	30.41	**75**	**73**	111	49
Haylage -- Legume	0.68	9.42	0.66	0.15	29.47	**85**	**83**	156	45
Haylage -- Mixed	0.6	8.87	0.66	0.15	29.59	**80**	**85**	150	45
Haylage -- Small Grain	0.28	5.47	0.54	0.12	25.71	**85**	**84**	146	49
Hay-Mixed	0.89	12.9	1.15	0.21	51.65	**85**	**89**	249	30
Whole Barley	0	10.99	1.65	0	71.5	122	**138**		
Whole Corn/Corn Grain	0.01	7.34	1.74	0.23	75.28	131	**122**		
Whole Oats	0	11.54	1.53	0	66.83	161	**146**		
Whole Wheat	0.04	11.03	1.71	0.3	74.9	140	**148**		
Corn Silage	0.09	3.07	0.64	0.08	28.19	72	**73**		
Mixed Grain	0.22	19.54	1.7	0.36	73.48	133	**132**		

Regression Output: #1 GRAINS components to DHI price

Constant	0
Std Err of Y Est	25.19471
R Squared	0.856565
No. of Observations	6
Degrees of Freedom	1

	Ca	CP	Neg-Mcal/k	P	TDN
X Coefficient(s)	124.841	0.002	-1357.341	-88.744	33.254
Std Err of Coef.	267.697	4.512	1185.720	114.172	27.171

Regression Output: #2 FORAGES components to DHI price

Constant	0
Std Err of Y Est	5.295677
R Squared	0.871273
No. of Observations	7
Degrees of Freedom	2

	Ca	CP	Neg-Mcal/k	P	TDN
X Coefficient(s)	-68.684	9.511	-714.981	901.551	12.784
Std Err of Coef.	265.186	33.002	172.608	871.162	3.807

[2] Dairy Herd Improvement is an Ontario Canada recording service for dairy cows. Included in their services is an annual survey of Ontario feed prices at market value.

Because grain markets are well established and reflect the value of nutritional components, it would be desirable to use grains to value forages. If the component coefficients for grains are used to value forage then a new set of values is $213 for hay-grass to $249 for hay-mixed, respectively. These are the values of forage if the components found in forage were 'packaged' as a grain. It is reasonable to use the grains component coefficients because these are related to grain prices which have been tested in the marketplace. These new estimated forage values are overstated because the intrinsic characteristics of forages will not allow for the marketplace to trade and handle forages similar to grains. By taking a reciprocal ratio of this new value to the DHI forage price, a new set of values is discovered; hay-grass at $26 to hay-mixed at $30, respectively. This forage imputed price is the value of components as found in grains, now 'packaged' as forage. The imputed prices used in Table 4 are dry grass hay at $26 per tonne, dry legume hay at $35 per tonne and silages at $47 per tonne (all as fed).

The Results in Detail

Survey results were further detailed showing an average production of all Ontario farms of 33.5 acres of grass hay production, 39.0 acres of legume hay, 9.6 acres of hay silage and 32.4 acres of legume silage production (Table 5). Yields ranged from 1.64 tonnes per acre for grass hay to 4.95 tonnes per acre for legume silage, respectively (all as fed). The average survey price per tonne of grass hay is $103.34 and that for legume hay was $139.00; both reflecting a bias towards farmers favoring market price for hay inventory. The imputed prices of hay based on components are $26 and $35 per tonne respectively. Dry forage sales are marginal at best, but in this survey represented 23.7 percent of production, which is thought to be fairly high. Dry forage inventory cannot be valued by the market place, and if so will overstate the value by about four times. Interestingly, silage value estimates by respondents were closely related to the imputed component values calculated, (suggesting DHI silage prices were overstated).

Table 5: Detailed Survey Results

	Dry hay production	Dry legume production	Silage hay production	Silage legume production
Total acres reported	20,510	23,894	5,896	19,800
Count of farms reporting	339	339	57	190
Total farms	612	612	612	612
Avg acres per reporting farm	60.5	70.5	103.4	104.2
Avg acres per 612 farms	33.5	39.0	9.6	32.4
Avg tonnes harvested per acre	1.64	1.75	3.89	4.95
Avg survey price per tonne	$ 103.34	$ 139.00	$ 46.04	$ 54.92
Imputed price from analysis	$ 26.00	$ 35.00	$ 47.00	$ 47.00
QUALITY	% Poor	% Good	% Premium	
Produced	7.73	50.54	41.73	
Purchased	15.57	61.74	22.69	
Sold	7.00	59.24	33.76	
GRASS HAY PRICES (survey)	$ Poor	$ Good	$ Premium	
Square	2.32	2.62	3.42	
Large	26.23	28.49	40.81	
Tonne	60.00	57.59	131.38	
LEGUME HAY PRICES (survey)	$ Poor	$ Good	$ Premium	
Square	2.00	3.24	5.52	
Large	21.56	36.93	38.14	
Tonne	nd	56.86	108.47	

The quality of forage was report as only 8% poor, 50% good and 42% premium. Price varied according to quality and harvesting method. A better price is generally offered for square bales versus large bales and then again for tonnage, when price is adjusted for weight. A better price is offered for quality although the data is inconsistent ranging from a mere 3% to 128%. Silage prices were not summarized due to low number of records.

Forage purchases and sales were recorded in the survey. Of the total forage produced, about 23.7% was sold. Very little silage was traded. Most farms traded dry hay in large bales at 56%, while square bales made up 40% of the market by weight. Forage seldom sells by tonne nor by the acre. The U.S. played a relatively large marketing role for hay sales in 2007 at 35% and Ontario sales accounted for 62%.

Table 6: Summary of Purchase and Sale Results – 612 records

	Silages	Dry Grass and Legume
Value Purchased	$62,774	$966,100
Price per Square Bale (50 lbs)	--	$2.81
Price per Large Bale (700 lbs)	--	$31.79
Price per Tonne	$53	$53.14
Price per Acre	$104	$82.58
Quantity of Square Bale (50 lbs)	--	105,164
Quantity of Large Bale (700 lbs)	--	18,363
Quantity of Tonne	361	529
Quantity of Acre	420	706
Number of records	612	612
no.of farms recording Sq. Bales	--	62
no.of farms recording Lg Bales	--	148
no.of farms recording Tonnes	5	8
no.of farms recording Acres	9	7
Value Sold	$31,204	$2,171,284
Price per Square Bale (50 lbs)	--	$3.24
Price per Large Bale (700 lbs)	--	$34.90
Price per Tonne	$35	$38.90
Price per Acre	$63	$160.00
Quantity of Square Bale (50 lbs)	--	313,285
Quantity of Large Bale (700 lbs)	--	31,367
Quantity of Tonne	535	724
Quantity of Acre	202	60
Number of records	612	612
no.of farms recording Sq. Bales	--	85
no.of farms recording Lg Bales	--	129
no.of farms recording Tonnes	8	8
no.of farms recording Acres	--	1
Value Sold to Ontario	30,004	1,339,209
Value Sold to Canada	1,200	62,605
Value Sold to USA	-	769,470
Value Sold to International	-	-

The average and sum of total costs were calculated for fertilizer, herbicides and pesticides, inoculants and desiccants, plastics and twine, and seed (Table 7). Overall, fertilizer dominated costs, with an average cost of $2,297 per farm. The least money was spent on herbicides and pesticides, with an average cost of $234 per farm. Total costs of forage production were reported at $5,002 per farm, and $37.82 per reported acre.

Table 7: Summary of Input Cost Results

	Fertilizer	Pesticides	Desicants	Plastics and Twine	Seed	Line Average	Line Totals
Number of Records	530	530	530	530	530	530	
Average Acres New Seeding						26.38	
Total per Cost	$1,217,588	$123,827	$165,214	$476,423	$668,259		$2,651,310
Total Acres of Forage						132.26	70,099
Average per Farm (recorded)	$2,297	$234	$312	$899	$1,261		$5,002
Average per Farm (total surveys)	$1,990	$202	$270	$778	$1,092		$4,332
Average per Acre (recorded)	$17.37	$1.77	$2.36	$6.80	$9.53		$37.82
Average per Acre (total surveys)	$15.04	$1.53	$2.04	$5.89	$8.26		$32.75

Table 8: Summary of Storage Results

	Dry Hay stored in a Barn	Dry Hay stored under a tarp	Dry Hay exposed	Silage stored in a Bunker Silo	Silage stored in an Upright Silo	Silage Individually Wrapped	Silage Tube Wrapped, whole bale	Silage Tube Wrapped, chopped
Number of Records	527	527	527	284	284	284	284	284
Percent	80.4%	9.0%	10.7%	22.2%	42.1%	9.2%	20.2%	6.2%

Storage methods for dry hay and silage were summarized for the survey results. As indicated by the table above, the majority of dry hay was stored in a barn, and upright silo was the leading storage method for silage.

Pasture was valued by asking the feed value provided per animal unit (Table 9). The equine industry valued their pastures at the highest value and sheep was the lowest, reflecting stocking rates. Pasture was valued for the industry by taking the average for all records, and extrapolating that to the number of animals in the Ontario census. The total value per industry was highest for the dairy industry, and lowest for the sheep industry, reflecting census population.

Table 9: Pasture Values per Animal Unit

	Beef Cow/Calf	Feeder Cattle	Dairy Cow	Dairy Heifer	Sheep	Equine
Average Feed Value per reporting farm	$142.72	$89.13	$103.82	$96.97	$52.73	$173.11
Average Feed Value per total Farms	$25.19	$3.20	$11.03	$14.26	$4.65	$16.97
Value of Pasture per industry	$9,318,601	$1,243,153	$3,583,683	$2,481,334	$774,233	$1,651,063

Statistical Significance

The farm population in Ontario that would include forage production is 47,537 farms. The survey included 612 complete records or 1.29% sample size. The confidence interval at a 95% level is ±3.94 percent. The data summarized for this study are reasonably dependable, including quantities of forage produced. The survey price for forages is also reasonably dependable statistically, remembering that this is reflective of the market price farmers wish to sell forage at. The imputed price assigned to forage is not data and so is not statistically significant, although the model used to derive these values had fairly high R^2 values. Thus the final estimate of forage value in Ontario is reasonably dependable although statistically indifferent.

Conclusion and Discussion:
The objective of the study was to estimate the value of forage production in Ontario for 2007. The fact that relatively little forage is traded makes it difficult to assess value. A higher than expected percentage of the industry was traded, and being statistically significant, is acceptable although a little surprising.

The range of values was from $206M at operating cost to $512M Canadian Census guestimate, to the outer range at $1,240M. When forage is valued at the high range reflecting market price, the profitability outstrips even the most lucrative of agriculture activities. As in this case, at a market price for legume hay, per acre revenues would be $243 ($139 * 1.75) with operating costs of $37, for a net of $206 per acre. No other field crop will better this under normal circumstances (OMAFRA crop budgets), adding evidence that forage inventory destined for homegrown feed is often over valued by farmers.

Pasture represented 2% of forage production, dry forage 62% and silage 36% on an acreage basis. Dry hay constitutes the largest portion of the forage industry. The cost of plastics is the second highest operating cost next to fertilizer.

Our best estimate of the value of the forage industry is $746.1M, based on imputed prices based on nutrient components. This estimate puts forage as the second largest field crop in Ontario; being about 2/3rds the size of the corn industry and about 30% larger than the soybean industry in 2007.

Table 1 Grain Prices and Source (To be determined)

Grain	Grain Price	Location
Corn		
Oats		
Barley		
Soybean Meal GM 48%		
Brewer grain (depends on the grain itself)		
Distiller grain		

Table 2 Nutrient Contents of Feeds (To be obtained from Agribands Purina)

Table 3 Sample Size Calculated for Each of the Sector in Ontario Agriculture

Type of farm	Number of farms	Confidence interval %	Sample size needed
Dairy cattle	4937	4	535
Beef cattle	11052	4	569
Hog and pig farming	2222	4	473
Poultry farming	1700	4	444
Sheep and goat	1365	4	417
Horse and other equine	4297	4	527
Hay farming	5917	4	545
Miscellaneous	15235	4	578

Appendix 1 Forage Survey

Farm Information

1. Please indicate all categories your farm produces.
   Select at least 1 response and no more than 6 responses.

   - ☐ Beef Cow/calf
   - ☐ Beef Feedlot
   - ☐ Dairy
   - ☐ Sheep
   - ☐ Equine
   - ☐ Cash Crop
   - ☐ Other, please specify

2. What type of farmer are you?

   - ○ Part Time
   - ○ Full Time
   - ○ Hobby Farm

3. Are you a Conventional, Organic, or Transitioning farmer?

   - ○ Conventional
   - ○ Organic
   - ○ Transition
   - ○ Other, please specify

4. Please enter the area code (first three numbers) of your ten digit phone number (ex 613, 519, etc).

Area Code

Area Code	

Forage Survey

Forage Information

5. Please indicate the quality of forage used on your farm.
The quality as expressed in nutrition value is a strong indicator of overall forage value.

	Poor	**Good**	**Premium**
Forage Harvested (Please estimate the average quality)			
Forage Purchased			
Forage Sold			

6. Please fill in the table using your forage crop data for 2007.

	Total Acres	**Indicate Harvest Unit Sq=Square-Bales Rd=Round-Bales T=tonnes A= acres**	**Total Harvest Units (number)**	**Estimate the Value ($) Per Unit**
Grass dry Hay				
Grass silage				
Legume dry				
Legume silage				
Native pasture				
Tame pasture				

7. Please fill in the approximate number of pasture acres used for each type of animal you farm.

	Native Pasture (acres)	Tame Pasture (acres)	Estimate how many animals you had grazing on the pasture during 2007	How many days did you use the pastures during the 2007 season	Estimate a $ feed value per day per animal for your pasture
Sheep					
Beef Cow					
Dairy Cow					
Dairy Heifers					
Calf					
Equine					

Financial Information

8. Please fill out the table with your purchased and sold forage crop data from 2007.

	Unit Sq=Square-Bales Rd=Round-Bails T=tonnes A=acres	Record total quantity PURCHASED during 2007	Record total $ value PURCHASED during 2007	Record total quantity SOLD during 2007	Record total $ value SOLD during 2007	Forage Sold to O=Ontario C=Canada US=USA I=International
Legume Dry Hay						
Legume Silage						
Grass Dry Hay						

Grass silage						

9. How would you value your forage in comparison with cost of production?

- ☐ Below cost of production
- ☐ Equal cost of production
- ☐ Above cost of production

10. What would you value your forage as a percentage of market value?
(for example: a value of $80 would be 80% of a $100 market value)

- ☐ 40%
- ☐ 60%
- ☐ 80%
- ☐ 100%

Storage and Cost

11. How was your dry hay stored in the year 2007?

- ☐ Stored in a barn
- ☐ Stored under a tarp
- ☐ Exposed, not under cover

12. How was your silage stored in the year 2007?

- ☐ Silo
- ☐ Wrapped

- ☐ Tube, baleage
- ☐ Tube, chopped

13. Record the total cost of fertilizer used on your forage during 2007.

14. Record the total cost of herbicides & pesticides used on your forage during 2007.

15. Record the total cost of inoculants used on your forage during 2007.

16. Record the total cost of plastics & twine used on your forage during 2007.

17. Record the total cost of forage-seed used during 2007.

18. How many acres did you seed to forage during 2007?

Appendix 2 Tame Hay Information

Table 001-0010[1]
Estimated areas, yield, production and average farm price of principal field crops, in metric units, annual

Survey or program details:
Field Crop Reporting Series - **3401**

Geography=Ontario

Harvest disposition	Seeded area (hectares)		Harvested area (hectares)		Production (tonnes)	
Type of crop	**Tame hay**[3,9,28]	**Fodder corn**[3,28,30]	**Tame hay**[3,9,28]	**Fodder corn**[3,28,30]	**Tame hay**[3,9,28]	**Fodder corn**[3,28,30]
2004	1,025,900	125,500	995,500	121,400	5,261,700	4,354,500
2005	1,031,900	117,400	1,001,600	115,300	5,057,600	4,322,700
2006	1,042,000	129,800	1,011,700	127,500	6,032,800	4,898,800

Source: Statistics Canada

Footnotes:

1.
Average farm price was discontinued in 1984.
3.
Data begin in 1908.
9.
Data for British Columbia begin in 1910.
28.
For imperial data see CANSIM table 001-0018.
30.
Data for Prince Edward Island, Nova Scotia and New Brunswick were discontinued in 1941 and re-activated in 1975. Data for Prince Edward Island and New Brunswick were discontinued again in 1987 and data for New Brunswick were re-reactivated in 1991. Data were discontinued in 1972 for Saskatchewan and in 1953 for Alberta. Data for the Prairie Provinces and British Columbia begin in 1910. Data for Canada do not include production data for the Maritime Provinces in 1975.

Endnotes

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